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Theory of mind and inhibitory processing among bilingual Mexican American young children

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THEORY OF MIND AND
INHIBITORY PROCESSING AMONG
BILINGUAL MEXICAN AMERICAN YOUNG CHILDREN

A Thesis

by

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THEORY OF MIND AND

INHIBITORY PROCESSING AMONG

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ABSTRACT

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Bilingual children have been found to demonstrate advantages on tasks dependent in part or in whole on inhibitory processing compared to their language dominant and/or monolingual peers. This study examines relations among performance on theory of mind (ToM), inhibitory processing (FF), and performance on an ambiguous-figures (AF) tasks among monolingual and bilingual children. Participants included 135 Hispanic children ages 4.5 to 8 from predominately low-income families. Results revealed a relationship between FF and AF performance with ToM performance and found no differences in performance between monolingual, language-dominant, and balanced-bilingual children.

DEDICATION

For my mother, Joey, and family. Thank you for your never ending love and support.

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CHAPTER I

INTRODUCTION

Bilingual children, "who can communicate in two languages by speaking, writing, listening, or reading, regardless of whether proficiency is native-like" (Lim, Liow, Lincoln, Chan, & Onslow, 2008, p. 289), have been found to demonstrate advantages on tasks dependent in part or in whole on inhibitory processing compared to their language-dominant and/or monolingual peers (e.g., Bialystok, 1999; Bialystok & Viswanathan, 2009; Blumenfeld & Marian, 2011). However, not all research supports this claim; other researchers suggest that findings of a bilingual advantage could be due in part to methodological errors, such as the use of self-report versus language-scores as a measure of bilingualism, and the need to assess a broader range of bilinguals and comparison groups (e.g., Bonifacci, Giombini, Bellocchi, & Contento, 2011; Prior, 2012). This study examines children's performance on inhibitory processing, ambiguous-figures, and theory of mind tasks and examines differences among monolingual, language-dominant bilinguals, and balanced-bilinguals.

Theory of Mind and Inhibition Processing

Theory of Mind (ToM) is the ability to understand mental states of oneself and others. It is often tested by using false belief tasks that assess children's ability to understand false beliefs, i.e., that someone else has an incorrect belief in comparison to reality. ToM develops around 4 to 5 years of age (for outline of developmental progression, see Wellman, 2012; see also Kristen, Thermer, Hofer, Achersleben, & Sodian, 2006; Peterson, Wellman, & Liu, 2005; Wellman &

Liu, 2004). Subtle, but consistent variations in the pace in which children progress and the order which children understand ToM concepts have been found based on geographic region – although most children proceed through a similar progression in the preschool years (Chasiotis, Kiessling, Hofer, & Campos, 2006; Wellman, 2012; Wellman, Cross, & Watson, 2001). Additionally, children's ability to succeed in ToM tasks fluctuates – children succeed and then subsequently fail assessments – while other cognitive abilities, such as inhibition, continuously progress (Wellman, 2012).

Cognitive inhibition refers to "the ability to inhibit responses to irrelevant stimuli while pursuing a cognitively represented goal" (Carlson & Moses, 2001, p. 1032). It is a component of executive functioning, and a precursor to ToM development (Putko, 2009). Hughes (1998) examined the relationship between ToM and three parts of executive functioning: working memory, attentional flexibility, and inhibitory control. She found a relationship between executive control and ToM even after controlling for age, verbal, and non-verbal ability.

Inhibition processing abilities are considered to be foundational to ToM development by researchers (e.g., Carlson & Moses, 2001; Flynn, 2007; Vetter, Algassen, Phillips, Mahy, & Kliegel, 2013). Carlson and Moses (2001) suggested that the emergence and expression of ToM could be fundamentally dependent upon inhibitory processing after finding strong a relationship between ToM and inhibitory processing across age groups. Flynn, O'Malley, and Wood (2004) found that children typically develop inhibition skills gradually prior to passing a false-belief task, during the timeframe when performance on false-belief tasks is unstable. In a longitudinal study of false-belief and inhibition control, Flynn (2007) found also that the majority of children obtained inhibitory control before they were able to succeed in a false-belief assessment. Importantly, ToM task success was not a predictor of inhibition processing skills in this research;

thus inhibitory processing is an antecedent of ToM. These findings support the idea that inhibition skills are necessary for false-belief understanding.

Dennis, Agostino, Roncadin, and Levin (2009) also suggest that ToM depends on cognitive inhibition, and add that working memory matters as well. Other accounts of ToM development propose that only particular types of inhibition tasks relate to ToM (Perner, Lang, & Kloo, 2002); thus, there might be distinct, cognitive process(es) of inhibition processing underlying ToM development. In a meta-analysis of 102 studies, Devine and Hughes (2014) found evidence supporting the link between false belief and executive functioning (including inhibition), but the strength of the association depended on the type of assessment.

Some researchers have opposed the importance of the relationship between ToM and inhibition processing, suggesting that, instead of inhibition skills, it is primarily perspective-taking and/or linguistic skills that contribute to ToM development. Farrar and Ashwell (2012) found little relationship between a false-belief task and inhibitory processing using a day-night task, which requires children to respond with reverse answers when shown a picture of either day or night. These mixed results leave questions about how cognitive inhibition specifically relates to ToM development.

Ambiguous-Figures Tasks

ToM and inhibition also have been found to relate to children's understanding of ambiguous-figures tasks, which are stimuli that can be perceived in at least two ways. Research has demonstrated that young children (3 to 4 year olds) are able to understand that the figures have multiple meanings, but are unable to reverse the images. The developmental time period when children come to be able to mentally reverse these stimuli that overlaps with ToM development (Gopnik & Rosati, 2001).

Inhibitory functioning is required when processing ambiguous-figures. The reinterpretation of an image is thought to require both the ability to suppress the first interpretation while selectively attending to other aspects of the image (Bialystok & Shaper, 2005). In fact, more executive and imagery capabilities are thought to be required to process ambiguous-figures task in comparison to false belief tasks (Doherty & Wimmer, 2005). However, the manner in which a stimulus is presented can bias interpretations of an ambiguous-figure (Chastain & Burnham, 1975). Particular interpretations of an ambiguous-figure can be achieved by setting stimuli around the image to invoke a particular perception from the viewer (e.g., placing ducks around a duck-rabbit ambiguous-figure; Brugger, 1999). Even the size of an ambiguous-figure can shift the viewer's attention and alter the perception of the image (Goodlkasian, 1987).

Doherty and colleagues (Doherty & Wimmer, 2005; Doherty, 2000; Doherty & Perner, 1998) have proposed that children's false-belief understanding relates to children's understanding of ambiguous-figures because both tasks require meta-representational understanding. Their model also includes the understanding of homonyms, words with distinct meanings, but similar appearance. Conversely, Garnham and colleagues (Garnham & Garnham, 2002; Garnham, Brooks, Garnham, & Ostenfeld, 2000) argue that it is inhibitory control that explains the relationship between false-belief and synonym and homonym understanding (i.e., children need not have a representational understanding). Thus, research investigating ToM, inhibitory processing, and related tasks could shed light on theoretical debates.

Bilingual Development

Bilinguals actively process two languages (Grainger, 1993; Grainger & Dijkstra, 1992; Guttentag, Haith, Goodman, & Hauch, 1984), instead of using language "switching" (e.g.,

Macnamara & Kushnir, 1971; Penfield & Roberts, 1959). Because of the activation of both languages, bilinguals must inhibit their unused language to process information in the needed language (Green, 1998; Kroll & De Groot, 1997). Young bilingual children receive extensive practice in this area - even two year old bilinguals have shown advantages on tasks that require inhibitory control (Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011).

While monolingual children, older adults, and those with frontal lobe damage often have difficulties using inhibition (Dempster, 1992), bilingual children and adults have been shown to have cognitive advantages (for overview, see Bialystok, Craik, & Luk, 2012). In a study comparing bilingual and monolingual college students, Prior (2012) found stronger inhibition skills in bilinguals, but this ability led to decreased performance in a switching task. This bilingual advantage also has been found in other areas, such spatial reasoning (Greenberg, Bellana, & Bialystok, 2013); however, there also is counterevidence.

Namazi and Thordardottir (2010) found that monolinguals and bilinguals were equally successful in ignoring the irrelevant perceptual distraction on a Simon Task, suggesting the groups have equal inhibitory processing capabilities. Furthermore, no differences were found between bilinguals and monolinguals on an attentional networks flanker task measuring inhibition processing (Bialystok, Barac, Blaye, & Poulin-Dubois, 2010). Martin-Rhee and Bialystok (2008) argue that the differences in performance arise from the type of inhibition task, finding advantages on a Simon task, but not a day-night task. Tasks requiring interference suppression, controlling attention to competing cues, show advantages while response inhibition tasks, that require control over competing responses, do not. To add further confusion, De Bruin, Treccani, and Della Sala (2014) found that studies with mixed or null findings were less likely to be published that studies finding a bilingual-advantage, suggesting a publication bias. These

contradictory findings may suggest that only some bilinguals show advantages on some tasks that involve selective attention and inhibitory control. Further research is needed to identify which cognitive processes are advantaged and under which particular circumstances bilingual advantages develop.

Theory of Mind (ToM) Development among Bilingual Children

Bilingualism has been highlighted as a beneficial factor for ToM development in children (Kovács, 2009). Bilingual children were shown to perform better than monolingual children on a ToM assessment, perhaps due to their increased inhibition skills (i.e., to inhibit their own beliefs and/or the incorrect location of an object; Kovacs & Mehler, 2009). Specifically, Kovács (2009) found that bilinguals performed better on two versions of an 'unexpected transfer' task (where an item was transferred from one location to another and the child was asked where an individual would look for the item: the first or second location). Goetz (2003) also has found a bilingual advantage when measuring children's performance on ToM tasks. However, the effects were only present during her first testing session, not in the second testing sessions. Moreover, the effects were only present in children's performance on the 'unexpected contents' ToM task (where the child was asked what someone else *would think* was inside a box after being shown the box containing an unexpected item) and not for an 'unexpected transfer' ToM task. Paap, Johnson, and Sawl (2014) argue that a bilingual advantage in inhibition is the result of small sample sizes and limited assessments. In a meta-analysis of potential bilingual advantages, Barac, Castro, Bialystok, and Sanchez (2012) found mixed findings of a bilingual advantage in inhibition control, but advantages in ToM.

These mixed results leave many questions about bilingual advantages on social cognitive tasks. Few studies have examined inhibitory functioning and ToM development in a bilingual

population, using multiple types of tasks, such as an ambiguous-figures task. While Bialystok and Shapero (2005) found that bilingual children were able to reverse the interpretation of an ambiguous-figure at a higher rate than monolinguals, questions about the processes underlying ToM development have not been fully addressed.

Purpose

In summary, current research is mixed, leaving questions about the effects of bilingualism on social cognitive development with some studies finding differences bilinguals and monolinguals and other studies finding mixed or no differences. Given that increased inhibition skills are expected to be higher in balanced-bilinguals, it is reasonable to hypothesize that balanced-bilinguals will have an advantage in the application of these skills in the two ToM tasks and the ambiguous-figures task.

Hypothesis 1

Children's ToM, inhibitory processing, and performance on ambiguous-figures tasks are expected to be positively and significantly related among all children in the sample.

Hypothesis 2

Balanced-bilingual children, as a group, are expected to have improved inhibition skills compared to Spanish- and English-dominant children. Given this relationship, it is also hypothesized that balanced-bilinguals will perform better on the theory of mind and ambiguous-figures task.

CHAPTER II

METHODOLOGY

Participants

Typically developing children (n = 138, girls = 60), ages four and a half to eight years (M = 6.14, SD = 1.08), from predominately low-income families were recruited from local daycares and schools. Median family income was $10,000 to $19,999 (See Figure 1). Parent's average (mean) age was 33.25 years for mothers and 36.19 years for fathers. The median education level completed by both mothers and fathers was high school. On average, children had two siblings (range = 0 to 5). An overwhelming majority of children were of Hispanic descent, having either one (11.86%) or both (83.70%) parents self-identifying as Hispanic. Only 18.26% and 19.15% of mothers and fathers were born in Texas, while 77.39% and 77.96% of mothers and fathers were born in Mexico respectively. For the children, 89.00% were born in Texas, 8.00% were born in Mexico, and 3.00% in another geographic region. All mothers resided with the child (3 cases did not respond). In comparison, 70.68% of fathers resided with the child. A majority of parents rated their child's computer skills as average or above average for their age group (78.15%). See Table 1. Appendix A contains recruitment materials and the demographic survey.

Figure 1.

Familial Income

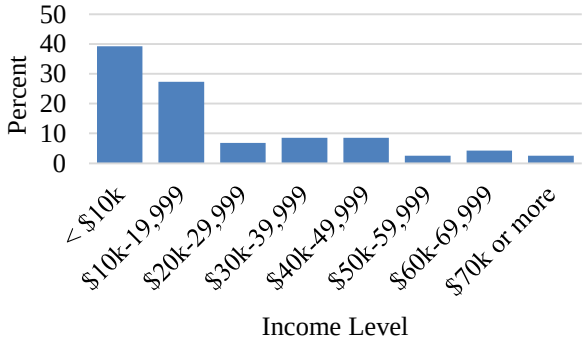


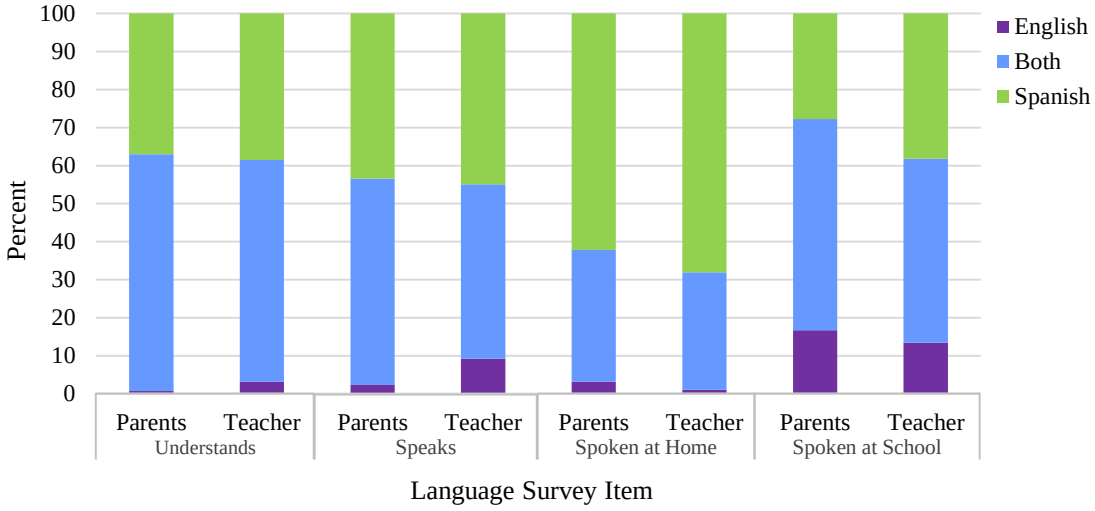
Table 1.

Descriptive Analysis of Demographics

	N	Minimum	Maximum	Mean (SD)	Median
Child's Age	135	4.50	8.58	6.15 (1.08)	
Child's Computer Skills	119	1	3	1.88 (0.56)	2
Number of Siblings	134	0	5	1.98 (1.21)	2
Household size	135	1	9	4.61 (1.47)	5
Mother's Age	129	21	46	33.25 (6.03)	34
Father's Age	113	22	63	36.19 (8.24)	35
Family Income	114	1	8	2.61 (1.93)	2

Figure 2.

Language Abilities and Usage via Parents and Teachers Reports



Parents indicated that most children spoke and understood both Spanish and English, both languages at school, and Spanish at home, similar to Teacher reports (See Figure 2). Parents reported reading to their child in Spanish for 2.70 hours a week and in English 2.51 hours a week. Teachers reported that they read to children on average (mean) 6.19 times in Spanish and 3.78 times in English.

Procedures

Public schools, day-care centers, and other child care facilities were contacted to obtain written permission to host the study. After obtaining permission from the director/administrator, packets were distributed to teachers to be given to parents. These packets included an informational letter, an informed consent form, and a demographic survey. Upon the return of the packet from the parent, teachers/caregivers were asked complete an informed consent document and a brief questionnaire for each participating child. All documents were provided in English and Spanish.

One 20 minute session was conducted for each child, led by a pair of bilingual research assistants. Sessions were held in a quiet room, away from the child's classroom, to minimize distractions. Each child was first administered the language assessment (counterbalanced for order of language) to ensure that each child could understand either English or Spanish with enough proficiency to perform the tasks and to create a bilingualism score, by subtracting English from Spanish Standardized scores, for those who had proficiency in both languages. The remaining tasks were administered in the child's higher-scoring language. In the circumstance where the child's language score for English and Spanish were within one point of each other, the child was asked which language they preferred to speak. Following the language assessment, the child was given the following tasks: one ToM (either false-belief or true-belief task),

ambiguous-figures, inhibition, and the remaining ToM task. This ordering was used to avoid confusion and/or priming between the two ToM tasks. As a reward for their participation, children received a book at the end of each session.

Measures

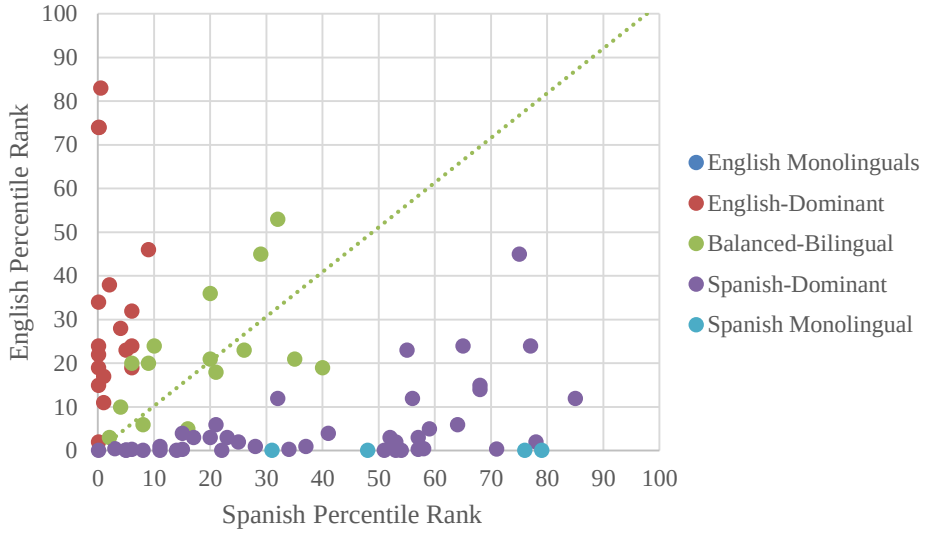
Demographics

Children's parents completed a demographic form provided within the recruitment materials (See Appendix A for parent survey). Teachers were asked to complete a questionnaire about the language use of the child, similar to those asked of parents (See Appendix B).

Language Assessment

The Picture Vocabulary subtest of the Woodcock-Munoz Language Survey – Revised uses 59 pictures to assess picture vocabulary and is appropriate for ages 2 to 90+ (Woodcock, Munoz-Sandoval, Ruef, & Alvarado, 2005). The assessment is standardized in both English and Spanish. Children were asked to verbally name pictures, and for each item correctly named, the child received one point. Children were required to pass a minimum of 6 items to demonstrate language proficiency. Possible scores range from 6 to 59. Language difference scores were developed by subtracting standardized English vocabulary scores from standardized Spanish vocabulary scores; the absolute value was then taken of the product. Scores closer to zero indicate similar vocabulary scores in English and Spanish, i.e., more balanced-bilinguals. The sample was divided into three groups based on these difference scores: Monolinguals (Only one assessment passed), Language-Dominant (>10), and Balanced-Bilingual (10 to 0). Figure 3 displays these groups along with the language of dominance. Table 2 displays the means and standard deviations for children's standardized Spanish vocabulary score and standardized English vocabulary score by language group.

Figure 3.
Spanish and English Percentile Rank Classified by Language Proficiency Group



Inhibition

A computer-presented flanker task was developed based Roebers, Schmid, and Roderer (2010) and Rueda et al. (2004). The task presents a series of pictures where the child is asked to respond only to the center fish's direction. To set-up the task, a computer was placed at approximately 1 foot away from each child at a comfortable angle. The child received instructions and an example of how to respond based on the direction of the center fish ("We are going to play a fish game. Here, on the computer screen is going to be a hungry fish–here in the center. When the fish is facing to the left – this direction [Researcher pointed to image], press the left button [Researcher pointed to left button]" Instructions were then repeated, but for the right facing fish.). After hearing these instructions, each child was asked to indicate their responses for each type of fish groupings: congruent image (target fish and surrounding fish pointed in the same direction), non-congruent (target fish pointed in the opposite direction of the other fish), and neutral (target fish with non-directional stimuli). For examples of stimuli used, see Figures 4.

If the child inaccurately responded to the control questions, the instructions were repeated and the child was given another opportunity to respond to the images (for a maximum of two repetitions).

After this introductory phrase was completed, the child began a practice session (of 8 images) followed by two assessment periods (of 24 images each) within the task software, Open Sesame. For both the practice and two assessment periods, a crosshair was displayed for a random time between 800 ms and 2,000 ms. Then, the stimulus image was presented where the child responded based on the direction of the target fish in the center. Between each session, the child was reminded to only feed the "hungry," center fish by pressing the button corresponding to the fish's direction, ignoring the fish surrounding the center fish, and respond as quickly and accurately as possible. Accuracy scores and response times were recorded for both sessions and averaged. For each correct response, the computer would emit a chewing noise indicating that the center fish had been properly fed. For each incorrect response, the computer emitted a tone. See Table 2 and Table 3.

Figure 4.
Examples of Fish Flanker (FF) Task Stimuli

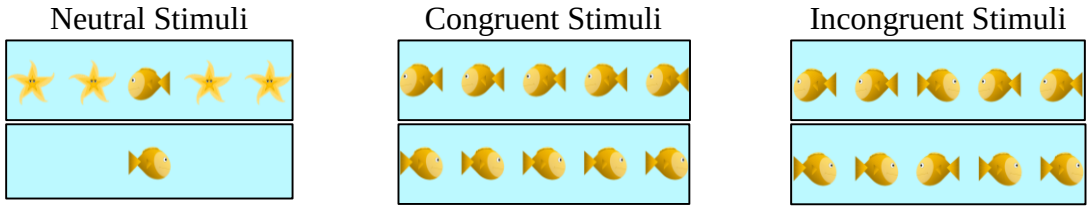


Table 2.
Age Groups' Percentage of Correct Responses (SD) for Neutral, Congruent, and Incongruent Conditions

	Neutral		Congruent		Incongruent	
4.5 to 5.5	85.57%	(15.53%)	83.04%	(19.96%)	61.61%	(22.94%)
5.5 to 6.5	90.36%	(15.61%)	92.71%	(19.14%)	69.27%	(26.30%)
6.5 to 7.5	95.69%	(8.73%)	95.98%	(10.36%)	91.09%	(19.41%)
7.5 to 8.5+	98.51%	(2.07%)	98.81%	(3.03%)	91.67%	(19.88%)

Table 3.
Age Groups' Response Time (SD) in ms for Neutral, Congruent, and Incongruent Conditions

	Neutral		Congruent		Incongruent	
4.5 to 5.5	1219.90	(426.92)	1354.24	(600.25)	1675.75	(626.94)
5.5 to 6.5	1027.50	(239.45)	1101.59	(259.96)	1693.18	(1216.89)
6.5 to 7.5	925.96	(281.59)	992.04	(329.45)	1120.50	(468.19)
7.5 to 8.5+	803.82	(198.80)	900.66	(326.21)	1181.32	(706.15)

Ambiguous-figures Task

The ambiguous-figures task was based on procedures and four line drawings in Doherty and Wimmer (2005). See Figure 5. A disambiguation phase occurred first to ensure that the child understood that the figures could have two meanings. The child was asked to interpret the duck-rabbit figure. Based on the child's response, the experimenter added the corresponding stimuli to confirm this possibility (e.g., for the duck interpretation, an overlay of the duck's body swimming with another duck was added). The experimenter then suggested that the figure could have two meanings and added stimuli suggesting the opposite interpretation's stimuli (e.g., if the child first interpreted duck, the rabbit stimuli was added). For each interpretation, two identification questions were asked to confirm the child's ability to see the interpretation.

In the 'say something different' phase, the child was be asked to say a different interpretation than that given by the experimenter. Before the session started, the child was reminded of the two meanings by interchanging the stimuli. The disambiguation image, the

duck-rabbit image, was shown so that the child could practice the game. Then, the child was shown three different ambiguous-figure combinations with two meanings. The researcher began by identifying one interpretation, describing two aspects of this interpretation, and then asked two identification questions (e.g., for man-mouse image, the researcher identified the image as a man, described where the man's eyes and chin were located, and then asked "Where is the top of the man's head?"; "Can you point to the man's nose?"). The child was then reminded the image was two different things and asked "What else can it be?" If the child correctly identified the image at this point, four points were awarded, and then the child was asked two identification questions for the second interpretation. If the child was unable to identify the image, the research showed an overlay of the remaining interpretation and asked the child again to interpret the image. If the child correctly identified the image at this point, two points were awarded, and the two identification questions were asked. If interpretation was still not possible, the research revealed the alternative interpretation with zero points awarded and asked the child the two identification questions. For each correct identification question for the first and second interpretation, children were awarded 2/3 of the points to the next identification level. Scores possible for each figure ranged from 0 points to 4.66 points. A total score was computed by taking the average of all four images in the 'say-something-different' phase.

Figure 5.
Ambiguous-Figures (AF) Images

Figure	Ambiguous Image	Supporting Stimuli 1	Supporting Stimuli 2
1 Duck-Rabbit			
2 Man-Mouse			
3 Vase-Faces			
4 Indian-Eskimo			

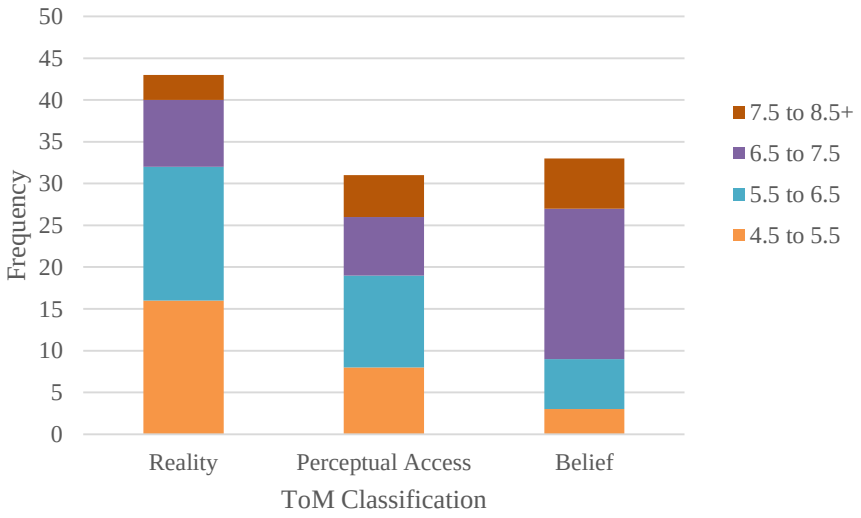
Theory of Mind

Theory of mind (ToM) reasoning level was assessed using two ToM tasks, one false-belief (FB) task and one true-belief (TB) task, based on procedures described by Fabricius, Boyer, Weimer, and Carroll (2010). In the FB task, the child was shown a box and asked to speculate what was inside. After the child responded, the experimenter revealed the contents of the box, showing the child the foreign object (e.g., a cereal box with a sock inside). The foreign object was then returned to the container in clear view of the child. Then, the child was asked to speculate what someone who has never seen inside the box would think was inside, without opening the box. In a follow-up question, the child was asked to justify his/her answer.

For the true-belief (TB) task, the child was shown a box with incorrectly matched contents (e.g., a candy box with a color inside) and asked what could be inside the box. The

correctly matching object was then traded out for the foreign item in viewing distance of the child. The child was then asked what someone would think was inside the box when he/she has never seen inside the box and has not opened the box. In a follow-up question, the child was asked to justify his/her answer. Based on the response to both the TB and FB tasks, children's ToM level was classified as either Reality, Perceptual Access, or Belief (See Figure 6 for ToM classification by age group).

Figure 6.
Theory of Mind Classification by Age Group



CHAPTER III

RESULTS

Table 4 shows the interrelations among the demographic variables (e.g., mother's and father's education level), and critical variables (performance on the flanker task (FF) measuring inhibitory processing, understanding of ambiguous figures (AF), and theory of mind (ToM)). These analyses were conducted to ensure that children's computer skills did not relate to performance on the computerized FF task (Accuracy: r = .04, n = 88, *ns*; Response time: r = -.00, n = 88, *ns*) and examine demographic correlates of the critical variables. Parental education was associated with children's response times on the FF task (Mothers' education: r = -.28, n = 98, p < .01; Fathers' education: r = -.37, n= 85, p < .01) and children's computer skills (Fathers' only: r = .23, n = 82, p =.36). Family income was not associated with any critical variable. Of interest, age was negatively and significantly correlated with language difference scores, meaning older children were more likely to be English-dominant and younger children Spanish-dominant (r = -.31, n = 135, p < .01). Age also positively and significantly correlated with ToM (r = .35, n = 107, p<.01), AF (r = 19, n = 124, p = .04), and negatively with FF (Accuracy: r = .49, n = 103, p < .01; Response time: r = -.38, n = 103, p < .01).

Table 4.

Intercorrelations of Demographic Variables and Critical Variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Child's Age	-	0.15	.22*	.14	.13	-.16	.11	-.05	.09	-.08	-.02	-.17	-.31**	.35**	.21*	-.22*	.49**	-.42**
2	Child's Gender		-	.15	-.04	-.05	.00	.07	.06	-.01	-.01	.05	.03	.00	-.01	.02	-.08	.07	-.07
3	Computer Skills			-	.06	.08	.09	.08	.23*	-.01	.22*	.00	.20	-.16	.18	.00	-.04	.04	.00
4	Household Count				-	.11	-.16	.09	-.06	.66**	-.24*	-.13	.03	-.06	-.15	.07	.05	.01	.03
5	Mother's Age					-	.17	.78**	.09	.19*	.15	.06	.21	.08	.00	.04	-.28**	.10	-.26*
6	Mother's Education						-	.01	.62**	-.29**	.39**	-.01	.17	-.12	.10	.02	.07	.05	.10
7	Father's Age							-	.10	.21*	.05	.04	.18	.23*	.01	.05	-.31**	.07	-.36**
8	Father's Education								-	-.22*	.55**	-.05	.03	-.20	.09	.09	-.16	.04	.10
9	Siblings Count									-	-.36**	-.10	-.08	.00	-.11	-.04	.04	.12	-.03
10	Family Income										-	-.04	.21	-.17	.05	.11	-.04	.02	.04
11	Spanish Score Standardized											-	-.24*	.34**	.08	.09	.07	.07	.17
12	English Score Standardized												-	-.067	.01	.19	-.09	-.17	.00
13	Language Dominance Scores													-	-.12	.00	-.12	-.22*	.12
14	ToM														-	.29**	-.19	.27*	-.18
15	AF															-	.00	.15	.14
16	FF																-	-.10	.47**
17	FF (Accuracy)																	-	-.31**
18	FF(Response Time)																		-

**.0.01 level (2-tailed). *0.05 level (2-tailed).

Hypothesis 1

Correlational analyses were conducted to test Hypothesis 1 (i.e., that children's ToM, inhibitory processing, and performance on ambiguous-figures tasks were positively and significantly related among all children in the sample). These are shown in Table 5. As shown, higher performance on the ToM tasks was found to be related to quicker response difference times on the FF task (r = .27, n = 89, p = .01) and higher performance on the AF task (r = -.20, n = 104, p < .01). However, there was not a significant relationship between FF and AF performance. Additionally, language dominance scores were not correlated with performance on the ToM, AF, or FF tasks. Given that age related to the critical variables, a hierarchical regression analysis was conducted to examine predictors of ToM understanding over and above age as a predictor (Table 6). Age was entered as the first step, followed by AF and FF in Step 2. Age and AF performance were both a significant predictors.

Table 5.

Intercorrelations among Ambiguous-Figures, Theory of Mind, and Flanker Task Performance, N>86

		1	2	3
1	Ambiguous-Figures	-	.27**	.02
2	Theory of Mind	-	-	-.20*
3	Flanker Task			-

**.0.01 level (1-tailed). *0.05 level (1-tailed).

Table 6.

Regression Analysis

		β	t	Sig.
1	Age	.35	3.44	.001**
2	Ambiguous-Figures	.22	2.12	.04*
2	Flanker Task	-.138	-1.36	.18

Hypothesis 2

Balanced-bilingual children, as a group, were expected to have improved inhibition skills compared to Spanish- and English-dominant children. It also was hypothesized that balanced-bilinguals would perform better on the theory of mind and ambiguous-figures task, compared to language dominant children. To examine this hypothesis, initial analyses were conducted to identify if the groups were demographically similar, followed by group comparisons.

Figure 7 shows the English and Spanish Percentile Ranks for each language proficiency group (English Monolingual, English-Dominant, Balanced-Bilingual, Spanish-Dominant, and Spanish Monolingual). A one-way ANOVA comparing language groups on language proficiency scores showed a significant difference between the groups, $F_{\text{Proficiency}}(2, 132) = 440.03$, $p < .001$, $\eta^2_p = .87$. Post-hoc test to explore differences among the language groups using the LSD method to control for family-wise error revealed that all language groups differed. Table 7 displays the standardized English and Spanish scores for each group. Children's language scores in comparison to national norm (100) were low. Analyses were conducted to examine if there were any language dominance group differences on gender, age, computer skills, mother or father education level, or family income. Specifically, a 3 x 6 (language group by demographic variable) MANOVA found the main effect of language group was significant, F_{Group} (12, 132) = 2.48, $p < .05$, $\eta^2_p = .18$. Univariate analyses revealed that the only significant difference was on income level ($F_{Age}(2, 70) = 3.05$, *ns*, $\eta^2_p = .80$; $F_{\text{Computer Skills}}(2, 70) = 2.20$, *ns*, $\eta^2_p = .06$; $F_{\text{Father's Education}}(2, 70) = 1.53$, *ns*, $\eta^2_p = .04$; $F_{\text{Mother's Education}}(2, 70) = 2.56$, *ns*, $\eta^2_p = .07$; $F_{\text{Family Income}}(2, 70) = 5.11$, $p < .01$, $\eta^2_p = .13$; $F_{\text{Gender}}(2, 70) = 1.08$, *ns*, $\eta^2_p = .30$). Thus, the monolingual group had significantly lower income levels that the language-dominant group ($M_{\text{Monolingual}} = 2.00$, $SD = 1.40$; $M_{\text{Language-Dominant}} = 3.11$, $SD = 2.15$), while the balance-bilingual group did not differ from

the monolingual group or the language-dominant groups ($M_{\text{Balanced-Bilingual}} = 2.54$, $SD = 2.26$). Language groups were similar on all other aspects.

Although, the balanced-bilinguals were expected to outperform other groups on all critical variables, three one-way ANOVAs: 1) language group by ToM, $F_{\text{ToM}}(2, 104) = 2.46$, *ns*, $\eta^2_p = .05$, 2) language group by FF, $F_{\text{FF}}(2, 96) = 1.16$, *ns*, $\eta^2_p = .01$, and 3) language group by AF, $F_{\text{AF}}(2, 121) = .17$, *ns*, $\eta^2_p = .02$, were all non-significant. Three figures below illustrate language group performance similarities on the FF (Figure 8), AF (Figure 9), and ToM tasks (Figure 10). Table 8 shows the valid cases, means, standard deviations, medians, minimum score, maximum score, and range for each task. Thus, the balanced-bilinguals did not outperform other groups on the critical variables, as expected.

Figure 7.
Language Proficiency Groups' Percentile Rank in Spanish and English

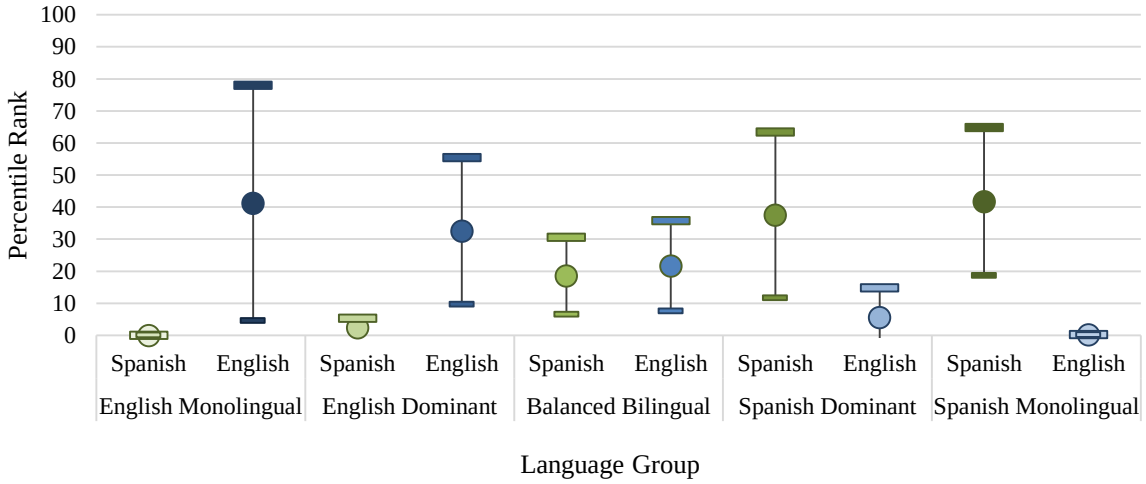


Table 7.
Means (SDs) for Standard Vocabulary by Language Group

Variable	Language Group					
	N	Monolingual	*N*	Language-Dominant	*N*	Balanced-Bilingual
Spanish Vocabulary	53	95.79 (11.55)	62	83.02 (20.70)	15	84.73 (8.05)
English Vocabulary	9	69.44 (32.73)	60	74.42 (18.19)	15	86.47 (8.11)

Figure 9.
Ambiguous-Figures Performance by Language Group

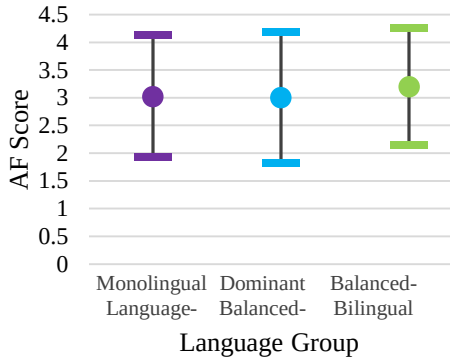


Figure 8.
Theory of Mind Performance by Language Group

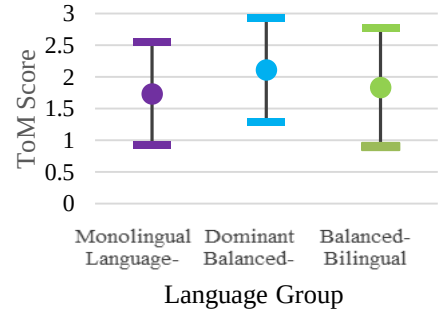


Figure 10.
Flanker Task Performance by Language Group

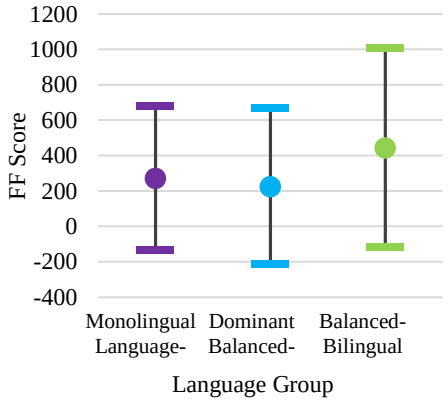


Table 8.
Task Performance by Language Group

		1	2	3
ToM	Valid	49	46	12
	Missing	9	16	3
	Mean	1.73	2.11	1.83
	SD	0.81	0.82	0.94
	Median	2.00	2.00	1.50
	Range	2.00	2.00	2.00
AF	Valid	53	57	14
	Missing	5	5	1
	Mean	3.02	3.00	3.20
	SD	1.09	1.18	1.06
	Median	2.85	3.10	2.98
	Range	5.25	5.00	3.25
FF	Valid	41	46	12
	Missing	15	14	3
	Mean	270.66	224.39	443.49
	SD	408.96	440.47	563.94
	Median	124.33	61.17	320.46
	Range	1938.08	2400.42	2095.58

1 Monolingual
2 Language-Dominant
3 Balanced-Bilingual

CHAPTER IV

DISCUSSION

The present study examined the relationship between inhibition, ambiguous-figures, and theory of mind performance in monolingual bilingual children. Hypothesis 1 predicted that these three factors would be interrelated. This was partially supported. As expected, the child's age and parental education level related to children's performance. Theory of mind related to ambiguous-figures and inhibition performance, but a relationship was not found between ambiguous-figures and inhibition, suggesting that these two tasks independently and significantly relate to theory of mind development. This finding support the theory by Doherty and colleagues (Doherty & Wimmer, 2005; Doherty, 2000; Doherty & Perner, 1998): children's meta-representational understanding underlies the development of theory of mind and understanding of ambiguous-figures, and not Garnham and colleagues' (Garnham & Garnham, 2002; Garnham, Brooks, Garnham, & Ostenfeld, 2000) theory that the similarity between children's performance on ambiguous-figures and ToM tasks was primarily due to both being dependent on children's inhibition processing skills. This was not supported; ToM and AF related independently of inhibitory skills.

Hypothesis 2 proposed that balanced-bilinguals would perform better than their language-dominant and monolingual peers. Bilinguals, contrary to other studies, did not differ in inhibition, theory of mind, or ambiguous-figures performance. Several explanations are available as to why these differences were not found. The lack of balanced-bilinguals in our sample may

have limited the ability for differences to be detected; however, the sample overall included a fair number of participants and effect size estimates were small. The median income was lower than the expected average for the Hidalgo County area of $34, 116 (U.S. Census, 2015). Due to the nature of our ToM classification scheme, belief understanding was conservatively awarded based on strong support of this reasoning level. The young children in the sample were recruited primarily from schools that focused on teaching children English, as evidenced by the relationship between age and bilingualism. Bilingualism was inversely related to age; most children were Spanish monolingual and then with age, became increasingly bilingual. Children's language scores in comparison to national norms were low; however, it should be noted that this language assessment is standardized with monolingual speakers and not bilingual speakers, like those included in this sample, and balanced-bilinguals have been shown to perform lower on picture naming tasks in comparison to monolingual speakers (Gollan & Acenas, 2004; Gollan Fennema-Notestine, Montoya, & Jernigan, 2007; Gollan, Montoya, Fennema-Notestine, & Morris, 2005; Kohnert, Hernandez, & Bates, 1998; Roberts, Garcia, Desrochers, & Henandez, 2002).

Although no predictions were supported in full, the present student adds to the field of child development in a meaningful way. There are methodological strengths including a conservative classification scheme and the use of standardized language scores instead of relying on parental or teacher report, which has been found to be inaccurate. Middle-income parents were approximately 72% accurate in their classification of their child's language abilities (Weimer, Meza, & Gasquoine, 2011). The study also extends findings to an underrepresented sample of the population, a Hispanic low-income and low parental education sample.

To avoid child fatigue, the present study limited the number of tasks administered. For example, the study only included one type of inhibition task. Other inhibition tasks are available that could be used to further examine the relationship between these factors (Martin-Rhee & Bialystok, 2008). Also, only one subtest of the Woodcock-Munoz Language Survey – Revised (Woodcock, Munoz-Sandoval, Ruef, & Alvarado, 2005) was administered. Classifying bilinguals by other aspects of language might reveal different results (e.g., Barac, Castro, Bialystok, & Sanchez, 2012). Future studies could also benefit by the inclusion of tasks examining other executive functions, such as working memory. Given that the measures of this study were linguistically demanding, non-verbal assessments could assist in understanding relations among variables relating to ToM development. Future researchers could also continue to refine the inhibition and ambiguous-figures task for easier administration to children of this and other age ranges. Further understanding of bilingualism, inhibitory processing, and social cognition will contribute to our understanding of ToM development.

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APPENDIX A

APPENDIX A

RECRUITMENT MATERIALS FOR PARENTS IN ENGLISH

Dear Parents/Guardians:

My name is Sarah Stegall. Together with my advisor, Dr. Amy Weimer, and the child development lab at the University of Texas-Pan American (UTPA), we are conducting a study at your child's school to complete part of the requirements for my Master's degree. The teachers and director at your child's school have agreed to help us conduct our study to further understand children's thinking abilities.

If you are willing to give permission for your child to participate:

1) **Please read and sign the enclosed Informed Consent Form (which describes the study), and indicate your approval for your child to participate**.

2) Please complete the enclosed survey and **return them to your child's teacher**. To maintain your anonymity, please do not write your name on the survey or demographic forms.

Your child will receive a small gift (a book) upon completion of the study, as a token of our gratitude of your time and participation.

If you have any questions, feel free to contact us at anytime. Thank you in advance for your interest in child research.

Sincerely,

Sarah Stegall, B.S.
Psychology Graduate Student
University of Texas–Pan American
Phone:
sestegall@broncs.utpa.edu

Amy A. Weimer, Ph.D.
Associate Professor
Department of Psychology
University of Texas–Pan American
Phone: 956-665-2650
aweimer@utpa.edu

Approved by:
UTPA IRB
Expires: 9/27/2015
IRB# 2013-033-03

INFORMED CONSENT FORM FOR PARENTS

Investigators: Amy A. Weimer, Ph.D. and Sarah Stegall, B.S.

Background: We are examining the influence of language skills on the development of children's abilities to understand other people's perspectives and how this relates to the development of social skills and behavior.

Procedure: The study involves the following procedures:

1. Completion of the enclosed demographic survey and questionnaire entitled "Survey for Parent."
2. Teachers will complete a questionnaire regarding your child's language use and skills.
3. Two separate 20- minute sessions with your child will conducted by two members of the research team - one session will be conducted in English and the other in Spanish. For each session, the research team members will get acquainted with your child before conducting the session, so that your child feels comfortable. Your child will be taken by the research team members to a quiet room at your child's school, accessible by school staff, where s(he) will: (a) take a short language comprehension test (in either English or Spanish depending on the type of session), (b) will listen to short stories and then be video-recorded while they answer questions about the characters' thoughts and actions (such as "Is it true what Mr. Brown says?" and "Why does he say that?"), (c) will be asked to distinguish vague pictures, and (d) play a short computer task to feed cartoon fishes.

Approximate Number of Participants Involved in the Study: Approximately 100 young children from the Rio Grande Valley of Texas are expected to participate in this study.

Risks or Possible Discomforts Associated with the Study: There are no anticipated risks or discomforts associated with your child's participation in the study.

Benefits of Participation: There are no direct benefits to your child for participation in this study, though he/she may find the experience interesting and it is hoped that the study will add to the science of childhood development.

Voluntary Participation: Your child's participation in this study is voluntary. Your child may discontinue participation at any time without penalty. After the study has started, your child may tell the researcher that he/she does not want to continue and your child will be returned to his/her teacher. Additionally, if you change your mind about allowing your child to participate in the study, you may call the researcher directly and withdraw your consent. If you choose not to allow your child to participate, the decision will not affect your child's standing in the class.

Approved by:
UTPA IRB
Expires: 9/27/2015
IRB# 2013-033-03

Anonymity and/or Confidentiality: Your child's responses will remain confidential. A number will be issued to your child rather than your child's name on all documents and video tapes. These items will be stored until the completion of the study in a locked UTPA facility. Only research team members will have access to them. No identifiable information will be included in any publications of this study.

Whom to Contact for Research Related Questions: For questions or concerns about the study or your child's participation in this study, contact the researchers, Sarah Stegall at sestegall@broncs.utpa.edu or Dr. Amy Weimer at (956)665-2650 or aweimer@utpa.edu.

Whom to Contact Regarding your Child's Rights as a Participant: If you have any questions or concerns about your child's rights as a participant, or feel that the child's rights were violated; contact the Institutional Review Board for Human Subjects Protection at (956)665-2889 or at www.utpa.edu/IRBfeedback.

Signatures: By signing below, you indicate that you have read the consent form and the procedures involved have been described thoroughly to your satisfaction. By checking the 'yes' box, you are voluntarily allowing your child _____ to participate in this study. The researcher will provide you with a copy of this form for your own reference.

I agree to participate and allow my child to participate in the study:

[ ] Yes [ ] No

_____ ____/____/____

Parent/Legal Guardian's Signature Date

Child's Birthdate: ____/____/____

For staff completion.

ID: _____

SHORT SURVEY (Please **do not** write your name on this form.)

Complete the following to the best of your knowledge. **All information is anonymous and confidential.**

1. Child's Gender
Male | Female

2. Birthday
/ /

3. City, State of Child's Birth

4. What language does your child…

… currently *understand*?	English	Spanish	Both
… currently *speak*?	English	Spanish	Both
… typically speak at *home*?	English	Spanish	Both
… typically speak at *school*?	English	Spanish	Both

5. How many hours per week do you read to your child?
… in *Spanish*? _____ hours per week
… in *English*? _____ hours per week

6. My child's computer skills for his/her age group are...
Below average | Average | Above average

7. Maternal figure (☐ Biological Mother ☐ Other:)

Ethnicity
Hispanic | Anglo | _____

Lives with Child?
Yes | No | Other: _____

Age
years old

Highest level of education completed
☐ < High School ☐ Bachelors or similar
☐ High School ☐ Masters or similar
☐ Associates or similar ☐ PhD, MD, or similar

City, State of Birth

8. Paternal figure (☐ Biological Father ☐ Other: _____)

Ethnicity
Hispanic | Anglo | _____

Lives with Child?
Yes | No | Other: _____

Age
years old

Highest level of education completed
☐ < High School ☐ Bachelors or similar
☐ High School ☐ Masters or similar
☐ Associates or similar ☐ PhD, MD, or similar

City, State of Birth

9. Siblings

First Name	Gender	Age	Language	Lives with Child
	Male | Female		English | Spanish | Both	Yes | No
	Male | Female		English | Spanish | Both	Yes | No
	Male | Female		English | Spanish | Both	Yes | No
	Male | Female		English | Spanish | Both	Yes | No
	Male | Female		English | Spanish | Both	Yes | No

10. Who else lives in the child's household?
☐ Grandmother ☐ Grandfather ☐ Aunt ☐ Uncle
☐ Cousin ☐ Other: _____

11. Family income (Reminder: This is confidential.)
☐ < $10,000 ☐ $20k-29,999 ☐ $40k-49,999 ☐ $60k-69,999
☐ $10k-19,999 ☐ $30k-39,999 ☐ $50k-59,999 ☐ $70k or more

12. Who completed this form?
☐Maternal figure ☐ Paternal figure ☐ Grandmother ☐ Grandfather ☐ Other

Thank you for your participation. Please return all forms.

APPENDIX B

APPENDIX B

RECRUITMENT MATERIALS FOR TEACHERS IN ENGLISH

Approved by:
UTPA IRB
Expires: 9/27/2015
IRB# 2013-033-03

INFORMED CONSENT FORM FOR TEACHERS

Investigators: Amy A. Weimer, Ph.D. and Sarah Stegall, B.S.

Background: We are examining the influence of language skills on the development of children's abilities to understand other people's perspectives and how this relates to the development of social skills and behavior.

Procedure: You will be asked to:

1. Complete the enclosed survey entitled "Survey for Teacher."

Risks and Benefits of Participation: There are no anticipated risks or discomforts associated with your participation in the study. There are no direct benefits to participating in this study.

Voluntary Participation: Your participation in this study is voluntary. You may discontinue participation at any time without penalty.

Anonymity and/or Confidentiality: Your responses will remain confidential. A number will be issued to you responses rather than your name on all documents and video tapes. These items will be stored until the completion of the study in a locked UTPA facility. Only research team members will have access to them. No identifiable information will be included in any publications of this study.

Whom to Contact for Research Related Questions: For questions or concerns about the study, contact the researchers, Sarah Stegall at sestegall@broncs.utpa.edu or Dr. Amy Weimer at (956)665-2650 or aweimer@utpa.edu.

Whom to Contact Regarding your Rights as a Participant: If you have any questions or concerns about your rights as a participant, or feel that your rights were violated; contact the Institutional Review Board for Human Subjects Protection at (956)665-2889 or at www.utpa.edu/IRBfeedback.

Signatures: By signing below, you indicate that you have read the consent form and the procedures involved have been described thoroughly to your satisfaction. By checking the 'yes' box, you are volunteering to participate in this study. The researcher will provide you with a copy of this form for your own reference.

I agree to participate in the study:

[ ] Yes [ ] No

_____ ___/____/____

Signature Date

For researcher completion.
ID: _____

QUESTIONS FOR TEACHER

(Please **do not** write your name anywhere on this form)

SECTION I: ABOUT THE CHILD

Please complete the following to the best of your knowledge.

1. What language does the child…
   a. … *currently* **understand**? English | Spanish | Both
   b. … *currently* **speak**? English | Spanish | Both
   c. …. speak at **home**? English | Spanish | Both
   d. … speak at **school**? English | Spanish | Both

SECTION II: ABOUT YOU

2. How many times do you read to the child… *(Write **number** in blank)*
   a. … in **Spanish** *per week*? _____ times per week
   b. … in **English** *per week*? _____ times per week

BIOGRAPHICAL SKETCH

Sarah E. Stegall earned her Bachelor of Science in Psychology from the University of Texas-Pan American (UTPA) in 2011. In 2012, she joined the graduate program in Experimental Psychology at UTPA.

During her career as a graduate student, Ms. Stegall has served as a teaching assistant with the Department of Psychology and research assistant with the College of Social and Behavioral Dean's Office. Currently, she in employed full-time on the Title V Grant, *Evaluation of Student Experimental Research Experiences at UTPA*. She has also served as president of her university's Psi Chi chapter and as Southwest Steering Committee student member. She has presented research at local, regional, and national conferences. Her thesis, *Theory of Mind and Inhibitory Processing among Bilingual Mexican American Young Children*, was supervised by Dr. Amy A. Weimer.