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COGNITIVE DIFFERENCES BETWEEN MONOLINGUAL AND BILINGUAL PRESCHOOLERS IN THEORY OF MIND AND EXECUTIVE FUNCTION

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Abstract

Research has suggested that bilingual children are more advanced than their monolingual peers in specific areas, including theory of mind and executive function. This study examines theory of mind, executive function and language skills of preschool-aged children who were placed into three groups: monolingual English speakers, monolingual Mandarin speakers and children who are proficient in each language. Data was obtained for 30 monolingual English speakers, 20 monolingual Mandarin speakers and 5 bilingual children. While previous research has suggested that there is a bilingual advantage, the current study did not yield results to support this claim. The English and Mandarin-speaking children achieved higher scores than their bilingual peers on various tasks, including those testing theory of mind, inhibition and working memory. There was also no clear association between theory of mind and executive function in the bilingual population, though this may be due to the small number of participants. Multiple suggestions for future studies are presented.

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Theory of Mind

In order to have a meaningful conversation with another person, one must be aware of and appreciate the thoughts, beliefs, desires and knowledge of others. This understanding of mental states is known as theory of mind (Miller, 2006). Similar to language, theory of mind develops over time, beginning with precursor skills that then grow into an understanding of how mental states and behavior are connected. In typical development, children have many of the necessary skills to lay the groundwork for a theory of mind by preschool. Between the ages of three and five, children begin to understand that our minds are constantly constructing representations of reality while their ability to understand another person's perspective is increasing (Miller, 2006).

As early as infancy, social-communicative behaviors, such as examples of joint attention, play, and imitation surface. These behaviors are said to be concurrently and longitudinally associated with language ability, though there is less evidence to prove that these behaviors are related to the development of theory of mind in later years (Charman, Baron-Cohen, Swettenham, Baird, Cox & Drew, 2000). Children with autism spectrum disorders (ASD) provide indirect evidence that there is an association between the early-emerging abilities mentioned and theory of mind because autism is characterized by both impairments in the development of all three precursors listed as well as theory of mind ability (Charman, et al., 2000).

Some abilities believed to be precursors of theory of mind include joint attention, appreciation of intentionality, recognition that different people have different perspectives, use of mental state words, and pretend play (Miller, 2006). The earliest developing precursor is joint attention, or the ability of an infant to coordinate her attention with a social partner via an object

or event. Between the ages of 6-12 months, children develop the ability to share a focal point with a communication partner and may use gaze and point following or an alternation of gaze between person and object (Bruinsma, Koegel & Koegel, 2004). Other experimenters have stated that around this age, infants also begin to understand that others want them to pay attention to a certain aspect of an object or event. In a study done by Charman et al. (2000), joint attention measured at 20 months was the best longitudinal predictor of theory of mind ability in the fourth year of life.

In the preschool years, typically developing children begin to understand that different people may have different interpretations of objects or situations, depending on their perspectives. Miller (2006) uses the example of two people sitting at a table across from one another with a picture lying flat on the table between them to explain different perspectives by stating that the picture will appear right-side up to one person and upside-down to the other. Children also begin to understand that every person does not have the same beliefs or desires as they do. In one task that is frequently used in many variations to test a child's grasp on this concept, the experimenter creates a character, possibly by using a doll or a cardboard cutout (e.g. Bill). The experimenter then asks the child which activity he prefers himself: playing with sand on the playground or playing with puzzles in the classroom. The experimenter then tells the child that Bill prefers the opposing option and asks the child to predict Bill's action. If the child properly identifies the option that is not the one that he himself prefers, then he passes the diverse desires task (Wellman & Liu, 2004). Wellman and Liu (2004) use a similar task to test the child's ability to accept different beliefs. To do so, the experimenter presents a situation in which Bill is unaware of where he left his backpack. The child is then asked to identify where he believes the backpack is and he must correctly identify the opposite location to match Bill's

belief. Diverse beliefs are more difficult for children to understand, so this concept is presented after the task that tests the ability to recognize diverse desires. The basic understanding that perspectives, desires and beliefs can differ is crucial to successful communication.

Because a mature theory of mind involves recognizing the thoughts, beliefs and desires of another person, an understanding of mental state terms such as think, want and believe is important. Children begin to talk about mental states during the third year of life; however, at this stage of development, it is clear that they do not fully understand the mental state terms. The ability to consciously use these words the proper way progresses gradually and children are more likely to clearly refer to the thoughts, beliefs and feelings of themselves and others as time passes (Miller, 2006).

Language in Relation to Theory of Mind

In the first few years of life, the development of language and theory of mind are connected in complex ways. Although both language and theory of mind abilities are developing rapidly in the first five years of life, other areas are as well, so this is not enough information to prove that a relationship exists (Miller, 2006). Many researchers have hypothesized about the directionality of the relationship between the two. Some say that language affects theory of mind while others have found the opposite. De Villiers (2007) proposed that the relationship is bidirectional, meaning that language and theory of mind affect each other.

The term "triangulation" is used to describe the ability of a child to follow another person's gaze or point to another entity (de Villiers, 2007). This skill may also be referred to as joint attention, a precursor to theory of mind. The triangulation between a speaker, a listener and a third entity, or object, is crucial to language learning in children. For example, a mother picks up a toy that her child is focused on, and then she says, "doll." The child now has a referent for

the formerly nameless object. In this situation, the child's awareness of the intentionality of his mother, a necessary component for theory of mind, is important to language learning. It is also notable that children who lack early sensitivity to triangulation have a more difficult time learning language. This is often the case with children with autism, who are categorized by their inability to engage in joint attention (de Villiers, 2007).

The effect that language has on theory of mind is easier to explain. When learning language, words for objects and actions that are tangible develop well before words for unobservable states. It is simply easier to understand a concept when it can be seen. For example, a child will learn the meaning of the word run by watching the action when the word is said, but he cannot learn the world think this way because thinking does not have a behavioral correlate (Gleitman, 1990). For this reason, language is critical for the development of theory of mind. We are able to get information about mental state terms from their roles in the grammatical and semantic systems of a language as well as from their roles in the pragmatics of a language. Language is necessary to explain the meaning of things that cannot be seen.

Multiple studies have suggested that exposure to the use of mental state words influences the development of theory of mind. Slade and Ruffman (2005) discuss the effect that the exposure to the use of mental state words has on the development of theory of mind abilities. The journal references a study that suggests that the use of mental state words by parents and siblings when a child is 2 is correlates to the child's use later in addition to another study, which states that the frequency of a child's mental state talk with family members at 33 months predicts false belief abilities at the age of 40 months. A few studies found that children with siblings were advanced in theory of mind development, which was most likely due to the great number of opportunities and experiences that they had with the thoughts and feelings of their siblings

(Miller, 2006).

Executive Function and Theory of Mind

Similar to the relationship between language and theory of mind, the link between theory of mind and executive function is unclear. The term "executive function" is used to refer to a set of functions that are necessary for flexible, future-oriented behavior, especially in new situations (Pellicano, 2007). The executive function system is crucial to cognitive development because it lays the foundation for all higher thought, including control of attention, working memory and switching, which is necessary for multitasking (Bialystok, Barac, Blaye & Poulin-Dubois, 2010). Throughout the preschool years, typically developing children make significant progress in their understanding of theory of mind as well as in their ability to consciously control their actions and thoughts (Müller, Liebermann-Finestone, Carpendale, Hammond & Bibok, 2011). Around the age of four, typically developing children are generally able to successfully complete a false belief task, which is the true test of theory of mind (Hale & Tager-Flusberg, 2003).

In a classic false belief, the experimenter may use puppets to administer the task. The child watches as the first puppet hides candy behind one door before leaving the scene. Then, a second puppet comes and moves the candy behind the second door. When the first puppet comes back, the experimenter asks the child where the puppet will look for the candy. If the child says that the puppet will look behind the first door, he passes the task because he realizes that the first puppet would look in the incorrect place, having a "false belief" that the candy would be where she left it. The child must understand that the puppet's belief, even though it is wrong, will dictate the action taken (de Villiers, 2007).

In order for the children to successfully complete the false belief task, they must be able suppress their own knowledge of where the candy is located to correctly identify which door the

puppet will choose to look behind. This also requires that they remember where the puppet was when the candy was moved. (de Villiers, 2007). Around the age that preschoolers master the false belief task, they also tend to succeed on tasks that require the retention of information in working memory and inhibition of a prepotent response, both of which are essential features of executive function tasks. Additionally, false belief understanding has been related to attentional flexibility in rule use, but not planning ability (Pellicano, 2007)

Perner and Lang (1999) illustrate the difference between executive inhibition and automatic inhibition by describing a task called Luria's hand game, which is closely related to a peg-tapping task used in the current study. In Luria's hand game, when the experimenter lays her hand flat on the table, the child is supposed to make a fist. When the experimenter makes a fist, the child is supposed to lay his hand flat. Executive inhibition is necessary to successfully complete this task because automatic inhibition does not help the child. The child cannot pass the task using automatic inhibition alone because the natural tendency is to imitate, but the task requires the child to complete the opposing action while focusing on that of the experimenter. Concentrating more intently increases both the desired action and the impulse to imitate. For this reason, executive inhibition is crucial to suppressing the prepotent action.

Although a link between executive function and theory of mind does exist, the nature of the connection may be more complex than researchers originally thought. The simplest explanation for the relationship is that tasks regarding theory of mind require executive control, meaning that executive function plays a vital role in the successful expression of theory of mind (Carlson & Moses, 2001). According to Pellicano (2007), two pieces of evidence suggest that this link demands further attention. First, there have been significant associations between executive measures and theory of mind tasks that make minimal demands on the executive

functions of typically developing preschoolers. Secondly, children with autism have passed a false-photograph task, which carries similar executive requirements to those of false belief tasks. Since children with autism show difficulties in the area of executive function, their success on the false-photograph task complicates the idea that executive function is absolutely necessary to theory of mind (Pellicano, 2007). There is a need to identify a clearer path between executive function and theory of mind.

Over time, there have been many proposals related to the emergence of theory of mind and executive abilities. The two most prominent theories, Perner's meta-representational account and Russell's executive account, both state that there is a functional dependency between theory of mind and executive function (Pellicano, 2007).

Perner and colleagues argue that theory of mind is a prerequisite for the development of executive control. Perner notes that at the age of four, children develop an understanding of representations as representations, or meta-representation. The child then possesses the knowledge that other people can have different perspectives and that representations can take precedence over reality. The key idea is that the understanding that behavior is causally mediated by internal states is critical to the development of executive control (Pellicano, 2007).

In direct opposition of Perner, Russell argues that executive function is crucial for theory of mind development and the understanding of other minds. Russell states that a child must be able to monitor his own actions in order to succeed in executive tasks. As a result, lacking the ability to control his actions results in failure to understand mental concepts (Pellicano, 2007).

Bilingualism

In the past, there has been concern that bilingualism hinders a child's social, cognitive and personality development in addition to negatively affecting linguistic competence (Paradis,

Genesee & Crago, 2011). Some evidence supporting these claims exists, but it is deeply flawed. In most cases, important factors affecting the participants were not controlled or even taken into account (e.g. socioeconomic status). Considering that these factors alone have a profound effect on development, there is little credibility in these studies. Contrary to the belief that bilingualism impedes development, many researchers have found that bilingual children are advanced in specific areas when compared to their monolingual peers (Bialystok, 2008; Bialysok, Barac & Poulin-Dubois, 2010; Carlson & Meltzoff, 2008; Goetz, 2003; Kovács, 2009). Some of this research has suggested that bilingual children have a distinct advantage in theory of mind abilities as well as in executive function and language development.

Paradis, Genesee & Crago (2011) place children into three categories regarding bilingualism: simultaneous bilingual children, sequential bilingual children and second language learners. Simultaneous bilingual children learn two or more languages from birth or begin learning both languages before the age of three. These children essentially have two first languages. The definitions for the other two categories are closely related since a second language learner follows a sequential pattern of language learning, meaning that they learn one language before they begin to learn another. Second language learners are typically children who start to learn an additional language after the age of three, though there is no definitive demarcation at this age.

Research reported by Bialystok (2008) focused on the effects that bilingualism might have on specific cognitive skills rather than an entire domain of development. This study focused on the following cognitive domains: concepts of quantity, task-switching, concept formation and theory of mind. Following this experiment, Bialystok found that bilingual children outperform monolingual children when solving problems that require the ability to

ignore misleading information (e.g. false belief tasks), or inhibitory control. Overall, they found that bilingualism must accelerate the development of a cognitive function concerned with attention and inhibition. Carlson and Meltzoff (2008) focused on investigating the effect of bilingualism on children's executive functioning in a Spanish-English language group. Performance was affected by age, verbal ability and socioeconomic status. When the researchers controlled for these factors, there was a significant relative advantage of native bilingualism on all tasks.

Bialystok, Barac, Blaye and Poulin-Dubois (2010) completed a study with 162 children who fell into one of two age groups (ages 3 or 4.5) and three language groups: monolingual English speakers, monolingual French speakers and bilingual English speakers who spoke another language. The children completed a series of tasks testing executive control and word-mapping skills. The monolingual children received higher scores than their bilingual peers on a receptive vocabulary test and were more likely to display the mutual exclusivity constraint, meaning that once an object has a name, they cannot assign it a second. The bilingual children earned higher scores on three tests of executive functioning: Luria's tapping task measuring response inhibition, the opposite worlds task in which the children must assign incongruent labels to a series of animal pictures, and reverse categorization in which required them to reclassify a set of objects into incongruent categories after an initial classification. The language groups showed no difference on an attention task, which required that they ignore a misleading cue using executive control. The results of this attentional networks flanker task could have been affected by several factors, such as the sensitivity of the task or the degree of within-subject variance.

Goetz (2003) tested three groups of children: monolingual English children, monolingual

Mandarin children and Mandarin-English bilinguals. They found that across the board, four-year-old children performed better than the three-year-old children. The performance of both groups of monolingual children was basically the same, despite the linguistic differences in mental verbs and the vast cultural differences. In general, the comparisons between the monolingual and bilingual children showed that a bilingual advantage does exist. The bilingual children performed significantly better on the theory of mind-related tasks than their monolingual peers. Goetz (2003) suggests that possible explanations for the bilingual advantage include greater inhibitory control, greater metalinguistic understanding, and a greater sensitivity to sociolinguistic interactions with communication partners.

The majority of the research on the differences between monolingual and bilingual children shows that there is a distinct bilingual advantage in theory of mind tasks and executive control.

Purpose

In light of previous research on the subject, the purpose of this research project is to examine the differences between the cognitive abilities of children who are bilingual versus those who are monolingual. Our participants include monolingual English speakers, monolingual Mandarin speakers and bilingual children who speak both English and Mandarin proficiently.

In this study, we will look at language measures, executive function and theory of mind. Our scale of measurement may be superior to existing studies because our scoring system has been used cross-linguistically (Wellman & Liu, 2004). Following this project, further research may be done to solidify the results found up to this point.

Questions addressed in this study include: Do bilingual preschoolers have an advantage in theory of mind abilities and executive function compared to monolingual speakers? Is there a correlation between theory of mind and executive function? What appropriate adjustments can be made when testing bilingual children? Is it feasible to test children in their second language? What improvements could be made or what steps could be taken when considering further research?

Method

Participants

Data for this study was drawn from three separate groups. The first group includes thirty monolingual English-speaking children ranging from ages 3 to 5 (mean= 51.2 months). This data was collected at the childcare centers run by the Department of Human Development and Family Studies at the Pennsylvania State University. The second group includes twenty monolingual Mandarin-speaking children ranging from ages 3 ½ to 5 (mean=52.1 months). These data was collected through the Beijing Normal University in China. The third group includes five bilingual children, proficient in both English and Mandarin for their age.

Materials

The first session contained various tasks to assess theory of mind abilities. The tasks used to assess theory of mind include: diverse desires, diverse beliefs, inhibition, knowledge access, contents false belief and explicit false belief. The tasks used in this study were designed based on information found by Wellman and Liu (2004) regarding previous theory of mind literature. Each task included at least one control question and an experimental question, both of which needed to be answered correctly in order for the trial to be accurate. Additional tasks were used to assess executive function and language abilities, including peg tapping, working memory and fast mapping.

For the diverse desires task, each child was shown a picture of a carrot and one of a cookie. The experimenter then asked which snack the child would prefer. Following the response, the child was introduced to Mr. Jones, a toy adult figure, and told that he preferred the opposite snack. After being given that information, the child was asked to answer an

experimental question: “So, now it’s snack time. Mr. Jones can only choose one snack, just one. Which snack will Mr. Jones choose? A cookie or a carrot?” In order to pass the task, the child must properly identify the snack that he himself does not prefer, signaling to the experimenter that he is able to recognize the desires of others, while different than his own.

For the diverse beliefs task, the children were shown a picture of bushes and one of a garage door, and then introduced to Linda, another toy adult figure who lost her cat. The children were asked where they thought the cat might be, either in the bushes or in the garage before being told that Linda believed the cat was in the opposite place. The experimental question was then administered: “So where will Linda look for her cat? In the bushes or in the garage?” To answer this question correctly, the child must say that Linda believes her cat is in the opposite place to that chosen by the child, which shows an understanding that a different person may have opposing beliefs than them.

In the knowledge access task, each child was shown a closed black box and asked what he thought was inside. After guessing, the child was permitted to open the box and see a toy shark. When he closed the box, the experimenter asked the child if the toy girl, Polly, knew what was inside. The correct response of “no” indicates that the child knows that sensory information, such as seeing, leads to knowledge.

In the contents false belief task, the children were asked to guess what was inside of a Band-Aids box. When they opened it, they found a toy pig. After closing the box, they were introduced to another toy figure, Peter, who did not see what was in the box. In order to successfully complete this task, the children had to answer the following question: “So, what does Peter think is in the box? Band-Aids or a pig?” The correct answer is that Peter thinks Band-Aids are in the box because he has not seen what is inside. To begin the explicit false

belief task, each child was shown a picture of a backpack and one of a closet, and then they were asked to find Scott's mittens. Although Scott's mittens were actually in his backpack, Scott believed that they were in his closet. The children were then asked where Scott would look for his mittens, with the correct answer being his backpack. Answering these questions correctly suggests that the children were aware that a person's belief could be incorrect, but they will still act according to that belief.

To measure response inhibition as a form of executive function, the experimenter administered a peg-tapping task similar to that used by Bialystok (2010) and Gathercole et al. (2010). This task tested the child's ability to observe the experimenters action and perform the opposite action, as a reverse imitation. To explain the task, the experimenter said, "When I tap once, like this (demonstrates), you tap twice, like this (demonstrates)." Then, the experimenter and the child practiced. Continuing the instructions, the experimenter said, "When I tap twice, like this (demonstrates), you tap once, like this (demonstrates)." Following this line, the experimenter and the child practiced before moving on to the trials. This task tests the child's ability to inhibit the manual response to do as the experimenter does and perform the opposite action.

To assess working memory, the children were shown a few objects in a specific order and asked to identify them (e.g. a sock, a book, a ball, etc.). They were then asked to count them in the order in which they were arranged on the table. Then, they were asked to number and name each object as they previously did, but simultaneously (e.g. One is a sock, two is a book, three is a ball).

The final part of the first session was a fast mapping task, which is a processing-based task used to measure the child's ability to learn new words quickly (Golinkoff, Hirsh-Pasek,

Bailey, & Wenger, 1992). For this task, the child is shown pictures of familiar objects to verify that he can identify them before the trials begin. During each trial, the child was asked to identify a familiar and an unfamiliar object. He was expected to choose the unfamiliar object when asked about the referent novel word. To begin the second session, there was a fast mapping prompt, in which the children were asked to identify a novel object from the previous session among familiar objects. The second session also contained the use of three subtests in the Clinical Evaluation of Language Fundamentals- Preschool 2 (CELF-P2) (Wiig, Secord, & Semel, 2004) and a syntactic bootstrapping task.

Each child was tested using the standard procedures of the CELF-P2 (Wiig et al., 2004) and scored according to the appropriate guidelines. The subtests that were used include Sentence Structure, Word Structure and Expressive Vocabulary. The Sentence Structure subtest evaluates a child's ability to interpret sentences that are spoken aloud as they increase in length and complexity, while the Word Structure subtest assesses the child's grasp on grammatical concepts using a sentence completion task. The Expressive Vocabulary subtest tests a child's ability to identify pictures of people, objects and actions.

The final task administered to the children in this study was a syntactic bootstrapping task, developed by O'Hara and Johnston (1997). This task assessed the children's ability to deduce the meaning of novel verbs using sentence structure, or syntax. The experimenter read specific sentences containing novel verbs to each child, and they were then asked to act out the sentence using toys to the best of their ability.

Procedure

The children tested at Penn State were removed from class and brought to a quiet room for testing with two experimenters. One experimenter ran the tasks, while the other videotaped the session to maintain the validity and reliability of the scores found. There were two sessions, each lasting between 20 and 30 minutes, and there was generally a week between each session. The children tested at the Beijing Normal University were also tested in a quiet room, with both sessions lasting about 20 minutes each. For the majority of the children, the second session was run a few days after the first, though some children completed all tasks in one day. For these children, the order of the tasks in the second session was adjusted so the fast mapping prompt was the last task administered.

Scoring

The theory of mind tasks were scored as pass or fail. Each task incorporated an experimental question and control questions. In order to pass, the children needed to correctly answer both types of questions. Failing to answer the control questions correctly indicates that a child either did not understand or did not remember what happened during the trial.

For the executive function tasks, the children were scored based on the total correct number of answers. The fast mapping score was determined by the number of times out of 12 the child answered correctly. The CELF P-2 test was scored according to the Wiig et al. (2004) scoring manual, as it is a standardized test. The number of correct trials out of 12 total determined the score for syntactic bootstrapping task.

Results

Descriptive Data

The focus of this study was on theory of mind, language and executive function abilities of three groups of preschoolers: monolingual English speakers, monolingual Mandarin speakers and children with exposure to both languages. This section summarizes the scores of participants on the theory of mind tasks as well as the inhibition and working memory tasks, which factor into executive function. A comparison was also made between the English speakers and the bilingual children using the CELF-P2 standardized test. The comparison of the language measures did not include data for the Mandarin speakers because the tasks had to be changed in order to be appropriate for the children in China.

The participants were divided into younger and older groups before the data analysis. There were 15 children considered in both the younger and older groups for the English speakers, 10 in each group for the Mandarin speakers, and 2 in the younger group and 3 in the older group for the bilingual children. Table 1 shows the proportion of children in each language group that passed each theory of mind task. To calculate these values, the total number of children that passed each task was found and divided by the total number of children in that age and language group. The scale for this comparison is 0-1, meaning that a score closer to 1 than 0 indicates that more children passed the task than failed it. Each task included at least one control question and an experimental question. In order to pass each task, the questions needed to be answered correctly. For this analysis, failing the task includes either a failure to answer the experimental question correctly or a failure to correctly answer one or more control questions (N/A). The theory of mind scores were lower for the bilingual children than the other two groups, but the tasks became increasingly difficult for all groups, as was intended by Wellman

and Liu (2004). There was a wide variation in the theory of mind scores of the bilingual children. Table 2 indicates whether or not each bilingual child passed the five theory of mind tasks.

Table 1

Theory of Mind Task

Language Group	Diverse Desires	Diverse Beliefs	Knowledge Access	Contents False Belief	Explicit False Belief
			Younger Children		
Chinese	1	0.90	0.30	0.20	0.40
English	0.87	0.73	0.67	0.13	0.47
Bilingual	0.5	0.5	0	0	0.50
			Older Children		
Chinese	0.9	1	0.80	0.10	0.60
English	1	0.87	0.73	0.33	0.27
Bilingual	1	0.67	0	0	0

Table 2

Theory of Mind Patterns for Bilingual Children

ID	Age (months)	Diverse Desires	Diverse Beliefs	Knowledge Access	Contents False Belief	Explicit False Belief	Number Passed
32	42	PASS	PASS	FAIL	N/A	PASS	3
35	47	FAIL	FAIL	FAIL	FAIL	FAIL	0
34	48	PASS	PASS	N/A	N/A	FAIL	2
31	51	PASS	FAIL	N/A	FAIL	FAIL	1
33	51	PASS	PASS	N/A	N/A	FAIL	2

Table 3 shows the averages and standard deviation in parentheses from the three language groups for both working memory and peg tapping, or inhibition. On the working memory task, the scores of the bilingual children were between those of the English and Mandarin speakers. The mean age of the younger English-speaking group was 44.8 months, while the mean age of the entire bilingual group is 47.8 months. With a group average of 1 and a standard deviation of 1, the performance of the bilingual children was slightly better than that of the younger English speakers, who had an average of 0.6 with a standard deviation of 0.74; however, the younger group of Mandarin speakers has an average age of 44.5 months and an average score of 1.5 with a standard deviation of 0.71. When looking at the proportions for individual performances on the inhibition task, there is no substantial difference between the bilingual and the monolingual children. On average, the older children in the monolingual groups performed better than the rest with the Mandarin speakers averaging a 0.94 and the English speakers averaging a 0.84. The standard deviations for the groups were 0.13 and 0.26 respectively.

Table 3
Peg Tapping and Working Memory Averages and Standard Deviation for All Groups

Language Group	Peg Tapping (Inhibition)	Working Memory
	Younger	
Chinese	0.74 (0.14)	1.5 (0.71)
English	0.48 (0.32)	0.6 (0.74)
Bilingual	0.54 (0.35)	1 (1.41)
	Older	
Chinese	0.94 (0.13)	2 (0)
English	0.84 (0.26)	1.33 (0.90)
Bilingual	0.45 (0.27)	1 (1)

Table 4 shows the average and standard deviation of the raw scores from the CELF-P2 test for the English speakers and the bilingual group. Similar to the results from the theory of mind tasks, a wide range of scores was seen on the three subtests of the CELF-P2: Sentence Structure, Word Structure and Expressive Vocabulary. The younger English group has an average raw score of 53.73 with a standard deviation of 10.34 and the older English group has an average raw score of 65.47 with a standard deviation of 6.79, while the bilingual group as a whole has an average of 22.6 with a standard deviation of 21.45. Because of this large difference, Table 5 shows the individual raw scores for the bilingual participants. Participants 34 and 35 had scores that were most similar to the English-speaking children, while the rest did relatively poorly.

Table 4

CELF-P2 Raw Score Averages for English and Bilingual Children

Language Group	**Sentence Structure**	**Word Structure**	**Expressive Vocabulary**	**Sum of Raw Score**
		Younger		
English	15.2 (3.03)	15.8 (4.41)	22.73 (6.04)	53.73 (10.34)
Bilingual	8 (7.1)	8 (11.31)	9 (9.9)	25 (28.3)
		Older		
English	17.67 (2.44)	18.13 (3.02)	28.67 (4.65)	65.47 (6.79)
Bilingual	7.33 (6.81)	6.33 (5.51)	7.33 (11.02)	21 (22.6)

Table 5

CELF-P2 Individual Raw Scores for Bilingual Children

ID	Age (months)	Sentence Structure	Word Structure	Expressive Vocabulary	Sum of Raw Scores
32	42	3	0	2	5
35	47	13	16	16	45
34	48	15	12	20	47
31	51	5	1	0	6
33	51	2	6	2	10

Correlation Data and Comparisons

The second research question asks whether or not there is a correlation between theory of mind and executive function. Nonparametric, or Spearman, correlations were found for both monolingual groups. For the English-speaking children, the theory of mind correlation with working memory was 0.02 and the correlation with peg tapping was 0.28. For the Mandarin-speaking children, the theory of mind correlation with working memory was 0.36 and the correlation with peg tapping was 0.32. Although none of these values reach statistical significance at the alpha= 0.5 level, the difference in the magnitude is important. The correlation between theory of mind and working memory for the English-speaking children is almost zero, whereas theory of mind seems to be associated with higher working memory scores in Mandarin-speaking children. In both groups, a trend shows that theory of mind scores are associated with higher peg tapping scores.

Table 6 shows the individual scores of each bilingual child in theory of mind, working memory and peg tapping. While Participant 31 had the highest total score for theory of mind with a 3, s/he had the second lowest score for peg tapping with 0.29 and one of the lowest for working memory, earning a 0. Alternatively, Participant 35 had the lowest score for theory of mind, earning a 0, while achieving the highest peg tapping score of 0.79 and a 2 for working

memory, which was the highest score for the group. A strong association between theory of mind and executive function cannot be suggested based on the results of this study because there is no clear relationship between the scores for the participants, though a larger study could yield different results.

Table 6

Comparisons of Theory of Mind Tasks with Executive Function

ID	Age (months)	Theory of Mind	Working Memory	Peg Tapping
32	42	3	0	0.29
35	47	0	2	0.79
34	48	2	2	0.57
31	51	1	1	0.64
33	51	2	0	0.14

Discussion

Monolingual and Bilingual Differences in Results

The focus of this study was to assess how bilingual preschoolers compared to monolingual English and Mandarin-speaking preschoolers on theory of mind tasks and in executive function abilities. Furthermore, we attempted to identify a relationship between theory of mind and executive function tasks based on the results from the tasks used in the study.

Although previous research studies, including Bialystok (2010) and Goetz (2003), have suggested that bilingual preschoolers have an advantage in the cognitive domains of theory of mind and executive function, the current study did not produce results to support this claim. The English and Mandarin-speaking children achieved higher scores than their bilingual peers on various tasks, including those testing theory of mind, inhibition and working memory.

When examining the data collected from the bilingual participants, we found no clear association between theory of mind and executive function. In fact, the child who scored the highest on the peg tapping task testing inhibition did not pass a single theory of mind task, while the child who received the highest score compared to the others in theory of mind scored the second lowest on the peg tapping task. These data do not suggest that there is a relationship because with these participants, strength in one area is categorized by relative weakness in another, although this data is not representative of the Mandarin-English bilingual population.

Limitations and Suggestions for Future Research

The bilingual children scored either around the level of their monolingual peers or below in all tasks considered in this study; however, there are many possible explanations for this discrepancy.

First, we must consider the definition of the term "bilingual." While the children who were tested seemed to understand the directions as they were explained, it is possible that certain tasks that require a lengthy verbal explanation could leave them somewhat confused. For example, in the diverse desires test of theory of mind, the child must decide what snack Mr. Jones would like following a strictly verbal scenario. A similar execution is seen in the diverse beliefs task, both using only pictures or toy figures and verbal instruction. When considering the results of the CELF-P2, it is clear that at least three of the bilingual children are not as proficient in English as their monolingual peers. In this study, no measures were taken prior to running the tasks to assess each child's proficiency in either English or Mandarin. For this reason, it is difficult to say that the children have a sufficient understanding of either language since it largely depends on the amount of exposure and practice they get with each language in their daily lives.

Secondly, the small sample of children presents a limited view of the abilities of children in this population. While some children did fairly well, a couple did rather poorly, affecting the group average and the overall results. Additionally, children with greater competence in both English and Mandarin could possibly fare better than the children in our limited sample, which would fall in line with other studies that have come to different conclusions. Another possibility is that the State College population of English-Mandarin bilinguals is not the best possible representation of this group. The same study performed in a more diverse area, such as a city, could lead to different results.

Due to the limitations listed, there are a number of changes that could be made to improve the outcome of this study. The most important of all changes would be to increase the sample size by as much as possible. Thirty English-speaking children and 20 Mandarin-speaking children were tested, while only five children with exposure to both English and Mandarin were

tested. The number of bilingual participants was limited for multiple reasons, with the biggest factors being time and the process of obtaining consent for the children's participation.

Goetz (2003) performed a similar study with three groups: monolingual English speakers, monolingual Mandarin speakers and bilingual Mandarin-English speakers. In this study, the monolingual children participated in two sessions of the exact same tasks one week apart. The bilingual children also participated in two sessions, but they did one session in English and one session in Mandarin. In the future, it might be beneficial to follow a similar format, allowing children with a greater proficiency in one language the opportunity to do the tasks in both and show their strengths. This could be an alternative and appropriate way to test bilingual participants.

If possible, the level of proficiency in each language could be assessed prior to the start of the study. This could be accomplished by asking the parents to return a short survey detailing their child's experience with each language along with the consent form before allowing him to participate. Additionally, designing theory of mind tasks that use less verbal instruction could have a positive effect on the scores of bilingual participants. This way, the experimenter could assess the maturation of the child's theory of mind without factoring language ability in as a potential obstacle.

This study could be thought of as the starting point for a more long-term study. With a larger number of participants and some of the other adaptations listed above, the results could change tremendously. Research in this area is beneficial to the field of Communication Sciences and Disorders because gaining a better understanding of the advantages seen in bilingual preschoolers could help teach those who are interested about the link between theory of mind, language and executive function.

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EDUCATION

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Schreyer Honors College
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RESEARCH EXPERIENCE

Undergraduate Honors Thesis: ***Cognitive Differences Between Monolingual and Bilingual Preschoolers in Theory of Mind and Executive Function***
The Child Language Development Lab, Penn State University
Fall 2010 to present
Thesis Supervisor: Dr. Carol Miller

- Purpose: To contribute to the understanding of the correlation between the development of theory of mind and executive function and bilingualism in preschoolers
- Reviewed relevant research literature
- Administered experimental tasks and the standardized CELF Preschool-2 to children

NOTABLE COURSEWORK

Introduction to Augmentative and Alternative Communication (AAC): Honors Option
Fall 2010

- Involved exposure to AAC programs, including EZ Keys, Minspeak and Speaking Dynamically Pro, or Boardmaker, and an AAC device, the L*E*O*
- Formal APA style report written discussing the strengths and weaknesses of each program and the device

Clinical Bases of Language Disorders: Honors Option
Fall 2010

- Reviewed relevant research literature
- Formal APA style paper written about the development of theory of mind in children with autism

Case History Approach to Communication Disorders
Spring 2011

- Focus on Down syndrome, Williams syndrome and Autism Spectrum Disorders
- Compared case histories to the profile of each syndrome or disorder
- Prepared an individual presentation about 5p- syndrome