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PROCESSING-BASED LANGUAGE ASSESSMENT AND THEORY OF MIND IN PRESCHOOLERS

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Abstract

Theory of mind, language and executive functions were assessed in seven children with normally developing language, ages 3 to 5. This study examines language as a predictor of later theory of mind development using processing-based language measures, knowledge-based measures and Wellman and Liu's (2004) theory of mind tasks. Relatively stronger correlations were found between processing-based language measures and theory of mind than knowledge-based measures and theory of mind. Executive function measures of inhibition and working memory were not highly correlated with theory of mind proficiency. Due to the small sample size, only limited conclusions are possible, but several directions for future research are suggested.

Table of Contents

LIST OF TABLES

Acknowledgments

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Theory of Mind

The complex understanding of how others think and feel is the concept of theory of mind (Miller, 2006). Although the development of theory of mind is a difficult concept to measure, evidence has shown that theory of mind develops over time and matures during the preschool years, between the ages of three to five (Miller, 2006). Recently, research has been devoted to studying the way a child's mind develops and how a child begins to first understand his or her own mind. After a long process of acquiring knowledge about one's own internal desires, beliefs and false beliefs, then achieving competence understanding that other people may have different internal thoughts, a theory of mind is fully developed. This complex process is a necessary component in building successful and healthy social relationships (Miller, 2009). The purpose of the present study is to understand how children develop a theory of mind with regards to the domains of language and cognition. These findings will assist in the enhancement of early prevention, intervention techniques and educational services (Miller, 2009).

To begin, it is imperative to discuss the interactions during infancy between child and caregiver, because it is suggested that these relationships influence theory of mind development. The verbal use of mental state verbs between caregivers and their children have shown positive results. Researchers have attributed this type of input from caregivers as helpful to the children's later understanding of their own beliefs and desires as well as those of others (Meins, Fernyhough, Wainwright, Das Gupta, Fradley, & Tuckey, 2002). De Villiers (2007) suggests that infants develop an "appreciation" of their caregiver's internal states during these early interactions. Infants are absorbed by their mother's voice and actions more often than a highly stimulating toy. A child is stimulated and comforted by the sound of their mother's voice, smiles

and songs. This does not mean a child understands their caregiver's internal thoughts and emotions, but this is a child's first encounter with another's internal thoughts.

An infant's ability to follow another's gaze or pointing to a third entity is called triangulation (de Villiers, 2007). Tomasello, Carpenter, Call, Behne and Moll (2005), suggest that when children and their caregiver engage in triangulation, infants are able to distinguish their caregiver's external intent. For example, when a mother persistently points at a particular object, infants recognize that there is an external goal for that particular action. Understanding internal goals is more complex and will be discussed later in this paper.

There has been debate over how joint attention, sharing eye gazes and pointing to a third entity directly influences theory of mind development. Tomasello (1995) has found the act of joint attention to be a component of language and theory of mind development. Charman, Baron-Cohen, Swettenham, Baird, Cox, and Drew (2000) strengthened this idea of a connection between joint attention, language and theory of mind. Charman et al. (2000) conducted a study which concluded that thirteen typical children proficient in joint attention skills at 20 months, showed competence in all aspects of theory of mind by 44 months, thus demonstrating a relationship between joint attention and later theory of mind maturity. It can be noted that children with autism begin to show delays in joint attention at a young age (Lewy & Dawson, 1992) which negatively impacts language learning and theory of mind proficiency.

Mental states are "nonobvious, internal states which are all potentially at odds with overt behaviors or external reality" (Wellman & Liu, 2004, p. 528). It is difficult to precisely determine when children fully understand mental states, but this understanding begins to develop during the preschool years and is demonstrated through the correct usage of words such as *think, know, want* and *feel* (de Villiers, 2007). It has also been established that children understand the

speaker's external states before understanding internal states (de Villiers, 2007). At age three mental state words are used in the simplest ways; by almost five years of age, children will use these words to talk about others beliefs and desires (Bartsch & Wellman, 1995). Shatz, Wellman, and Silber (1983) found that children between 2;4 and 2;8 begin using mental states in routine phrases such as "I don't know" or "Know what?" Dunn, Brown, Slomkowski, Tesla and Youngblade (1991) concluded that if children consistently use mental state talk at 33 months, false belief will develop soon after at 40 months. Furrow, Moore, Davidge and Chiasson (1992) found that parents' and siblings' use of mental state words with children two years of age correlated with children's usage at age three.

When children enter preschool, they begin to learn that their own internal desires, emotions, knowledge and beliefs may not correspond exactly with their peers', parents' or persons of authority's mental states. Children must learn and understand that their internal knowledge of a situation can, and often times is, different than another's, in order to fully develop a theory of mind. Emotions, desires, knowledge and beliefs are overwhelmingly inconsistent and can change instantaneously, making understanding the mind very complicated.

Wellman and Liu (2004) designed a theory of mind scale to measure the different aspects that make up a theory of mind. These components are measured chronologically based on the order in which children acquire the subcategories of theory of mind. Each facet becomes increasingly more difficult, building on one another, as children developmentally progress. Between the ages of two and three, children learn that people in their life may have different likes and dislikes (Repacholi & Gopnik, 1997). In this study the diverse desires task is used to test the child's ability to understand that other people may have different desires about the same object. Understanding beliefs is more difficult than understanding desires (Wellman & Liu

2004). For this reason, the theory of mind tasks used in this study begin testing a child's understanding of desires, then go proceed to test their ability to understand that people have different beliefs. The diverse beliefs task should be mastered by age three and a half, according to Wellman and Woolley (1990), because children master diverse beliefs and diverse desires tasks before the mastery of false belief tasks. This would be the reason that the last two theory of mind tasks of Wellman and Liu's scale (as used in the present study) are contents false belief and explicit false belief. Children begin to understand false beliefs consistently by age four (de Villiers, 2007).

Executive Function

Executive functions are a set of cognitive processes that underlie self control and are necessary in problem solving and goal-directed activities. Self regulation, inhibitory control, planning, attention shifting and working memory are among the many skills executive functions encompass. The ability to control distractions, inhibit impulse answers to questions and problem solve thoughtfully are all executive function skills (Hughes, 1998a).

There have been speculations that executive functions begin to develop during the first year of life. Researchers have also found ties between executive functions and theory of mind (Carlson, Moses & Breton, 2002). Most studies support the idea that development of executive function leads to the development of theory of mind (Frye, Zelazo, & Palfai, 1995; Hughes, 1998a,b; Perner & Lang, 1999; Carlson & Moses, 2001). Hughes (1998b) found that executive function skills at 3 years correlated highly with theory of mind proficiency at 4 years.

Inhibition is a specific executive function skill that involves the ability to suppress automatic responses by filtering out distracters in order to respond correctly (Carlson et al., 2002). Inhibition is needed to successfully complete the false-belief task. One theory behind a false belief task is children inhibit reality-based responses. The individual accomplishing this task must hold back their desire to choose the true location of the object in order to choose the false location of the object. This leads to the possible theory that response inhibition can predict theory of mind. Hughes (1998a) has established that inhibitory control predicts theory of mind. Carlson et al. (2002) confirmed this based on the results of their study with 47 normally developing preschool children. Specifically they found a strong correlation between inhibition control and false belief performance.

Hughes (1998a) took this idea a step further and found that early executive function performance significantly predicted performance on theory of mind tasks one year later. Hughes (1998a) theorized that early development, specifically of response inhibition, impacts the success or failure in the false-belief task. Hughes (1998a) concluded that performance on the detour-reaching box task, which tested inhibition, was the best predictor of later performance on theory of mind tasks of the three executive function tasks she tested.

Although there has been evidence of inhibition as a predictor of theory of mind, working memory is also an important executive function skill that develops at a young age (Carlson et al., 2002). Working memory is used to store and manage information. Researchers focus on finding connections between the cognitive domain using working memory because this specific aspect of cognition develops early and has been found to underlie other executive functions (Roberts & Pennington, 1996). In theory of mind tasks, children may use their working memory capacity to remember important information that will be essential in the success or failure of the task. Carlson et al. (2002) did not find strong correlations between working memory and false belief performance alone. However, the Bear/Dragon task implemented by Carlson et al. (2002) requires inhibiting a response while activating a different response, therefore using inhibition control and working memory capacity. The Bear/Dragon task involved a child responding to prompts from the bear, but not executing commands from the dragon, similar to the Simon Says game. The working memory and inhibition demands of this task demonstrated a relationship between these specific executive functions and false belief tasks. Astington and Jenkins (1999) and Slade and Ruffman (2005), in two different studies, found that working memory does not explain the relation between language and false belief. Individually, executive functions may not be as powerful of a predictor of theory of mind as the language domain, but a relationship still

remains possible. Carlson et al. (2002) have found associations between executive functions and theory of mind, especially inhibition and working memory. A particular aim in the present study is to test child's working memory capabilities and inhibitory skills to see the relationships between these executive function skills and development of theory of mind.

One of the strongest pieces of evidence supporting a role for executive function in theory of mind development comes from populations with executive function deficits (Hill, 2003). There have been many hypotheses to explain the relationship between executive dysfunction and the deficits in theory of mind. Most research supports the hypothesis that in typical development, executive function leads to the development of "theory of mind." Hill's (2003) findings suggested that atypical individuals lacking executive control, focusing mainly on the autistic population, also have difficulties with theory of mind tasks. Ozonoff, Pennington and Rogers (1991) found that some children with autism showed impairments in the executive function tasks dealing with planning, but continued to pass the false-belief task. This shows us that not every executive function resolves itself before theory of mind develops and not all executive functions may affect theory of mind.

The influence executive function has over theory of mind has been widely debated. This study will focus on assessing working memory and inhibition in relation to theory of mind. Working memory and inhibition have shown the most promise in discovering the precise manner executive functions impact theory of mind.

Role of Language on Theory of Mind

The coordination of language and social-cognitive development is evident at a young age (de Villiers, 2007). This interaction of domains is observable in the first year of life, when infants use joint attention to communicate with their caregivers. Shared eye gazes and pointing between child, caregiver, and unfamiliar objects aid the word learning process, which influences the progression of theory of mind development (de Villers, 2007). Slade and Ruffman (2005, p. 117) suggested that a relationship exists between language ability and theory of mind performance. The precise nature of this relationship is still unclear and highly debatable. Specific aspects of language including semantics, syntax and pragmatics have been researched individually to see which are highly correlated with theory of mind understanding.

Certain studies have focused on the big picture by investigating the effects of overall language ability on theory of mind. Most of the theory of mind tasks researchers have used in their studies involve verbal language ability; however, de Villiers and de Villiers (2000) used a nonverbal false belief task to test theory of mind in the deaf population. A significant delay in understanding other's false beliefs was found, but more importantly, the successful completion of the task was dependent on their language inventory. This research study confirms the significant impact language has on theory of mind development. Language and theory of mind causality is not reciprocal. Theory of mind proficiency may predict later language achievement, but according to Slade and Ruffman (2005) there is a stronger relationship of early language ability as a predictor of later theory of mind proficiency.

There has been abundant evidence supporting the idea that specific aspects of language predict theory of mind. Some researchers believe that semantics, specifically a child's vocabulary inventory, predicts theory of mind performance. Ruffman, Slade, Rowlandson,

Rumsey, and Garnham (2003) support this claim in a study where they compare syntax with semantics.

Syntax, the structure of sentences, has also been linked to the understanding of theory of mind (Astington & Jenkins, 1999). The importance of word order impacts the meaning of a sentence. For example "Pat sat on Sally" does not have the same meaning as "Sally sat on Pat." To understand false belief, specific aspects of syntax must be mastered.

Sentence complementation structure allows there to be embedded sentences about beliefs, which de Villiers (2007) argues must be understood in order to understand true or false to beliefs, because it is the only way to represent false beliefs through language. The development of mental state words has been suggested to promote the development of theory of mind, but the grammatical placement of these mental state words has been found to even further predict relationship between language and theory of mind (de Villiers, 2007). Sentence complementation provides a way to talk about mental states. Even if part of the sentence is false, the sentence complementation structure allows the statement to remain true. For example, if the child states "I think my mommy made me chicken nuggets" it remains true even if the child's mother did not make him chicken nuggets, because the mental state word "think" does not require the complement to be true. Only certain words including mental state words permit sentence complementation structure. De Villers and Pyers (2002) found that the mastery of this complex grammatical sentence structure predicted false belief proficiency three to four months later. However, Miller (2006) concluded that understanding complementation is not necessary to achieve false belief understanding, but has helped in typical preschoolers.

Processing-Based Language Measures vs. Knowledge-Based Measures

The majority of research that has been done to find a relationship between language and theory of mind has been based on knowledge-based measures, which include all standardized tests. These easily administered, reliable and valid tests are used to measure receptive, expressive, grammatical, semantic and syntactic skills. These tests are used to identify speech and/or language disorders in children and adults. Although these tests are useful in determining if children and adults are at risk for language disorders, there are limitations to knowledge-based measures. Alone, they fail to provide speech therapists with a complete picture of the speech and/or language disorder. The language abilities of minorities or high-risk populations may be underestimated by standardized test results as well (Miller, 2009).

Since knowledge-based measurements may not be the best indicator of a child's language ability, researchers have designed dynamic or processing-based language tests. Dynamic or processing-based measures may be better predictors of theory of mind performance than standardized tests (Miller, 2009). These processing-based tests examine how well children acquire new noun and verb meanings and reflect a child's ability to learn or apply what they have learned. Feuerstein (1979) argues that dynamic assessment can provide the best reflection of a person's learning ability or future growth. Standardized tests measure semantic and syntactic knowledge, rather than a child's ability to use their knowledge in new learning situations.

In previous studies, language test scores have been shown to highly correlate with later theory of mind scores (Slade & Ruffman, 2005). This study will attempt to determine which type of language measure has a stronger relationship to theory of mind. The two processing-based tasks used to evaluate language acquisition were fast mapping and syntactic bootstrapping,

and the knowledge-based test used in this study is the Clinical Evaluation of Language Fundamentals-Preschool [CELF P-2] (Wiig, Secord, & Semel, 2004).

Purpose

The purpose of this research project is to explore the relationship of theory of mind in preschool children with their language and executive functioning skills. The intended outcome of this project is to use the results to lay the foundation for a larger study that will lead to a better understanding of how theory of mind develops in preschoolers (Miller, 2009). A more in depth understanding of the interrelationship of language, theory of mind and executive function in typical children will lead to the expansion of knowledge that will ultimately benefit developmentally disabled individuals. Early intervention and prevention strategies of educators can be strengthened by more precise knowledge of the relationships between aspects of language and aspects of theory of mind. Furthermore, investigating a child's language inventory using different techniques such as dynamic, processing-based measures instead of static, knowledge-based measures may be useful in making later theory of mind development predictions.

Questions addressed in this study include: Are the measures that were chosen useful for assessing language, executive function, and theory of mind? How highly do the processing-based and knowledge-based measures correlate with theory of mind and the executive functions of inhibition and working memory? What do the results suggest for the design of further research?

Method

Subjects

Seven children, ranging in age from 3 to 5 years, participated in this study. The data was collected at the Child Development Lab, run by the Department of Human Development and Family Studies, located at the Pennsylvania State University, University Park campus. The study participants included two boys and five girls, all proficient English speakers for their age. Children with developmental disabilities were not included in this study.

Materials

The first session involved the implementation of five tasks to assess theory of mind development. These included: diverse desires, diverse beliefs, knowledge access, contents false belief and explicit false belief. The contrasting characteristics of each of these tasks were created by Wellman and Liu (2004) based on tasks that have been used in theory of mind literature. The tasks were intended to engage the subjects through the acting out of different scenarios with pictures and toys. All of the tasks incorporated control questions and an experimental question. The subjects were required to answer the experimental question correctly.

In the diverse desires task subjects were prompted to select a carrot or a cookie based on their own preference. Whichever snack the child selected, the adult figure would choose the opposite. Then the child was then asked the experimental question: “So, now it’s snack time. Mr. Jones can only choose one snack, just one. Which snack will Mr. Jones choose? A carrot or a cookie?” The diverse desires task determined whether the child understood that two people possess differing opinions about the same object.

The diverse beliefs task began with two pictures, a bush and a garage. The adult figure lost her cat and the child is asked where they believe the cat is hidden, the bushes or the garage. The adult figure believes the cat is hidden in the opposite location that the child had chosen. The subject is then asked the target question: “So where will Linda look for her cat? In the bushes or in the garage?” This task assessed the concept that a person can hold a different belief about the same situation.

Knowledge access involved a child seeing inside a box, then drawing conclusions about the knowledge of another person who has not seen inside the box. To pass this test, the child must answer “no” to the experimental question “So, does Polly know what’s inside the box?” A correct answer to this question suggested the child recognized that sensory experience lead to knowledge.

In the contents false belief task children were shown a Band-Aid box that contains a toy pig. During the task, the child saw inside the Band-Aid box, but the toy figure presented had not seen inside the box. To pass the task, the child had to answer the target question: “So, what does Peter think is in the box? Band-Aids or a pig?” with the correct answer of “Band-Aids.” In the most complex task, explicit false belief, children were asked to find Scotts mittens which were either in his backpack and closet. In reality, Scott’s mittens were in his backpack, but he thinks they are in his closet. The subject tested was asked the target question: “So, where will Scott look for his mittens?” Passing the contents false belief and explicit false belief tasks shows that a child understands that a person’s belief may be incorrect, but they will still act in accordance with their own belief.

Following the theory of mind assessment, the children participated in two executive function tasks. Inhibition control was evaluated using the peg-tapping task. The child was

presented with a block and asked to follow the experimenter's lead. If the experimenter tapped once, the child was required to tap twice, and vice versa. Working memory proficiency was tested using the counting and labeling task. In this task the child was asked to label three objects, number each object 1, 2, or 3, and then combine labeling and numbering ("1 is a dog, 2 is a sock, 3 is a car").

The first session ended with the execution of the fast mapping task. Fast mapping is a dynamic processing-based task that examines a child's ability to rapidly learn words (Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992). There were 3 blocks of 4 trials, 12 trials in all. The child was presented with novel objects mixed with familiar objects. In each trial the child was asked to find an unfamiliar object and a familiar object given 4 object choices. They were asked to identify the referent of a novel word, where the correct choice would be the novel object. Once the novel object was initially recognized, the child was asked to extend the novel word to a different colored example of that same object. The second session incorporated a memory probe for the fast mapping task in which the child was instructed to choose a novel object, the name of which was learned in the previous session, out of a group composed of both novel objects and familiar objects.

The traditional, standardized measures used in this study were drawn from the CELF P-2. The subtests used were Sentence Structure and Word Structure which assessed receptive syntax and expressive morphology, and the Expressive Vocabulary subtest.

A syntactic bootstrapping task was administered to the participants in this study (O'Hara & Johnston, 1997). The seven children were tested on their ability to infer verb meaning appropriately based on sentence syntax. The child was given a scenario, described using an unfamiliar verb, and asked to act out the sentence as best as they could. The three sentence

structures were transitive, locative and coordinated. A simple transitive sentence consists of agent, verb and patient (e.g., The woman soogs the bunny). The locative sentence type consisted of an agent + verb + patient + "to" + patient (e.g., The bear gebs the boy to the women), while the coordinated sentence types read agent + verb + patient + "and" + patient (e.g., The bunny bims the farmer and the cow). The inability to reenact the sentence correctly was recorded as a fail, then analyzed further to consider the error pattern following O'Hara and Johnston (1997). Common error patterns seen were role assignment errors, an unclear event, no event, coordinated sentence type to locative, locative sentence type to coordinated and object omission.

Scoring

Theory of mind tasks were scored as pass or fail. Answering the control questions correctly demonstrated that the child understood the task scenario and if he/she answered the corresponding experimental question correctly the child passed. If any of the control questions were answered incorrectly, this was taken to mean the child did not understand the task, therefore failing the theory of mind task.

Subjects were given a score for the two executive function tasks based on the total correct answers. Incorrect answers were awarded no points. There were 2 trials in the working memory task and 14 trials in the inhibition task.

The children received an overall fast mapping score, which states how many trials out of the 12 he/she correctly answered. The CELF-P2 was scored according to Wiig et al. (2004) scoring manual. There was an overall syntactic bootstrapping score based on how many trials the child correctly answered out of 12.

Procedure

Children were taken out of their classrooms to be tested in a quiet playroom setting by two test administrators. One administrator tested the child, while the other video taped the session. The present study was broken down into two sessions of 30-35 minutes each, administered at least a week apart. Sessions were video taped to help ensure reliable and valid scoring.

Results

Descriptive Data

This section will provide a detailed overview of how the subjects performed on the theory of mind tasks, the two executive functions tasks, fast mapping and syntactic bootstrapping and the CELF-P2 standardized test. Each child was assigned an ID number. The data table orders the children from youngest to oldest to get a better idea of how age impacted competence. Table 1 lists the results of all five theory of mind task and clearly summarizes the subject's theory of mind competence as it indicates how many of the five tasks were passed. The mean number of tasks passed was 2.5, with a standard deviation of 0.9.

Peg tapping, working memory and syntactic bootstrapping results are displayed in Table 2. Peg tapping consisted of 14 trials. The mean number correct was 10 with a standard deviation of 4. The working memory task involved 2 trials. The mean number correct was 1, with a standard deviation of 1. Success on the syntactic bootstrapping task was documented as the number of correct trials out of 12 total trials. It gives an overall score based on how many appropriate sentence interpretations they were able to correctly represent. The mean correct was 7, and standard deviation was 2.

Fast mapping results are displayed in Table 3 according to the child's responses in each of the three blocks of trials. Of the 12 trials, the average correct was 10 with a standard deviation of 1.7.

Three sections of the CELF-P2 (Wiig et al, 2004) test were administered. The scaled scores and standard scores for each individual are recorded in Table 4. The mean scaled score for the sentence structure portion was 11.8 with a standard deviation of 3.4. The sample mean scaled score for the word structure portion was 10.7 with a standard deviation of 1.3. The

expressive vocabulary sections mean was 13.7 with a standard deviation of 2. The mean standard score for this population is 112.4 with a standard deviation of 10.4.

Table 1
Theory of Mind Data

Age	Subject	Diverse Desires	Diverse Beliefs	Knowledge Access	Contents False Belief	Explicit False Belief Task	# Passed
3 ;7	**1**	PASS	PASS	FAIL	FAIL	PASS	3
3;11	**7**	PASS	FAIL	FAIL	FAIL	FAIL	1
4;0	**3**	PASS	PASS	FAIL	FAIL	FAIL	2
4;6	**4**	PASS	PASS	PASS	PASS	FAIL	4
4;9	**6**	PASS	PASS	PASS	FAIL	FAIL	3
4;10	**2**	PASS	PASS	FAIL	PASS	FAIL	3
4;11	**5**	PASS	PASS	FAIL	FAIL	FAIL	2

Table 2
Peg Tapping, Working Memory and Syntactic Bootstrapping Data

Age	Subject	Peg Tapping # Correct	Working Memory # Correct	Syntactic Bootstrapping # Correct
3 ;7	1	6	1	10
3;11	7	2	0	3
4;0	3	14	0	10
4;6	4	13	0	6
4;9	6	14	2	8
4;10	2	14	2	8
4;11	5	12	2	5

Table 3
Fast Mapping Data

Age	Subject	Trial 1	Trial 2	Trial 3	Trial 4	Overall
3 ;7	1	3	3	3	3	12
3;11	7	2	3	2	2	9
4;0	3	3	2	2	3	10
4;6	4	3	3	3	3	12
4;9	6	3	3	3	3	12
4;10	2	3	2	2	1	8
4;11	5	3	3	3	3	12

Table 4
CELF-P2 Data

Age	Subject	Sentence Structure	Word Structure	Expressive Vocab	STANDARD SCORE
3 ;7	1	14	12	12	116
3;11	7	10	11	14	110
4;0	3	8	8	12	96
4;6	4	13	11	13	114
4;9	6	9	10	17	112
4;10	2	11	11	12	108
4;11	5	18	12	16	131

Correlation Data

The second research question revolves around the correlations between tasks. Due to the small sample size, nonparametric correlations were used for this analysis. Table 5 and 6 show the Spearman rho correlation results between all tests. Table 5 specifically shows the correlations of the processed-based tests, fast mapping and syntactic bootstrapping, with the standardized test scores, and executive function task scores. Table 6 shows the correlations between theory of mind and each processing-based test, standardized test and executive function task.

Table 5

Spearman's Rho Correlations of Processing-Based Tests with CELF, Executive Function tasks and Theory of Mind Tasks

	Fast Mapping	**Syntactic Bootstrapping**	**CELF-P2 Sentence Structure**	**CELF-P2 Word Structure**	**CELF-P2 Expressive Vocab**	**CELF-P2 Standard Score**	**Working Memory**	**Inhibition**
Overall Fast Mapping Score	1	0.08	0.433	0.31	0.429	0.788	0.128	-0.143
Overall Syntactic Bootstrapping Score	0.08	1	-0.273	-0.276	-0.623	-0.273	0.039	0.491

Table 6

Correlations of Theory of Mind Tasks with CELF, Processing-Based Tests and Executive Function tasks

	CELF-P2 Sentence Structure	**CELF-P2 Word Structure**	**CELF-P2 Expressive Vocabulary**	**CELF-P2 Standard Score**	**Fast Mapping**	**Syntactic Bootstrapping**	**Working Memory**	**Inhibition**
Sum of Theory of mind Tasks	0.349	0.231	-0.286	0.349	0.486	0.467	0.119	0.171

Discussion

Relation of Task Performance to Age

This section will discuss which tasks performed in this study appear to reflect age. The results of the peg tapping task were clearly related to age. Subjects 1 and 7, the two youngest of the group, failed the task, while the other five subjects passed. The working memory task proved to be more difficult for the participants. Age also appeared to be a factor in the results of this executive function task. The youngest four subjects, 1, 7, 3 and 4 failed the task, while the oldest three showed working memory competence.

Although there was not a clear increase in overall score with age, the results of the theory of mind tasks were consistent with the results of Wellman and Liu (2004), as children passed earlier, "easier" tasks and failed later tasks, with only two exceptions. Each child passed the diverse desires tasks and all but one child passed the diverse beliefs task. Subject 2, aged 4;10, failed knowledge access but then passed contents false belief. Subject 1, 3;7, was the youngest and only subject who passed the fifth and hardest theory of mind task. Therefore, this may be considered a result of sheer chance, since none of the other children passed the explicit false belief task.

Fast mapping results did not appear to be related to age. The few errors that resulted throughout the fast mapping task might be attributed to the unchallenging nature of the task. Subject 1, the youngest at 3;7, completed the trial with no errors. In order to gain more insight into children's word learning abilities, it may be necessary to adjust the difficulty level of the task. The fast mapping task used in the present study introduced a novel object in trial 1 and trial 2 was designed to test the subject's ability to extend the just learned label to another token of that object (Golinkoff et al., 1992). A way to make this task more difficult could potentially be to

introduce a novel object in trial 1, and in trial 2 bring in a second novel object. The purpose of trial 3 would be to see if after learning two novel objects, the child would be able to extend these newly learned objects to the same objects in different colors. Introducing a second novel object prior to asking the subject to use what they learned in trial 1, could potentially add a new dimension to the task. There is no conclusive evidence that adjusting the fast mapping task in this manner would increase the difficulty of the task and produce more valuable results, but it should be considered for future studies.

As a whole the subjects scored very high on the CELF-P2. The standard score is calculated from the raw score the child gets on the test and that score takes into account the child's age category. The participants tested in this study were enrolled at a university laboratory preschool and most likely were raised in upper-middle class families. Increasing the diversity of the sample group in the future by taking into account socioeconomic and ethnic differences may provide a wider range of standard scores.

Syntactic bootstrapping results were inconsistent with age. Subject 1, 3; 7, and subject 3, 4;0, had the highest scores, while subject 5, 4;11, had the lowest score. In general, the overall scores were low, suggesting the task might have been too difficult for this age group. Another factor that might have led to the inconsistent results was the fact that the toys were not all given to the children in the same manner. Subjects 1, 2, 3, 5 and 7 were given the toys needed for every trial. Subjects 4 and 6 had to pick the toys from a pool of toys for each trial, which was more difficult. There is no clear conclusion that could be drawn from the variability in how we distributed the toys. It was not clear that giving the toys or allowing the children to pick the toys from a group would influence the syntactic bootstrapping results. For the future this will be controlled; either one method will be used or the methods must be varied systematically.

Correlation Between Measures

We can examine the joint relationships of language and executive function tasks with theory of mind and assess the associations among the variables. Although the sample size was small, and statistical comparisons of correlations were not appropriate, there were hints of interesting patterns of relationships among the three domains. Fast mapping and syntactic bootstrapping appeared to be largely independent of one another and showed different patterns of association with the other variables. This showed that the two processing-based tests tap into different skills and other variables showed higher correlations with each specific task. In particular, fast mapping was more highly correlated with CELF-P2 standard score than any other variables, even the subtests of the CELF-P2. Syntactic bootstrapping, however, was more highly correlated with the expressive vocabulary subtest than with the other CELF-P2 subtests or the overall standard score. The strong relationship between processing-based tests and knowledge-based tests might tell us that these tests were more similar than we originally thought. Syntactic bootstrapping also showed some evidence of a positive association with inhibition (peg tapping).

The negative correlations reported between the CELF scores and syntactic bootstrapping scores caused speculation. In the case of a large sample size, these negative correlations would reveal that better performance on CELF-P2 is associated with worse performance on syntactic bootstrapping. We can speculate that these negative measures might be associated with the inconsistent syntactic bootstrapping scores. Those who scored the highest on syntactic bootstrapping were the youngest children, one of which had the lowest CELF Standard Score. The oldest subject, 4;11, had a relatively low syntactic bootstrapping score, and the highest CELF Standard Score. These correlations need to be investigated in future studies with larger sample sizes to make further conclusions.

This pilot study has pointed to key results that need to be further examined in subsequent studies of this nature. Theory of mind was more highly correlated with the two processing-based tasks (syntactic bootstrapping and fast mapping), than with the knowledge-based tests and executive function tasks. Both the inhibition and working memory tasks showed very low correlations to theory of mind. These results provide evidence of a stronger relationship between language and theory of mind than executive functions and theory of mind. The findings also indicate that processing-based tests may have a stronger relationship to theory of mind ability and serve as a more reliable measure to predict theory of mind development than knowledge-based tests.

As we pursue this line of research with a larger group of participants, there will be some required modifications, mostly with the processing-based tests. These will include, modifying the fast mapping task to make it more difficult for future participants and making sure there is a system in place for distributing the materials for the syntactic bootstrapping task. Increasing the sample size will be necessary in order to confidently conclude that these processed-based language tests are accurate predictors of theory of mind. The larger sample size will allow for a regression analysis to be conducted and used to analyze the causal relationship between language tests and theory of mind.

This pilot study has built the foundation for a more extensive study to be developed and implemented in the future. We have learned that processing-based measures potentially have a stronger relationship to theory of mind than knowledge-based tests. Having a better understanding of how theory of mind develops in preschoolers and which types of tests better predict theory of mind competence will be very useful to speech language pathologists because theory of mind is crucial for a solid language foundation (Miller, 2009). There is a very high

possibility that outcomes from future studies involving these types of tests on a larger scale will prove useful in improving language intervention strategies.

References

Astington, J.W., & Jenkins, J. M. (1999). A longitudinal study of the relation between language and theory-of-mind development. *Developmental Psychology*, *35*, 1311–1320.

Bartsch, K., & Wellman, H. (1995). *Children talk about the mind*. New York: Oxford University Press

Carlson, S. M., Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development, 72*, 1032-1053.

Carlson, S. M., Moses, L. J., Breton C. (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development, 11*, 73- 92.

Charman, T., Baron-Cohen, S., Swettenham, J., Baird, G., Cox, A., & Drew, A. (2000). Testing joint attention, imitation, and play as infancy precursors to language and theory of mind. *Cognitive Development, 15*, 481-498.

de Villiers, J. (2007). The interface of language and Theory of Mind. *Lingua*, *117*, 1858-1878.

de Villiers, J. G., & de Villeers, P. A. (2000). Linguistic determinism and the understanding of false beliefs. In P. Mitchell & K. Riggs, *Children's reasoning and the mind* (pp. 191-228). Hove, East Sussex: Psychology Press.

de Villiers, J. G., Perner, J. E., (2002). Complements to cognition: A longitudinal study of the relationship between complex syntax and false-belief-understanding. *Cognitive Development, 17*, 1037-1060.

Dunn, J., Brown, J., Slomkowski, C., Tesla, C., & Youngblade, L. (1991). Young children's understanding of other people's feelings and beliefs: Individual differences and their

antecedents. *Child Development, 62,* 1352–1366.

Feuerstein, R. (1979). *The dynamic assessment of retarded performers: The learning potential assessment device, theory instruments and techniques.* University Park Press, Baltimore.

Frye, D., Zelazo, Palfai, T. (1995). Theory of mind and rule0based reasoning. *Cognitive Development, 10,* 483-527.

Furrow, D., Moore, C., Davidge, J., & Chiasson, L. (1992). Mental terms in mothers' and children's speech: Similarities and relationships. *Journal of Child Language, 19,* 617–631.

Golinkoff, R. M., Hirsh-Pasek, K., Bailey, L. M., & Wenger, N. R. (1992). Young children and adults use lexical principles to learn new nouns. *Developmental Psychology, 28,* 99-108.

Hill, E. (2003). Evaluating the theory of executive dysfunction in autism. *Developmental Review, 24,* 189-233.

Hughes C. (1998a). Executive function in preschoolers: Links with theory of mind and verbal ability. *British Journal of Developmental Psychology, 80,* 112-141.

Hughes C. (1998b). Finding your marbles: Does preschoolers; strategic behavior predict later understanding of mind? *Developmental Psychology, 34,* 1326-1339.

Lewy, A. L., Dawson, G. (1992). Social stimulation and joint attention in young autistic children. *Journal of Abnormal Child Psychology, 20,* 555-566.

Meins, E., Fernyhough, C., Wainwright, R., Das Gupta, M., Fradley, E., & Tuckey, M. (2002). Maternal mind-mindedness and attachment security as predictors of Theory of Mind understanding. *Child Development, 73,* 1715-1726.

Miller C. A. (2006). Developmental relationships between language and Theory of Mind.

American Journal of Speech-Language Pathology, 15, 142-154.

Miller, C. A. (2009). *Processing-based assessment of language and its relation to theory of mind in preschoolers.* Proposal submitted to American Speech-Language-Hearing Foundation New Century Scholars Program.

Morales, M., Mundy, P., Delgado, C., Yale, M., Messinger, D., Neal, R., & Schwartz, H. (2000). Responding to joint attention across the 6- through 24-month age period and early language acquisition. *Journal of Applied Developmental Psychology, 21*, 283–298.

O'Hara, M., & Johnston, J. (1997). Syntactic bootstrapping in children with specific language impairment. *European Journal of Disorders of Communication, 32*, 189-205.

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive function deficits in high functioning autistic children: Relationship to theory of mind. *Journal of Child Psychology and Psychiatry, 32*, 1081-1105.

Perner, J., & Lang, B. (1999). Development of "theory of mind" and executive control. *Trends in Cognitive Sciences, 3*, 337-344.

Repacholi, B., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month olds. *Developmental Psychology, 34,* 1017-1025.

Roberts Jr. R. J., Pennington B.F. (1996). An interactive framework for examining prefrontal cognitive processes. *Developmental Neuropsychology, 12*, 105-126.

Ruffman, T., Slade, L., Rowlandson, K., Rumsey, C., & Garnham, A. (2003). How language relates to belief, desire, and emotion understanding. *Cognitive Development, 18*, 139-158

Shatz, M., Wellman, H., Silber, S. (1983). The acquisition of mental verbs: a systematic investigation of first references to mental state. *Cognition, 14*, 301-321.

Slade, L., Ruffman, T. (2005). How language does (and does not) relate to theory of mind: A

longitudinal study of syntax, semantics, working memory and false belief. *The British Journal of Developmental Psychology, 23*, 117-139.

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore, & P.J. Dunham (Eds.), *Joint Attention: Its Orgin and Role in Development* (pp. 103-130). Lawrence Erlbaum Associates, Mahwah, NJ.

Tomasello, M., Carpenter, M., Call, J., Behne, T., Moll, H. (2005). Understanding and sharing intentions: the origins of human social cognition. *Behavioral and Brian Sciences, 28*, 675-735.

Wellman, H. M., & Liu, D. (2004). Scaling of Theory-of-Mind tasks. Child Development, 75, 523-541.

Wellman, H., Woolley, J. (1990). From simple desires to ordinary beliefs: The early development of everyday psychology. *Cognition, 35,* 245-275.

Wiig, E. H., Secord, W. A., & Semel, E. (2004).Clinical Evaluation of Language Fundamentals Preschool (2nd edition). San Antonio, TX: Harcourt Assessment.

Youngblade, L. M., Dunn J. (1995). Individual differences in young children's pretend play with mother and sibling: Links to relationships and understanding of other people's feelings and beliefs. *Child Development, 54*, 858-867.

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EDUCATION

Pennsylvania State University, University Park, PA
Schreyer Honors College
Bachelor of Science, Communication Sciences and Disorders, May 2010

Study Abroad: Cultural Experiences Abroad Global Campus
Liberal Arts and Social Sciences Program
Barcelona, Spain, Spring 2009

HONORS

Schreyer Honors College
Schreyer Ambassador Travel Grant 2008; Barcelona, Spain
National Society of Collegiate Scholars
Phi Eta Sigma Honors Fraternity
Dean's List

RESEARCH EXPERIENCE

Undergraduate Honors Thesis: ***Processing-Based Language Assessment and Theory of Mind in Preschoolers***
The Child Language Development Lab, Penn State University
Spring 2009 to present
Thesis Supervisor: Dr. Carol Miller

- Purpose- Contribute to understanding the relationship between specific language skills and theories of cognitive development in preschoolers
- Reviewed relevant research literature
- Administered experimental tasks and standardized tests to preschoolers
- Spring 2010 to analyze data and report findings

RELEVANT EXPERIENCE

Assistant to Speech-Language Pathologist
Winston Churchill Elementary School & Adlai E. Stevenson Elementary School, Fairfield, NJ
May-August 2009

- Assisted Speech Language Pathologist in planning speech and language therapy sessions for elementary school aged diagnosed with various speech and language disorders.

- Observed Speech Language Pathologist implement direct therapy and evaluations.
- Assisted Speech Language Pathologist during sessions by participating in activities, as appropriate, to reinforce session goals.
- Discussed rationale for long term goals, short term goals, activities and assessment tools with Speech Language Pathologist.

NOTABLE CORSEWORK

Acoustic Principles in Communication Sciences and Disorders: Honors Option
Fall 2008

- Acoustical analysis of a subject with unilateral vocal fold paralysis compared to a normal subject

Introduction to Organic Disorders of Speech and Language
Fall 2009

- Formal APA style report analyzing the second formant frequency transition slopes in Dysarthric subjects
- Formal APA style report comparing factors that affect voice onset time in stutterers' during the adaption effect
- Formal APA style report analyzing speaking fundamental frequency and standard deviation of voice disorder samples compared to normal samples

Clinical Bases of Language Disorders: Honors Option
Fall 2009

- Developed a research proposal and designed a unique experiment to enhance knowledge of theory of mind in autism