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PROCESSING-BASED ASSESSMENT OF LANGUAGE AND ITS RELATION TO THEORY OF MIND IN PRESCHOOLERS

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ABSTRACT

Research suggests that bilinguals have advanced executive function and theory of mind skills (Bialystok, 2008; Bialysok, Barac & Poulin-Dubois, 2010; Carlson & Meltzoff, 2008; Goetz, 2003). This study examines associations among processing-based language, knowledge-based language, executive function, and theory of mind in 18 Mandarin-Cantonese bilingual preschoolers. The research questions were: Do high executive function scores correlate with high theory of mind in bilingual children? Are processing-based language measures more predictive of theory of mind abilities than knowledge-based measures? Theory of mind was most strongly related to fast mapping (processing based) and Mandarin grammar (knowledge based). Findings suggest that language experience may play an important role in theory of mind development for bilinguals.

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Chapter 1 INTRODUCTION

THEORY OF MIND

In order to think about another person's mental states, one must consider that the other person may have thoughts, beliefs and desires that are similar or different to one's own. This understanding of another person's mental state is called theory of mind. (Miller, 2006; Wellman & Liu, 2004)**.** The development of theory of mind is complex; however, research reveals that skills required for theory of mind develop and mature in typically developing children by preschool. Between the ages of three to five, children begin to understand concepts of reality while understanding that others may construct different representations of the same reality (Miller, 2006).

Theory of mind can be examined using a developmental scale that measures different aspects of theory of mind (Wellman & Liu, 2004). Each part of the test becomes increasingly more difficult because the components are chronologically ordered in the way children developmentally progress. Understanding beliefs is more difficult than understanding desires (Wellman & Liu, 2004); therefore, the theory of mind tasks used in this study first test a child's understanding of desires, then proceed to test their ability to understand that people have different beliefs.

LANGUAGE AND THEORY OF MIND

The relationship between theory of mind and language is complex and each quickly develops during the first five years of life. Many researchers have hypothesized that language affects

theory of mind, while others would argue the opposite. De Villiers (2007) proposed that the relationship between language and theory of mind is bidirectional, meaning that the two affect each other.

There are aspects of language development that may play a role in theory of mind development such as joint attention, the use of mental state words, and pretend play (Miller, 2006). Joint attention begins early in development and is the ability to share eye gaze with a communication partner and an object/focal point (Bruinsma, Koegel & Koegel, 2004; Tomasello 1995). This eye gaze can be paired with pointing and alternating eye gaze between the communication partner and the object. In a study conducted by Charman, Baron-Cohen, Swettenham, Baird, Cox, and Drew (2000), joint attention competence at 20 months old was a strong predictor of theory of mind proficiency at 44 months.

Mental states are "nonobvious, internal states which are all potentially at odds with overt behaviors or external reality" (Wellman & Liu, 2004). According to De Villiers (2007), children begin understanding and using mental state words such as *think, want, know*, and *feel* beginning in the preschool years. The use of mental state words develops from age three to five; children first use mental state words without understanding the true meaning and later develop the use of these words to discuss others' beliefs and desires. (Bartsch & Wellman, 1995)

EXECUTIVE FUNCTION

Executive function is a term used to describe cognitive processes such as self -regulation, inhibitory control, planning, attention shifting and working memory (Hughes, 1998). The relationship between executive function and theory of mind is similar to language development and theory of mind because the direction of casual influence is also unclear (Pellicano, 2007). Many studies support the theory that development of executive function leads to the

development of theory of mind (Frye, Zelazo, & Palfai, 1995; Hughes, 1998; Carlson & Moses, 2001). During the preschool years, while children's theory of mind is progressing, their ability to consciously control their actions and thoughts is also developing (Müller, Liebermann-Finestone, Carpendale, Hammond & Bibok, 2011).

Inhibition and working memory are important skills that are required for executive function. Inhibition demonstrates the ability to suppress an automatic response in order to respond correctly with a false reality-based response (Carlson et al., 2002). Working memory requires managing and retaining information. A child's working memory capacity is important in completing theory of mind tasks. A correlation may exist between the two aspects of executive function (inhibition and working memory) and theory of mind (Carlson et al., 2002)

There is a strong correlation between inhibitory control and the theory of mind false belief task (Hughes 1998; Carlson et al., 2002). As children begin to succeed at skills required for working memory and inhibition, children also start mastering the false belief task. By time children are around four years old, they are generally able to successfully complete the false belief task.

De Villiers (2007) describes a classic false belief task as follows. The experimenter uses puppets to tell a story as the child watches. The puppet hides candy in container A and then leaves the scene. Then, a second puppet moves the candy from container A to container B. When the first puppet returns, the child is asked where the puppet will first look. Most children under age four usually answer where the candy is in reality (container B). If the child answers, "container A"—that is, the location where the first puppet placed the candy—he/she is correct and demonstrates the understanding that the character has a "false belief" about the location of the candy.

Inhibition is used in the false belief task when children suppress reality-based responses in order to respond correctly with the protagonist's false belief. This leads to the possible theory that response inhibition can predict theory of mind. Carlson et al. (2002) supported this theory when they found a correlation between inhibition and false belief in 47 typically developing preschool aged children.

PROCESSING BASED LANGUAGE MEASURES VS. KNOWLEDGE BASED LANGUAGE MEASURES

Most research uses knowledge-based measures to examine the relationship between language and theory of mind. Knowledge-based language measures describe more static knowledge and are usually assessed using a standardized test. These tests are generally used to identify a language or speech disorder by measuring receptive, expressive, grammatical, semantic or syntactic skills. Alone, this static knowledge does not paint the total picture of a person's language abilities (Miller, 2009).

Processing-based language measures are much more dynamic and examine how children apply what they learn. In a processing-based language measure, a child is tested by his ability to apply his understanding of a newly learned novel noun or verb. An example of a processing-based language measure task is fast mapping. In this task, the child looks at a picture with three known objects and one unfamiliar object (e.g., honey dipper). The experimenter will say, "point to the dax." The child is correct if he matches the novel noun "dax" to the unknown object (honey dipper). Fast mapping tasks are useful because they provide information about a child's lexical acquisition (Golinkoff et al., 1992).

Campbell, Dollaghan, Needleman and Janosky (1997) suggest examining children's psycholinguistic processing operations because such tasks do not rely on prior knowledge.

Campbell et al. defined psycholinguistic processing as "comprising the mental operations required to manipulate linguistic units," as opposed to knowledge-based measures, which rely on prior knowledge and experience. Campbell et al. found that while minority children scored lower on knowledge-dependent language measures than majority children, both the minority and majority children obtained similar scores on processing-dependent language measures.

BILINGUALISM

There are two categories of bilingualism: simultaneous and sequential (sequential bilinguals are sometimes referred to as second language learners) (Paradis, Genessee & Crago 2011). Simultaneous bilinguals learn two or more languages from birth or before age three. Both sequential language learners and second language learners learn one language from birth and an additional language any time after age three.

Some research suggests that bilingual children have a language advantage when compared to their monolingual peers. There is research that suggests that bilingual children are advanced in theory of mind as well as aspects of executive function and language development (Bialystok, 2008; Bialysok, Barac & Poulin-Dubois, 2010b; Carlson & Meltzoff, 2008; Goetz, 2003).

Goetz (2003) examined three to four year old English monolinguals, Mandarin monolinguals, and balanced Mandarin-English bilinguals. The Mandarin-English bilinguals were exposed to Mandarin from birth and English from around age two. The bilingual children were tested first in one language and a week later in their second language. The groups were matched for language proficiency using a vocabulary test. Then, the children performed a variety of tasks including perspective taking, false belief, and theory of mind. The bilinguals showed an advantage on some theory of mind tasks, but they also had a disadvantage on some theory of

mind tasks. Overall, the data does show evidence supporting a bilingual advantage on theory of mind tasks. Possible explanations for this conclusion include a metalinguistic advantage, greater linguistic control, and a greater sociolinguistic awareness with communication partners (Goetz, 2003).

Another study performed by Bailystok (2008) focused on the relationship between bilingualism and the following cognitive domains: concepts of quantity, task switching, concept formation, and theory of mind. This research found that bilingual children have an advantage over monolingual peers in solving problems that require inhibitory control and ignoring misleading information. The research concluded that bilingualism accelerates the development of cognitive functions related to attention and inhibition. Kovács (2012) suggests that the acceleration of cognitive functions may be due to bilingual children using the same mechanisms for language switching that they use when performing difference executive function tasks.

Carlson and Meltzoff (2008) examined Spanish-English bilinguals, English monolinguals, and English-speaking children enrolled in Spanish language immersion kindergarten. This study investigated the effect of bilingualism on children's executive functioning. When the researchers controlled for factors such as age, verbal ability and socioeconomic status, the native bilingual children performed significantly better than both language groups on the executive function tasks.

Overall the majority of research suggests that there is a bilingual advantage in aspects of theory of mind and executive function.

PURPOSE

The purpose of this research project is to further examine how executive function, knowledge-based language measures, and processing-based language measures are related to the

development of theory of mind in bilingual children. The participants include Mandarin-Cantonese bilingual preschoolers.

Questions addressed in this study include: Do high executive function scores correlate with high theory of mind in bilingual children? Are processing-based language measures more predictive of theory of mind abilities than knowledge-based measures?

Chapter 2 METHOD

PARTICIPANTS

The participants in this study were 18 Mandarin-Cantonese bilingual children ranging from ages 4.5 to 6.5 years (mean= 5.8 years, range: 1.84 years). Nine children were male and 9 were female. All participants were recruited through the University of Hong Kong. A consent form was sent to the parents of children in two different preschools. All children whose parents consented participated in this study and were included in the data. All 18 participants, with the exception of syntactic bootstrapping, are included in the data analysis. Only 9 of the 18 participants are included in the data for syntactic bootstrapping. For syntactic bootstrapping, the trials ended for 2 participants, 2 participant videos of this task were lost and 5 participants did not have permission for recording.

MATERIALS AND PROCEDURES

Parent Questionnaire

The parents of participants were asked to fill out a questionnaire, which provided information about the age of the child's first and second language acquisition, the frequency of each language being used and the child's proficiency in each language. The parents were asked to rank their

children's languages in order of proficiency. Parents did not always report their child's first learned language as the most proficient language. Nine parents ranked Mandarin as their child's most proficient language, while 9 parents ranked Cantonese as their child's most proficient language. The questionnaire also revealed that 12 of the participants' first language was Mandarin, while 2 of the participants' first language was Cantonese and 3 of the participants' first language was both Mandarin and Cantonese. One participant learned Hubei first, then Cantonese. Ten parents also reported that their child was exposed to an additional third or fourth language; however, all the children were exposed to English in the preschool they attended.

Theory of mind

This study used theory of mind tasks that were developmentally scaled for Chinese children (Wellman et. al, 2006). Theory of mind was assessed through six different tasks: diverse desires, knowledge access, contents false belief, explicit false belief, and hidden emotion. Other tasks, including peg tapping and working memory, were used to examine executive function.

For the diverse desires task, each child was shown a picture of an egg and a picture of an ice cream cone. Then, the experimenter asked the child which snack he/she would prefer. After the child pointed to or named the desired item, the experimenter introduced the toy, Aunt Zhang, who preferred the opposite snack. Once the child was told that Aunt Zhang preferred the opposite snack, he was asked the experimental question: "Now, Aunt Zhang is going to eat. She can only have one choice, not two. Which one will Aunt Zhang (pointing) choose? The egg or ice-cream?" The child must correctly identify the snack that he does not prefer. This demonstrates the child's ability to recognize a desire different than his own.

For the knowledge access task, the child was presented with a closed small black box containing an unknown object. The child was asked, "What do you think is in the box."

Naturally, the child usually says, “I don’t know” or the child completely guesses. After answering, the box was opened and the child could see that the box contained a toy dog. The experimenter then asked the child, “What is inside the box?” Then a toy character, Feifei, was introduced and the experimenter explained that Feifei has not seen inside the box. The experimenter then asked, “Does Feifei know what’s in the box?” Lastly, the experimenter asked, “Has Feifei seen what’s inside the box?” If the child answers “no” to both questions, then he is correct.

For the diverse belief task, the child was shown a toy boy and a picture of a bed and a picture of a cupboard. The experimenter introduced the boy character and explains he is looking for his ball; it might be under the bed (pointing) or in the cupboard (pointing). The experimenter asks, “Where do you think the ball is? Is it under the bed, or in the cupboard?” The experimenter explained that the boy thinks his ball is in the opposite place of the child’s choice. The child was then asked, “Where will the boy look for his ball?” The child is correct if he chooses the opposite of his own belief, which demonstrates the child’s ability to recognize the desires of others, though different than his own.

For contents false belief, the child was shown a Pringle canister that contained a pencil. The experimenter asked the child, “What do you think is in here?” Once the child answered, the experimenter showed the child that the canister really contained a pencil. Then the experimenter put the pencil back in the canister and asked the child, “Now, tell me, what is in the canister?” After the child responded, a toy character was introduced. The experimenter told the child that the character has not seen inside the canister. The experimenter asks, “What will the boy think is inside the canister?” “Has the boy seen what’s inside the canister?” If the child answers, “chips,”

and “no” respectively, then the child is correct, which suggests that the child is aware that a person’s belief could be incorrect, but they will still act according to that belief.

For the explicit false belief task, the child was introduced to a toy girl and was shown a picture of a desk with a drawer and a backpack. The child was told that the girl is looking for her book. The book may be in the drawer, or it might be in the backpack. The experimenter said, “BeiBei’s book is in her backpack (pointing), but BeiBei thinks her book is in the drawer.” Then the experimenter asked the child, “Where would BeiBei look for her book?” and “Where is the book really located?” The child is correct if he answers “drawer” and “bag” respectively.

For the hidden emotion task, the child was shown pictures of three facial expressions: happy, neutral, and unhappy. The child was asked to identify each facial expression. The experimented explained that a child may feel (patted chest) one emotion, but look (patted face) another emotion. The child was told a story about a boy who wanted a toy gun, but was given a book instead. The boy does not like books, but the boy hides his feelings. The child is asked, “What toy did the Uncle give the boy?” then “If uncle knows how the boy feels, what will the uncle do?” If either of these are wrong, the story is told again. The experimental questions were then asked, “When Uncle brought the boy a book, how did the boy feel at heart?” and “What was the boy’s expression (patting face)?” If the child answers, “unhappy” or “neutral” and “happy” respectively, then the child is correct.

Executive Function

To measure inhibition as a form of executive function, the experimenter administered a peg-tapping task (Diamond & Taylor, 1996). The experimenter used a pencil and instructed the child with the following rules: “When I tap one time like this (experimenter tapped once), you tap two times like this (experimenter tapped twice).” Then the child practiced with the

experimenter. If the child was wrong, the experimenter modeled the rule again before moving to the next rule. Then the experimented explained the second rule, "When I tap twice, like this (demonstrates), you tap once, like this (demonstrates)." After this instruction, the experimenter and the child practiced. If the child was incorrect, the experimenter modeled the rule again. This task requires the child to remember two rules while exercising inhibitory control over his own behavior.

To examine working memory, the child was shown three different objects (e.g. a train, a cow, a sock). First the child was asked to name the objects in the order they were on the table. Then the child was asked to count the objects in the order in which they appeared on the table (e.g. one, two, three). Lastly, the child was asked to simultaneously count and label the objects (e.g. one is a train, two is a cow, three is a sock).

Processing-based language measures

A fast mapping task and syntactic bootstrapping task were used to assess processing-based language ability. In the fast mapping task, the child was first shown several pictures of familiar objects (e.g. sock, book, cup etc.) The child labeled each familiar object to verify that he could identify each object before the trial began. In each trial, the child was shown a picture with of an array of four familiar and unfamiliar objects. The child was expected to choose the unfamiliar object when asked about the referent novel word, such as "Where is the dax?" To begin the second session, there was a fast mapping memory check, in which the children were asked to identify a novel object from the previous session among familiar objects.

For syntactic bootstrapping, the child was first presented with 15 toys (cat, woman, girl, gorilla, etc.) The child was asked to verbally name each object to verify he could label each toy before the trial began. When a child labeled the gorilla as "monkey," the experimenter referred to

the gorilla as monkey for the duration of the task. Many children labeled the man and woman as, "dad/uncle" or "mom/aunt" respectively. In this case, the experimenter explained that the toys were "man" and "woman" and were reviewed again after the rest of the items were identified. After identifying the 15 toys, the children began a practice trial with 6 tasks. The child was asked to demonstrate sentences such as, "The cow chases the pig." The child was expected to choose the correct toys and then demonstrate the command using the toys. On the fourth task in the practice trial, a non-word was introduced, "The pig teebs the horse." If the child asked, "What does teebs mean," then the experimenter replied, "show me what you think it means," or, "you can make something up."

The task continued with four trials with a total of 12 scored tasks. Each trial consisted of one transitive task, one locative task, and one coordination task. The three types of tasks were given in a different order in each trial.

Knowledge-based language measures

Each child's knowledge-based language was examined by using a grammatical comprehension test, a Cantonese and a Mandarin picture-naming task. The grammatical comprehension test examined the child's grammatical skills (Lei et al., 2011). The child was presented with four pictures (e.g., a cat in a shoe, a cat next to a shoe, a dog in a shoe, and a dog next to a shoe) and orally presented with a sentence or phrase such as, "the cat is next to the shoe." The child was asked to point to the picture that corresponded with the sentence. The Mandarin picture-naming task consisted of 20 pictures of line drawings that were age appropriate and increased in difficulty. These pictures were selected based on the norming study conducted by Liu et al (2011). The child was shown a picture and asked to verbally state the item on the picture. The Cantonese picture naming task was a standardized Expressive Vocabulary Test

(T'sou et al., 2006). The child was shown a picture and asked to verbally name it. The test was comprised of 100 pictures; however, if a child answered incorrectly five times in a row, the test ended.

Procedure

All tasks were performed in Mandarin with the exception of the Cantonese picture-naming task. The theory of mind, picture naming and grammatical comprehension tests were already normed for Mandarin speaking children or published data from Mandarin-speaking children was available. A native Mandarin speaker at Penn State University translated the fast mapping, peg tapping, working memory and syntactic bootstrapping tasks into Mandarin for this study. A second Mandarin speaker checked these translations. Disagreements in translation were resolved through discussion.

Colleagues at the University of Hong Kong made a few changes to the non-words in the fast mapping and syntactic bootstrapping tasks. For fast mapping, the original non-words revealed information about the unfamiliar object's shape or function. All of the fast mapping non-words were changed to make them truly ambiguous in meaning. For syntactic bootstrapping, the original non-words suggested actions such as "come out," or "to take" etc. Eight of the fifteen non-words were changed to make the non-words truly novel. To change the non-words, native Mandarin speakers from the University of Hong Kong looked in a newspaper for ideas of Chinese characters. They combined two characters that are not ever paired semantically.

The children completed all tasks in two sessions. The tasks were always administered in the same order. Session one's order was as follows: theory of mind, fast mapping, peg tapping,

working memory and Cantonese picture naming. Session two's order was as follows: fast mapping recall, syntactic bootstrapping, grammatical comprehension and Mandarin picture naming. Each session lasted approximately 30 minutes with one week between each session. The children were brought to a quiet room for testing. One experimenter ran the tasks, while the other videotaped the session to maintain the validity and reliability of the scores found. Sessions were only videotaped for 13 participants, whose parents gave permission for their child to be video recorded.

Scoring

The theory of mind tasks were scored as pass or fail. Passing one task resulted in one point and failing a task earned zero points. Theory of mind was scored out of a total of 6 points. Each task included an experimental question and control questions. In order to pass, the children needed to correctly answer both types of questions.

For the executive function tasks, the children were scored based on the total correct number of answers. Peg tapping included 14 trials and working memory included 2 trials.

For processing based language measures, the fast mapping and syntactic bootstrapping scores were pass/fail. Passing resulted in one point and failing was zero points. Fast mapping was scored as a summary of the session one and session two (fast mapping recall) trials, which was the number correct out of 15 total trials.

For knowledge-based language measures, the tests were scored according to the specific test's manual. The grammatical comprehension task was 76 trials. The children were scored based on the number of trials answered correctly. The Mandarin picture naming task was the scored as total correct out of the 20 trials. For the Cantonese picture-naming task, the participant received a raw score. The raw score was analyzed using the tests manual. If the child scored

within one standard deviation of the age-appropriate mean, the child was considered within normal limits.

Of the 18 participants, 13 participants' parents allowed video recording of the sessions. These 13 video recordings were viewed by a second person for reliability. A Penn State student who was a native Mandarin speaker assisted when translations were needed. Any discrepancies were resolved through discussion.

Chapter 3 RESULTS

DESCRIPTIVE DATA

This section will provide an overview of how the participants performed in the theory of mind tasks, executive function tasks, processing based and knowledge based language measures. For theory of mind, the mean number of tasks passed was 4.39 with a standard deviation of 1.89. The proportion of children who passed each task are as follows: diverse desires (100%), knowledge access (88.89%) diverse beliefs (83.33%) content false belief (77.78%) explicit false belief (44.44%) and hidden emotion (44.44%).

Peg tapping consisted of 14 trials with a mean of 13.44 tasks passed and a standard deviation of 1.19. Twelve of the 18 participants obtained a scored of 14, while 5 of the 18 participants scored a 13. Working memory consisted of 2 trials with a mean of 1.61 and a standard deviation of 0.78. 14 of the 18 participants scored a 2.

Fast Mapping was completed over two sessions. Session 1 included 12 trials and session 2 (fast mapping recall) had 3 trials. Out of the 15 trials, the mean of tasks passed for fast mapping was 11.44 with a standard deviation of 2.38.

For syntactic bootstrapping, the 9 participant videos were examined by a second experimenter. Syntactic bootstrapping consisted of 12 trials with a mean of 5.33 and standard deviation of 3.25.

For the knowledge-based language measures, the grammar comprehension test consisted of 76 trials with a mean of 66.83 and standard deviation of 5.29. The Mandarin picture naming test included 20 trials with a mean of 12.94 and standard deviation of 2.87. The Cantonese picture naming task used a ceiling**;** all children were within one standard deviation of the mean with the exception of one participant. The participant who was not within one standard deviation was reported as being more proficient in Mandarin on the parent questionnaire form.

CORRELATION DATA

The first research question asks if high executive function scores correlate with high theory of mind in bilingual children. This was examined using Pearson correlations. Cohen (1988) defines a small effect size as r=.10, a medium effect size as r=.30 and a large effect size as r=.50. The correlation between peg tapping and theory of mind was r= -0.10 (p= 0.71). The correlation between working memory and theory of mind was r= -0.09 with a p-value of 0.73. The data from the executive function tasks show no correlation in relation to theory of mind.

The second research question asks if processing-based language measures more predictive theory of mind abilities than knowledge-based measures. The processing based language measures were the fast mapping and syntactic bootstrapping tasks, while the grammatical comprehension test, Mandarin and Cantonese picture naming tasks measured language knowledge.

The fast mapping and theory of mind correlation was r=0.54 (p= 0.02) while the syntactic bootstrapping and theory of mind correlation was r= .25, which is not statistically significant (p =

.52). The fast mapping results have a large effect size and show a significant and positive correlation with theory of mind. The magnitude of the correlation for syntactic bootstrapping is not negligible, but smaller than for fast mapping.

The grammatical comprehension and theory of mind correlation was r=0.643 (p=0.004). This shows a high correlation between grammar skills and theory of mind. The Mandarin vocabulary and theory of mind correlation was r=0.056 (p=0.825), which is not statistically significant. The Cantonese vocabulary and theory of mind correlation was r=0.42 (p=0.122). While the Cantonese vocabulary is a medium effect size, there is still a positive correlation to theory of mind.

Chapter 4 DISCUSSION

One focus of this study was to examine how bilingual children perform on executive function and theory of mind tasks. Many studies (Frye, Zelazo, & Palfai, 1995; Hughes, 1998; Carlson & Moses, 2001) show that skills in executive function lead to development in theory of mind; however this study did not find any correlation between the executive function tasks (peg tapping and working memory) and theory of mind. The lack of correlation between executive function and theory of mind may be the result of the participants' ceiling performances on the two executive function tasks. The ceiling performance may have occurred because the participants in the study were older than participants in previous studies related to executive function.

A unique feature of this study was examining the participants' processing-based language as a possible predictor of theory of mind skills. Because of the participants' exposure to two or

more languages, we predicted that processing based language measures would correlate more highly with theory of mind than language knowledge measures. The results showed a high correlation with fast mapping (language processing) and grammatical comprehension (language knowledge). The syntactic bootstrapping results showed a small effect size, but this may be due to the small number of participants included in the data for this particular task. It's hard to know how much confidence to put in the syntactic bootstrapping correlation, given the small sample, but it does hint at a role for processing-based language.

It is interesting that theory of mind was correlated most strongly with both language processing and language knowledge. These results tell us that it is important to examine both what children know and how children process new information rather than one or the other.

Fast mapping's high correlation with theory of mind is interesting to examine. All of the participants in this study come from a language rich environment while many of the participants were exposed to more than two languages. The fast mapping scores show that these children have the ability to learn new nouns rather quickly. The results may suggest that language experience has an important role in theory of mind development.

All of the tasks in this study were completed in Mandarin with the exception of the Cantonese picture-naming task. While majority of the children were reported as learning Mandarin from birth, only half of the children were most proficient in Mandarin. The official language of Hong Kong is Cantonese and the children receive formal instruction in Cantonese. The findings may have varied if the testing the entire test was administered in Cantonese.

Limitations and Directions for Future Research

The small sample size (n=18) presents challenges in drawing concrete conclusions about the data presented. While most of the children did fairly well, some did poorly on certain tasks. The participants also had different language backgrounds. All of the tasks were conducted in Mandarin, but some of the children were reported as being more competent in Cantonese.

Theory of mind begins to develop and mature between the ages of 3-5 year old, while the average age of the participants in this study was 5.8 years. The participants in this study still had difficulty on 2 theory of mind tasks (explicit false belief and hidden emotion). In the future**,** it may be beneficial to examine children who are younger, or use tasks that are more appropriate for the participant's age. If participants are a similar age to the children in this study, additional explicit false belief and hidden emotion tasks may be beneficial. These additional tasks could provide another opportunity for children to demonstrate if they are beginning to understand these concepts.

As previously stated, the participants showed a ceiling performance on the executive function tasks. In future studies, if the children are older than 5 years old, we would suggest using different executive function tasks. Bialystok (2010a) examined executive control in bilingual 6 year olds using the global-local task and the Trail-Making Task (TMT). Both tasks require the child to interpret a display of symbols (letters and shapes) while retaining a complex rule.

In the global-local task, the child is presented with either four shapes (circles and squares) or four letters (H, S or X). A sample of the stimuli is shown in Figure 1. The child is asked to identify either a global or local feature and uses a computer mouse to make the selection. By identifying the global or local feature, the child attends to certain features of the

symbol while ignoring others. The TMT task consists of two trials Trial A and Trial B. During Trials A, the child is asked given a sheet of numbers 1-25. The child is asked to draw a line to connect the numbers in order without lifting the pencil. In Trials B, the child is presented with number 1-12 and letters A-L. The child is asked to connect the symbols by alternating letters and numbers (1-A, 2-B, 3-3 etc.) The child is scored based on the time required to complete the task.

Figure 1

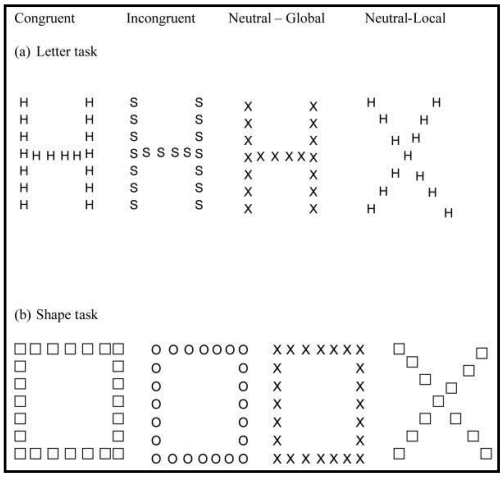

Image taken from Bialystok, E. (2010a). Global-Local and Trail-Making Tasks by Monolingual and Bilingual Children: Beyond Inhibition. *Developmental Psychology*, *46*(1), 93–105. doi:10.1037/a0015466.

Both the global-local and TMT tasks are an appropriate measure of executive function because the tasks both require inhibition, updating and switching. The two tasks use letters or number, so adaptations would have to be made if the participants are Mandarin-Cantonese speakers.

Another interesting aspect of the tasks to examine is response time. The tasks could be adapted to a computer or tablet that measures and records the time it take the children to respond. Response time would be useful for many of the tasks used in this study because it is a more sensitive indicator of skills compared to pass/fail. The data would provide more information about response time and its correlation with theory of mind. Based on findings from Bailystok (2010), we would predict that correct and quick executive function response time would correlate

highly with theory of mind. Response time would be a useful measure in comparing results across language groups (monolingual vs .bilingual).

This study could be the pilot of a more long-term study. By examining a larger number of participants and using the considerations and changes mentioned above, we could learn more about bilingual children's language and theory of mind development. Research in this area is important to the field of Communication Sciences and Disorders because it will help professionals understand the link between language processing, executive function and theory of mind. As we learn more about this area, speech-language pathologists may be able to use this information to improve language interventions for bilingual children.

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ACADEMIC VITA

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Education

The Pennsylvania State University — University Park, PA
Schreyer Honors College — Graduation: May 2015
Communication Sciences and Disorders, B.S.

Research

Partnership for International Research & Education (PIRE) — Hong Kong, HK
Research Assistant — June-August 2013

- Collaborated with professors from Penn State and Hong Kong
- Worked in the Speech and Hearing Department at the University of Hong Kong
- Examined Mandarin-Cantonese bilingual preschoolers theory of mind development
- Collected data **among** 18 participants
- Compared data across language groups to investigate research questions

Child Development Lab — University Park, PA
Research Assistant — Fall 2012- Present

- Examined published literature related to theory of mind
- Conducted research under Carol Miller, Ph.D.
- Gathered data through testing in local preschools
- Recorded and imported results into a research database

Research Presentations

- Poster at Symposium on Research in Child Language Disorders (SRCLD) — June 2014
- Poster at Penn State's Undergraduate Research Exhibition — April 2014
- Oral presentation at Penn State's Center for Language Science symposium — November 2013

Volunteer Work/Awards

Edith Pitt Chase Award — April 2014

- Awarded for academic excellence and community service within the College of Health and Human Development

Health and Human Development Honors Society — September 2012-present

Jumpstart Leader — August 2012-present

- Assisted with facilitating an overnight seminar for freshman in the College of Health and Human Development

Mission Mexico President — September 2011-present

- Volunteer in an orphanage in Tijuana, Mexico

National Student Speech-Language-Hearing Association (NSSLHA) — September 2011-present

- A pre-professional membership association for students interested in the study of Communication Sciences and Disorders

Penn State IFC/Panhellenic Dance Marathon (THON) — September 2011-present

- Held various roles in a year-long fundraising effort to conquer childhood cancer

Taylor Community Foundation Scholarship — April 2011

- Awarded for High School academic excellence and community service