Effects of early bilingualism on theory of mind development among children in economic adversity

Rong Huang
University at Albany, State University of New York, rhuang5@albany.edu

Follow this and additional works at: https://scholarsarchive.library.albany.edu/legacy-etd

Part of the Developmental Psychology Commons, and the Educational Psychology Commons

Recommended Citation
https://scholarsarchive.library.albany.edu/legacy-etd/2927

This Dissertation is brought to you for free and open access by the The Graduate School at Scholars Archive. It has been accepted for inclusion in Legacy Theses & Dissertations (2009 - 2024) by an authorized administrator of Scholars Archive.
Please see Terms of Use. For more information, please contact scholarsarchive@albany.edu.
EFFECTS OF EARLY BILINGUALISM ON THEORY OF MIND DEVELOPMENT
AMONG CHILDREN IN ECONOMIC ADVERSITY

by

Rong Huang

A Dissertation
Submitted to the University at Albany, State University at New York
In Partial Fulfillment of
The Requirements for the Degree of
Doctor of Philosophy

School of Education
Department of Educational and Counseling Psychology
2022
The present study investigated the associations between bilingualism and Theory of Mind (ToM) development among children from low-income backgrounds. ToM is the capacities of understanding others’ mental states, such as beliefs, knowledge, or emotions, which develops rapidly during early childhood. Previous studies showed that bilingual experience may be associated with an enhanced ToM, while it is less known whether the similar effect can be generalized to the low-income populations. In addition, it remained unclear what role of Executive Function (EF) plays in the relationship between bilingualism and Theory of Mind under economically disadvantaged environments. The current study aims to address the two research gaps.

Sixty-eight economically disadvantaged preschool children (54.4% boys) completed the language assessment, three EF tasks, and a five-task ToM battery by Wellman and Liu’s (2004), which includes measures of Diverse Desires, Diverse Beliefs, Knowledge Access, False Belief Understanding, and Hidden Emotions. The three standardized EF tasks assessed inhibition control, working memory, and cognitive flexibility respectively. Participants were categorized into two groups based on their Bilingualism Status: Thirty-five English monolinguals (M_{age} = 48.91 months, M_{INR} = 1.23), 33 English-Spanish bilingual children (M_{age} = 51.97 months, M_{INR} =1.22). Parents provided information about family demographics and the child’s language experience at home.

Both ANCOVA and hierarchical linear regression results showed that after controlling children’s age and English proficiency, there was a positive correlation between bilingualism and ToM among children in low-income families. Specifically, bilingual children were more likely to demonstrate a better ToM competence compared to monolingual children. In addition, the higher
degree of bilingualism is associated with better ToM performance in bilingual children. Mediation analysis indicated that the effect of bilingualism on ToM through the pathway of working memory and cognitive flexibility was significant, while the pathway through inhibitory control were not significant.

The findings suggest that an early bilingual learning experience can be a protective factor for economically disadvantaged preschool children’s ToM development, and different EF components may play a different role in this relationship. The present study offers great significance in exploring the boundaries and mechanisms of bilingual effects on preschool children’s ToM development. Educational implications and future directions are discussed.
ACKNOWLEDGEMENTS

I would like to express my sincere gratitude and appreciation to the many people who made it possible for me to complete this dissertation. First of all, I am indebted to my advisor and chair, Dr. Erin Ruth Baker, for her intense and unwavering support, guidance and feedback during the period of this project. Her expertise on young children’s Theory of Mind and Executive Function development was a great help to me in refining my vision in the dissertation. She also guided me to be a better academic writer, to manage time and stress, and to move forward to the next chapter of my career. I would also extend my thanks to Dr. Tianlin Wang and Dr. Hae In Park, for their constructive comments and insightful advice from the perspective of language development, which made my dissertation robust.

I want to say special thanks to the excellent, dedicated, responsible research assistants: Anabelle Lopez, Michelle Barranco, Rosemary Avila, Jessica Hyman, Anabel Espinal, Malene Torres, and Anahi Chabla. Without their contribution on recruiting participants and leading the interview with participants, this project would not have been possible. I also must express my gratitude to the participated children and parents for their willingness to be part of the study.

In addition, I own more than thanks to my husband, Yehui Liu, who has been working tirelessly to support me and taking care of the little man, Henry Liu. My words here cannot express how thankful I am to him. Henry Liu, thanks for his lovely smiles and kisses, which removes my tiredness and offers me strong motivation to complete the dissertation.

Lastly, I would also like to thank my friends and my extended families. During the pandemic, despite the geographical distance that separate us, my friends, and parents in two sides strongly believes in me and supports me without condition.
# TABLE OF CONTENTS

ABSTRACT ii
ACKNOWLEDGEMENTS iv
TABLE OF CONTENTS v

CHAPTER I: INTRODUCTION .................................................................................................................. 1
   Research Background .......................................................................................................................... 3
   Research Purposes and Significance ................................................................................................. 6

CHAPTER II: LITERATURE REVIEW .................................................................................................. 9
   Theory of Mind .................................................................................................................................. 9
      *The Nature of Theory of Mind* ..................................................................................................... 9
      *Theory of Mind and Executive Function* .................................................................................... 15
      *Theory of Mind and Language* .................................................................................................... 16
   Bilingualism ..................................................................................................................................... 18
   Bilingualism and Cognitive Development ....................................................................................... 20
      *Bilingualism and Language Abilities* .......................................................................................... 21
      *Bilingualism and Executive Function* .......................................................................................... 23
      *Bilingualism and Theory of Mind* ............................................................................................... 26
   Role of EF on the Relationship between Bilingualism and Theory of Mind ...................................... 30
   Impacts of Poverty Exposure ............................................................................................................. 31
   The Current Study ............................................................................................................................. 33

CHAPTER III: METHOD ...................................................................................................................... 38
   Participants ....................................................................................................................................... 38
   Sampling Procedure .......................................................................................................................... 39
   Measures .......................................................................................................................................... 42
   Data Collection and Procedure ......................................................................................................... 55
   Data Preparation ............................................................................................................................... 57
   Analytical Plan .................................................................................................................................. 58

CHAPTER IV: RESULTS ..................................................................................................................... 59
   Preliminary Analysis and Descriptive Statistics .............................................................................. 59
      *Group Equivalency in Age, INR, and Language Proficiencies* ..................................................... 59
      *Descriptive Analysis of Theory of Mind Performance* ................................................................. 59
      *Descriptive Analysis of Executive Function Performance* ......................................................... 61
      *Correlations Among the Key Variables and Control Variables* .................................................. 64
   Hypothesis Testing .............................................................................................................................. 66
      *Effects of Bilingualism on Low-income Children’s Theory of Mind* ........................................... 66
      *Role of EF in Relationship between Bilingualism and Theory of Mind* .................................... 72

CHAPTER V: DISCUSSION .................................................................................................................... 75
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilingualism and Theory of Mind</td>
<td>75</td>
</tr>
<tr>
<td>Monolingual and Bilingual Children’s Theory of Mind Development</td>
<td>75</td>
</tr>
<tr>
<td>Protective Effects of Bilingualism on Low-Income Children’s Theory of Mind Development</td>
<td>76</td>
</tr>
<tr>
<td>Mediating Role of EF on Relationship between Bilingualism and Theory of Mind</td>
<td>78</td>
</tr>
<tr>
<td>Bilingualism and Executive Function</td>
<td>78</td>
</tr>
<tr>
<td>Executive Function and Theory of Mind</td>
<td>78</td>
</tr>
<tr>
<td>Educational Implications</td>
<td>84</td>
</tr>
<tr>
<td>Limitations and Future Directions</td>
<td>86</td>
</tr>
<tr>
<td>Conclusion</td>
<td>88</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>90</td>
</tr>
<tr>
<td>APPENDIX A: THE QUALIFICATION SCREENING SURVEY (PARENT INTEREST FORM)</td>
<td>128</td>
</tr>
<tr>
<td>APPENDIX B: BACKGROUND QUESTIONNAIRE</td>
<td>130</td>
</tr>
<tr>
<td>APPENDIX C: ONLINE ASSESSMENT INSTRUCTIONS FOR CAREGIVERS</td>
<td>131</td>
</tr>
</tbody>
</table>
Chapter I: Introduction

With globalization, the phenomenon of being able to speak two or more languages has been rapidly increasing in the U.S. society and all over the world since the 1980s (Kids Count Data Center, 2018). According to American Community Survey Reports in 2018, nearly one fifth of the population aged five and over (21.8 %) spoke a language other than English at home in the United States (Zeigler & Steven, 2019), which almost doubled since 1980 (11%). With the tradition of immigration patterns in the United States, one of the major reasons for children becoming bilingual is that they are from immigrant families; that is, they have at least one foreign-born parent (Hoff, 2018). The newest data regarding children of immigrants in the U.S. showed that around 56% of children in immigrant families speak two languages, and among those bilingual children from immigrant families, 71% of children speak Spanish (Zeigler & Steven, 2019). Being exposed to the environment with the heritage language, namely their immigrant parent’s native language, and the English-speaking social community ensures that children grow up with the ability to understand and speak two languages actively in their daily life, which is termed as bilingualism (Byers-Heinlein & Lew-Williams, 2018; Grosjean, 2010).

In the frequent transition between using the heritage language and English, young bilingual children may struggle with some aspects of language development (Bialystok, 2009; Calvo & Bialystok, 2014; Hoff, 2018; Gollan et al., 2002; Scheele et al., 2010). Specifically, research has found that bilingual children had a smaller vocabulary size in each language than their monolingual peers (Bialystok, 2009; Calvo & Bialystok, 2014). Additionally, they also underperformed in speech production and reduced verbal fluency compared to monolinguals (e.g., Gollan et al., 2002; Giezen & Emmorey, 2017). It was once believed that learning two languages simultaneously would be a burden for children’s brain. However, the current literature
refuted that idea (Bosch & Ramon-Casas, 2014; de Houwer et al., 2014; Vihman et al., 2017). Although bilingual children usually show smaller vocabulary in each language compared with monolingual peers, they often have a larger total vocabulary in general than monolingual children after three years old (de Houwer et al., 2014; Potter & Lew-Williams, under review). In addition, research suggests that bilingual children start to demonstrate their comprehension and production of their first words at similar ages as monolinguals (see Fennell & Lew-Williams, 2018 for review).

When exploring the effects of learning two languages on cognitive abilities, research found that bilingual children tend to show benefits in cognitive abilities, such as better inhibition in unfavored response, thinking in a more flexible way (Baker, 2011; Bialystok, 2001; Bialystok & Martin, 2004; Carlson & Meltzoff, 2008; Morales et al., 2013; Poulin-Dubois et al., 2011), as well as better understanding of others’ mental states (Diaz & Farrar, 2018; Goetz, 2003; Kovács, 2009; Schroeder, 2018) compared with monolingual children.

The capacity to understand others’ mental states, including desires, beliefs, intentions, and emotions is known as Theory of Mind (ToM) (Shahaeian et al., 2015), a form of social cognition. ToM is a crucial capacity developed during the preschool years to ensure children’s success in early communication and social activities. The cognitive skills that serve to guide and monitor goal-directed behaviors, such as inhibiting unfavorable responses, short-term memory, and flexible attention shifting are referred as components of Executive Functions (EF) (Miyake et al., 2000). A large body of research has demonstrated that bilingual children are likely to outperform monolingual children in ToM tasks (Goetz, 2003; Schroeder, 2018) and EF tasks (Bialystok & Martin, 2004; Morales et al., 2013). However, poverty, as a unique environmental context, has profound impacts on children’s cognitive development (Matheny et al., 1995;
Vernon-Feagans et al., 2012), including ToM (Current, 2004; Holmes-Lonergan, 2003; Pears & Moses, 2003). The relationships between learning two languages and ToM have seldom been investigated in children from poverty. It is unknown whether the better ToM performance in traditional bilingual children can be extended to bilingual children living in poverty.

In the current study, I investigated concurrent relationships between bilingualism, ToM, and poverty exposure in preschool children. Specifically, I examined the following three research questions:

1) Do bilingual preschool children living in low-income families have a better ToM ability than monolinguals in low-income families?

2) How does degree of bilingualism make a difference to low-income children’s ToM performance?

3) What potential roles does EF play in the relationship between bilingualism and ToM among children living in economic adversity?

Research Background

The preschool years (3- to 5-year-old) is a critical period for both language development and cognitive development generally (e.g., Genesee, 2010; St. John et al., 2018). Substantial research examines how language and cognition interact with each other in child development (Bialystok & Martin, 2004; Carlson & Meltzoff, 2008; Kovács, 2009; Morales et al., 2013; Schroeder, 2018). At the beginning and middle of the nineteenth century, the majority of research suggested that ownership of two or more languages had detrimental consequences (Saer, 1923) or at least neutral effects (Pitner & Arsenian, 1937) on individuals’ cognitive capacities.

The turning point in the history of exploring the relationship between bilingualism and
cognition was the research conducted by Peal and Lambert (1962), which is the first study supporting that the experience of speaking two languages may lead to higher cognitive capacities over monolingual speakers. Specifically, they demonstrated that bilingual children showed higher Intelligent Quotient (IQ) scores than monolingual children. Although IQ tests have been criticized from many perspectives, this particular research led researchers later on to take a broader look at the potential bilingual strengths on other cognitive abilities (Baker, 2011).

Currently, bilingual children demonstrate greater cognitive abilities in many aspects compared with monolingual children, from intelligence to EF (Peal & Lambert, 1962; Bialystok & Martin, 2004; Carlson & Meltzoff, 2008; Morales et al., 2013), and to social cognition - ToM (Diaz & Farrar, 2018; Goetz, 2003; Kovács, 2009; Schroeder, 2018).

Many studies have demonstrated that bilingual children outperform their monolingual peers on EF (e.g., Bialystok, 2001; Bialystok & Martin, 2004; Morales et al., 2013), such as attention flexibility, inhibitory control and working memory (Bialystok, 2005; Bialystok & Craik, 2010; Carlson & Meltzoff, 2008; Miyake et al., 2000; Stocco et al., 2014). Attention flexibility refers to the ability to shift their thinking or attention between different tasks or operations in response to a change in rules (Miyake et al., 2000; Zelazo, 2015). Research findings indicated that bilingual children tend to have a higher accuracy in rule shifting tasks with a faster response time than monolingual children (e.g., Bialystok, 2001; Bialystok & Martin, 2004; Prior & MacWhinney, 2010). Inhibitory control requires children to inhibit autonomous responses related to the stimuli while carrying out a less relevant response (Diamond, 2013). Similarly, studies have found that bilingual children are more likely to control unfavorable responses than monolingual peers (e.g., Bialystok, 2001; Carlson & Meltzoff, 2008; Martin-Rhee & Bialystok, 2008). Working memory refers to a mental process to store information temporarily
during active processing of such information (Gathercole et al., 2004). Past studies also have demonstrated that bilinguals may recall the non-verbal stimuli from memory more accurately and quickly than monolingual peers (e.g., Blom et al., 2014; Calvo et al., 2016; Hernandez et al., 2012; Morales et al., 2013).

Extending from cognition to social cognition, many recent work indicates that bilingual children may also show more accurate understanding of others’ intents, beliefs, and social behaviors (Fan et al., 2015; Goetz, 2003; Kovács, 2009; Raisa et al., 2019; Schroeder, 2018), which is also the foundation of this dissertation.

As the environmental context, in which children growing up, plays an important role in children’s developmental outcomes (Bronfenbrenner & Evans, 2000), it is highly possible that poverty exposure, as a common but unique environment, may have different impacts on the relationship between bilingualism and ToM (Matheny et al., 1995; Vernon-Feagans et al., 2012). Impoverished families tend to experience more instability of houses and work status, parents tend to have longer working hours, and children often have less access to childcare and learning resources compared with middle-or-upper income families (Evans & Wachs, 2010; O’Hare, 2009). Much research argues that poverty exposure would put children at-risk and have negative impacts on developing cognitive abilities, such as longer response time in EF tasks and failure in passing ToM tasks (Holmes-Lonergan, 2003; Lawson & Farah, 2017; Seidenfeld et al., 2014; St. John et al., 2018; Tompkins et al., 2017), which is a deficit model.

In more recent years, researchers argue that the deficit model can be stigmatizing and instead, an ecologically adaptive model has been proposed (Frankenhuis & de Weerth, 2013; Frankenhuis & Nettle, 2020). The ecologically adaptive model proposes that children living in poverty may make adaptive changes to meet the environment’s needs, such as developing...
necessary abilities to cope with the challenges in their life, rather than passively influenced by the negative environments (Frankenhuis & Nettle, 2020). Therefore, it is worthwhile to focus on children living in economic adversity and explore the possible disadvantages and strengths they may have in language and ToM development. In this dissertation, following the ecologically adaptive model, I gravitated to use a non-stigmatized language when describing the possible comparisons between groups. However, as most of the existing studies used a deficit model to summarize the possible effects of poverty on children’s development, sometimes certain contrastive language is unavoidable (e.g., advantage/disadvantage, better performance, underperformed, etc.).

**Research Purposes and Significance**

The current literature relating bilingualism to ToM has several critical gaps remained to be answered. First of all, although current literature tends to suggest that traditional bilingual children generally showed higher ToM abilities than monolingual children, existing studies are mainly limited to the traditional children from middle-class backgrounds (Greenberg et al., 2013). Few studies examined whether the bilingual advantage in ToM can be generalized to children living in impoverished families. Given that a large portion of the children living in economically disadvantaged families are bilingual (Zeigler & Steven, 2019), it is worthwhile to investigate whether the findings from previous studies about bilingualism and ToM can be generalized to children in a different socio-economic context.

Second, even in traditional samples, it is not clear what mechanisms can explain the bilingual advantage on children’s ToM performance (Fan et al., 2015; Kovács, 2009). The possible explanations may include EF (Schroeder, 2018), metalinguistic awareness (Diaz & Farrar, 2018), or social-linguistic experience (Schroeder, 2018). Given that the large portion of
literature supporting bilingual advantage in EF (Bialystok, 2001; Bialystok & Martin, 2004; Morales et al., 2013) and the close relationship between EF and ToM has been well-established (Carlson et al., 2004; Devine & Hughes, 2014; Marcovitch et al., 2015), it is necessary to understand what roles EF play in the relationship between bilingualism and ToM among children from low-income families as well.

Therefore, the current study is targeted to address the above two gaps in literature and improve our understanding of the relationship between bilingualism, ToM, and poverty in preschool children. In addition, I decided to select Spanish-English bilinguals as the potential target participants based on the following considerations.

First of all, Spanish-English bilingual children are the most representative bilingual children in the United States, as reports showed that over 41 million people (14% of the population) spoke Spanish at home in 2018 (Zeigler & Steven, 2019). At the same time, Spanish-speaking families were more likely to experience poverty in the U.S. According to the U.S. Census Bureau (2018), the poverty rate in 2018 for Hispanics was 17.6%, which is much higher than non-Hispanic whites (8.1%) and Asians (10.1%).

In addition, the standardized versions of language proficiency tests in Spanish are more readily available compared to other languages. For instance, the receptive vocabulary test Peabody Picture Vocabulary Test (PPVT) has a Spanish version, called the Test de Vocabulario en Imágenes Peabody (TVIP) (Dunn et al, 1986). In addition, there is a widely used web-based language tests targeting at English-Spanish bilingual children - Quick Interactive Language Screeners: English-Spanish tests (QUILS:ES). The standardized language tests in both languages are comparable, which not only enable us to measure children’s language proficiency in both
languages, but also allow us to compare the languages proficiencies across two languages and investigate how the balance of two languages impacts bilingual children’s ToM development.

More importantly, although eliminating cultural effects in bilingual children is impossible, I urged to reduce the interference of culture to a minimum in bilingual groups. Many researchers devoting themselves to explore bilingualism effects have examined children from heterogeneous language backgrounds, such as Chinese-English bilingual children (Bialystok & Martin, 2004; Bialystok et al., 2005). Carlson and Meltzoff (2008) indicated that when examining bilinguals with two languages from largely different cultures, it is hard to disentangle whether the cognitive advantages found in bilingual children is due to the culture effects or bilingualism per se. Compared with bilinguals getting involved in Asian and Western cultures at the same time (e.g., Chinese-English bilinguals), Spanish-English bilingual speakers share more cultural commons due to the similarities shared in Spanish and English (August et al., 2002; Oller & Eilers, 1982), which may reduce the confounds of culture effects in this study.

Overall, this study seeks to offer insights into the bilingualism effects on preschool children’s ToM development. It bridges the gaps in our understanding of low-income bilingual children’s ToM development. In addition, this study has practical implications to parents and educators who are concerned with the development of children from economically disadvantaged families as well as parents from low-income families. It is important for parents and educators to know whether exposing economically at-risk children to two languages early in life can be beneficial to child development or not. Further studies based on the current study could also inform parents, educators, and policy makers on how to effectively help economically at-risk bilingual children to achieve better developmental outcomes.
Chapter II: Literature Review

The relation between children’s ToM and language development, including bilingualism, have been well documented in research (Dahlgren et al., 2017; Diaz & Farrar, 2018; Milligan et al., 2007). However, the connections between ToM and bilingualism largely come from more affluent samples. It is unclear how the relationship between bilingualism and ToM operates among children under economic adversity, and what is the mechanism within this relationship. In this chapter, relevant literature regarding these topics is reviewed. First, an introduction on ToM and bilingualism is provided, respectively. Then, the bilingual effects on children’s cognitive development, including EF and ToM, are discussed. The following section concerns the mechanisms of bilingual effects on ToM, specifically the role of EF. Lastly, the impacts of poverty exposure on children’s cognitive development are discussed. At the end of this chapter, the research questions and proposed hypotheses of the current study are presented.

Theory of Mind

The Nature of Theory of Mind

As an important aspect of social cognition (Curenton, 2004), ToM majorly manifests as the capacity to make inferences about others’ mental states, such as others’ wants, thoughts, beliefs and feelings, and using this understanding to interpret and predict others’ behaviors (Gopnik & Astington, 1988; Shahaeian et al., 2015; Wellman & Liu, 2004). In other words, development of ToM allows children to realize that different people may have different mental states, one’s mental states can change over time, and these mental states may be consistent or inconsistent with the external world (Wellman & Liu, 2004). Researchers have reached a consensus that ToM grows with age and develops dramatically during the preschool years, between age 2 to 6 years (Curenton, 2003, 2004; Kyuchukov & Villiers, 2009; Wellman & Liu,
Usually around age 4, normally developing children have acquired the typical ToM capacity - False Belief Understanding (which described in the next section) which marks when children are able to form mental representations of others’ internal states (Cutting & Dunn, 1999; Perner et al., 1987).

Development of ToM during the preschool age is crucial as it holds implications for children’s social competence (Razza & Blair, 2009; Devine et al., 2016) and academic achievement (Blair & Razza, 2007; Cavadel & Frye, 2017). As children in the early childhood years are learning social conventions and establishing initial friendships, ToM abilities allow them to understand others’ minds, as well as their behaviors; for instance, children need to be able to interpret what others say, why they take a different perspective when they have different opinions, and to develop an appropriate social response. Overall, ToM is a crucial ability in human daily life (Admed & Miller, 2011; Blair & Razza, 2007).

**False Belief Understanding (FBU) as One Typical Aspect of ToM.** FBU refers to one’s ability to anticipate another’s actions and behaviors, particularly when the person’s beliefs are inconsistent with reality (that is, the other person holds a belief that is false, and acts according to that false belief; Astington & Jenkins, 1999; Wellman, 2011). Although ToM is made of several components of perspective taking, FBU is the most commonly assessed component during the preschool years.

Various forms of FBU tasks have been used in literature to measure ToM. The traditional task used to measure FBU is the Sally-Anne task (Baron-Cohen et al., 1985; Wimmer & Perner, 1983). In this task, the child is shown that Sally places a marble into a basket, and then she leaves the room. While she is out of the room, Anne takes the marble out from the basket and puts it into the other box. The child is then asked where Sally will look for the marble when she
comes back. A child who correctly answers that Sally will look for the marble in the basket would be considered to have developed FBU because the child understands that Sally did not witness the location change and therefore still hold the original, but false, belief that the marble is in the basket, and that these false beliefs guide Sally’s actions.

Research has demonstrated that most preschoolers at age 3 fail in the FBU tasks whereas by age 5 children from middle- or upper-class families reliably pass it (Wellman et al., 2001; McAlister & Peterson, 2013). However, as FBU tasks are the most ubiquitous assessments of ToM, many researchers considered FBU exclusively when it comes to ToM, rather than all aspects of ToM (Flavell, 2000; Wimmer & Perner, 1983).

**Considering ToM as A Multi-component Concept.** Myriads of research have demonstrated that ToM is a multi-component psychological phenomenon and is comprised of a number of different mental state understandings, such as diverse desires, diverse beliefs, knowledge base, FBU and emotion recognition, etc. (Wellman & Liu, 2004). In recent decades, researchers have criticized that previous studies placed too much emphasis on FBU relative to other ToM aspects (Wellman, 2011; Wellman & Liu, 2004; Pears & Moses, 2003; Shahaeian et al., 2015; Smogorzewska et al., 2018). Although FBU is a significant milestone in children’s development of ToM, equating FBU with ToM may lose much of the variability in understanding ToM overall. Having developed FBU does not necessarily guarantee having a developed understanding of disparate emotions. For example, a child who is able to understand others hold a false belief may not realize that someone displays disparate internal and external emotions.

The development of different components of ToM follows a protracted and predictable sequence over the childhood years (Wellman & Liu, 2004). Specifically, Wellman and Liu
(2004) proposed that there are five unique ToM faculties, and the developmental progression for children from the United States is like this (from the earliest to latest developed): Diverse Desires, Diverse Beliefs, Knowledge Access, Explicit False Beliefs and Hidden Emotions (see Table 1 for a summary of the five components of ToM). Specifically, they demonstrated that children can first correctly recognize that others' desires may differ from their own before they understand the inconsistencies of their own and others’ belief or emotions.

Table 1

Descriptions of the Five-task ToM Battery by Wellman and Liu (2004)

<table>
<thead>
<tr>
<th>ToM Tasks</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diverse Desires</td>
<td>Child judges that two individuals (child vs. target) have different desires about the same object.</td>
</tr>
<tr>
<td>Diverse Beliefs</td>
<td>Child judges that two individuals (child vs. target) have different beliefs about the same object, when the child does not know which belief is true or false.</td>
</tr>
<tr>
<td>Knowledge Access</td>
<td>Child sees the contents of a box and judges the knowledge of an ignorant person who does not see the contents of the box.</td>
</tr>
<tr>
<td>False Belief Understanding</td>
<td>Child judges how the target search for an object, given the target's mistaken belief of the object’s location.</td>
</tr>
<tr>
<td>Hidden Emotions</td>
<td>Child judges the target’s capacity to display and feel disparate emotions.</td>
</tr>
</tbody>
</table>

Originally, Wellman and Liu (2004) tested a seven-task battery of ToM development among children in the United States. The seven-task ToM battery includes two FBU tasks and
two emotion-related ToM tasks in addition to Diverse Desires, Diverse Beliefs, and Knowledge Access tasks. Through Rasch model and Guttman scales, Wellman and Liu (2004) found that the five-task battery is more parsimonious and systematic, because each task here represents a unique aspect of ToM with a comparable difficulty level, which demonstrates that children developed the five ToM components in a predictable sequence during the preschool years.

Diverse Desires is the first developed mental state understanding (Flavell & Miller, 1998; Wellman & Liu, 2004). It assumes that children can correctly recognize that others may want (desire) something different from their own. For instance, a young boy who has not developed Diverse Desires may select his favorite toy train or sticker as the birthday gift for his mom; this is because the child currently can only recognize his own desire and does not yet recognize that desires are not universal. Desires are believed to be the most original and basic mental state (Schroeder, 2006); for instance, infants are born with desires to eat and sleep, which take place prior to the development of beliefs (e.g., Astington, 2001; Wellman & Woolley, 1990).

The capacity of Diverse Beliefs, which refer to children being able to understand that two persons can own different beliefs toward the same object regardless of whether the beliefs are true or false, is believed to develop later than Diverse Desires (Wellman & Liu, 2004). For instance, a child may realize that when they believe a missing toy might be in a storage box, their mom would think that it will be under the bed. While the child without having developed the reasoning of Diverse Beliefs may think that others will hold the same belief as he/she does, that is, others will also believe that the missing toy will be in the storage box.

Knowledge Access, which usually is the next competence to develop in ToM, refers to the understanding that one needs to have direct exposure to knowledge in order to obtain that knowledge (Wellman & Liu, 2004). As an example, a young child may assume that others will
know the same secret they know, even when others are not told the secret. This faculty serves as an immediate precursor to FBU -- in other words, before children can both understand that others hold different beliefs, and judge the validity of that belief, they will first realize that knowledge access needs direct exposure of that knowledge.

The most mature component of ToM, within the preschool age, Hidden Emotion allows children to understand that a person could feel and display disparate emotional states simultaneously (Wellman et al., 2006). That is, children can recognize that one’s internal emotions may be hidden and not represented by their external behaviors, such as expressions on their face (Wellman & Liu, 2004). For example, children at an older age may be able to recognize that another child who tumbled over the floor put on a smiling face was just trying to avoid displaying his distress openly and instead showing his bravery. Hidden Emotion is reliably the most difficult faculty of ToM, in all early childhood studies to date, and as such development of this concept follows the previously described four aspects of ToM (Shahaeian, 2015; Wellman & Liu, 2004).

To sum up, each of the five aspects represent unique and crucial mental state understanding in children’s ToM development, and together constitute a comprehensive understanding of ToM (Wellman & Liu, 2004). Considering ToM as a multi-component concept, involving its diverse faculties that developed in a predictable order allows us to fully capture children’s development of mental states understanding and further explore its overall relationships with other child outcomes, (e.g., EF, language abilities, family dynamics; Wellman & Liu, 2004; Kuntoro et al., 2013). Therefore, to be consistent with the nature of ToM and to obtain a full understanding of ToM and its relations to other child outcomes, the current study has included the five unique ToM faculties and view ToM as a comprehensive concept of
children’s mental state understanding.

**Theory of Mind and Executive Function**

EF is an umbrella term used to describe a set of underlying cognitive abilities, including inhibitory control, cognitive flexibility, and working memory, which aids higher-level processing and goal-directed behaviors (Blair & Razza, 2007; Miyake et al., 2000). Inhibitory control (IC) is considered as the ability to suppress a dominant or automatic response in favor of less dominant but more appropriate response (Diamond, 2013). Cognitive flexibility refers to one’s ability to switch rapidly between different tasks or rules and complete tasks while ignoring misleading cues (Miyake et al., 2000; Zelazo, 2015). Working memory (WM) refers to the capacity to temporarily store and manage information, and nonverbal WM is limited to the non-words information to be temporarily stored, such as images, smells, shapes, faces, sounds, etc. (Baddeley, 1992; Liao et al., 2014). These components are believed to develop together during the early childhood years and function cooperatively to assist individuals to process information, reason, plan, and solve complex tasks in academic and daily life (Baker et al., 2019; Hongwanishkul et al., 2005).

EF is closely related to ToM development during early childhood (Carlson & Moses, 2001; Carlson et al., 2004; Devine & Hughes, 2014; Doenyas et al., 2018; Hughes, 1998; Marcovitch et al., 2015), even after controlling for age, gender, verbal ability, and non-verbal intelligence (Hughes, 1998; Muller et al., 2012). For instance, Hughes (1998) found that EF and ToM were significantly and positively related. A meta-analysis study reviewed 102 studies targeted at preschool children from different cultures found a moderate relationship between EF and FBU (Devine & Hughes, 2014). In addition, the EF-ToM associations were not only found in normally developing children (Carlson et al., 2002; Hughes, 1998; Perner & Lang, 1999), but
also in children with autism (Ozonoff, Pennington, & Rogers, 1991) and children from low-income families (Hughes & Ensor, 2005).

Researchers argue that the robust EF-ToM connection may be due to certain similarities shared by EF and ToM; for instance, both EF and ToM develops dramatically during the preschool years, specifically 3 to 6 years old, as a function of brain maturation and socialization opportunities (Curenton, 2004; Korucu et al., 2017; Marcovitch et al., 2015; St. John et al., 2018). Importantly, many empirical studies support that the emergence and performance of ToM requires a certain level of EF abilities (Devine & Hughes, 2014; Hughes & Ensor, 2007; Moses, 2001; Müller et al., 2012). Specifically, most of the evidence shows that EF developed at early time predicted the development of ToM at his/her later years, but earlier ToM did not predict later EF abilities (Carlson, et al., 2004; Doenyas et al., 2018; Marcovitch et al., 2015). For instance, a longitudinal study conducted by Flynn (2007) found that the majority of children obtained IC before they were able to pass a FBU task, while FBU performance was not a predictor of IC. Similarly, Marcovitch et al. (2015) showed that in a diverse group of preschool-age children, EF at 3 years of age predicted ToM at 4 years of age, but ToM at 3 years of age did not predict EF at 4 years of age. Together, these findings support that children’s EF abilities, particularly IC, is an essential precursor to their understanding of others’ mental states (Carlson & Moses, 2001; Devine & Hughes, 2014; Marcovitch et al., 2015).

Theory of Mind and Language

Similar to EF, language is an important factor relating to ToM in early childhood. As language is one main tool for individual’s social communication and enables representation of mental states (Astington & Baird, 2005), it is believed that language facilitates children’s cognitive processing, such as reasoning about other’s mental states (Zelazo, 1999). With age and
increased vocabulary, children use language to express their intentions, beliefs, and knowledge frequently and more intricately.

When examining language, researchers typically distinguish between receptive language and productive language. Receptive language refers to understanding of words and sentences (i.e., comprehension), while productive language refers to speaking of words and sentences that make sense to others (Bloom, 1974; Rose et al., 2018; Walle & Campos, 2014). Based on the above definitions, receptive language ability, includes detecting and identifying the correct words or sentences with given prompts, such as pictures, and discriminating different words or sentences (Young & Killen, 2002), is usually considered as a prerequisite for productive language ability (Fraser et al., 1963; Huttenlocher, 1974; Walle & Campos, 2014).

The relations between children’s language ability and ToM, especially FBU, has been thoroughly investigated and demonstrated in traditional samples (Milligan et al., 2007; Ruffman et al., 2003), children in low-income families (Tompkins et al., 2013), as well as children with specific language impairment (Schick et al., 2007; Whyte et al., 2014; Woolfe et al., 2002). A meta-analysis conducted by Milligan, Astington, and Dack (2007), including 104 studies with children from diverse backgrounds, supports that among children under seven years old, the positive associations between FBU and both receptive and productive language ability are significant with a moderate to large effect size, after controlling for age. Similarly, using FBU and appearance-reality tasks (similar to diverse beliefs tasks), Astington and Jenkins (1999) demonstrated that children’s language ability and ToM are closely connected. When examining ToM through diverse belief and FBU tasks, and their verbal ability through productive and receptive language tests in a sample of two-years-old from economically at-risk families, Hughes and Ensor (2005) also found that those economically at-risk children’s verbal ability was
positively associated with their ToM competence. In other words, the better verbal ability these children have, the better ToM competence they tend to possess.

Furthermore, researchers argue that language plays a fundamental role in ToM development, which has been consolidated in two main threads of empirical studies. First, longitudinal studies indicate that the relationship between language ability and ToM is unidirectional. That is, children’s earlier language abilities predicted later ToM, but early ToM did not predict later language abilities (Astington & Jenkins, 1999; Milligan et al., 2007).

Secondly, studies of children with language difficulties, such as deaf children with hearing parents (Woolfe et al., 2002) and children with autism (Whyte et al., 2014), have consistently found delayed ToM competence compared with those without language difficulties. These two threads of studies suggest that language sets a foundation for the development of mental state understanding.

As research has consistently showed that language is closely intertwined with ToM development, it is reasonable to assume that learning two languages would also greatly impact children’s ToM development. Next, I introduced the theoretical background of bilingualism, and then transition to the relationship between bilingualism and cognitive development.

**Bilingualism**

Although English is the most dominant language used in the United States, diverse language communities exist and continue to develop in the United States (Karr, 2018). Due to the immigration history and an increased multi-language education, the population of young children who speak a language other than English at home and acquire English as their second or third language has dramatically increased in recent decades (Espinosa, 2015). Bilingualism is also a hot topic in child developmental research (Altarriba & Heredia, 2018; Bialystok, 2001).
Different linguists offer various definitions toward bilingualism and there is no consensus on this issue. For instance, Bloomfield (1933) believed that bilinguals are those who have native-like control of two languages. On the other hand, Diebold (1964) proposed that even in situations where the individual has one well-developed language while the other language is at the early stage of development, they can also be considered as bilinguals. In addition, Grosjean (2010) stated that we should place more emphasis on the regular use of both languages rather than language proficiency when identifying bilinguals. Generally, and for the purposes of this study, bilinguals are those who use two languages in their daily lives (Grosjean, 2010).

Different types of bilingualism were proposed based on various considerations, such as age, ability of languages, balance of two languages, etc. However, this is a large discussion, much of which is a bit out of the scope of this paper, and so a brief description of the different types of bilingualism is provided in Table 2.

**Table 2**

*Types of Bilingualism*

<table>
<thead>
<tr>
<th>Types</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early vs. Late bilinguals</td>
<td></td>
</tr>
<tr>
<td>Early bilinguals</td>
<td>Child was exposed to two languages and acquire two languages from birth or in early childhood.</td>
</tr>
<tr>
<td>Late bilinguals</td>
<td>Child learns a second language after the first language is well-established.</td>
</tr>
<tr>
<td>Balanced vs. Unbalanced bilinguals</td>
<td></td>
</tr>
<tr>
<td>Balanced bilinguals</td>
<td>Child have relatively equal abilities in both languages.</td>
</tr>
<tr>
<td>Unbalanced bilinguals</td>
<td>Child has one language’s ability dominant, and another language’s ability is relatively weak.</td>
</tr>
</tbody>
</table>
When age is the main consideration, bilingualism is divided into early bilingualism and late bilingualism (Amengual, 2019; De Houwer, 2009). Early bilinguals refer to those who develop both languages at an early age and naturally from the environment (e.g., a child with parents who speak in different languages; Baker, 2011; De Houwer, 2009). In contrast, if a child learns a second language after the first language is well-established (usually after six or seven years old), it is considered as late bilingualism (e.g., a child learning a second language through formal education or because of migration; Baker, 2011; Hoffmann, 1991). As this study targets bilingual children at the preschool years, the participants are considered as early bilinguals.

For the purposes of this study, the most relevant distinctions are early versus late bilingualism and balanced versus unbalanced bilingualism. When language proficiencies in two languages is the main concern, bilingual speakers can be either balanced or unbalanced bilinguals (Baker, 2011). As its names suggest, balanced bilingual children have relatively equal abilities in both languages while unbalanced bilingual children have one dominant language compared to the other language (Treffers-Daller, 2015; Yow & Li, 2015). Children being frequently exposed to two languages at a young age are more likely to become balanced bilinguals (Pelham & Abrams, 2014). When recruiting bilingual children, it is hard to control the variations in their language proficiency of two languages. Therefore, bilingual children with varying degrees of two language’s proficiencies were accepted to be recruited.

**Bilingualism and Cognitive Development**

Researchers believe that learning two languages plays crucial roles in children’s cognitive development (Bialystok et al., 2010; Calvo & Bialystok, 2014; Poulin-Dubois et al., 2011; Stocco et al., 2014). Regarding bilingualism and cognition, language abilities and other cognitive abilities (i.e., EF and ToM) are the frequently discussed topics in literature relating to
bilingualism. Therefore, in this section, I discussed the effects of bilingualism on language abilities, EF, and ToM, specifically discussing the difference between bilinguals and monolinguals in the three cognitive abilities mentioned above.

**Bilingualism and Language Abilities**

It is believed that bilingual children tend to experience a temporary set-back in linguistic abilities, such as smaller vocabulary size, reduced verbal fluency, etc. (Bialystok, 2009; Calvo & Bialystok, 2014; Oller & Eilers, 2002). Given that young children are still in the early process of language development, vocabulary size is the most extensively studied aspect of language ability (Calvo & Bialystok, 2014). Numerous studies have indicated that bilinguals typically have smaller vocabularies in each language than do their monolingual peers (Bialystok, 2009; Bialystok et al., 2010; Calvo & Bialystok, 2014; Oller & Eilers, 2002). For instance, Oller and colleagues (2007) compared English monolinguals and Spanish-English bilingual children’s vocabulary using both Woodcock-Johnson language tests in English and Spanish versions and the Peabody Picture Vocabulary Test (PPVT) and its Spanish version (TVIP). Their research found that overall, bilingual children have low vocabulary scores in both English and Spanish. However, the disparities of vocabulary size between monolingual and bilingual children have been shown as temporary and may decrease as children getting older and having more experience in using both languages (de Houwer et al., 2014; Kieffer, 2008; Potter & Lew-Williams, under review).

The findings were consistent when vocabulary was divided into receptive and productive vocabulary (Oller et al., 2007), that is, compared to monolingual peers, bilingual children tend to have lower performances in both receptive (Bialystok et al., 2010; Calvo & Bialystok, 2014) and productive vocabulary (Oller & Eilers, 2002). For instance, Calvo and Bialystok (2014)
compared a diverse group of mono- and bilingual six-year-olds’ English receptive vocabulary through the PPVT. It showed that bilingual children had significantly lower receptive vocabulary, than monolingual children. Similarly, in productive vocabulary tasks, such as picture naming tasks (e.g., ask children to retrieve words while presenting the pictures), bilinguals tend to have poorer lexical retrieval abilities in both languages, especially for nouns (e.g., Gollan et al., 2011; Ivanova & Costa, 2008). Moreover, Giezen and Emmorey (2017) demonstrated that this disadvantage also existed in bimodal bilinguals. That is, bilinguals with American Signed Language (ASL) and English have smaller productive vocabulary in word retrieval tasks in their dominant language compared to monolingual English speakers after controlling their age and non-verbal intelligence.

In addition to vocabulary size, research have stated that bilinguals tend to have underperformed speech production and verbal fluency than monolinguals (e.g., Gollan et al., 2002; Giezen & Emmorey, 2017). Sadat and his colleagues (2012) indicated that early Spanish-Catalan bilinguals obtained lower scores in both multi-word utterance and noun phrase production tasks compared with Spanish monolingual peers. Sandoval et al. (2010) found that bilinguals not only have fewer correct word and phrase production, but also showed a slower response time, relative to monolingual peers.

Altogether, the studies suggest that bilingual children tend to experience certain levels of disadvantages in vocabularies and speech production, especially at the first few years after exposure to the second language. Bilinguals’ difficulties in these language abilities may be attributed to the interference of two languages (Bialystok, 2009; Giezen & Emmorey, 2017; Kroll et al., 2006). According to Kroll and his colleagues (2006), even when bilinguals listen, read, or plan to speak in one language, both languages are simultaneously active, so bilinguals
cannot just “turn off” one language and avoid the interference of another language—not dissimilar to the EF component of cognitive interference. Therefore, the two languages potentially compete, which leads to delayed language processing. Another explanation is that compared with monolinguals, bilinguals use each language in a much less frequency (Gollan et al., 2011). With less language exposure and environment to use each language, bilinguals are likely to have underperformed language abilities, including vocabulary size and verbal fluency.

**Bilingualism and Executive Function**

Although bilingual children may temporarily experience disadvantages in language development, they are found to have some cognitive advantages, and the most compelling evidence is from research of EF. For instance, bilingual children are shown having better IC and cognitive flexibility (Bialystok, 2001; Bialystok & Craik, 2010; Carlson & Meltzoff, 2008; Poulin-Dubois et al., 2011; Stocco et al., 2014), and increased non-verbal WM (e.g., Blom et al., 2014; Hernandez et al., 2012) compared to monolingual peers.

Researchers believe that bilingual children have higher EF performance because of the unique cognitive demands of learning and using two languages and continuous engagement in inhibition (Bialystok, 2001; Bialystok et al., 2012; Carlson & Meltzoff, 2008). As just described, because both languages are simultaneously active during language processing (Grainger & Dijkstra, 1992; Kroll et al., 2015), bilinguals constantly need to select the appropriate language, inhibit the inappropriate language use in their daily life, and switch between languages in different environments (Bialystok et al., 2004; Bialystok & Martin, 2004). The intense and continuous competition of two language systems (Bialystok, 2009, 2017) plays a crucial role in “training the brain” to solve conflicts more efficiently and developing bilinguals’ cognitive capacities in a daily routine.
A number of studies have demonstrated that bilingual children tend to have better performance in tasks requiring inhibition control, such as Simon Says (Bialystok, 2001; Carlson & Meltzoff, 2008; Martin-Rhee & Bialystok, 2008). “Simon Says” is a common schoolyard game that asks children to follow instructions involving physical actions only when the instructions are started by the phrase “Simon Says”. Carlson and Meltzoff (2008) compared the IC performance between Spanish-English bilingual children and English monolingual children and found the bilingual group surpassed their monolingual peers in a series of IC tasks, including the Simon task. That is, bilingual children tend to better inhibit the automatic response and are able to follow instructions with higher correction rates. Specifically, when the instruction is “Simon says turn around”, children follow it and turn around, but when the instruction is “clap your hands” (i.e., without the preceding “Simon says”), bilingual children are more likely to successfully inhibit this action (i.e., clapping) and respond by doing nothing, whereas monolinguals would be more likely to clap.

Bilingual children also have demonstrated better IC in other tasks, such as the Day-Night Stroop task (e.g., training children to say “day” when they saw a picture of a moon, and say “night” when they saw a picture of a sun, Bialystok et al., 2008; Bialystok & Senman, 2004) and Flanker task (e.g., children see a row of arrows and then press appropriate button to indicate which way a target arrow is pointing (Carlson & Meltzoff, 2008; Costa et al., 2009; Yang et al., 2011).

Bilingual children also appear to perform better in tasks that involve cognitive flexibility. The dimensional change card sort (DCCS) task is a commonly used task to measure young children’s cognitive flexibility (Carlson & Meltzoff, 2008). In this task, children are given a series of cards with different colors and shapes to sort (Zelazo & Frye, 1998). At first, children
are asked to sort the cards by one dimension (e.g., color), then they are asked to switch and sort the cards by a different dimension (e.g., shape). During this task, children need to pay attention to one dimension and withhold their focus from another dimension, and flexibly change their attention to another dimension at the second round. Children at age of 3 years are more likely to sort incorrectly on the second round, while by 4- or 5-years-old, most children are able to switch successfully. In bilingualism studies, early bilinguals tend to have a better performance on the DCCS task than monolingual children and late bilinguals, after controlling for age and their shared language vocabulary (Bialystok, 2001; Bialystok & Martin, 2004; Carlson & Meltzoff, 2008; Prior & MacWhinney, 2010), which demonstrating greater cognitive flexibility in early bilinguals.

In a similar vein, bilingual children’s cognitive advantage has also been found in non-verbal WM tasks, although relatively fewer evidence exists regarding this component of EF and bilingualism compared with other EF components (Blom et al., 2014; Hernandez et al., 2012; Liao et al., 2014; Morales et al., 2013). For instance, Morales, Calvo, and Bialystok (2013) compared visuo-spatial WM between monolingual and bilingual children aged from 5 to 7 years old. All bilingual children spoke English in the school setting but spoke diverse languages at home. In the visuospatial WM, children were presented a picture stimulus (e.g., a yellow flower or a red heart), and within 500 milliseconds children needed to press the correct key as quickly as possible to indicate the position of the picture. The study found that seven-year-old monolinguals’ WM capacity was roughly equal to that of 5-year-old bilinguals’ (Morales et al., 2013), suggesting that bilingual children have an advantage on visuo-spatial WM compared with monolinguals.

However, the findings of the difference in EF between mono- and bilinguals is not
always consistent (Duñabeitia et al., 2015; Gunnerud et al., 2020; Morton & Harper, 2007; Nichols et al., 2020; Paap et al., 2016). For example, for WM, some researchers reported similar performance between monolingual and bilinguals (Luo et al., 2010), others reported a bilingual advantage (Morales et al., 2013) or even a monolingual advantage (Bialystok, 2010).

Task types can be an important factor explaining the variations of findings. It is possible that the bilingual advantages exist in certain EF tasks but not in other EF tasks. Past studies supported that bilinguals tend to have a better non-verbal WM performance (e.g., Hilchey & Klein, 2011) while does not have difference in verbal WM performance (e.g., Bialystok & Craik, 2010). In addition, research supports that the bilingual advantage is more likely to be found in tasks of IC (such as Flanker and Simon tasks), and switching (such as DCCS), other than WM or monitoring (Bialystok, 2017; Gunnerud et al., 2020; Hilchey & Klein, 2011; Ware et al., 2020).

In addition, variations of the bilingual effects may be due to different age or SES groups. It is believed that the bilingual advantage may develops as children age (e.g., Bialystok, 2018). The meta-analysis conducted by Ware et al. (2020) showed that the effect sizes of having a bilingual advantage in EF tasks were significantly larger in adult samples than child samples. However, when examining children only (18 months -14.5 years old) in 143 group comparison studies, Gunnerud et al., (2020) did not found significant age variations in terms of the bilingual effects in EF. Instead, they demonstrated that the bilingual effects are significantly larger in samples from middle class backgrounds compared to low-income samples. Overall, when examining the bilingual effects in cognitive abilities, these interfering factors should be considered and controlled.

*Bilingualism and Theory of Mind*

Although there are relatively a smaller portion of studies examining the associations
between bilingualism and ToM compared to bilingualism-language ability and bilingualism-EF relations, the effects of bilingualism on ToM have received increasing attention among psychologists and psycholinguists in recent decades (Kovács, 2009; Schroeder, 2018; Weimer & Gasquoine, 2016). It is believed that the need to use different languages to communicate with people who own varied language knowledge supports children’s social understanding and development (Byers-Heinlein et al., 2014; Singh et al., 2020). Most studies examining the differences of ToM in monolingual and bilingual children targeted at children from middle-or-upper income families, and findings regarding whether bilinguals have an advantage in the development of ToM are variable (e.g., Dahlgren et al., 2017; Diaz & Farrar, 2018; Gordon, 2016; Kovács, 2009; Schroeder, 2018; Weimer & Gasquoine, 2016; Yow & Markman, 2011).

Some studies indicate that there are no obvious relations between bilingualism and ToM; specifically, there is no difference in ToM performance between bilinguals and monolinguals (e.g., Dahlgren et al., 2017; Weimer & Gasquoine, 2016). For instance, in the study conducted by Dahlgren and his colleagues (2017), Swedish monolingual and Swedish-Slavonic bilingual preschoolers were compared in terms of their FBU performance. There were no significant differences found in all the individual FBU task scores, and the composite scores of five FBU tasks, between monolinguals and bilinguals. Another study conducted by Weimer and Gasquoine (2016) examined ToM performance in Spanish-English bilingual children and divided them into balanced and unbalanced bilingual groups. In this study, ToM was measured by diverse belief and FBU tasks. Similarly, no significant difference in the belief reasoning performance between balanced and unbalanced bilingual groups was found.

However, most studies have contradicted the idea that monolinguals and bilinguals display similar ToM performance. In these studies, bilingual children outperformed their
monolingual peers in ToM performance (e.g., Bialystok & Senman, 2004; see Byers-Heinlein & Lew-Williams, 2013 for review; Diaz & Farrar, 2018; Fan et al., 2015; Kovács, 2009; Schroeder, 2018). As bilinguals are consistently experiencing more complex social environments, in which different people have different language knowledge and use different languages to interact, they are more likely to have a better understanding of others’ thoughts, beliefs, and knowledge (Byers-Heinlein & Lew-Williams, 2013; Rimm-Kaufman & Pianta, 2000).

Goetz (2003) compared the understanding of mental states in 3- and 4-year-old children from three groups: English monolinguals, Chinese monolinguals, and English-Chinese bilinguals. All the groups were given a set of ToM tasks, including two diverse belief tasks and two FBU tasks. No significant differences in aggregate ToM performance between the two monolingual groups were found, whereas the bilingual children group demonstrated superior ToM competence over monolingual groups.

Similarly, Kovács (2009) tested 3-year-old Romanian-Hungarian bilingual and Romanian monolingual children using one traditional FBU task (i.e., Sally-Anne task) and one modified language-switch FBU task. The language-switch FBU task requires children to demonstrate a false belief understanding by considering others’ understanding of diverse languages. Specifically, two dolls were introduced, one doll is monolingual, another doll is bilingual, and both of them want to eat ice cream. There are two food stands, one selling ice-cream and the other selling sandwiches. When the bilingual doll approaches the ice-cream vendor, he announces in the language that the monolingual puppet does not speak that he has run out of ice-cream, but the sandwich vendor still has some. Then the question for the children is: “where will the monolingual doll go to buy ice-cream?” The study found that twice as many bilingual children passed both the standard and modified FBU tasks as monolingual children.
In addition, Schroeder (2018) did a meta-analysis of 16 studies including 1,283 children to explore whether advantages in ToM performance exist in bilinguals. After adjusting for the monolingual-bilingual difference in language proficiency, they found a medium effect size to support the beneficial effects of learning two languages on mental state reasoning. As the studies in the meta-analysis included bilinguals with different languages, such as English-Spanish, Bulgarian-Romani, etc., cultural differences may not be sufficient in explaining the effects of bilingualism on ToM performance.

Although the findings pertaining to ToM and bilingualism are at times inconsistent, it is believed that acquiring two languages is beneficial to the development of ToM (Diaz & Farrar, 2018; Goetz, 2003; Kovács, 2009; Schroeder, 2018). The existing studies showing no difference in ToM performance among monolingual and bilingual children indicated that the bilingual advantage in ToM may be selective due to various factors, such as types of ToM tasks used, socio-economic status (Nguyen & Astington, 2014; Weimer & Gasquoine, 2016), number of siblings (Weimer & Gasquoine, 2016), and language proficiencies (Gordon, 2016). For instance, Chan (2004) found no bilingual advantage in FBU competency between a sample of 3-to-5-year-old Chinese-English bilingual children and English monolingual counterparts, but after he statistically controlled for the confounding variables such as language ability, bilingual children significantly outperformed monolingual peers in FBU. Similarly, Nguyen and Astington (2014) stated that socio-economic status is often ignored as a contributing factor to both language proficiency and ToM in bilingualism studies. Altogether, however, there seems to be a bilingual advantage in ToM development in children from middle- or upper-class families.
Role of EF on the Relationship between Bilingualism and Theory of Mind

Researchers proposed that EF may be a possible explanation for the differences in ToM between monolingual and bilingual children; that is, bilinguals’ advanced EF skills lead to better mental state reasoning (Goetz, 2003; Bialystok & Senman, 2004; Kovács, 2009). This can be attributed to two main streams of research: first, bilinguals surpass monolinguals in EF performance (e.g., Bialystok & Craik, 2010; Carlson & Meltzoff, 2008; Morales et al., 2013; Stocco et al., 2014); second, EF is strongly associated with mental state understanding and is a significant predictor of ToM performance (Devine & Hughes, 2014; Doenyas et al., 2018; Marcovitch et al., 2015; Muller et al., 2012).

That is, bilingual children tend to have better EF abilities (e.g., Carlson & Meltzoff, 2008; Morales et al., 2013) and children’s early EF performance significantly predict later ToM performance (Devine & Hughes, 2014). Therefore, it is possible that bilinguals’ more advanced ToM performance results from better EF skills (Bialystok & Senman, 2004; Goetz, 2003; Kovács, 2009). In other words, as bilingual children have more experiences in practicing EF abilities compared to monolingual children, such as inhibiting using another language, switching from different settings, and exchanging two languages fluently, they tend to have higher executive abilities, which may also lead to a better mental state understanding in these children.

So far, the two streams of evidence have only been validated in the studies with samples from relatively more affluent families. However, among economically disadvantaged children, it is unknown what roles EF play in the relationship between bilingualism and ToM. In addition, the development of EF, ToM, and language have all reliably been found to be greatly impacted by poverty, as discussed next. Yet, these relations have not been examined in concert together with bilingualism. Therefore, the current study dives into the role of EF on the relationship
between bilingualism and ToM among children living in economic adversity.

**Impacts of Poverty Exposure**

In addition to the hypothesized mechanistic power of EF in explaining ToM differences between monolinguals and bilinguals, children’s experiences with poverty have been found to impact both language development and ToM, yet largely remains unexplored. Poverty exposure, as a stressful environment, plays a crucial role in child development (Blair et al., 2005; Bradley & Corwyn, 2002; Frankenhuis & Nettle, 2020; Hair et al., 2015). A bulk of studies have consistently demonstrated that compared with more affluent peers, children living in poverty may show great developmental differences in many aspects, such as vocabulary development (e.g., Hart & Risley, 1995; Vernon-Feagans et al., 2012), executive functions (e.g., Blair & Razza, 2007; Lawson et al., 2018; Ursache et al., 2015), and social understanding (e.g., Holmes-Lonergan, 2003; Hughes & Ensor, 2005; Tompkins et al., 2013; Weimer & Guajardo, 2005).

Regarding the relations between poverty and language development, Hart and Risley (1995) found that children from economically disadvantaged families tend to show below-average language abilities and have relatively smaller vocabulary size than their economically advantaged peers (also see Qi et al., 2006; Rowe, 2008). Further studies have indicated that this may be partly due to that parents in low-SES families tend to use relatively shorter sentences, less diverse child-directed speech in their daily interactions (Hoff, 2003; Huttenlocher et al., 2010), and spend less time to read with their children (Yaroz & Barnett, 2001).

In addition, poverty exposure has been consistently found to affect children’s EF, for instance, children under poverty may have less possibilities in controlling unfavorable responses and shifting their attention, as well as having longer reaction time on WM tasks (Brown et al., 2013; Hackman et al., 2014; Lawson et al., 2017; St. John et al., 2018). Neuroimaging studies
have indicated that the condition of poverty was associated with dysfunctions in certain brain areas, including the prefrontal cortex and hippocampus, which are responsible for EF and memory (Lupien et al., 2001; Pruessner et al., 2010). The brain dysfunctions due to poverty may interfere with language development directly and indirectly through its effects on the development of EF (Im-Bolter et al., 2006; Perkins et al., 2013).

However, recently many researchers argue that the development of children in adverse environments may also fulfill ecologically adaptive needs (Frankenhuis & de Weerth, 2013; Frankenhuis & Nettle, 2020; Sturge-Apple et al., 2016). For instance, studies showed that economically disadvantaged children showing a longer reaction time in WM tasks may indicate a “trade-off” thinking process, in that they tend to have more careful decision-making processes to reach an accurate choice given their greater experience in risky or harmful stimuli (St. John et al., 2018). In other words, children living in economic adversity may focus more on completing the tasks accurately to avoid any potential risks, therefore they tend to spend more time in thinking about the tasks.

In terms of ToM performance, some studies have showed that children in economically disadvantaged families are more likely to fail in false belief tasks than more affluent same-age peers (Currenton, 2004; Holmes-Lonergan, 2003; Seidenfeld et al., 2014). As FBU is closely connected to children’s EF (Carlson et al., 2004; Devine & Hughes, 2014; Doenyas et al., 2018; Marcovitch et al., 2015) and language abilities (Milligan et al., 2007; Ruffman et al., 2003), children’s EF performance and language ability may partly account for the discrepancies of FBU performance between children with and without poverty exposure. For instance, Tompkins et al. (2013) pointed out that the economically disadvantaged children’s relatively lower FBU performance was partially attributed to the risk of delayed language ability associated with
poverty.

However, this apparent disadvantage in FBU does not extend to all the other ToM tasks. For instance, Shahaeian (2015) compared ToM development using Wellman and Liu (2004)’s five-task battery in Iranian children from three different socioeconomic backgrounds: high SES urban, low SES urban, and rural. Although children from rural areas showed a lag in diverse desire, diverse belief, knowledge access, and FBU compared with the high SES urban group and low SES urban group, they have superior performance in hidden emotions task than the other two groups. Similar findings can also be found in U.S. low-income samples, who showed relative precocious development of the emotional components of ToM (Baker, Huang, Battista, et al., 2021). They proposed that children in poverty, exposed to various emotional stress, may have urgent needs to develop the emotionally salient ToM component - hidden emotions, compared with other ToM components.

Given the above discussion, it is possible that poverty exposure also greatly affects bilingual children’s ToM development. What’s more, due to the different impacts of poverty exposure on different components of ToM, it is worthwhile to consider comprehensive aspects of ToM, and explore and compare ToM development between monolingual and bilingual children reared in poverty in the United States.

The Current Study

Although the literature reviewed thus far has provided support of the relationship between ToM and bilingualism, prior studies that have investigated the bilingual effects on ToM have several limitations, and the current study is designed to address these limitations. First, the bilingual advantage on ToM is mainly demonstrated by studies using only FBU tasks. Although some studies involved diverse belief tasks as well, few studies have examined ToM as a multi-
component concept. As such, these studies are unable to provide us with a complete picture of bilingual effects on ToM development. The current study addresses this limitation by using the full 5-task ToM composite battery developed by Wellman and Liu (2004), which is used throughout contemporary research, including children living in poverty (Baker, Huang, Battista, et al., 2021; Kuntoro et al., 2013; Shahaeian, 2015).

Second, the majority of the existing studies of bilingualism and ToM were conducted on children from middle- or upper-class families (e.g., Greenberg et al, 2013), while children in economically disadvantaged families (who are likely to perform differently on language abilities and ToM tasks compared to their affluent peers; Curenton, 2004; Holmes-Lonergan, 2003) have been underrepresented in the research. Moreover, among children with poverty exposure, it remains unclear what mechanisms might explain the relations between bilingualism and ToM. The current study addresses this limitation by targeting 3 to 5 years old English monolingual and Spanish-English bilingual preschool children from low-income families in the United States.

**Research Questions**

The current study aims to concurrently examine the relationships between bilingualism, EF, and ToM in early childhood, with a specific focus on the impacts of economic adversity on these relations. As Spanish-English bilingual children are the most representative bilingual children, and more likely to experience poverty in the United States compared to other bilingual children (U.S. Census Bureau, 2018), I chose Spanish-English bilingual children as the target participants in the current study and English monolingual children as the comparison group. Three main questions are addressed in the study.

First, do Spanish-English bilingual children raised in low-income families have a better ToM performance compared with English monolingual children in low-income families? This
question tests the boundary of the bilingual effects on ToM performance, that is, whether the bilingual effects on ToM can be generalized to children who are living in low-income families.

Second, how does the degree of bilingualism make a difference to low-income children’s ToM performance? In this question, I only included bilingual children and examined if the degree of bilingualism would impact low-income children’s ToM performance.

Third, what role does EF play in the relationship between bilingualism and ToM among children living in poverty? This question helps explain the mechanism of the bilingual effects on low-income children’s ToM performance.

When addressing these questions, I did not include other comparison groups, such as samples from middle income families for the following reasons. First, although it is interesting to consider other SES groups and see if there are buffer/protective effects of bilingualism on children’s cognitive abilities due to poverty, I am particularly interested in the bilingual effects on ToM development among children from low-income backgrounds and interpret the developmental needs of the unique context, socio-economic status is not the primary variable of interest, and the income-related variable is controlled. In addition, when looking at the development of children from poverty, the direct comparison with more affluent children would be highly risky to follow the deficit model, which might stigmatize the marginalized group (see Burlew et al., 2019 for review).

To explore these questions discussed above, it is necessary to parse out intervening effects of other variables which may impacts ToM and language development. Studies have supported that factors such as age, family income, shared English proficiency, and the starting age of second language exposure (SLE) may affect bilingual children’s ToM development (Dahlgren et al., 2017; Schroeder, 2018; Yow & Markman, 2015). For instance, Luk et al. (2011)
have found that early bilinguals exhibit better inhibition and false belief abilities than late bilinguals and monolinguals. Further, these factors were commonly controlled in the empirical studies focusing on bilingualism and ToM (Weimer & Gasquoine, 2016; Yow & Markman, 2015). For this reason, the above variables were assessed and controlled when examining the relationship between bilingualism and ToM among economically disadvantaged children.

**Hypotheses**

The first question focuses on testing the boundary of bilingual advantage in ToM. Previous studies of children from middle- or upper-income families has demonstrated that children learning two languages tend to have a better performance in ToM, especially FBU; however, it is unclear whether the bilingual advantage in ToM can be extended to children in economically disadvantaged families. Considering that economic adversity may be an important factor in the development of language and ToM, as discussed above, it is crucial to test whether there is a bilingual advantage on ToM performance using a full set of tasks addressing different aspects of ToM among children with poverty exposure. The comprehensive battery of ToM not only allows us to examine the differences in the general ability to reason about others’ mental states between monolingual and bilingual groups in poverty, but also to investigate whether bilingualism can contribute to a broader effect on other ToM components except for FBU.

Based on the evidence that economically disadvantaged children are more likely to have underperformed language abilities (e.g., Hart & Risley, 1995) and mental state reasoning (e.g., Cutting & Dunn, 1999; Hughes & Ensor, 2007), it is likely that the cognitive strengths that come with bilingualism (i.e., ToM) is attenuated for low-income bilingual children. However, as both monolingual and bilingual children here are from low-income families, bilingual children still have the unique experience of acquiring two languages and the associated cognitive challenges,
it is expected that focusing on children from low-income families, bilingual children may still show an advantage in ToM, or at least FBU, compared to monolingual children.

For the second question, when only including bilingual children, it is expected that the degree of bilingualism would be an important predictor of low-income children’s ToM performance. That is, the higher degree of bilingualism is associated with better ToM performance.

The third question examines the role of EF in the relations between bilingualism and ToM; specifically, it looks at whether EF works as a significant mediator impacting the relations between bilingualism and ToM. As I discussed previously, EF may be a crucial factor explaining the discrepancy of monolingual and bilingual children’s ToM performance, however, existing findings focusing on the mechanisms of bilingual advantage in ToM were limited in studies with relatively more affluent children.

I hypothesize that EF mediates the relationship between bilingualism and ToM based on the following evidence. First, bilingual children consistently have shown advantages in EF not only in middle- or higher- income families (e.g., Bialystok & Craik, 2010; Blom et al., 2014; Stocco et al., 2014), but also in low-income families (e.g., Calvo & Bialystok, 2014; Carlson & Meltzoff, 2008; Engel de Abreu et al., 2012). Second, studies have shown that EF robustly predicts later ToM across SES (Carlson et al., 2002; Hughes, 1998; Hughes & Ensor, 2005). These two pieces of evidence support that EF may significantly mediate the relation between bilingualism and ToM.
Chapter III: Method

The current study aims at exploring the relationship between ToM and bilingualism among preschool children under economic adversity and the mechanism of EF on this relationship. This chapter focuses on the design of the research study, which consists of participants, sampling procedure, measures, data collection and procedure, data preparation and analytical plan.

Participants

Eighty preschool-aged U.S. children (\(M_{\text{age}} = 50.4\) months, \(SD = 8.64\) months, age range [36, 66], 54.4% boys) and their parents were recruited for the study. Forty-three of them were English monolinguals and 37 were Spanish-English bilinguals. As I am targeting children from low-income families (i.e., income-to-needs ratio lower than 2), three monolingual participants were excluded from our analysis with an income-to-needs ratio (INR) larger than 2 (i.e., INR = 2.36, 2.49, 3.0 respectively). Seven participants (five monolinguals and two bilinguals) chose not to continue the study after Step 1 (i.e., only completed the parental survey); as these children did not complete any assessments, they were excluded from the study. In addition, two participants were excluded because the parent reported that they had mild language delay and were receiving speech therapy. As a result, 68 children (35 English monolinguals, 33 Spanish-English bilingual) children were included in the analytical sample, all of whom had normal hearing and vision based on parental report.

Parents reported family income (\(M_{\text{income}} = \$34,920.21\)) and the number of individuals living in the home. This information was used to calculate INR by dividing household income by the poverty thresholds for the specific family size (\(M_{\text{INR}} = 1.23\)). In the analytic sample, 44.1% of children lived under the federal poverty threshold (INR <1), and 55.9% lived in low-income families (1 < INR < 2). The monolingual children were predominantly from White families.
(54.3% White, 17.1% African American or Black, 17.1% Multi-racial, 5.7% Asian American, 2.9% Hispanic, 2.9% Other), while bilingual children were mostly from Hispanic/Latino families (60.6% Hispanic/Latino, 21.2% Multiracial, 18.2% White). Demographic and linguistic information for the three groups is presented in Table 3.

**Table 3**

*Demographic and Linguistic information for the Monolingual and Bilingual Groups*

<table>
<thead>
<tr>
<th></th>
<th>Monolingual (n = 35)</th>
<th>Bilingual (n = 33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child age (months)</td>
<td>48.91 (8.83)</td>
<td>51.97 (8.27)</td>
</tr>
<tr>
<td>Gender</td>
<td>51.4% boys</td>
<td>57.5% boys</td>
</tr>
<tr>
<td>Family income</td>
<td>$33,685.71 ($19,996.72)</td>
<td>$36,229.52 ($18,160.51)</td>
</tr>
<tr>
<td>INR</td>
<td>1.23 (.63)</td>
<td>1.22 (.61)</td>
</tr>
<tr>
<td>English vocabulary</td>
<td>116.4 (9.20)</td>
<td>115.79 (8.55)</td>
</tr>
<tr>
<td>Spanish vocabulary</td>
<td>N/A</td>
<td>109.36 (10.89)</td>
</tr>
<tr>
<td>Onset of SLE (months)</td>
<td>N/A</td>
<td>15.88 (16.71)</td>
</tr>
</tbody>
</table>

*Note.* INR = Income to needs ratio; SLE = Second language exposure.

**Sampling Procedure**

Due to the COVID-19 pandemic and social distancing, researchers experience unique data collection challenges (Lobe et al., 2020). As with many other developmental psychology studies, I had changed my original plan and transferred to online data collection. After receiving approval from the institutional review board, I started recruitment for the study.

I utilized two main recruitment strategies: first, advertising through social media (i.e., Facebook), online research participant recruitment website (i.e., childrenhelpscience.com) and
two research lab websites (i.e., Social Cognition in Preschoolers Lab, supervised by Dr. Erin R. Baker and the Oral and Written Language Lab, supervised by Dr. Tianlin Wang). By posting key research information and general recruitment criteria on these platforms, interested parents can clearly understand the research purposes, general requirements for participants, data collection procedures and how children and parents can benefit from the study, etc. To recruit the targeted participants who fulfill the requirements of participation, all the interested parents were asked to complete a short screening survey (i.e., “parent interest form”, see Appendix A).

The second approach I used is directly contacting with nationwide Head Start programs using their public websites and requesting the programs to send out my research advertisement (i.e., research recruiting flyer, research lab website links) through their families’ email list. Head Start program is a federal funded early childhood education program that supports children from low-income families (Early Childhood Learning and Knowledge Center, 2020). From my previous collaboration with Head Start preschool programs, I have learned that many of the children enrolled in that Head Start program were Spanish-English bilinguals. Therefore, sending out the recruitment information via the email list in Head Start programs can efficiently recruit the targeted participants.

All the potential monolingual and bilingual participants who are interested in our online study were guided to complete the short screening survey, which can be completed within two minutes. The screening survey link is provided in the recruiting flyer and the recruitment websites, parents can complete it on their own once they decided to further explore if their child is qualified for the study. The criteria for participants include 1) the participating child is within age 3 to 5, 2) either English monolingual speaker or Spanish-English bilingual speaker, and 3) the family INR is “less than 200% of the US federal poverty level”, as suggested by Schnirer and
For instance, in the question: “Does your child speak English only or speak English and Spanish?” If parents select the option “My child speaks English only”, then the child was considered as “monolingual”. If parents select the option “My child speaks English and Spanish”, then the child was considered as the target bilingual child in the study. If the child is reported as bilingual in other languages, such as English and Chinese, or trilingual, they were not considered as potential participants in the study. For the third criteria, the target participants should be from low-income families, thus I followed the guidance from Schnirer & Stack-Cutler (2017), that is, the family INR should be within 200% of the US federal poverty level. In the screening survey, I requested parents to provide information about number of adults and siblings at home, and the household income so that the family INR is calculated by the ratio of family income to the federal published poverty threshold level which depends on the number of adults and children at each home.

Only the children and families who provided the necessary information and fulfilled all the four criteria above, indicated in the screening survey, were followed up and provided the informed consent. Once I obtained the informed consent from the parents, they and their children were considered as the participants of the study. At the same time, a random participant ID was assigned to the child. Assent was not collected from the children, as per IRB regulations for children of this age (i.e., children under the age of 7 are considered by this IRB to be unable to give assent). The child and the families were notified that they have the rights to stop or skip any parts of the study. At the end of the study, each participating child received a “Junior Scientist
Certificate” no matter whether they completed the study or not. Also, the family was rewarded $10 Amazon e-gift card after completion of the study.

Measures

Demographic Characteristics

Parents completed a more detailed online questionnaire of demographic information about the child and the family through Qualtrics (see Appendix B) after they were identified as qualified participants. Specifically, the collected information includes children’s age, gender, ethnicities, family structure, number of adults and siblings in the family, siblings’ age, family income, parents’ education level and occupation. Again, the family INR was calculated as a relevant variable, based on the provided information of number of adults and number of siblings at home, and family income. The demographic background questionnaire can be completed in 2 to 3 minutes.

Language Background

An online version of the Learning Experience and Proficiency Questionnaire (LEAP-Q) adapted for use with bilingual or multilingual children by Rochanavibhata, Kaushanskaya, and Marian (2018), were presented to parents through Qualtrics along with the demographic background questionnaire at the beginning of the study. The LEAP-Q for children serves as a tool for collecting information about children’s language preference, language dominance, home language environments, language learning experiences, and parents’ subjective judgment of children’s language proficiency in both languages. The self-reported LEAP-Q for adolescents and adults has demonstrated internal validity within each of the aspects in the questionnaire (Marian et al., 2007). Also, studies showed that the parent reported language experience and proficiencies in the LEAP-Q questionnaire predicts children’s productive language abilities
(Speranza et al., 2021). In the past 10 years, the LEAP-Q has been translated into 22 languages and used in various social-cultural contexts (Ettlinger et al., 2015; Rochanavibhata & Marian, 2020). It has been demonstrated that the questionnaire can be completed by individuals whose literacy levels are in elementary level (Blumenfeld et al., 2017). The LEAP-Q for children version can be completed in 5 minutes by the parents.

**Theory of Mind**

In order to obtain a comprehensive understanding of low-income preschoolers’ ToM, the five-task ToM battery proposed by Wellman and Liu (2004) was used. Rasch model analysis and Guttman Scale analysis supported that the five-task ToM battery provided a consistent scale that captures preschool children’s developmental progression in ToM (Wellman & Liu, 2004). It is necessary to employ a series of tasks with different difficulty levels to assess children’s general ToM capacities and development. Specifically, the ToM battery includes the tasks measuring Diverse Desires, Diverse Beliefs, Knowledge Access, False Belief Understanding, and Hidden Emotions.

As completing the ToM tasks requires interactive communication between examiner and participants, a Zoom interview has been used to conduct these tasks. To exclude the interference of language bias, Spanish-English bilingual research assistants lead the interview in the child’s preferred language to communicate clearly throughout the Zoom session. The image props were presented in a shared PowerPoint over the screen, and the whole process takes less than 20 minutes. The portion of the Zoom interview with the child completing the five ToM tasks was recorded, and the audio recording file with participants’ verbal responses was later used for coding and analysis. Each task was scored such that successful demonstration of ToM competency receives a score of 1 on that task and failure to demonstrate the competency receives
a score of 0 (details of scoring for each task is described below). A composite ToM score for each child was obtained by summing the five task scores, ranging from 0 to 5.

**Diverse Desires (Mr. Smith Task).** On a shared screen over Zoom, children were presented a cartoon figure of a male adult in the center of the screen. When the child was focusing on the screen, a trained research assistant (RA) introduced that “Here’s Mr. Smith. It’s snack time, so Mr. Smith wants a snack to eat. Here are two different snacks: a carrot and a cake. Which snack would you like best?” [control question]. This question asks about children’s own desire. At the same time, an image of carrot and an image of a cake appeared on the screen by the sides of Mr. Smith. If the child chooses the cake, then the RA responds: “That’s a good choice, but Mr. Smith really likes carrots. He doesn’t like cake. What he likes best is carrots.” If the child chooses the carrot, the RA states that Mr. Smith really likes cake and doesn’t like carrots. Then the target question was asked: “So, now it’s time to eat. Mr. Smith can only choose one snack. Which snack will Mr. Smith choose? The carrot or the cake?” [target question]. To pass the task and be scored as 1, the child must answer the target question opposite from his or her answer to the control question (indicating that Mr. Smith wants the opposite snack), otherwise the child is scored as 0.

**Diverse Beliefs (Cathy’s Cat Task).** On a shared screen over Zoom, children were presented with a cartoon figure of a girl in the center of the screen. The RA introduce as: “This is Cathy, Cathy wants to find her cat. Her cat might be hiding in the bushes or it might be in the garage. Where do you think is the cat? In the bushes or in the garage?” [control question]. This question asks about children’s own belief. While the RA is introducing, the image of a bush and a garage appear by the sides of the girl figure. If the child chooses the bushes, RA continues: “That’s a good idea. But Cathy thinks her cat is in the garage. She thinks her cat is in the
garage.” If the child chooses the garage, then RA states that Cathy believes that her cat is in the bushes. Then the target question was asked: “So, where would Cathy look for her cat? In the bushes or in the garage?” [target question]. To succeed in this task and score as 1, the child must have a opposite answer in the target question compared with the answer in the control question, otherwise the child is considered as being failed in understanding diverse beliefs and scored as 0.

**Knowledge Access (Mystery Box Task).** In the center of the shared screen over Zoom, children were presented a closed box, which has no remarkable features. The RA asked the child: “What do you think is in the box?” This is an open question, and the children can answer anything or just state that he or she does not know. Once the child provided an answer, the RA play an animation on the screen which shows that the box is opened, and there are some colorful candies inside. To confirm children’s knowledge, the question “What is that?” was asked. After the child responded, the candies disappeared, and the box was closed then. Meanwhile, a figure of a child was presented on the screen and the RA introduced that, “This is Davey! Davey has never seen inside this box. So, does Davey know what’s inside the box?” [target question] “Did Davey see inside the box?” [control question]. To be scored as 1, the child must answer “No” to both the target and memory questions, otherwise, a score of 0 is assigned, indicating that the child is not able to access others’ knowledge yet.

**False Belief Understanding (Sally and Anne Task).** On a shared screen over Zoom, children were shown two figures, Sally and Anne, as well as a pink box and a blue box. The RA introduced the two figures and state that “Here are my two friends. This is Sally, and this is Anne. Sally has a ball, and she places it into the pink box, and then she goes outside the room and can’t see in the room anymore.” Story continues, “While Sally is out of the room, Anne comes in and picks up the ball from the pink box and puts it into the blue box. Then, Anne goes
away.” While the story was verbally shared, the animation on the screen also demonstrated Sally and Anne’s actions. The child was then asked, “Where is the ball right now?” [control question]; “When Sally comes back, where do you think she will look for the ball first?” [target question]. If the child understand that Sally doesn’t know the real position of the ball and may have a false belief of its position, they may answer that Sally will look for the ball in the pink box. The child who answers accordingly was considered having developed a false belief understanding and scored as 1. If the child answers that Sally will look for the ball in the blue box, failing at this task, score 0 is assigned.

**Hidden Emotion (How Matt Feels Task).** On a shared screen over Zoom, children were showed a picture of emotions including three faces on it (a happy, sad, and neutral face). The RA first explained each of the emotions and ask the child to show their own happy, sad, and okay faces - to ensure that they understand each of the face emotions. Then the next slide showed the child a picture of the back of the boy (Matt)’s head so that the boy’s facial expressions cannot be seen. Meanwhile, the RA introduced the story:

“I am going to tell you a story about a boy. I will ask you about how the boy really feels inside and how he looks on his face. He might really feel one way inside but look a different way on his face. Or he might really feel the same way inside as he looks on his face. I want you to tell me how he really feels inside and how he looks on his face. Okay?”

“This is Matt, Matt and his friends were playing together and telling jokes. One of the older children, James, called Matt a name and everyone laughed. Everyone thought it was funny, but not Matt. But Matt didn’t want the other children to see how he felt, because they would call him a baby. So, Matt tried to hide how he felt.”

Then, three following questions were asked, “In the story, what would the other children
do if they knew how Matt felt?” [control question] “How did Matt really feel, when everyone laughed? Did he feel happy, sad, or okay?” [target question 1] “How did Matt try to look on his face, when everyone laughed? Did he try to look happy, sad, or okay?” [target question 2]. When asking the last two emotion-related questions, the previous image of three face emotions appeared on the screen again, so the RA can point to the emotions when asking the questions. Only when the child’s answer to the target question 2 is more positive than their answer to the target question 1, for instance, when the child answered “sad” in the target question 1 and “okay” or “happy” in the target question 2, or “okay” in the target question 1 and “happy” for the target question 2, he or she is considered passed the task and scored 1, otherwise, score 0 is assigned.

Executive Function

Three EF tasks were used to measure children’s IC, WM, and AS. All the EF tasks were made available on an online platform called Gorilla Experiment Builder (www.gorilla.sc) (Anwyl-Irvine et al., 2019), which serves to design and run online psychological experiments, as well as collect behavioral data for researchers. Currently, a number of studies in which data collected through the Gorilla platform has been published (Beltran et al., 2020; Jasmin et al., 2020), demonstrating that Gorilla is a well-established online data collection tool. Furthermore, given that the target participants from low-income families may have less access to laptop or computer, it is necessary to make these online EF tasks friendly for tablets and cellphone as well. Gorilla platform creates online tasks suitable for all the devices (computers, tablets and cell phones).

All the instructions for the tasks have Spanish and English versions on the screen. In addition, parents were suggested to explain the tasks in their child’s preferred language to their child if necessary. Children’s responses in the three EF tasks were collected through children’s
motor actions of tapping the screen, for two reasons. First, tapping the screen can be done easily when using tablets and cell phones. Second, the action of tapping the screen is easy and feasible for young preschool children to do. Moreover, considering that the target participants are young and have limited reading ability, all the instructions and feedback through the tasks are in simple language and provide with both text and audio formats, making sure children can fully understand the task rules. Detailed descriptions of each task are provided below.

**Inhibitory Control (Animal Go/No Go Task).** The Animal Go-No Go task was derived from Durston et al. (2002) and transferred into an online format. This task is a typical IC measure in literature and has been demonstrated that it is appropriate to be conducted to children as young as three years old (Willoughby et al., 2010).

In this task, a motor response (e.g., tapping the bar on the screen) is required to be selectively executed or inhibited depending on the stimuli displayed on the screen. The stimuli consist of seven images of cartoon animals: a giraffe, hippo, tiger, zebra, cow, sheep, and pig. All the animals in the stimuli were in a standing position with the body toward the same direction, which maintains children’s attention in the types of animals, rather than actions of these animals in the stimuli. In the training trials, the child was instructed to tap a long black bar under the stimuli every time when they see an animal which is not a pig (“go” stimulus). If the animal on the screen is a pig (“no go” stimulus), then the child should inhibit the motor response of tapping the black bar and do nothing.

In the testing trials, the center of the screen presented an image of one animal (selected from 7 images of cartoon animals) for 2000 milliseconds, followed by a fixation cross shown for 500 ms. A visual depiction of this task is presented in Figure 1. The order of go (image of any other animal) stimuli and no-go (image of a pig) stimuli followed a standard order: 1-go, 1-no
go, 3-go, 1-no-go, 3-go, 1 no-go, 5-go, 1-no go, 1-go, 1-no go, 1-go, 1-no go, 3-go, and 1 no go. Participants were instructed to respond as quickly and as accurately as possible.

**Figure 1**

*Visual Depiction of the Go/No Go Task*

The response time and responses of either “go” or “no go” actions in each trial were collected and recorded from the onset of the target to the onset of the participants’ response by the Gorilla platform. Children’s IC ability is indicated by whether children can successfully inhibit their actions when presented no-go stimuli. Therefore, the score is calculated by the number of accurate responses to no-go trials (ranging from 0-7).

**Working Memory (Corsi Block Tapping Task).** The Corsi Block Tapping test was derived from Corsi (1972) and modified into an online version. The task has been widely used to measure preschool children’s WM in previous studies (e.g., Bull et al., 2010; Fuhs et al., 2014) and showed good test-retest reliability in preschool children (Alloway, 2006; Van Der Veer et al., 2020).

In this task, the child was presented with nine identical grey 2x2 centimeter cubes in a
white background on a shared screen, and an image of a green frog appears at some of the cubes in a random order and then disappears. The child was instructed to pay attention to the order of the cubes that the frog has appeared, as they are required to repeat the order the green frog has appeared by touching the same cubes in the same order after they hear the sound “go”. In the training trials, the frog appeared at two random cubes consecutively. The frog stays for 1000ms on one of the nine cubes and disappears (500ms) and then appears to another cube and stays for another 1000ms. At this point, the child has the chance to practice how to respond in this task: touching the cubes in the same order that the frog has appeared once they hear the sound “go”. After the training trial, audio feedback was provided (“Great job, that’s how to play the game: Touch the cubes in the same order the frog has appeared.” Or “Oops, you should remember and repeat the same order the frog has appeared.”) to make sure the child can follow the task given.

**Figure 2**

*Visual Depiction of the Corsi Block Tapping Task (An Example for 2-Cubes Trial)*

The testing trials begin with the frog appearing at two out of nine blocks, and there are two trials for each length pattern. The visual depiction for the two-cubes trial can be found in Figure 2. Once the child provided correct responses on both trials for each length pattern, the
difficulty increases gradually by asking the child to repeat one more block than previous trial (the length pattern is up to 6, so the maximum of testing trial is 10). During the testing process, no feedback was provided. Task ended when children make errors on both trials of a given length pattern.

The order of cubes the participants tapped in each trial as well as the response time from the onset of sound “go” to the onset of children’s tapping behaviors or between the two onsets of tapping behaviors were recorded on Gorilla platform. Again, we focused on the accuracy of repeating the order in trials of different difficulty length. The longest length of cubes (ranging from 2 to 6) children accurately response is considered as the score in the WM task.

**Cognitive Flexibility (Dimension Change Card Sort task).** This task, derived from the standard version of the DCCS task, is a reliable measure of cognitive flexibility for young children during preschool years (Frye et al., 1995; Bialystok, 1999). In the task, children must sort stimuli by one category (i.e., shape), and then must change to sort stimuli by a different category (i.e., color). In the study, it is modified into an online version which requires child’s motor response of sorting on the screen (i.e., tapping one of the two available buttons).

In this task, at the bottom of the screen, the child was showed two boxes, one box attached with an image of a blue rabbit is presented on the left side and the other box attached with an image of a red boat is presented on the right side. The target image was presented at the center of the top of the screen (See Figure 3 for a visual presentation). The child was first introduced the shape game. In the shape game, the child needs to sort target images by shape. Specifically, the child was instructed to put all the rabbit images into the box with blue rabbit image and put all the boat images into the box with red boat image. To do so, children were guided to touch the box with blue rabbit image if they want to put the images into the box with
blue rabbit image and touch the box with red boat if they want to put images into the box with red boat image. Before the testing, two practice trials and feedback were provided to ensure children understand the rule, with stimuli of a blue rabbit and blue boat image. Testing phase in the shape game includes 10 trials with the target images presented in a random order. Among the stimuli, images of rabbits and boats were evenly appeared.

**Figure 3**

*Visual Depiction of the Stimuli in the Dimension Change Card Sort Task*

Then, the color game with a different rule was introduced. The child was instructed to sort images by color this time. That is, they must put all the blue images into the box attached with blue rabbit image, and all the red images into the box attached with red boat image. Children was also told that touching one of the boxes below the target stimuli indicates that they want to put the target image into that certain box. Like the shape game, two practice trials and feedback were provided in the color game, and the stimuli becomes the blue rabbit and the red rabbit image. There were also 10 trials in the color game and the target red and blue images are evenly presented in a random order.

In this task, only when participants made a response by clicking either box below the stimuli on the screen, the next trial will begin, and the task moves forward. Children’s responses
and the response time in each trial were collected and recoded by Gorilla platform. Since our goal is this task is to measure children’s performance of flexibly shifting from one sorting rule to the other rule, therefore the scores in the DCCS task were calculated by the number of trials that child responses correctly in the color game (10 points in total).

Since the development of EF components during preschool years are usually interrelated and hard to statistically distinguish (Baker et al., 2019; Willoughby et al., 2016), it is necessary to aggregate EF performance across multiple tasks (Willoughby et al., 2017). To create a composite EF score, following Sasser et al. (2017), the raw scores of the three EF tasks is transformed into z-scores, which can be done easily using Descriptives command in SPSS, and then the three scores are averaged into a composite score using Transform > Compute Variable command in SPSS.

Language Proficiency in Two Languages

The Quick Interactive Language Screener (QUILS) was used to measure monolingual children’s English proficiency. The QUILS: English-Spanish version (QUILS: ES) was used to measure bilingual children’s language proficiencies in two languages. Both assessments were conducted over Zoom with the shared screen. The QUILS is a standardized web-based assessment that measures vocabulary, syntax, and language learning processes in young children through 3 to 5 years (Golinkoff et al., 2017; Levine et al., 2020). Importantly, as a web-based assessment, it can be administered without special training, children can complete it with just a little supervision. The QUILS and the QUILS:ES version are comparable in assessment structure and item format (de Villiers et al., 2021). Completing either of them takes about 10-15 minutes.

The vocabulary subtests, which requires children to point to a named image out of three or four options, were used in the analysis as the proxy of young children’s language
proficiencies. The vocabulary subtest includes 16 items, which measures children’s knowledge of nouns (4 items), verbs (4 items), prepositions (4 items) and conjunctions (4 items). Children’s responses in each trial were saved synchronously within the QUILS station while taking the language tests. As soon as they completed the assessments, the responses were scored automatically and ready to be reviewed.

Degree of bilingualism is considered as the difference between the two language’s proficiency. Followed by previous studies (Thomas-Sunesson, Hakuta, Bialystok, 2018; Umbel et al., 2008), degree of bilingualism is calculated by the absolute difference between the English and Spanish test scores multiplied by −1 to reverse the ordering of scores and then adding a constant of 100. The formula is: 

\[ 100 + (-1 \times \text{Abs (English – Spanish)}) \].

In the first step, reversing the order of scores by multiplying -1 resulted in the larger numbers indicating better balance in language skills. In the second step, adding a constant of 100 leads to a score of 100 indicating perfect balance and lower scores indicate less balanced proficiency.

**Control Variables**

In addition to age and onset of SLE, the following variables were controlled in the study.

**Income-To-Needs Ratio (INR).** Although all the participants were from low-income families, there are variations in the levels of poverty they experience. So, I controlled the impacts of INR. First of all, I collected the information of poverty thresholds for 2020 published on the official United States Census Bureau website ([https://www.census.gov](https://www.census.gov)). Poverty thresholds are determined and reported by the United States Census Bureau each year based on previous year’s collected data. Then, I identified the poverty thresholds for each family considering their reported family size and number of children at home based on the official federal poverty threshold information. By calculating the ratio of poverty threshold for the family and their
actual family income, I obtained their respective INR. For instance, based on the published poverty threshold in 2019 (the most recent report), the poverty threshold for a 2 adult and 2 child household is $ 25,926. If the actual household income for this family is $30,000, then the INR is $30,000/25,926 ≈ 1.16, for the family in this example.

**Shared English Vocabulary.** When comparing monolingual and bilingual children’s cognitive abilities, it is necessary to control their English vocabulary scores. It ensured that their English language proficiency would not interfere our interpretation of the difference between their cognitive performance. The English vocabulary was measured by the QUILS and QUILS:ES.

**Data Collection and Procedure**

Once the interested parent-child dyads were identified as qualified participants through the screening survey, I followed up with the parents through emails and provide detailed steps for completing the study. In the first step, parents are provided with the online Qualtrics survey link including the demographic questionnaire and the LEAP-Q questionnaire. At the first page of the online survey, parents were provided necessary research information in an informed consent form and asked if they are willing to continue doing the study. Only when parents agreed to participate in the study, the following surveys then are presented, otherwise, the website directs them to an ending page that thanks them for participation. At the end of the survey, parents were invited to choose preferred time periods for their child to complete the language assessment and a series of ToM tasks over Zoom interview.

Once parents had completed the first step, the questionnaires, I sent out a follow-up email to them. One part of the email was to thank them for their completion of the surveys, and the other part was to, 1) provide the computer game link, including three EF tasks; 2) confirm the
Zoom interview time with the parents according to their preferred time given; 3) provide necessary remote assessment instructions for parents (see Appendix C) when their child is engaging in the online computer games and the Zoom interview.

The remote assessment instruction explains to parents what specific assessments will be conducted, how long it will take, and more importantly, the requirements for the technology, environment and caregiver as well, so that parents fully understood their roles and responsibilities before and while their child was completing these online assessments.

For the computer games (three EF tasks), parents can select any convenient time for them and their child to complete at home via a shared link provided by researcher. As there are no researchers involved in the completion of these tasks, the child needs some guidance from parents during training and practice trials. For instance, during training trials of EF tasks, parents were responsible for clicking the continue button once their child understood the instructions. During the testing trials, parents should remain neutral, and no feedback should be provided. The three EF tasks are designed to be presented in a random order. Completing the online computer games takes about 15 - 20 minutes.

The last step in the study is to complete the language tests and ToM tasks over a Zoom interview. The Zoom link and password were sent out to parents one day before the scheduled interview time through email. During the Zoom interview, the trained RA first confirmed with the parents about the technology stability, appropriate environment (i.e., a quiet room with few distractions) and whether the child is ready for the assessment (i.e., fed and rested) according to the assessment instruction provided to parents in advance. In order to build a rapport with children before starting the assessment, the RA then introduced themselves and asked some warm-up questions, such as “what’s your favorite color?”, etc. Children were also informed that
they can request for a break (e.g., if they feel tired/go to the bathroom), skip the tasks they don’t want to complete or stop at any point during the interview if they don’t want to continue.

**Figure 4**

*Flow Chart for the Procedure of Data Collection*

The language test and five ToM tasks were conducted in random order. The whole interview lasts no longer than 30 minutes, 10 minutes for completing ToM tasks, and another 10-15 minutes for doing language assessments. The Zoom interviews were video recorded and
children’s verbal responses were transcribed and coded later. The full procedure of the data collection process is presented in a flow chart - Figure 4.

**Data Preparation**

**Analytical Plan**

*Effects of Bilingualism on ToM Development Among Children from Low-income Families*

In RQ 1, I considered bilingualism as categorical variable, and one-way ANCOVA will be conducted to determine if there are significant differences between the monolingual and bilingual groups on the composite ToM performance, after controlling for age, INR, English vocabulary, and onset of SLE.

In RQ 2, I only included bilingual children and tested if the continuous variable degree of bilingualism impact ToM performance significantly among bilingual children from low-income families through hierarchically linear regression model. In the first step, the demographic variables including age and family INR is entered and controlled. In the second step, the language-related variables, English vocabulary and onset of SLE, is entered and controlled. The variable of interest degree of bilingualism is entered in the last step.

*The Roles of EF in the Relation Between Bilingualism and ToM Development*

In RQ3, mediation analysis will be conducted through PROCESS macro in SPSS version 25 (Hayes, 2018). With the continuous variable degree of bilingualism considered as the independent variable, the composite ToM as dependent variable, and EF is treated as the mediator, the model 4 in PROCESS macro will be used (Hayes, 2018; Hayes & Preacher, 2014). At the same time, to control the impacts of children’s age, INR, English proficiency, and onset of SLE on children’s ToM performance, those variables will be considered as covariates in the mediation analysis.
Chapter IV: Results

Preliminary analyses were first conducted to compare the three groups in terms of demographic variables and language abilities. I also conducted descriptive analyses and correlations for the major variables of interest. Next, an analysis of covariance (ANCOVA) was conducted to compare ToM performance in the three groups. Then, hierarchical multiple linear regression was conducted; for this analysis, bilingualism was treated as a continuous variable, as required for this type of analysis. Lastly, to examine the role of EF in the relationship between bilingualism and ToM development, I conducted a mediation analysis.

Preliminary Analysis and Descriptive Statistics

Group Equivalency in Age, INR, and Language Proficiencies

To test for significant differences in demographic factors between groups, a series of independent sample t-tests were conducted. Between monolingual and bilingual children groups, there were no significant differences in children’s age, \( t(66) = -1.47, p = .146 \), household income, \( t(66) = -0.55, p = .585 \), and INR, \( t(66) = -0.055, p = .966 \). In addition, there was no significant difference in the two groups’ English vocabulary scores, \( t(66) = 0.284, p = .778 \).

Descriptive Analysis of Theory of Mind Performance

To assess possible group differences between children’s scores on ToM tasks, I first examined children’s responses to the control questions, which tested either participants’ memory of the story/reality or their own desires/beliefs, depending on the task. Overall, the majority of participants passed all the control questions. Specifically, all participants (100%) passed control questions in the Diverse Desires and Diverse Beliefs tasks, 95.2% passed the control question in the Knowledge Access task, 96.8% passed the control question in the FBU task, and 90.5% passed the control question in the Hidden Emotions task. This indicates that participants
generally were able to understand and follow the instructions of the ToM tasks.

**Table 4**

*Performance and Passing Rates of Theory of Mind Tasks amongst Monolingual, Bilingual Groups, and Overall Sample*

<table>
<thead>
<tr>
<th></th>
<th>Monolingual</th>
<th>Bilingual</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ToM Composite</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.43</td>
<td>3.21</td>
<td>2.81</td>
</tr>
<tr>
<td>SD</td>
<td>1.12</td>
<td>1.19</td>
<td>1.21</td>
</tr>
<tr>
<td>Skewness</td>
<td>-.41</td>
<td>.03</td>
<td>-.09</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-.41</td>
<td>-.89</td>
<td>-.33</td>
</tr>
<tr>
<td><strong>Passing Rates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DD</td>
<td>71.4%</td>
<td>87.8%</td>
<td>79.4%</td>
</tr>
<tr>
<td>DB</td>
<td>65.7%</td>
<td>75.8%</td>
<td>70.6%</td>
</tr>
<tr>
<td>KA</td>
<td>37.1%</td>
<td>45.5%</td>
<td>41.2%</td>
</tr>
<tr>
<td>FBU</td>
<td>31.5%</td>
<td>54.5%</td>
<td>42.6%</td>
</tr>
<tr>
<td>HE</td>
<td>37.1%</td>
<td>57.6%</td>
<td>47.1%</td>
</tr>
</tbody>
</table>

*Note.* ToM = Theory of Mind; DD = Diverse Desires; DB = Diverse Beliefs; KA = Knowledge Access; FBU = False Belief Understanding; HE = Hidden Emotions.

The ToM composite scores and passing rates among the three language groups is shown in Table 4. Then, I compared the current sample’s passing rates on each task with previous studies focusing on low-income samples (i.e., Baker, Huang, Battista, et al., 2021). Although the passing rates of Diverse Desires, Diverse Beliefs, Knowledge Access and Hidden Emotions are generally consistent with that found in Baker, Huang, Battista, et al., et al. (2021), the passing
rates of FBU in our monolingual sample was lower than that in Baker, Huang, Battista, et al. (2021) (i.e., 42.7%).

**Descriptive Analysis of Executive Function Performance**

All participants completed the online Executive Function tasks. Next, I briefly remind the reader of the scoring criteria for each EF task. I also describe the performance of children on these tasks in other, relatively similar studies, to provide context for the values reported here.

**Animal Go-NoGo task.** In the Animal Go-NoGo task, I planned to examine the accuracy of inhibition in the No-Go trials (that is, children inhibit the action of pressing the black bar when seeing an image of a pig) as the index of IC. The mean IC accuracy was 4.62 (Range: 0-7), SD = 1.65. Most of the participants successfully inhibited a response 3 to 6 out of 7 No-Go trials (<3 times: 7.4%; 3 times: 16.2%; 4 times, 16.2%; 5 times, 20.6%; 6 times, 14.7%, and 7 times: 13.2%).

As this task was conducted online, I was not able to examine children’s responses while they were completing the task (i.e., in real-time). Reviewing the data, I noticed some unexpected response patterns: although some participants inhibited most or all of the No-Go trials, they also showed low accuracy in the Go trials (i.e., they did not hit the button when they should have). This may suggest that those children were less engaged in this task. To examine if there is a pattern in those participants who did not frequently respond to the Go trials, I compared them (N=19) and the remaining 49 participants in terms of INR, English vocabulary and ToM performance. No significant differences in their INR, English proficiency, or ToM were found.

Considering that using the inhibition trial data alone may not be valid in this case, I decided to adapt the scoring to be based on the overall performance rather than just inhibition trials using signal detection theory (Tottenham et al., 2011). Signal detection theory argues that
accuracy in the No-Go trials alone is not a meaningful index of IC; instead, accuracy on both the No-Go ("sensitivity") and Go trials ("bias") should be considered (Macmillan, 2002; Tottenham et al., 2011). Suggested by signal detection theory, I calculated \(d'\) as the index of children’s inhibition accuracy accounting for response bias. To calculate \(d'\), I used the formula (Macmillan, 2002):

\[
  d' = z(H) - z(F)
\]

In this formula, “H” refers to the hit rate, calculated as the proportion of Go trials to which participants responded correctly, and “F” refers to the false alarm rate, which is the proportion of No-Go trials to which participants responded incorrectly. The \(d'\) value is calculated as the difference of the z-scores of “H” and “F”. The mean scores of \(d'\) for the three groups and sample overall are summarized in Table 5.

Table 5

<table>
<thead>
<tr>
<th>Task</th>
<th>Monolingual</th>
<th>Bilingual</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go-NoGo Scores</td>
<td>0.93 (1.12)</td>
<td>1.77 (1.29)</td>
<td>1.34 (1.26)</td>
</tr>
<tr>
<td>Corsi Block Scores</td>
<td>2.49 (1.15)</td>
<td>3.27 (0.91)</td>
<td>2.87 (1.11)</td>
</tr>
<tr>
<td>DCCS Scores</td>
<td>6.94 (1.64)</td>
<td>8.18 (1.26)</td>
<td>7.54 (1.59)</td>
</tr>
</tbody>
</table>

Note. DCCS = Dimensional Change Card Sorting.

Given that few studies have used \(d'\) in preschool children’s Go-NoGo tasks, and those studies which used the \(d'\) index have seldom reported the mean value of \(d'\), I cannot compare the current sample’s performance with other studies using the same age samples. However, Tottenham et al. (2011) reported that the average \(d'\) for the Emotion Go-NoGo
task completed by 5- to 12-year-old English-speaking children is approximate 1.50. Tottenham and colleagues (2011) study may give us some idea that our monolingual sample has a generally normative performance given their young age; however, as Tottenham et al. (2011) did not report SES we do not know if this typical for low-income populations.

**Corsi Block Tapping Task.** The Corsi Block Tapping task requires participants to repeat the order of cubes in which a stimulus (i.e., green frog) has appeared, with the length of the sequence of cubes gradually increasing. The score is coded as the longest length of cubes for which the child can correctly repeat the order (Corsi, 1972; Van Der Veer et al., 2020). Performance here ranged from 1 to 5, with a maximum possible score of 6. Results showed that 14.7% of children missed both of the two-cube trials (scored as 1), 20.6% of children only correctly repeated the order of two-cubes length; 30.9% repeated the order of three-cubes length, 30.9% repeated the order of four-cubes length, 2.9% repeated the order of five-cubes length.

Table 5 presents the mean scores for each group and the sample overall. Scores for monolingual children in this study were higher than that reported for monolingual preschool children found in other studies (i.e., Fuhs et al., 2013; M = 1.59; Bull et al., 2009; M = 1.94). To my knowledge, no bilingualism studies have used the Corsi Block task to assess bilingual children’s WM, so it is unknown if values for these bilingual groups are typical.

**Dimensional Change Card Sort task.** The Dimensional Change Card Sort task (DCCS) includes a pre-switch phase (i.e., sorting cards based on shape) and a post-switch phase (i.e., sorting cards based on color). Scoring was based on sorting accuracy in the post-switch phase (score range: 0-10). Mean scores for each group and the sample overall are in Table 5.

Monolingual children in this sample had slightly lower DCCS scores compared to English-speaking monolingual children’s performance in previous studies (i.e., 71% and 72.27%;
Muller et al., 2005 and Tarullo et al., 2018, respectively). This could partly be due to our sample being from low-income families. Unbalanced bilingual and balanced bilingual children here performed similarly to middle-class bilingual children in other studies (Bialystok, 1999, M = 8.23).

**Correlations Among the Key Variables and Control Variables**

First, I conducted Pearson product-moment correlations between the four covariates (Age, INR, English proficiency, Onset of SLE) and the four key variables of interest (scores in ToM, Go-NoGo, Corsi Block, and DCCS tasks). As Table 6 shows, age was significantly associated with all the task scores, while family INR was significantly associated only with children’s Go-NoGo scores. Children’s English proficiency was correlated to ToM, Go-NoGo, and DCCS, but not Corsi Block scores. Onset of SLE was not significantly related to ToM or Go-NoGo scores but was significantly correlated with DCCS and Corsi Block scores.

**Table 6**

*Correlations between Covariates and Scores in ToM, Go-NoGo, Corsi Block, DCCS, and Bilingualism Status*

<table>
<thead>
<tr>
<th></th>
<th>ToM</th>
<th>Go-NoGo</th>
<th>Corsi Block</th>
<th>DCCS</th>
<th>Bilingualism Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Age</td>
<td>.372***</td>
<td>.312**</td>
<td>.243*</td>
<td>.419***</td>
<td>.178</td>
</tr>
<tr>
<td>INR</td>
<td>.156</td>
<td>.366**</td>
<td>-.057</td>
<td>.151</td>
<td>-.007</td>
</tr>
<tr>
<td>English Vocabulary</td>
<td>.419***</td>
<td>.253*</td>
<td>.234</td>
<td>.338**</td>
<td>-.035</td>
</tr>
<tr>
<td>Onset of SLE</td>
<td>.109</td>
<td>.194</td>
<td>.285*</td>
<td>.321**</td>
<td>NA</td>
</tr>
</tbody>
</table>

64
Note. INR = Income to needs ratio; SLE = Second Language Exposure; ToM = Theory of Mind;
DCCS = Dimensional Change Card Sorting.

* \( p < .05 \), ** \( p < .01 \), *** \( p < .001 \).

As Bilingualism Status is a categorical variable (i.e., monolingual = 0, bilingual = 1), the
correlations between Bilingualism Status and the four covariates were conducted by point
biserial correlations. Results showed that Bilingualism Status was not significantly related to any
of the covariates. Since only bilingual group has reported the onset of SLE, the correlation
between Bilingualism Status and onset of SLE is meaningless and thus noted as NA.

Table 7

<p>| Correlations and Partial Correlations Among the Major Variables |
|---------------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th></th>
<th>ToM</th>
<th>Go-NoGo</th>
<th>Corsi Block</th>
<th>DCCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ToM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.387**</td>
<td>.560***</td>
<td>.613***</td>
<td>.325**</td>
</tr>
<tr>
<td>Go-NoGo</td>
<td>.196</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.192</td>
<td>.501***</td>
<td></td>
<td>.333**</td>
</tr>
<tr>
<td>Corsi Block</td>
<td>.490***</td>
<td>.060</td>
<td></td>
<td>.365**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.365**</td>
<td>.359**</td>
</tr>
<tr>
<td>DCCS</td>
<td>.454***</td>
<td>.315*</td>
<td>.180</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.393***</td>
<td></td>
</tr>
<tr>
<td>Bilingualism Status</td>
<td>.341**</td>
<td>.258*</td>
<td>.251*</td>
<td>.271*</td>
</tr>
</tbody>
</table>

65
Note. Above the diagonal are the correlations among the major variables; Below the diagonal are the partial correlations after controlling for age, INR, English proficiency, and onset of SLE. ToM = Theory of Mind; DCCS = Dimensional Change Card Sorting.

*p < .05, **p < .01, ***p < .001.

Table 7 below presents the correlations among the key variables: ToM scores, Corsi Block scores, Go-NoGo scores, DCCS scores, and Bilingualism Status, located above the diagonal. Values below the diagonal represent the partial correlations after controlling for child age, INR, English vocabulary, and onset of SLE. Bilingualism Status was significantly associated with all four cognitive task scores (ToM, Corsi Block, Go-NoGo, DCCS). After the effects of covariates were partialled out, the correlations of Bilingualism Status with ToM, Go NoGo, Corsi Block, and DCCS scores remained significant.

In addition, the associations between ToM scores and three EF scores (Corsi Block, Go-NoGo, DCCS) were significant, while ToM scores and Go-NoGo scores became insignificant after controlling for the covariates. Among the three EF task scores, some significant correlations emerged. After controlling for covariates, however, only the relationship between Go-NoGo scores and DCCS scores remained significant. Therefore, I decided to examine the three EF components separately, rather than their composite score.

Hypothesis Testing

Effects of Bilingualism on Low-income Children’s Theory of Mind

To address the first research question regarding whether bilingual children raised in low-income families have higher ToM scores compared to monolingual children in low-income families, I hypothesized that there is a significant ToM difference between the monolingual and
bilingual groups. Specifically, I expected that the bilingual group would have higher ToM scores than the monolingual group.

**Hypothesis 1: Difference in Theory of Mind between Monolingual and Bilingual Groups.** The first hypothesis was tested using a one-way ANCOVA. The independent variable was Bilingualism Status (categorical: monolingual, bilingual) and ToM performance was the dependent variable. Age, INR, English proficiency, and onset of SLE were entered as covariates.

Before conducting the ANCOVA, the relevant assumptions were tested. First, the assumption of independent observations was met as all the participants were from random independent samples. Second, the non-significant Shapiro-Wilk normality test results in the two groups suggested that ToM was normally distributed in both groups (Shapiro & Wilk, 1965). This is also confirmed by skewness and kurtosis values (i.e., values less than |2|; George & Mallery, 2010). In addition, Levene’s test indicated that the assumption of homogeneity of variance was met, $p = .97$ (Levene, 1960). Scatterplots of the covariates and ToM along with the Pearson correlation results, discussed above, showed that ToM has an obvious linear relationship with child age and English Vocabulary, but not INR or onset of SLE. To make sure the assumption of the linearity is met, only child age and English vocabulary were added to the ANCOVA as covariates. Additionally, scatterplots of ToM and covariates (age and English vocabulary scores) showed that the regression slopes were relatively parallel across the two language groups, so the data also met the assumption of regression slopes: age and English proficiency were linearly related to ToM in all three language groups (Poremba & Rowell, 1997; Field, 2013).

Then, I proceeded to conduct the ANCOVA. Regarding the covariates, ToM scores were significantly related to age, $F(1, 64) = 8.83, p = .004$, partial $\eta^2 = .12$, and English vocabulary
scores, $F(1, 64) = 17.38, p < .001$, partial $\eta^2 = .21$. Moreover, there was a significant effect of bilingualism status on ToM performance after adjusting for age and English proficiency, $F(1, 64) = 8.15, p = .006$, partial $\eta^2 = .11$. It suggests that bilingual children have a significantly better ToM performance than monolingual children after controlling for children’s age and English proficiency. The two groups’ comparison of ToM performance was showed in Figure 5.

The observed power was calculated by G*Power version 3.1 using the statistical test: ANCOVA: fixed effects, main effects, and interactions (Faul & Erdfelder, 1992). Given the obtained partial $\eta^2$ for bilingualism status’s effect on ToM (.11), G*Power reported a large effect size ($f = .35$). With the alpha of .05, sample size of 68, 2 comparison groups, 2 covariates, the power obtained is .815, which support that the results are sufficiently powered.

**Figure 5**

*Group Comparisons of ToM Performance in Terms of Bilingualism Status*

---

**Hypothesis 2: Degree of Bilingualism Predicts Theory of Mind.** Although group comparisons in terms of bilingualism (i.e., treating bilingualism as a categorical variable) in
cognitive abilities are widely utilized in research, many studies appropriately criticize this approach for oversimplifying a complex phenomenon (i.e., that treating bilingualism as a categorical variable obscures true variations amongst bilingual children, as bilingual children may have different mastery levels of the two languages, and it is therefore inappropriate to treat them as a homogenous collective). Therefore, I tested whether the balance level of the two languages (i.e., degree of bilingualism) affects low-income children’s ToM performance using hierarchical linear regression analysis. I hypothesized that the higher degree of bilingualism would correspond with higher ToM scores after controlling for the relevant covariates. That is, children with more balanced language proficiencies will pass more ToM tasks.

As the degree of bilingualism considered both English and Spanish language proficiencies, only bilingual children were included in this analysis. Following Thomas-Sunesson et al. (2018) and Umbel et al. (2008), degree of bilingualism was calculated as: 100 + (−1*| (English – Spanish) |). For instance, bilingual children with equivalent scores in English and Spanish received the maximum score of 100. The mean score of bilingual children’s degree of bilingualism is 86.12, SD = 9.69. Figure 6 shows the histogram of degree of bilingualism.

Before conducting the hierarchical regression analysis, the relevant assumptions were tested. Scatterplots showed a linear relationship between ToM and degree of bilingualism (see Figure 7), as well as ToM and two covariates: age and English vocabulary scores. As the collinearity statistics were all within acceptable limits (i.e., Tolerance > .20 and VIF < 5), the assumption of multicollinearity was met (Hair et al., 2011; Tabachnick & Fidell, 2013). The result of the Durbin-Watson test was 1.95, which supports the independence of residuals based on the standard acceptable value range of 1.5 to 2.5 (Durbin & Watson, 1950; Field, 2013). Residual plots and scatterplots indicated the assumptions of normality and homoscedasticity.
were satisfied (Hair et al., 1998).

**Figure 6**

*Histogram of the Degree of Bilingualism (N=33)*

![Histogram of the Degree of Bilingualism](image)

**Figure 7**

*Scatterplot of ToM by Degree of Bilingualism*

![Scatterplot of ToM by Degree of Bilingualism](image)
A two-step hierarchical linear regression was conducted with ToM scores as the dependent variable and the relevant covariates and degree of bilingualism as independent variables. Specifically, I entered the covariates (i.e., age, English vocabulary scores) in Step 1, and degree of bilingualism was put in Step 2. Results are summarized in Table 8.

**Table 8**

*Summary of Hierarchical Regression Analysis*

<table>
<thead>
<tr>
<th>Steps/Variables</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>p</th>
<th>R²</th>
<th>Change in R²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.05</td>
<td>.02</td>
<td>.35</td>
<td>.035</td>
<td>.290</td>
<td>.290**</td>
</tr>
<tr>
<td>English Vocabulary</td>
<td>.07</td>
<td>.02</td>
<td>.48</td>
<td>.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.06</td>
<td>.02</td>
<td>.39</td>
<td>.011</td>
<td>.434</td>
<td>.144*</td>
</tr>
<tr>
<td>English Vocabulary</td>
<td>.07</td>
<td>.02</td>
<td>.49</td>
<td>.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of Bilingualism</td>
<td>.05</td>
<td>.02</td>
<td>.38</td>
<td>.011</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. N = 33; *p < .05, **p < .01, ***p < .001.*

At Step 1, both age and English vocabulary scores contributed significantly to the model, \( R^2 = .290, F (2, 30) = 6.13, p = .006. \) At Step 2, the added degree of bilingualism explained an additional 14.4% of the variance in ToM scores, and this was a significant increase, \( \Delta F (1, 29) = 7.36, p = .011. \) Based on the formula for effect size calculation (Selya et al., 2012):

\[
f^2 = \frac{\Delta R^2}{1-R^2}
\]

The obtained effect size is .254, which is a medium-to-large effect size based on Cohen (1988). The effect size was used to conduct the post-hoc power analysis through G*Power (Faul & Erdfelder, 1992). With the type of statistical test (Linear multiple regression: Fixed model,
$R^2$ increase) and the model design ($\alpha = .05$, $N = 33$, 1 tested predictor, and 3 total predictors), the obtained power is satisfied (.80).

This finding demonstrates that the degree of bilingualism explains a significant amount of variance in low-income children’s ToM performance, above and beyond child’s age and English proficiency. Consistent with the results from ANCOVA, the regression model indicates that children with more balanced dual-language proficiencies showed more accurate performance in ToM tasks than children with less balanced dual-language proficiencies.

**Role of EF in Relationship between Bilingualism and Theory of Mind**

**Hypothesis 3: EF mediates the relationship between bilingualism and Theory of Mind.** Regarding the third research question, I hypothesized that EF would mediate the associations between early bilingualism and ToM after controlling for significant covariates. That is, the improvements we witnessed for ToM with bilingual proficiency are in part due to enhanced EF. To test this hypothesis, a parallel mediation analysis with three mediators (model 4) was conducted through PROCESS Macro v 3.4 in SPSS 25 (Hayes, 2018). Again, this was done using parallel mediation – meaning all three EF were retained as separate, non-sequential mediators – as the three EF variables did not significantly correlate with one another.

The assumptions for mediation analysis were tested. Similar to hierarchical linear regression, the data for the mediation model met the assumptions of linearity, normality, homoscedasticity, multicollinearity, and independence of residuals (Field, 2013; Hair et al., 1998; Tabachnick & Fidell, 2013). The results for the mediation path coefficients are presented in Figure X. The total effect of degree of bilingualism on ToM was significant, $c = .009$, $p = .002$, 95% CI [.004, .014]. The direct effect of degree of bilingualism on ToM was not significant, $c’ = .002$, $p = .53$, 95% CI [-.004, .008]. After controlling for the four covariates (age, INR,
English vocabulary score, onset of SLE), children with a higher bilingualism score had higher scores on the Corsi Block task \( (a_1 = .009, p = .002) \), the DCCS task \( (a_2 = .014, p < .001) \), and the Go-NoGo task \( (a_3 = .009, p = .014) \) than those with lower bilingualism scores. Meantime, the increased scores in Corsi Block and DCCS tasks were associated with higher ToM scores \( (b_1 = .361, p < .001; b_2 = .239, p = .001) \).

The indirect effect from bilingualism to ToM scores through the Corsi Block scores was significant, \( a_1 b_1 = .003 \), and 95% CI based on 10,000 bootstrap sampling ranged from 0.001 to 0.006. The indirect pathway through DCCS scores was also significant, \( a_2 b_2 = .003 \), with 95% bootstrap CI ranged from 0.001 to 0.006. In contrast, the indirect effect through Go-NoGo scores was not significant, \( a_3 b_3 = .0004 \), 95% bootstrap CI \([-0.001, 0.002]\).

A Monte Carlo Power Analysis for the parallel mediation model was conducted through the platform designed by Schoemann et al. (2017): [https://schoemanna.shinyapps.io/mc_power_med/](https://schoemanna.shinyapps.io/mc_power_med/). The total number of replications is selected as 10000, and the number of random draws per Replication is set as the default 20000. To calculate the power for each of the mediation pathway, I input the correlations and standard deviations between the variables of interests (see Table 4, 5, and 7). With the sample size of 68 and 95% CI, the power for the mediating paths of Corsi Block and DCCS scores were strong (.88 and .92 respectively), which is greater than the recommended minimum power of .80 (Cohen, 1998), while the path through Go NoGo scores is underpowered (.13).

Overall, the mediation results indicate that the effect of bilingualism status on ToM performance was fully mediated by some of the EF abilities, specifically WM and cognitive flexibility, but not IC.
Figure 8

The mediation effect of three EF components in the relationship between bilingualism status and ToM performance

\[c' = 0.02\]
\[c = 0.09\]

Note. All presented effects are unstandardized. ToM = Theory of Mind; DCCS = Dimensional Change Card Sorting.

* \( p < .05 \), ** \( p < .01 \), *** \( p < .001 \).
Chapter V: Discussion

This chapter consists of five parts. I first discuss the findings related to the first two research questions: how does bilingualism contribute to ToM performance for children in poverty? In part two, I discuss the findings addressing the third research question: does EF explain the relationship between bilingualism and ToM? In part three, implications for parents and educators are discussed. The fourth part briefly presents the limitations of the current study and directions for future studies. Lastly, I conclude the interpretations and summations of this dissertation.

Bilingualism and Theory of Mind

Monolingual and Bilingual Children’s Theory of Mind Development

The relationship between language ability and ToM performance has been well documented in both monolingual and bilingual children (e.g., Astington & Jenkins, 1999; Buac & Kaushanskyam 2020; Cutting & Dunn, 1999; Farhadian et al., 2010; Hughes & Ensor, 2005). The current low-income sample replicated previous work: there is a positive correlation between English Vocabulary and ToM. This supports the claim that language ability is an important factor linking to children’s ToM development (Zelazo, 1999). Taking this further, knowing two languages with increased vocabulary and language skills may allow children to better use languages to express their beliefs, intentions, and knowledge (Buac & Kaushanskyam, 2020; Farhadian et al., 2010). Similarly, the enhanced ToM may likely allow for easier second language learning, which needs to be explored by future studies.

Regarding the findings related to my first research question, I found that bilingual children have significantly better mental state understanding than monolingual children in low-income families after controlling for age and English vocabularies, which is consistent with my...
hypothesis and previous studies with more affluent samples (Diaz & Farrar, 2018; Goetz, 2003; Kovacs, 2009). It is also worthwhile to mention that this study has employed 5 different ToM tasks which captures 5 unique perspectives of mental state understanding. With such as comprehensive measure, the study extended from previous studies that mainly used FBU or diverse belief tasks and supported that bilingual children in low-income families have developed more aspects of mental state understanding compared to monolingual children in low-income families.

Considering that group comparisons obscure variations in two language’s proficiencies within bilingual group, I further looked into the effects of degree of bilingualism on bilingual children’s ToM performance. Consistent with the group comparisons, children with greater proficiency in both languages demonstrated stronger ToM. This finding supports that to ensure the benefits of bilingualism regarding ToM, having developmentally appropriate and equivalent proficiencies in two languages seems to be an important factor.

The two main findings in RQ1 and RQ2 together provides some support to the threshold hypothesis proposed by Cummins (1976). The threshold hypothesis proposes that limited bilingual proficiencies may be detrimental for cognition, but that these issues can be overcome with increased bilingual proficiency. To reach the cognitive advantages of bilingualism, children need to be highly proficient in both languages (Cummins, 1976). This study confirmed that children with more balanced and robust language proficiencies are more likely to have better metal state understanding.

**Protective Effects of Bilingualism on Low-Income Children’s Theory of Mind Development**

Children living in poverty develop differently in many aspects compared to children in affluence, such as cognition, language ability, and educational outcomes (Blair & Razza, 2007;
Hughes & Ensor, 2005; Holmes-Lonergan, 2003; Tompkins et al., 2013; Weimer & Guajardo, 2005; Yang et al., 2019). Until recently it was commonly assumed that impoverished children’s development is “impaired” or “delayed” compared to more affluent peers (Frankenhuis & de Weerth, 2013; Frankenhuis & Nettle, 2020). However, guided by the ecologically-salient developmental model, developmental scientists are motivated to consider economically-impooverished children’s development within their context, instead of making comparisons to more affluent samples which stigmatize children in poverty (Baker, Huang, Liu, et al., 2021; Burlew et al., 2019; Frankenhuis & Nettle, 2020).

Within the context of limited resources and economic stress, the contemporary view is that children are able to adapt to their environment, a claim supported by evidence that shows robust abilities for individuals in poverty and other areas of adversity that do not occur for more affluent individuals (see Frankenhuis & de Weerth, 2013 for review; Frankenhuis & Nettle, 2020), such as enhanced emotional perspective taking (Baker, Huang, Battista, et al., 2021). Given that in more affluent families, bilingual children show more advanced mental state understanding than monolingual children (Diaz & Farrar, 2018; Goetz, 2003; Kovács, 2009), I expected that having a robust understanding of two languages would be positively associated with low-income children’s ToM performance. The findings here somewhat support this expectation. In particular, low-income children with higher degree of bilingualism were linked to better ToM capacities. To unpack the findings from the perspective of ecologically adaptive model, it is necessary to understand the possible mechanisms explaining the relationship between bilingualism and ToM development in the low-income environments.
Mediating Role of EF on Relationship between Bilingualism and Theory of Mind

After confirming the associations between early bilingualism and ToM among low-income samples, I further explored the possible mechanisms behind this relationship, specifically regarding the role of EF. The results are generally consistent with my hypothesis: among children in economically impoverished families, the enhanced mental state understanding in bilingual children with higher degree of bilingualism was fully explained by some components of EF, namely WM and Attention Shifting (AS). The detail of this mediation suggests that learning two languages at a young age was not directly associated with impoverished children’s ToM, but instead through the path of enhanced cognitive capacities (i.e., WM and AS). This is discussed in detail below through two perspectives: Bilingualism to EF, and EF to ToM.

Bilingualism and Executive Function

As the connections between bilingualism and EF were not the main concern of this dissertation, I did not test the EF difference in bilingualism status groups or the role of bilingualism in EF. However, the mediation model provided some incidental evidence. The mediation model in Figure 8 illustrates that bilingualism was associated with all three components of EF, that is, within a low-income sample, bilingual children who have more balanced and robust language proficiencies in two languages tend to have greater working memory capacity, more flexible cognitive shifting, and enhanced inhibition. This is consistent with the studies that support the positive association between bilingualism and cognitive capacities in affluent samples (i.e., Bialystok & Craik, 2010; Blom et al., 2014; Guo & Yao, 2022; Hernandez et al., 2012; Li et al., 2022; Mehrani & Zabihi, 2017; Stocco et al., 2014).

IC is one of the most commonly investigated components in the field of bilingualism and
cognition, and a large portion of studies with middle- and upper-class samples supported that the bilingual advantage existed in some types of IC tasks, such as Simon Says, Flanker task, Stroop task, and nonverbal Go-NoGo task (Bialystok et al., 2008; Carlson & Meltzoff, 2008; Foy & Mann, 2014; Mehrani & Zabihi, 2017; Santillán & Khurana, 2018; Yang et al., 2011). Here, the finding replicated that the enhanced inhibition performance in bilingual children is exhibited in nonverbal Go-NoGo task and expanded to low-income samples after controlling for child’s age, INR and English proficiency.

It is worth noting that these IC tasks vary conceptually and require different levels of cognitive demands (Baker et al., 2019). For instance, Simon says and Go-NoGo tasks only require a behavioral response to a single stimulus (e.g., if “other animals”, then press a button, if “pig”, then do nothing), while the Stroop-like task and Flanker task require behavioral/verbal responses while processing multiple stimuli and require suppressing interference from competing stimuli (i.e., tap once when the experimenter taps twice, and tap twice when the experimenter taps once; Baker et al., 2019). It is believed that the Stroop-like tasks and Flanker tasks involving interference suppression may require a greater level of regulation of inhibitory mechanisms compared to the Go NoGo tasks (Baker et al., 2019; Poulin-Dubois et al., 2011). Therefore, the current positive finding on low-income children’s nonverbal Go NoGo performance may not be generalized to other IC performance, especially those involves cognitive interference and requires greater IC capacities, such as Stroop task.

Compared to the bilingual advantage in IC abilities, the findings of the connection between bilingualism and AS and WM are less consistent (Bialystok, 2017; Gunnerud et al., 2020; Hilchey & Klein, 2011; Ware et al., 2020. Generally, previous studies suggest that the inconsistent findings may be due to the sample variations (e.g., SES, age, English abilities) not
controlled, or the bilingual advantage only limited to certain task types (Gunnerud et al., 2020; Morton & Harper, 2007; Paap et al., 2016). The current study has controlled the possible confounders, such as age, SES, English proficiency, and onset age of SLE, hence the positive associations between bilingualism and AS and WM supported that economically disadvantaged bilingual children with higher balance in both language proficiencies are likely to have an enhanced flexibility shifting their attention and hold a great WM capacity.

This is consistent with previous studies from middle-class samples using the similar nonverbal WM and AS tasks. For instance, young bilingual children shift attention more flexibly between different rules in DCCS compared to monolingual children after controlling for age and shared language vocabulary (Bialystok & Martin, 2004; Carlson & Meltzoff, 2008; Okanda et al., 2010; Prior & MacWhinney, 2010; Yang et al., 2011). Similarly, research supported that bilingual children tend to have a larger memory capacity to remember more in a short time (Daubert & Ramani, 2019; Garcia et al., 2018; Morales et al., 2013). More recently, Grote and colleagues (2020) examined the potential bilingual effects of children’s EF in a low-income sample. Their findings coincide with what we have found here: bilingual children exhibit enhanced IC, WM, and AS, even in low-SES backgrounds, which suggests that bilingualism may serve as a buffer for economically disadvantaged children’s cognitive capacities.

Overall, the associations between bilingual experience and EF (i.e., IC, WM, AS) found here can be explained by the claim that learning two languages and approaching a more balanced and advanced level of the two languages provides children rich opportunities to practice cognitive skills, such as inhibiting one language while using another language, shifting their focus from one language to another, and remembering word equivalents in two languages, which therefore linked to enhanced cognitive capacities in daily life (Adesope et al., 2010; Bialystok &
Martin, 2004; Bialystok, 2008; Carlson & Meltzoff, 2008; Prior & MacWhinney, 2010). More importantly, the cognitive benefits of bilingualism extend to children from low-income backgrounds.

**Executive Function and Theory of Mind**

Regarding the relationships between EF and ToM, this study indicated that only WM and AS were significantly and positively related to low-income children’s ToM. This is consistent with previous studies that focus on children from relatively more affluent families (Davis & Pratt, 1995; Mutter et al., 2006; Marcovitch et al., 2015). Unexpectedly, IC did not contribute to explaining low-income children’s ToM performance. This may also result in the finding that IC did not explain the relationship between bilingualism and ToM. Previous studies generally support that EF, especially IC, and ToM are closely related to each other (Carlson et al., 2004; Devine & Hughes, 2014; Doenyas et al., 2018; Hughes, 1998; Marcovitch et al., 2015).

One explanation for the non-significant association between IC and ToM is that the relationship between IC and ToM is greatly impacted by resource-poor environments (Blair & Razza, 2007; Razza & Blair, 2009; Shahaeian et al., 2015). For instance, although the emergence account posits that IC may take a leading role in guiding ToM development in affluent communities (Moses, 2001; Devine & Hughes, 2014; Marcovitch et al., 2015; Muller et al., 2012), this has seldom been found in low-income samples. Huang et al. (under review) found that IC does not predict low-income children’s ToM, but instead, Hidden Emotions predicted IC. Moreover, as Table 6 shows, IC is uniquely associated with INR; given that the entirety of the sample was drawn from low-income families, this suggests perhaps a deeper relationship between resource availability and IC, particularly for those in poverty. In other words, IC may be more sensitive to poverty’s effect compared to the other two EF components (WM and AS),
which leads to different connections with ToM.

However, after controlling for child age, INR, English vocabulary, age of SLE, the significant link between IC and ToM was greatly attenuated (see Table 7), suggesting there might be an interaction effect between IC and INR on low-income children’s ToM development. For instance, children in different levels of INR (i.e., INR <1 versus 1< INR <2) may experience different patterns of IC and ToM development, which in turn affects the relationship between IC and ToM. Relatedly, previous studies support that both IC and ToM are impacted by the severity of poverty (Baker, Huang, Battista, et al., 2021; Brown et al., 2013; Haft & Hoeft, 2017; Moilanen et al., 2010). Moilanen et al. (2010) examined young children’s IC longitudinally and found that less severe family poverty was associated with a relatively increased growth in IC across a two-year period in early childhood.

As previous stated, children’s development is environmentally sensitive and adaptive. Kidd and colleagues’ (2013) experimental design demonstrated that children’s performance on IC tasks was largely based on their previous experience with the reliability of the environments. In an unreliable environment (children waiting for a greater reward, but were disappointed twice), children extrapolated their experiences and later tended to not wait for a greater reward, whereas in a reliable environment (children waited for greater rewards and were rewarded), children were subsequently more willing to wait for a reward in the IC task. This study suggests that children learn from their experiences the likelihood of delayed gratification coming to fruition. Applied here, at different levels of poverty, IC development should not follow patterns found for more affluent samples.

Another possible reason for the non-significant IC-ToM relationship and the mediating role of IC may be measurement errors. As stated in the Method section, few participants had
relatively low accuracy in the Go trials in the online version Go-NoGo task, which indicate that those children may be less engaged in the task overall. Stucke et al. (2022) encountered a similar situation with their Go-NoGo task, which also used online data collection technologies. Interestingly, instead of using d prime, they set a criterion for this situation: children must respond to at least 75% of the Go for their data to be valid. However, 33% of their participants had accuracy lower than 75% in the Go trials, and so Stucke et al. (2022) excluded this task from their analysis. According to this criterion, 19 out of 68 (27.9%) participants in the current study did not respond to at least 75% of the Go trials in the current sample.

Given that participants who did not frequently respond to the Go trials and those who did frequently respond to the Go trials did not differ in terms of INR, English proficiency, and ToM, those measurement errors may be occurred by random. It is possible that these children were less attentive in the online Go-NoGo task. Inattention and distraction may occur to a larger degree during online data collection compared to in-person data collection (Finley & Penninggroth, 2015). Even though the d prime index provides a better estimate of those children’s IC considering response biases in the Go trials, the more reliable IC index should keep the response bias at a minimum range. In other words, to best represent children’s inhibition of a prepotent response in the NoGo trials, children have to establish a capacity for a prepotent response first. During in-person data collection, the response bias may be effectively reduced by a researcher’s supervision, for instance, they can ensure children’s attention during this task. Future studies with in-person data collection are encouraged to replicate the mediating role of IC on the relationship between bilingualism and ToM with low-income children.
Educational Implications

The number of bilingual children is rising in recent decades (Kids Count Data Center, 2018), and low-income families face even more challenges in raising a bilingual child, such as having limited exposure to books in one or both languages and having fewer language learning opportunities (i.e., attending language courses; Guerrero, 2001). The findings in the current study offer important implications for parents and educators concerned about young, economically at-risk children learning two languages.

There is a belief among parents that learning two languages may make children confused and may negatively impact their development (American Academy of Pediatrics, 2017). The current study demonstrated that even within economically-disadvantaged families, learning two languages may coincide with advanced cognitive capacities, such as greater working memory capacity and more flexible shifting of attention, which are associated with enhanced mental state understanding. However, these positive effects become stronger if children acquire more advanced and balanced language proficiency levels. Considering the possible protective effects of bilingualism on impoverished children’s socio-cognitive development, this study may assuage parents’ concerns, especially those in low-income families, and encourage them to raise bilingual children by creating environments for children to approach more balanced expertise in the two languages.

The question then becomes how to best support bilingual children in low-income families to become proficient in two languages. After reviewing the parental reported Language Experience and Proficiency (LEAP) Questionnaire, some patterns emerge that might speak to this question. First, regarding the age of second language exposure, 13 out of 33 (39%) bilingual children were exposed to English and Spanish from birth, and the remaining 20 bilingual
children have a relatively broad range of age of second language exposure, from 6 to 48 months (M = 26 months), eight of them have achieve relatively equivalent language proficiencies. This echoes previous work suggesting that young children, in the early years, are capable of quickly acquiring another language and achieving a balanced level of two languages (Hu, 2016; Lightbown, 2008).

Second, 14 out of 33 bilingual children (42.4%) have relatively equal exposure to both English and Spanish (50% Spanish vs 50% English or 40% Spanish vs 60% English) in their daily lives at the time of data collection, and 10 of them have achieve relatively equivalent language proficiencies. In addition, eight of these children do not have a preference for predominantly speaking one language versus the other language (i.e., the proportion of time spent speaking English and Spanish: 50% vs 50%, or 60% vs. 40%). It suggests that the near equivalent language exposure and active use of two languages may be important factors leading children to a balanced language status (Hoff, 2018).

Although previous studies suggest a “one-parent, one-language” strategy to establish a bilingual home environment (i.e., each parent sticks to one language when communicating with the child, so that the child receives exposure to two languages; Logan-Terry, 2008; Olmedo, 2005), this suggestion may not be practical in immigrant families. Spanish-English bilingual children in economically impoverished families in the U.S. were more likely to be raised in dominantly Spanish-speaking families and learn English at school (see King & Fogle, 2013 for review; Rodríguez, 2010), which is a typical language learning environment in immigrant families. Within the context of English at school and Spanish at home, the greatest difficulty of reaching equivalent language proficiencies is minority language loss, that is, after children attend English-speaking daycare or schools, children tend to gradually refuse to use Spanish and move
toward English monolingualism (Kan & Kohnert, 2005). To maintain Spanish learning and bilingual development, applying a Spanish-only-at-home rule can be a strategy to encourage children’s Spanish use (Surraín, 2018). In addition to families’ efforts to promote the children’s degree of bilingualism, it is vital that the schools also provide support for children’s Spanish learning (Surraín, 2018; Winsler et al., 1999).

Relatedly, another feature I noticed from the data provided by the families of bilingual children is that although most of the bilingual children were exposed to English when interacting with teachers, 13 out of 33 bilingual children (39.4%) reported using both English and Spanish when interacting with their teachers at school, and 8 of them have relatively strong language proficiencies in two languages. Unfortunately, many low-income families have limited options for daycares, and bilingual daycare/education is often not affordable. It can be helpful for educators and daycare administrators to increase the ratio of Spanish-English bilingual teachers in Head Start programs and other daycare programs (Rodríguez, 2015). Teachers should be aware of children’s language backgrounds (such as children’s home language environments) and language proficiencies in both languages and adjust their language use when speaking to children. For instance, when children just start to attend daycare and be exposed to English, teachers should speak more English than Spanish to help children quickly learn English, while as children are able to use English fluently, teacher can give more balance to Spanish in daily communication to retain children’s Spanish use. Meanwhile, children should be encouraged to speak both languages in the classroom, which helps build a positive attitude toward native and novel languages and an understanding that bilingualism is an asset (Rodríguez, 2015).

Limitations and Future Directions

The current study is the first attempt, to my knowledge, to address the interconnections
among poverty, bilingualism, and ToM, and to test the boundary and mechanisms of the bilingual effects on ToM, specifically regarding EF. There are a few noteworthy limitations and several research lines for future studies’ consideration. First, the study has a relatively small sample size, due to the shift from in-person data collection to online data collection during the COVID-19 pandemic. Although online data collection has many benefits, such as robust random samples, it also has disadvantages, such as random responses, inattention or distraction, etc. (Dandurand et al., 2008; Grootswagers, 2020; Howell, 2019). Especially considering that the EF tasks were completed at home without involvement of researchers, further studies with a larger sample size from in-person data collection could allow for a better interpretation of the study.

In addition, our sample of low-income children has a relatively loose criterion: INR <2. About 44% of the participants were in poverty, as federally defined in the United States (i.e., INR <1), and a slightly larger proportion of participants (i.e., 56%) were from low-income families (1< INR <2). Therefore, we cannot generalize the findings to samples who are living in extreme poverty, or generally in poverty. I recommend caution in interpreting these findings beyond the socioeconomic communities that participated here and suggest future studies examine, for those living in extreme poverty, whether bilingualism would play a protective role for their ToM and cognitive development broadly.

Although this study supports that some components of EF (i.e., WM and AS) statistically mediate the relationship between early bilingualism and ToM, results were based on cross-sectional data, and so causation cannot be tested or determined with these data. For instance, another interpretation of these patterns is that ToM may support better bilingual proficiency. It is helpful to confirm if the patterns examined here exist over time by conducting longitudinal studies. In addition, this study does not exclude other possible explanatory mechanisms, such as
metalinguistic awareness (i.e., the ability to attend and reflect on the structural features of the language itself, such as phonetics and grammar awareness (Galambos & Hakuta, 1988) and socio-linguistic experience (e.g., amount of exposure to each language, frequency of language switch in daily life; Hammer et al., 2012; Schroeder, 2018; Verreyt et al., 2016). It is worthwhile for future studies to explore the other possible mechanisms and the interactions of different mechanisms in the association between bilingualism and ToM, which provides us with a comprehensive picture of the relationships between poverty, bilingualism, and ToM.

Lastly, extending from the relationship between bilingualism and mental state understanding, future studies should examine how this bilingual effect matters for children’s daily life, especially within the low-income context. For instance, does the advanced ToM in children with relatively equivalent language proficiencies lead to a better understanding of deception and forgiveness, enhanced social competence, or reduced aggressive behaviors?

**Conclusion**

The mechanisms of dual language development and its impacts on children’s social cognition within the context of poverty is an important yet under-investigated research area. Findings based on comprehensive ToM battery suggest that bilingualism may play a protective role in economically-disadvantaged children’s ToM development. This paper also provides evidence that these effects may be in part mechanized by EF, namely WM and AS. I also offer implications to parents and educators, regarding improving the degree of bilingualism at home and school and preparing economically-disadvantaged children to flourish in the world. As a pioneer study to examine the associations between poverty, bilingualism, EF, and ToM, these findings should be replicated by future studies to be interpreted fully. Moreover, future studies should further explore longitudinal patterns among bilingualism, EF, and ToM within low-
income samples, extending bilingual children’s ToM to more advanced social understanding and social behaviors, which may be valuable to depict a comprehensive picture of impoverished bilingual children’s overall development.
References


[https://doi.org/10.1007/s10803-010-1087-7](https://doi.org/10.1007/s10803-010-1087-7)


training: A multidisciplinary approach. IntechOpen.

https://doi.org/10.5772/intechopen.88700


https://doi.org/10.1037/a0015466


https://doi.org/10.1016/j.cognition.2011.08.003

https://doi.org/10.1177/0963721409358571

https://doi.org/10.1037/0882-7974.19.2.290

https://doi.org/10.1037/0278-7393.34.4.859


https://doi.org/10.1017/S136728909990423

https://doi.org/10.1111/j.1467-7687.2004.00351.x

https://doi.org/10.1177/13670069050090010701


https://doi.org/10.1146/annurev.psych.53.100901.135233


https://doi.org/10.1016/j.cognition.2013.11.015


https://doi.org/10.1207/s15566935eed1502_1


Farhadian, M., Abdullah, R., Mansor, M., Redzuan, M., Gazanizadand, N., & Kumar, V. (2010).


(Eds.), *Young English language learners: Current research and emerging directions for practice and policy*, Teachers College Press.


Gordon, K. R. (2016). High proficiency across two languages is related to better mental state

https://doi.org/10.1017/S0305000915000276


https://doi.org/10.1016/S0166-4115(08)61496-X


https://doi.org/10.1002/9780470756997.ch2


https://doi.org/10.1177/01427237211024220


http://dx.doi.org/10.1037/bul0000301


https://doi.org/10.1111/cdev.12242


https://doi.org/10.1044/1092-4388(2012/11-0016)


https://doi.org/10.1207/s15326942dn2802_4

Howell, B. (2019). Online psychology experiments: Everything you need to know.

https://www.psychstudio.com/articles/online-experiments/


https://doi.org/10.1207/s15326942dn2802_5


https://doi.org/10.1037/0012-1649.43.6.1447


Annie Casey Foundation; https://datacenter.kidscount.org/updates/show/184-the-number-of-bilingual-kids-in-america-continues-to-rise#:~:text=In%202016%2C%2022%25%20of%20children,kids%2C%20in%20the%20last%20decade

https://doi.org/10.1037/0022-0663.100.4.851


Muller, U., Liebermann-Finestone, D. P., Carpendale, J. I., Hammond, S. I., & Bibok, M. B. (2012). Knowing minds, controlling actions: The developmental relations between theory of mind and executive function from 2 to 4 years of age. *Journal of Experimental Child...


https://doi.org/10.1017/S0142716407070117

https://doi.org/10.1017/S0272263105250283


https://doi.org/10.1016/j.cortex.2015.09.010


https://doi.org/10.1177/0956797617711640


https://doi.org/10.1111/j.1467-8624.2007.01004.x


https://doi.org/10.1111/j.1747-9991.2006.00047.x


Speranza, I., Aharon, M., Al-ees, Somayah, Boles, N., Galeazzi, S., Suri, A., & Molnar, M.


perceived stress: Associations with stress physiology and executive functioning.

*Behavioral Medicine, 41*(3), 145-154. [https://doi.org/10.1080/08964289.2015.1024604](https://doi.org/10.1080/08964289.2015.1024604)


Yang, S., Yang, H., & Lust, B. (2011). Early childhood bilingualism leads to advances in
executive attention: Dissociating culture and language. *Bilingualism: Language and Cognition, 14,* 412-422. [https://doi.org/10.1017/S1366728910000611](https://doi.org/10.1017/S1366728910000611)


https://doi.org/10.1016/j.dr.2015.07.001


Appendix A: The Qualification Screening Survey (Parent Interest Form)

Thank you for your interest in participating in our online study at the University at Albany, State University of New York!

We use this short form to screen if your child is qualified for our study. The criteria include: 3-5 years old, English native speaker or English-Spanish bilingual speaker, and living in a low-income family. After completing this form, we will inform you if your child is qualified or not via email within 1-2 business days. If your child is not qualified, all the information we collected will be deleted immediately.

1. Name of parent/caregiver: ______________

2. Your email address (We will contact you through email): ______________

3. What’s your child’s date of birth? (Note: Providing the month and the year is enough, such as 2018/05.) ______________

4. Does your child speak English only or speak both English and Spanish?

   _____My child only speaks English.

   _____My child speaks both English and Spanish.

5. How many adults live with the child at home? ______________

6. How many siblings (under 18-years-old) live with your child at home? ______________

7. Please provide the approximate annual household income (before taxes): ______________

8. Please identify your preference for Zoom interviews (Choose all that apply).

   _____Weekday mornings

   _____Weekday afternoons

   _____Weekday evenings
_____Weekend mornings
_____Weekend afternoons
_____Weekend evenings

If you have preference for specific time periods, please specify here in your time zone:
(e.g., Monday 7 p.m. -8 p.m. EST)

__________________________________________________________________________

Thank you for your time filling this form!

We will contact you soon via email!
Appendix B: Background Questionnaire

Please fill out the following information regarding your child:

Child’s Participation ID: ___________     Child’s Date of Birth: ___________
Child’s Gender: _______________       The zip code in which the child live: ____________

1. Child’s Ethnic/Racial Background:
   Caucasian             African American       Hispanic/Latino       Native American
   Asian-American        Multi-racial          Other: Specify_________

2. Has your child ever had a vision problem □, hearing impairment □, language disability □, or learning disability □? (Check all applicable).
   If yes, please explain (including any corrections): ______________________________

3. What adults live with the child at home? (Please select all the apply)
   Mother           Father           Grandparent(s)       Adult sibling(s)       Aunt(s)/Uncle(s)
   Total number of adults at home: __________

4. Mother’s highest level of education:
   Nursery school to 8th grade      Some high school      High school Diploma
   Some college             College degree      Some graduate school     Graduate degree

5. Father’s highest level of education:
   Nursery school to 8th grade      Some high school      High school Diploma
   Some college             College degree      Some graduate school     Graduate degree

6. What are the current occupations of the caregivers?
   ______________________________________________________________________________
Appendix C: Online Assessment Instructions for Caregivers

1. Games-based Online Assessment

Preparation

A link with three online games included will be provided by our researcher through email. With your assistance, your child can complete it at any time you prefer. No meeting needed.

- What will be assessed and how long it takes?
  - The online games link will be used to assess your child’s Executive Function skills – the ability to stay focused, remember and follow instructions, control impulses, and think flexibly. Executive Function ability is important for children to manage their own behaviors and achieve goals. Completing the Executive function tasks will take about 10-15 minutes.

- Technology requirements
  - An electronic product, such as a computer, tablet, or phone. Touch screens will be preferred.
  - The assessment link (It will be shared to you via email.)
  - Stable internet connection that allows you to get access to the assessment link and complete the games.

Before Assessment

- Preparing your child:
  - Rested & Fed.
  - Gone to bathroom.
  - Ready for playing games.

- Preparing a quite space or room for your child
• Somewhat boring – minimal visual/auditory distraction (close window blinds, close the door, inform others not to bother during this time, turn off TV or music).

• Only your child and you should be in the room.

• A table/desk and two chairs (one for your child, and one for you). You may be seated next to your child but avoid lap-sitting.

• Have the device (laptop/tablet/cell phone) set on the table directly facing your child, avoids holding the device in your or your child’s hands.

• Making sure the device is fully charged or at least half charged (can lasts for at least 30 minutes).

• Making sure the internet signal is strong.

**During Assessment**

• Child should be made comfortable.

  o Child should be in their own chair if possible.

  o Child should be placed directly in front of the device screen.

• Instead of clicking the links directly, we recommend you **copy and paste the link** on your device through Chrome or Safari.

• Once you click the link, log in with the provided participant ID for your child (It can be found in emails from us).

• When the screen is giving instructions (both audio and text) and inviting your child to do practice before the real games start, the parent needs to confirm if your child understands the rules, and then press the continue buttons for your child.

• Once the games start, no actions should be done by parents. The child needs to complete the tasks alone through **tapping the screen** or clicking the mouse (which can be hard for
young children).

- During the games, parents should remain neutral.
  - These assessed abilities take a long time to develop, so making mistakes is very common in young children.
  - No guidance or feedback – verbal or nonverbal (e.g., do not give the answer, no nodding or shaking your head, do not say “yes” or “no”, etc.)
  - Your child might look to you for the answers. Instead of helping, you can say things like, “It’s your game, I believe you can do it well”, Or repeat the question if necessary, such as “which box do you think it should go?”

- Parents should monitor your child’s attention to tasks.
  - If your child is distracted, redirect them to the tasks by saying things like, “Let’s finish the games first, then we can … (the things they are distracted from)”
  - If your child feels bored, encourage them to try it out by saying things like, “This game is so much fun, do you want to try it out?”
  - If you tried those things above and your child still refuses to complete the games, then you may choose to let your child try next time. (If you log in with the same participant ID, you can resume the experiment where you child left it, so they don’t need to redo the previous games.)

2. Zoom Interviews

Preparation

In the Zoom session, two parts are included. One is storytelling and asking your child some story-based questions. It will take about 10 minutes. The other one is language assessment,
which may take 10-20 minutes. The whole interview session will last less than 30 minutes.

- What will be assessed and how long it takes?
  - The interactive story part will be used to assess your child’s abilities to think about their own and others’ mental states, such as beliefs, desires, emotions, and knowledge. It helps individuals to interpret others’ thinking, predict others’ behaviors, and direct their own behaviors in the social environment. This ability develops gradually during the early childhood years and continues growing in later stages.
  - Language tests will be used to assess your child’s current language abilities, especially their vocabulary via an online website. We will assist you child step by step to complete the test. If your child only speaks English, they will complete an English language test. If your child speaks both English and Spanish, then they will complete both English and Spanish tests.

- Technology requirements
  - A touchscreen tablet (preferred) or a computer with a mouse. Camera function in the device will also be needed.
  - Zoom link (It will be share to you via email one day before the scheduled time)
  - Stable internet connection

**Day of Assessment**

- Prepare your child:
  - Rested & Fed.
  - Gone to bathroom.
  - Ready for having fun.
• Prepare a quite space or room for your child:
  o Somewhat boring – minimal visual/auditory distraction (close window blinds, close the door, inform others not to bother during this time, turn off TV or music)
  o Only your child and you should be in the room.
  o A table/desk and two chairs (one for your child, and one for you). You may be seated next to your child, but avoid lap-sitting
  o Have the device (tablet/laptop) set on the table directly facing your child, avoiding holding the device in your or your child’s hands
  o Make sure the device is fully charged or at least half charged (can last for at least 30 minutes).

• Make sure the internet signal is strong:
  o Have a speed test: http://beta.speedtest.net (a minimum of 20mb/s downloading speed)
  o If you are cut out during the Zoom session, please try to enter the link again, we will continue to complete the assessment from the point we left.

• Be a few minutes early and connect to the Zoom link provided by the researcher.

• Make sure the microphone and camera work well.

During Assessment

• Guidance for setting up the Zoom and remote control will be provided by our researcher.

• For research purposes only, the session with storytelling will be recorded. We will ask for your consent on recording.

• We will ask for your child’s verbal consent for helping with the study.

• Child should be made comfortable.
  o Child should be in own chair if possible
• Child should be placed directly in front of the screen

• Parent should remain neutral
  
  o Making mistakes in these assessments is very common among young children. Do not intervene or correct your child’s answers.
  
  o No guidance or feedback – verbal or nonverbal (e.g., do not give the answer, no nodding or shaking your head, saying “yes” or “no”, etc.)
  
  o Your child might look to you for the answers. Instead of helping, you can ask them to listen carefully to the researcher, who will say things like, “It’s your turn now. What do you think Mr. Smith would choose?”

• Your child’s verbal responses must be clear
  
  o For the story part, make sure the researcher can hear your child’s responses, repeat the answers for your child if necessary (when the researcher requested).
  
  o Younger children will be more comfortable pointing to the images for their responses rather than speaking it out. In this case, you will need to tell the researcher which image your child pointed to. Always tell which one they pointed to first.
  
  o For language assessment, if you are using a computer without a touch screen and your child is not familiar with mouse clicking, then we encourage you to repeat your child’s answers by clicking the mouse.

Thank you for your help and participation in the study with your child!