

LANGUAGE DEVELOPMENT IN PRESCHOOL CHILDREN WITH AUTISM  
SPECTRUM DISORDERS: INVESTIGATING FAST-MAPPING  
ABILITIES AND UTILIZATION OF WORD  
LEARNING CONSTRAINTS

by

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A DISSERTATION

Submitted in partial fulfillment of the requirements  
for the degree of Doctor of Philosophy  
in the Department of Psychology  
in the Graduate School of  
The University of Alabama

TUSCALOOSA, ALABAMA

2009

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## DEDICATION

This dissertation is dedicated to Colleen, Beck, Richard, and Sean, who are the first 4 children with autism that I ever worked with. These children not only inspired me to embrace one's own set of unique strengths and difficulties, but also challenged me to think outside the box when trying to solve puzzling questions or tackle new obstacles.

## LIST OF ABBREVIATIONS AND SYMBOLS

<i>a</i>	Cronbach's index of internal consistency
<i>df</i>	Degrees of freedom: number of values free to vary after certain restrictions have been placed on the data
<i>F</i>	Fisher's <i>F</i> ratio: A ratio of two variances
<i>M</i>	Mean: the sum of a set of measurements divided by the number of measurements in the set
<i>p</i>	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
<i>r</i>	Pearson product-moment correlation
<i>t</i>	Computed value of <i>t</i> test
SD	Standard deviation
<i>z</i>	<i>z</i> value used in Sobel test of mediation
<	Less than
=	Equal to

## ACKNOWLEDGMENTS

I would like to take this opportunity to thank the individuals who offered support, guidance, and motivation throughout the entire dissertation process. First and foremost, I would like to thank Laura Klinger, my adviser and chairperson of this dissertation, who has significantly shaped my development as both a researcher and clinician in graduate school through her excellent teaching and supportive mentoring. I am also indebted to my other research mentor, Jason Scofield, who first inspired me to investigate word learning in children with autism and has always been a continuous source of encouragement. I would like to express gratitude towards Mark Klinger, who provided critical input about the methodology and statistical analyses of this study. I would also like to thank all my other committee members, Fran Connors and Melissa Jackson, for their support and critical input with the theoretical and practical issues that were abundant in my dissertation study. Lastly, I would also like to wholeheartedly thank Joanna Mussey and Hylan Noble for their invaluable assistance in helping to recruit participants and collect data while I was on internship.

I am also indebted to my partner, Brady Duncan, who not only provided unwavering support and constant motivation during the dissertation process, but throughout graduate school and beyond. Finally, I would also like to thank my fellow graduate students, friends, and family for helping me to see the big picture when I became stuck and encouraging me to be persistent in all of my pursuits.

Lastly, I would like to thank the Organization for Autism Research for providing me with a Graduate Student Grant that allowed me to complete this research.

## CONTENTS

DEDICATION .....	ii
LIST OF ABBREVIATIONS AND SYMBOLS .....	iii
ACKNOWLEDGMENTS .....	iv
LIST OF TABLES .....	vi
LIST OF FIGURES .....	vii
ABSTRACT .....	viii
1. INTRODUCTION .....	1
2. METHODOLOGY .....	28
3. RESULTS .....	38
4. DISCUSSION .....	51
REFERENCES .....	70

## LIST OF TABLES

Table 1. Demographics and Diagnostic Data .....	87
Table 2. Tasks Each Participant Completed in Experimental Sessions.....	88
Table 3. Correlations in TD Group - All.....	89
Table 4. Correlations in ASD Group .....	90
Table 5. Performance in Word Learning Conditions.....	91

## LIST OF FIGURES

Figure 1. Basic Word Learning Condition.....	92
Figure 2. Taxonomic Word Learning Condition (TAX) .....	93
Figure 3. Mutual Exclusivity Word Learning Condition (MEC) .....	94
Figure 4. Whole-Object Word Learning Condition (WOC).....	95
Figure 5. Performance in the Basic Condition Across Groups.....	96
Figure 6. Performance in the MEC & TAX Conditions Across Groups ...	97
Figure 7. Scatterplot of Basic Condition on Joint Attention.....	98
Figure 8. Scatterplot of TAX Condition on Joint Attention .....	99
Figure 9. Scatterplot of MEC Condition on Joint Attention.....	100

## ABSTRACT

Children with typical development utilize social-cognitive skills (e.g., joint attention, imitation) and word learning constraints to quickly learn new words (i.e., fast-map). However, few studies have investigated fast-mapping in children with autism spectrum disorders (ASD) and the effects that social-cognitive skills have on word learning. The objectives of the current study were to examine the following questions: (1) Do preschoolers with ASD and preschoolers with typical development fast-map at similar rates?; (2) Do preschoolers with ASD utilize word learning constraints?; and (3) What is the relationship between joint attention, imitation, and fast-mapping in preschoolers with ASD?

Preschoolers with ASD and typical development completed a basic fast-mapping condition (i.e., the ability to link a novel label with a novel object) and 3 conditions measuring the uses of word learning constraints; (1) Mutual Exclusivity – examined the ability to assume that a novel label applies to a novel object; (2) Taxonomic – examined the ability to assume that novel labels extend to objects that are similar in shape; and (3) Whole-Object – examined the ability to assume that novel labels refer to whole objects. Various assessments measured language, joint attention, and imitation skills.

Results revealed that children with ASD showed equivalent word learning to children with typical development in the basic fast-mapping condition. This intact word learning occurred despite significantly lower joint attention and imitation skills. However, children with ASD were less effective at using word learning constraints,

showing significantly less word learning in these conditions than children with typical development. Further, while increased joint attention was related to performance in the mutual exclusivity and taxonomic constraints for both diagnostic groups, joint attention was only related to performance in the basic fast-mapping condition for children with typical development.

Overall, preschoolers with ASD fast-mapped and learned new words in a similar manner to children with typical development, despite impairments in joint attention and imitation. However, children with ASD were less accurate at utilizing word learning constraints. Although research has emphasized the link between social-cognitive skills and language, the current study suggests that children with ASD may be utilizing alternative strategies or skills to increase their vocabulary.

## CHAPTER 1

### INTRODUCTION

Between 2 and 6 years of age it is estimated that children acquire about 6 new words per day and understand a total of 10,000 words by the time they enter the first grade (Anglin, 1993). This remarkable rate of vocabulary development is enhanced by the use of word learning constraints (e.g., taxonomic, mutual exclusivity, and whole-object) and social-cognitive skills such as joint attention (e.g., gestures, gaze direction, face checking, and facial expressions) (Akhtar & Tomasello, 1996; Baldwin, 1991, 1993a; Jaswal & Hansen, 2006; Markman, 1989, 1990; Markman & Hutchinson, 1984; Sabbagh & Baldwin, 2001; Saylor, Sabbagh, & Baldwin, 2002; Tomasello & Barton, 1994; Tomasello, Strosberg, & Akhtar, 1996; Woodward & Markman, 1998). These skills allow children to limit the number of hypotheses they consider when a novel label is presented among a number of novel referents. For example, if a mother utters the novel label “slide” while playing with her child at a playground, the child may take advantage of her mother’s eye gaze and point (i.e., joint attention) to narrow down the number of possible objects being referred to. The child may realize that she already has a label for the objects swing and sandbox (i.e., mutual exclusivity word learning constraint) and that her mother is likely referring to a whole object, rather than part of an object (i.e., whole-object word learning constraint). Taken together, the above knowledge and cues allow the child to correctly link the novel label “slide” with its appropriate referent on the playground. Thus, when children are presented with a novel label they have a variety of

skills at their disposal to guide them in quickly linking the novel label with the appropriate referent, a process known as fast-mapping (Carey & Bartlett, 1978).

While the actual process of utilizing these skills in word learning episodes may seem complex, various studies have conclusively demonstrated that children with typical development (TD) take advantage of these processes when learning new words (Baldwin, 1991, 1993a, 1993b; Baldwin & Moses, 2001; Tomasello & Barton, 1994; Woodward & Markman, 1998; Woodward, Markman, & Fitzsimmons, 1994). These word learning strategies and joint attention cues likely play a major role in rapidly increasing a preschool child's vocabulary.

More recently, researchers have begun to examine the ability of young children with language delays or disorders, including autism spectrum disorders (ASD), to fast-map new words. Several studies have found that some fast-mapping abilities are intact for children with ASD (Baron-Cohen, Baldwin, & Crowson, 1997; Luyster, 2007; McDuffie, 2006a; Parish-Morris, Hennon, Hirsh-Pasek, Golinkoff, & Tager-Flusberg, 2007; Preissler & Carey, 2005; Preissler, 2008; Swensen, Kelley, Fein, & Naigles, 2007; Williams, Klinger, & Scofield, 2007). However, the role that social-cognitive skills play in the vocabulary development of preschoolers with ASD is mixed. For example, while several studies have shown that children with ASD have impaired joint attention skills and have difficulties understanding and utilizing cues such as eye gaze (Baron-Cohen, Allen, & Gillberg, 1992; Charman et al., 1998; Osterling & Dawson, 1994), other studies have shown that children with ASD are able to follow attentional cues such as eye contact, pointing, and verbalizations (see Luyster, 2007; Parish-Morris et al., 2007, Experiment 1). The role of other social-cognitive skills such as imitation on the ability to fast-map a new word in children with ASD has not been thoroughly examined despite the demonstrated link between language development and imitation (Carpenter, Pennington, & Rogers, 2002; Luyster et al., 2008; Stone, Ousley, & Littleford, 1997; Stone & Yoder, 2001). Additionally, preschoolers

with ASD have social and cognitive impairments (e.g., theory of mind, implicit learning, central coherence, attentional focus, and categorization) that may make it more difficult for them to understand and utilize word learning constraints to fast-map new words, but little research has been done to investigate this hypothesis (see Parish-Morris et al., 2007; Preissler & Carey, 2005; Preissler, 2008; Swensen et al., 2007; Tek, Jaffrey, Fein, & Naigles, 2008).

The current study seeks to (1) examine whether preschoolers with ASD have the ability to fast-map a new word in word learning episodes; (2) determine if preschoolers with ASD are able to utilize word learning constraints; and (3) examine how the social-cognitive skills of joint attention and imitation affect the abilities of children with ASD and children with TD to learn new words. The word learning abilities of children with TD and the use of word learning constraints will be reviewed before discussing these same issues in children with ASD.

#### *Word Learning in Children with Typical Development*

While there are a variety of theories posited to account for word learning in preschool-aged children, hybrid or midline theories that integrate aspects of attentional cues (e.g., perceptual salience, associative learning), intentional cues (e.g., joint attention, social intent), and the use of word learning constraints (see Parish-Morris et al., 2007 for a brief discussion) are becoming increasingly more accepted. These hybrid theories take into account that while children have access to an abundance and variety of information in a word learning episode, they may utilize different information depending on their stage of development (e.g., 10 month olds are more likely to orient to perceptual cues) or particular set of strengths and difficulties (e.g., children with ASD may have increased difficulties interpreting social cues and rely on other intact skills).

In spite of the vast array of cues available to children to help them build their vocabulary, word learning is believed to be facilitated by fast-mapping, which is the rapid process through

which children learn to link a novel label with a novel referent (Carey & Bartlett, 1978). Fast-mapping is not the process, but rather the end product of the integration of various skills, cues, and knowledge that work together to link a novel label with a novel referent (see Heibeck & Markman, 1987). The current study will use the term “fast-mapping” to refer to the end product of learning new words quickly with just a few exposures. The term “word learning” will be used to refer to the process that leads to a word being fast-mapped and the subsequent integration of the new word into children’s vocabularies. This rapid manner in which children learn new words after a single exposure is believed to be unique to word learning and differs from other processes that require explicit thinking and reasoning or many exposures. For example, children do not learn how to tie their shoes or learn how to say the entire alphabet in a single exposure.

Woodward and Markman (1998) argued that the ability to fast-map in word learning episodes “depends on an ability to recruit and integrate information from a range of sources to come up with the most plausible interpretation of a novel word” (*p.* 374). The steps that lead to a word being fast-mapped are (1) generating a set of possible hypotheses about a word’s meaning after it is heard and (2) testing each of these hypotheses by waiting for further occurrences or directly asking about the meaning of the word (Woodward & Markman, 1998). Thus, the main goal in word learning episodes is to reduce the number of hypotheses to be considered so that a novel label can be correctly linked to the novel referent (*i.e.*, fast-mapped). These hypotheses can be drastically reduced when children utilize both joint attention cues provided by the speaker and word learning constraints. After the initial fast-mapping process, children gradually incorporate the newly learned word into their vocabulary (*i.e.*, slow-mapping) so that it is extended to other contexts and associations over time.

Numerous studies have investigated the word learning capabilities in children with TD (Akhtar & Tomasello, 1996; Baldwin, 1991, 1993a, 1993b; Baldwin et al., 1996; Markman,

Wasow, & Hansen, 2003; Tomasello & Barton, 1994; Tomasello, Strosberg, & Akhtar, 1996; Woodward, et al., 1994). In particular, Woodward and colleagues (1994) illustrated that children as young as 13 months of age were able to learn and retain novel words after just a few exposures. Baldwin (1991) demonstrated that children 16-19 months of age are not using simple associations to successfully learn new words, but rather rely on joint attention cues (e.g., eye gaze, pointing) provided by the speaker. More specifically, Baldwin (1993a, 1993b) investigated children's ability to learn words in conditions in which the social partner's joint attention cues had to be understood and then utilized to effectively fast-map. In a "follow-in" labeling condition, a social partner looked at and labeled a novel object that children were already focused on, and children were able to learn and retain the link between the novel word and referent as early as 18 months of age (Baldwin, 1993b). In contrast, in "discrepant" labeling conditions, a social partner looked at and labeled an object that differed from the object that children were focused on, thus requiring children to utilize joint attention cues such as eye gaze to correctly fast-map. Results indicated that by 19 months of age, children showed an appreciation for the social partner's joint attention cues and linked the novel word with the appropriate referent (Baldwin, 1993a; Tomasello & Barton, 1994). The above studies clearly demonstrated that children rely on a social partner's joint attention cues such as eye gaze and following a point to successfully link a novel label with a novel referent.

Joint attention, which is the ability to share attention on an object or event with a social partner, is a social-cognitive skill that plays a pivotal role in language development and many researchers believe it to be a critical and necessary precursor to word learning (Akhtar & Tomasello, 1998; Bakeman & Adamson, 1984; Baldwin, 1993a, 1993b, 1995; Dunham & Dunham, 1992; Tomasello, 1995, 1999). Children with TD are able to learn new words by following a social partner's point or eye gaze or initiating eye gaze or pointing with a social

partner. There is strong, replicated evidence that joint attention behaviors are related to both vocabulary comprehension and production vocabulary (Carpenter et al., 1998; Landry & Loveland, 1988; Mundy & Gomes, 1998; Mundy, Kasari, Sigman, & Ruskin, 1995). Nonetheless, there is also evidence that children with TD can learn words in the complete absence of or in minimal conditions of joint attention (Akhtar, 2003, 2005; Akhtar, Jipson, & Callanan, 2001; Baldwin, 1991, 1993b; Scofield & Behrend, under review; Scofield, Williams, & Behrend, 2007; Slaughter & McConnell, 2003; Williams, Klinger, & Scofield, 2007). As the hybrid theories of word learning suggest, it is likely that when social or intentional cues such as joint attention are minimal or absent, children with TD may utilize other intact skills (e.g., perceptual salience, associative learning, imitation) or strategies such as word learning constraints. Nonetheless, children's vocabulary begins to rapidly develop around their first birthday which coincides not only with their ability to utilize joint attention cues, but also with their ability to implement word learning constraints to further increase their success in word learning episodes.

#### *Facilitation of Word Learning Through Constraints*

Researchers have posited that children may heavily rely on word learning constraints to fast-map and further develop their vocabulary and that these constraints are unique to word learning (Behrend et al., 2001; Jaswal & Hansen, 2006; Markman, 1987, 1989, 1990, 1992; Markman & Wachtel, 1988; Merriman & Bowman, 1989; Woodward & Markman, 1998). Three central word learning constraints (i.e., mutual exclusivity, taxonomic, and whole-object) are believed to facilitate word learning because they limit the amount of hypotheses to be considered when a novel label is presented (Markman, 1989). More specifically, these constraints can be thought of as “default assumptions” that allow children to narrow down the possible referents to attribute to a novel label (Woodward & Markman, 1998). Word learning constraints do not fully

account for children's rapid vocabulary development or word learning in general, but rather are useful and highly successful strategies that children can rely on. Thus, it is important to conceptualize word learning constraints as default assumptions that work in combination with and interact with cues such as joint attention, referential intent, and syntactic and lexical cues (Woodward & Markman, 1998). Word learning constraints are likely most useful to young children who may lack experience and have less developed strategies than older children. Each of the three word learning constraints that young children have access to will be defined and discussed in detail below.

*Mutual Exclusivity.* The word learning constraint of mutual exclusivity assumes that each object has only 1 label or name associated with it (Woodward & Markman, 1998). This strategy is efficient because it decreases the number of redundant hypotheses that children have to consider in a word learning situation. Jaswal & Hansen (2006) suggested that children may be utilizing an "implicit social reasoning" in that they believe that social partners are unlikely to give them 2 labels for 1 referent. For example, if presented with a red fruit and a yellow fruit, children are much more likely to link the label "apple" with the red fruit than they do not have a label for *if* they already have a label for the yellow fruit (i.e., banana). Thus, children are not likely to associate multiple labels with the same object, which likely decreases frustration in word learning situations and increases the child's vocabulary.

There is very strong evidence that 2 year olds effectively utilize the mutual exclusivity strategy (see Woodward & Markman, 1998 for a review), and evidence that children as young as 15 months of age utilize mutual exclusivity in word learning episodes (Liittschwager & Markman, 1994; Markman et al., 2003). The constraint of mutual exclusivity is a powerful strategy for young children and they are more likely to rely on it even in the face of contradictory social cues such as pointing or eye gaze (Jaswal & Hansen, 2006).

*Taxonomic.* The taxonomic word learning constraint allows for children to extend a previously labeled exemplar to new referents based on their similarity to the original referent (Behrend, Scofield, & Kleinkecht, 2001; Golinkoff, Mervis, & Hirsh-Pasek, 1994; Woodward & Markman, 1998). Similarity is typically defined by shape, color, size, or thematic relations. For example, if an adult labeled a child's small, blue cup a "cup," the child would likely extend this label to cups of different colors, sizes, and shapes. Preschool aged children are more likely to use shape, rather than color, material, or function, as a defining characteristic when extending novel labels to novel objects (Au, 1985; Dockrell & Campbell, 1986; Heibeck & Markman, 1987; Smith, Jones, & Landau, 1992; Tomikawa & Dodd, 1980). This preference for attending to the shape of an object in word learning episodes, rather than other features, is often referred to as the shape bias (see Smith, Jones, & Landau, 1996; Diesendruck & Bloom, 2003). In particular, Baldwin (1989) found that when a speaker presented and labeled a novel target object a "dax," 2 year-olds were likely to choose another novel object based on shape rather than color when the speaker told them to "find another dax." However, when the speaker presented a novel object and instructed children to "find another one," children chose other novel objects based on shape or color at an equal rate. Thus, preschool-aged children appear to believe that if a novel target object is given a label, it then refers to other objects of similar shape.

*Whole-Object.* The whole-object word learning constraint assumes that a novel label is likely to refer to a whole-object rather than its parts or properties (Markman, 1990; Woodward & Markman, 1998). Children are likely to process novel referents in a holistic manner because it is the most easily accessed and information-rich aspect of an object and is more perceptually apparent than an object's parts or properties (Gentner, 1981, 1982; Markman, 1989, 1992). The use of the whole-object constraint in 2-year-olds was demonstrated in a study by Soja, Carey, & Spelke (1991) in which a social partner labeled a novel object made of a distinctive substance.

When children were then presented with a selection array that included 1 object of the same shape, but different material, and 1 object that consisted only of pieces of the material, children were more likely to choose the whole object over the pieces of the material. Markman and Wachtel (1988) demonstrated that children are likely to associate a novel label with a whole object when the object is *unfamiliar*, but are likely to associate a novel label with a part of an object when the object is *familiar*. Thus, the whole-object assumption appears to be another highly effective strategy that children use to fast-map.

#### *Word Learning in Children with Autism Spectrum Disorders*

Children with ASD often have delayed or deviant language development and acquisition (Tager-Flusberg, 1988; Tager-Flusberg & Sullivan, 1998), which may be related to difficulties in linking novel labels with novel referents in word learning episodes. It is highly plausible that children with ASD may have language acquisition difficulties because of their impairments in joint attention (Baron-Cohen et al., 1995; Mundy & Sigman, 1989; Mundy, Sigman, & Kasari, 1990, 1994; Mundy, Sigman, Ungerer, & Sherman, 1986; Sigman, Mundy, Sherman, & Ungerer, 1986) or impairments in understanding and/or utilizing word learning constraints (Luyster, 2007; Tek et al., 2008). While there is an abundance of literature focusing on how joint attention skills affect language development in children with ASD, there is very little research devoted to investigating whether impairments in using word learning constraints affect language development in this population, although there has been increased interest in this topic recently (see Luyster, 2007; Preissler & Carey, 2005; Swensen et al., 2007; Tek et al., 2008).

Individual differences in joint attention behaviors often account for differences in language development in children with ASD (Loveland & Landry, 1986; Mundy et al., 1986; Mundy et al., 1990). For example, children with ASD, who possessed joint attention skills, acquired language that was superior to children with ASD who had impaired joint attention skills

(Sigman & Kasari, 1995). There is strong evidence that joint attention behaviors are related to both comprehension and production vocabulary in children with ASD (Carpenter et al., 2002; Landry & Loveland, 1988; Luyster, Kadlec, Carter, & Tager-Flusberg, 2008; McDuffie et al., 2006b; Mundy et al., 1986; Murray et al., 2008; Sigman & Ruskin, 1999). For example, in a recent study conducted on over 150 preschoolers with ASD, Luyster and colleagues (2008) found that responding to joint attention behaviors (e.g., following eye gaze) was correlated with both receptive and expressive language (see also Mundy, Sigman, & Kasari, 1990; Mundy et al., 1986; Mundy, Sigman, Ungerer, & Sherman, 1987; Sigman & Ungerer, 1984; Ungerer & Sigman, 1984), and was a significant predictor of concurrent receptive language abilities (also see Mundy, Kasari, & Sigman, 1992; Mundy et al., 1990; Sigman & Ruskin, 1999; Siller & Sigman, 2002). In another recent study, McDuffie, Yoder, & Stone (2006b) found that the joint attention abilities of children with ASD was significantly correlated with expressive language, but there was not a significant correlation between joint attention abilities and receptive language. It has been hypothesized that joint attention impairments make it particularly difficult for children with ASD to fast-map (Baron-Cohen et al., 1997; McDuffie, 2006b; Preissler & Carey, 2005). Adamson and colleagues (2008) suggested the following possibilities for why difficulties sustaining coordinated joint attention with a partner may affect language acquisition in preschoolers with ASD: being uninterested in the speaker, failure to orient to the speaker, affective unresponsiveness, restricted interests, and difficulties integrating all cues and stimuli that occur during a social interaction. Despite the fact that many children with ASD have delayed or deviant language development, only a handful of studies have specifically investigated the ability to fast-map in children with ASD.

### *Fast-Mapping Studies in Children with ASD*

The basic ability to map a novel label onto a novel object was investigated in a study by Williams, Klinger, and Scofield (2007), which found that children with ASD (N = 11; mean chronological age = 52 months) were able to map a new label onto a novel object at similar rates of children with TD (N = 11; mean chronological age = 31 months) that were matched on receptive language (see also Luyster, 2007). More specifically, children with ASD learned words at a rate of 66.7% and children with TD learned words at a rate of 63.6%. This finding is somewhat remarkable because it suggests that preschool-aged children with ASD are able to learn words in a similar manner as children with TD despite possible joint attention impairments.

In a recent study, Swensen et al. (2007) investigated whether children with ASD demonstrated a preference for mapping a novel label to a noun, rather than an action (i.e., noun bias). Using a preferential looking task, preschool-aged children with ASD (N = 10; mean chronological age = 33 months) mapped novel labels onto nouns in a similar manner as a group of preschool-aged children with TD (N = 13; mean chronological age = 21 months) that were matched on production vocabulary. The authors noted that their study clearly illustrated that despite possible joint attention impairments, children with ASD are utilizing the noun bias to map novel labels to novel nouns in the environment in order to further develop their vocabulary (see also Tek et al., 2008).

Baron-Cohen, Baldwin, and Crowson (1997) also demonstrated that school-aged children with ASD (N = 17; mean age = 9.2 years) have intact fast-mapping abilities in that 82% of their participants were able to correctly associate a novel label with a novel referent in just a few exposures. However, their results indicated that children with TD (N = 24; mean age = 24 months) and a language matched group of children with developmental delay (N = 17; mean age = 9.1 years) used a speaker's direction of gaze strategy while children with ASD used a listener's

direction of gaze strategy. More specifically, children with TD and children with developmental delay were more likely to follow the attention (i.e., eye gaze) of a social partner to correctly map a novel label to the correct referent object (i.e., speaker's direction of gaze strategy). In contrast, children with ASD were less likely to use a social partner's attentional cues and typically mapped a novel label to the referent object that their attention was focused on and that they were looking at (i.e., listener's direction of gaze strategy). While 79% of children with TD and 71% of children with developmental delay were able to utilize the speaker's direction of gaze strategy, only 29% of children with ASD were able to do so. This suggests that children with ASD had more difficulty utilizing joint attention cues such as gaze alternation to fast-map in situations where the speaker's focus on an object differed from their own. Baron-Cohen et al. (1997) hypothesized that the impaired attention-following (i.e., joint attention) abilities in children with ASD likely increases the probability of a novel word being mapped to several referents and may lead to increased frustration and decreased motivation in word learning episodes.

Replications investigating the use of speaker and listener direction of gaze strategies in individuals with ASD have produced mixed results. Preissler and Carey (2005) also found that while 70% of children with TD (N = 20; mean age = 24 months) utilized the speaker's direction of gaze strategy, only 28% of children with ASD (N = 20; mean age = 7.8 years) were able to do so. Luyster (2007) also replicated Baron-Cohen et al.'s (1997) study, but tested preschool-aged children with ASD matched to children with TD on expressive vocabulary and verbal mental age. The results indicated that children with ASD performed in a similar manner to preschoolers with TD. More specifically, children with ASD used the speaker's direction of gaze strategy significantly more often than the listener's direction of gaze strategy. Thus, Luyster (2007) found that preschoolers with ASD appear to be able to utilize social and attentional cues provided by the speaker in order to fast-map new words.

McDuffie, Yoder, & Stone (2006a) recently examined fast-mapping abilities in preschoolers with ASD (N = 29; mean age = 32.4 months; mean mental age = 18.9 months) in a longitudinal study. Their results indicated that fast-mapping abilities mediated the relationship between joint attention skills and the number of object nouns children with ASD were able to both comprehend and produce. More specifically, joint attention skills predicted increased object noun comprehension and increased object noun expression through the mechanism of fast-mapping. One major limitation of McDuffie et al.'s (2006a) study was that she did not compare the performance of the children with ASD to a control group of children with TD. Without a control group it is difficult to determine the significance of the role that fast-mapping skills played as a mediator between joint attention skills and object noun acquisition, and how this differs from what we would expect to find in children with TD. Another limitation of McDuffie et al.'s (2006a) study was that gaze latency, rather than object selection, was used as the measure of fast-mapping. The use of gaze latency makes it difficult to determine if the children with ASD did indeed map the novel label onto the novel referent, or were instead engaging in visual inspection or looking at a preferred or more salient object (see also Luyster, 2007 for a discussion of word learning paradigms).

Parish-Morris and colleagues (2007, Experiment 2) recently conducted a study to determine if children with ASD (N = 38; chronological age = 5.1 years; mean receptive language age equivalent = 21 months; mean nonverbal mental age equivalent = 48 months) can utilize social cues to map a new word as compared to 2 groups of typically developing children (one matched on language age and one matched on nonverbal mental age). Results revealed that children with ASD were able to map a novel label with a novel referent in the coincidental condition (i.e., examiner labeled the 1 object that the child chose as the one they "liked better" out of 2 objects). However, children with ASD had greater difficulties learning a new word in the

conflict condition (i.e., examiner labeled the remaining object that the child had chosen as “not liking”). The conflict condition put perceptual cues (i.e., favorite or more salient object to the child) in conflict with social attentional cues (i.e., speaker labeling “boring” object and directing attention to “boring” object by pointing or touching). Both groups of matched typically developing children were able to learn words in the coincidental and conflict conditions. The authors noted that children with ASD may have to engage in increased attention shifting and social processing when the salient or interesting object in the environment is not the one labeled by a speaker.

#### *Word Learning Constraints in Children with ASD*

Only a handful of studies have examined the abilities of preschool children with ASD to utilize word learning constraints to further develop their vocabulary (Luyster, 2007; Preissler & Carey, 2005; Tek et al., 2008), and each of these studies will be briefly reviewed below.

Preissler and Carey (2005) found that school-aged children with ASD (N = 20; mean age = 7.8 years; mean comprehension age = 23 months) utilized the mutual exclusivity constraint in a similar manner to preschool-aged children with TD (N = 20; mean age = 23.8 months). More specifically, children with ASD correctly fast-mapped with 82% accuracy and children with TD correctly fast-mapped with 79% accuracy when a novel label was uttered in the presence of both a familiar and unfamiliar object. Thus, Preissler and Carey (2005) argued that despite the fact that children with ASD may have difficulties using joint attention cues in word learning episodes, they were able to successfully fast-map by utilizing a word learning constraint. The authors suggested that while children with TD may rely heavily on social-cognitive cues such as joint attention when a speaker’s intent is ambiguous or unknown, children with ASD are less likely to use joint attention cues and may be relying more heavily on other strategies such as word learning constraints. One major limitation of this study was that the word learning

performance of school-aged children with ASD was compared to the performance of preschool-aged children with TD. It seems plausible that older children with ASD may have developed compensatory strategies due to experience and direct instruction, which may influence their understanding and usage of word learning constraints.

Tek and colleagues (2008) investigated the ability of preschoolers with ASD to understand and apply the shape bias (i.e., principle that children are more likely to use shape, rather than color, material, or function, as a defining characteristic when extending novel labels to novel and exemplar objects). Participants with ASD (N = 14; mean chronological age = 33.4 months) were matched to participants with TD (N = 15; mean chronological age = 20.6 months) based on an expressive and receptive language composite score created from both direct assessment and parent report. The authors utilized an intermodal preferential looking paradigm to measure the ability to utilize the shape bias across 4 different time points. The results revealed the children with ASD did not utilize the shape bias despite the fact that their receptive and expressive vocabularies increased over the 4 time points. In contrast, children with TD demonstrated the shape bias at time points 2-4 and their vocabularies also increased across all time points. Tek and colleagues posited that children with ASD may have difficulties organizing words into “abstract conceptual units” despite their ability to comprehend and produce new words (2008, pg. 220). Further, the authors noted that difficulties with the shape bias may correspond to later difficulties with category processing in individuals with ASD. However, it is important to note that this study also utilized a preferential looking paradigm, rather than object selection, to measure word learning.

Luyster (2007) also assessed whether children with ASD were able to utilize categorization principles in word learning episodes and found results that contrasted with the findings from the study by Tek and colleagues (2008). More specifically, Luyster (2007)

examined whether children with ASD (N = 17; mean chronological age = 30 months) and children with TD (N = 17; mean chronological age = 21 months) matched on expressive vocabulary and verbal mental age would extend a familiar label to a set of objects based on taxonomic versus thematic principles. Results indicated that both groups of children chose objects based on taxonomic principles, which supports previous research on the taxonomic word learning constraint (e.g., Markman & Hutchinson, 1984).

In conclusion, it is clear that more studies need to be done to determine if children with ASD utilize word learning constraints in a similar manner to children with TD in order to target their language development more effectively through appropriate and individualized interventions.

#### *Role of Social and Cognitive Impairments in Word Learning in Children with ASD*

While it is known that children with ASD have impaired joint attention skills that may affect their language development, they also have other social and cognitive impairments that may affect their ability to utilize word learning constraints to effectively increase their vocabulary. The manner in which the social and cognitive impairments found in children with ASD may affect the successful application of the specific word learning constraints used in the current study will be briefly discussed below. Further, relevant studies on word learning in children with ASD that address any social and cognitive issues or impairments will be included when available.

#### *Theory of Mind*

Several theories of word learning (Baldwin, 1995; Tomasello, 1995) emphasize the importance of being able to understand that a speaker is intending to refer to an object (i.e., referential intent) and also being able to utilize the social cues provided by the speaker to correctly link a novel label with the appropriate referent. Thus, it is highly beneficial for children

to be able to take the perspective of a speaker during a word learning episode (e.g., following eye gaze). Children with ASD have significant impairments in perspective taking, or theory of mind, which likely affects their ability to acquire new words and develop their vocabulary (see Baron-Cohen, 2000 for a review). For example, Frith and Happe (1994) found that individuals with ASD who had increased or relatively intact language abilities tended to perform better on theory of mind tasks. Further, Parish-Morris et al. (2007) determined that the ability to use and understand the hidden intentions of others was highly related to the receptive vocabulary of preschool-aged children with ASD. The authors suggested that because children with ASD have less access to the intentions of others, they may have particular difficulties linking novel labels to referents when social cues and social information are ambiguous or differ from obvious attentional or perceptual cues. Thus, the ability to infer and understand the intentions and perspectives of others likely facilitates vocabulary development.

Further, Bloom (2002) suggests that theory of mind impairments may make it difficult for children with ASD to utilize the mutual exclusivity and whole-object word learning constraints. For example, the principle of mutual exclusivity is built upon the idea that children expect speakers to be knowledgeable and only use familiar words to refer to familiar things. The whole-object constraint involves perspective taking such that children infer that adults are intending to refer to whole objects in word learning episodes.

### *Implicit Learning*

Learning that occurs automatically with little conscious awareness from very early on in life is defined as implicit learning (see Klinger, Klinger, & Pohlig, 2006 for a review). The three word learning constraints discussed above are key examples of implicitly learned strategies. That is, a child is never directly instructed on the idea that they could build their vocabularies by assuming that each object has only 1 label (i.e., mutual exclusivity). Rather, these constraints are

learned automatically and with little conscious awareness. Implicit learning contrasts with explicit learning, which is a more conscious and effortful attempt to learn, in that a preschool-aged child is unlikely to be able to verbalize why they use rules such as the word learning constraints to increase their vocabulary. Klinger and colleagues (2006) proposed the individuals with ASD have impaired implicit learning abilities, which likely affect language development and acquisition (see also Klinger & Dawson, 1992, 2001). Thus, it would seem plausible that because implicit learning emerges early in life, children with ASD may have difficulties understanding and applying the word learning constraints to fast-map new words.

Interestingly enough, various studies have revealed that children with ASD appear to be able to implicitly learn several of the grammatical and semantic components of language. For example, Swensen et al. (2007) recently found that preschoolers with ASD utilize the noun bias and follow subject-verb-object word order (see also Kelley et al., 2006; Kjelgaard & Tager-Flusberg, 2001) in a similar manner to preschoolers with TD. A longitudinal study by Tager-Flusberg and colleagues (Tager-Flusberg, 1994; Tager-Flusberg et al., 1990) also revealed that 6 preschoolers with ASD displayed similar patterns of language acquisition (e.g., mean length utterance, grammatical morpheme, pronoun case, and question form development) as compared to children with typical development. These results suggest that some of the automatic processes that aid in language development may be relatively intact for children with ASD.

#### *Attentional Focus*

Frith (1989) posited that children with ASD have impairments in central coherence, which is the ability to process incoming information for the “gist” and pulling pieces of information together for meaning rather than focusing on details (see Happe, 2005 for a review). Individuals with TD tend to process information in this holistic manner, but individuals with ASD appear to focus on details and perceptual features when processing information (Frith,

1989; Joliffe & Baron-Cohen, 1997, 2001). Similarly, Plaisted (2001) argued that individuals with ASD process similar features of objects poorly and process unique features of objects well. This weak central coherence present in individuals with ASD may affect their ability to utilize word learning constraints to fast-map new words. In particular, individuals with ASD may have difficulties applying the whole-object constraint because of their proclivity for focusing on details rather than whole objects. Weak central coherence may also affect the ability of children with ASD to generalize a novel label for a referent to other taxonomically related referents. Children with ASD may focus on minute details (e.g., texture, material, color, size) that may make it difficult for them to understand the relationship between 2 like objects.

Individuals with ASD also possess impairments in disengaging and shifting their attention (Casey et al., 1993; Townsend, Courchesne, & Eggas, 1996). More specifically, children with ASD may get their attention stuck on an object or event and have difficulty shifting their attention to another object or event. This attentional impairment may specifically affect the word learning constraints of taxonomy and whole-object. For example, children with ASD may focus on specific details or properties of a newly labeled referent and have difficulties linking the label to the whole-object or generalizing it to other taxonomically related objects. Interestingly, Parish-Morris et al. (2007, Experiment 2) recently found that children with ASD have difficulties shifting their attention when a preferred and perhaps more salient object is not the object labeled by an adult in a word learning episode. In addition, Parish-Morris and colleagues (2007, Experiment 1) demonstrated that when multiple attentional cues are available (e.g., eye contact, touching, pointing, verbalization), children with ASD can attend to the appropriate target object (see Baron-Cohen et al., 1997 for contrasting results). Taken together, the authors posit that children with ASD may be relying on basic attentional skills or overlapping attentional cues,

rather than social intention or social understanding, to make associative links between novel labels and their referents.

### *Categorization*

Children with TD appear to be able to categorize objects very early on in life (see Southgate & Meints, 2000; Strauss, 1979; Younger & Gotlieb, 1988) and their ability to categorize more complex objects increases with age. In contrast, while children with ASD do not appear to be impaired in their ability to categorize objects based on simple rules or distinct, definitive features (Tager-Flusberg, 1985; Ungerer & Sigman, 1987), they appear to have more difficulty classifying objects based on complex rules or abstract features (Klinger & Dawson, 1995, 2001; Plaisted, 2001). Tek and colleagues (2008) found that children with ASD did not utilize the shape bias (i.e., extending a newly learned word to exemplar objects based on the principle of shape). The authors noted that these results may be an early indicator of difficulties with category processing and may also highlight how children with ASD attend to or consider some perceptual characteristics over others. However, Luyster (2007) found that preschoolers with ASD were able to apply familiar labels to a set of objects based on taxonomic similarity. Thus, the current study will provide additional information about the ability of children with ASD to apply the taxonomic word learning constraint to objects that are composed of abstract or complex features.

Overall, the above social and cognitive impairments seems to suggest that children with ASD may experience significant difficulties applying various word learning constraints to quickly link a novel label with a novel referent.

## *Facilitation of Word Learning Through Social-Cognitive Skills*

### *Developmental Pattern of Social-Cognitive Skills*

Social-cognitive skills such as joint attention and imitation likely interact with word learning constraints to increase a child's ability to successfully link a novel label with a referent. Previous research has demonstrated that preschool children with TD and preschool children with ASD develop social-cognitive skills in a reliable developmental sequence that then facilitates the understanding and use of social cues in language acquisition (Carpenter, Nagell, & Tomasello, 1998; Carpenter, Pennington, & Rogers, 2002).

Carpenter et al. (1998) examined the developmental sequence of early social-cognitive skills and found that children with TD (N =24) showed a reliable pattern of sharing, following, and directing others' attention before following and directing others' behavior. More specifically, children with TD between the ages of 9-15 months developed early social-cognitive skills in the following pattern: (1) sharing attention with adults by alternating eye gaze on an object (i.e., joint attention); (2) following an adult's attention through eye gaze or point toward an object (i.e., joint attention); (3) following an adult's behavior on objects (i.e., imitation); (4) directing an adult's attention through declarative gestures such as pointing and reaching to share attention on an object; and (5) directing an adult's behaviors through imperative gestures such as pointing and reaching to request an object. Thus, children with TD appeared to develop the joint attention behaviors of attention-following and joint engagement before imitating a social partner's actions.

In a follow-up study, Carpenter et al. (2002) found that preschool children with ASD (N = 12, mean age = 48.8 months; mean non-verbal mental age = 35.8 months) showed a different developmental sequence of early social-cognitive skills as compared to children with TD. More specifically, children with ASD had greater difficulty sharing, following, and directing others'

attention than following and directing others' behavior. The authors reported the following developmental sequence for children with ASD: (1) following an adult's behavior on objects (i.e., imitation); (2) sharing attention with adults by alternating eye gaze on an object (i.e., joint attention); (3) directing an adult's behaviors through imperative gestures such as pointing and reaching to request an object; (4) following an adult's attention through eye gaze or point toward an object (i.e., joint attention); and (5) directing an adult's attention through declarative gestures such as pointing and reaching to share attention on an object. Thus, children with ASD appeared to develop the ability to imitate a social partner's actions before the joint attention behaviors of joint engagement or attention-following.

The above studies demonstrated that children with TD and children with ASD differ in the developmental pattern in which they acquire these social-cognitive skills. In particular, joint engagement and attention-following are the first social-cognitive skills to emerge in children with TD, while children with ASD developed the ability to imitate before joint engagement and attention-following. Carpenter and colleagues (2002) suggested that while children with TD are likely utilizing joint attention behaviors to develop language, children with ASD may be relying on their imitation skills to develop language because their joint attention skills emerge later. Thus, based on Carpenter et al.'s results, it seems plausible to hypothesize that children with ASD may use the social-cognitive skill of imitation to initially acquire language and may then utilize their later-emerging joint attention skills to supplement and further build their vocabulary.

#### *The Role of Joint Attention & Imitation in Word Learning.*

It is clear that joint attention abilities lead to successful language acquisition in children with TD (Akhtar & Tomasello, 1998; Bakeman & Adamson, 1984; Baldwin, 1993a, 1993b, 1995; Dunham & Dunham, 1992; Tomasello, 1995, 1999) and children with ASD (Baron-Cohen et al., 1997; Carpenter et al., 2002; Landry & Loveland, 1988; McDuffie et al., 2006a, 2006b,

2006c; Mundy et al., 1986; Preissler & Carey, 2005; Sigman & Kasari, 1995; Sigman & Ruskin, 1999). However, there are several studies that point to alternative theories or strategies by which language may be acquired for both children with TD (Akhtar, 2003, 2005; Akhtar et al., 2001; Baldwin, 1991, 1993b; Scofield & Behrend, under review; Slaughter & McConnell, 2003;) and children with ASD (Carpenter et al., 2002; McDuffie et al., 2006b; Preissler & Carey, 2005; Rogers & Pennington, 1991; Williams, Klinger, & Scofield, 2007). In particular, several of these studies seem to suggest that children with ASD may be relying on word learning constraints (e.g., Luyster, 2007; Preissler & Carey, 2005; Swensen et al., 2007; Tek et al., 2008), which is similar to how children with TD develop language. However, other studies suggest that children with ASD may be relying on their imitation abilities to develop language (Carpenter et al., 2002; Luyster et al., 2008; McDuffie et al., 2006b; Stone & Yoder, 2001), which differs from children with TD who appear to rely more on joint attention behaviors and word learning constraints. Thus, an understanding of word learning in children with ASD may require an understanding of both joint attention, as reviewed above, and imitation skills, which will be reviewed below.

### *Imitation*

Imitation is an early social-cognitive skill that is believed to play a pivotal role in the development of language, social skills, and cognition (Nadel, 2002). There are many theories on how and why imitation and language are related (see Charman, 2006 for a review). For example, infants utilize communicative sounds and gestures (e.g., waving goodbye, clapping, etc.) to communicate what they observed and then learned through the imitated actions of adults. Thus, imitation is one of the first ways in which infants share information with others (Nadel, 2002). There is also solid evidence of the concurrent emergence of several language and imitation skills in children with TD. One study found that communicative gestures, words, and imitation of actions were highly correlated by 12 months of age (Bates et al., 1979). In addition, the time at

which a child begins to speak his first words coincides with his ability to imitate actions on objects (Bates et al., 1989). Vocal imitation, gestural imitation, and motor imitation are all associated with language development in children with TD (Bates et al., 1979; Bloom, Hood, & Lightbown, 1974; Carpenter et al., 1998; Snow, 1981, 1989).

Nadel and Butterworth (1999) argued that there are 3 aspects of imitation that are related to the development of spoken language: (1) it is a form of learning that requires one to observe, listen, and learn from others; (2) it involves the acquisition of novel responses through social experience and reinforcement; and (3) it demonstrates that children can form internal representations of what they observe, listen, and learn from others and then reproduce these representations. More specifically, children are able to learn the meaning of words and how to comprehend and produce language by observing how others use it and then reproducing it, which is similar to the ability to imitate the actions of others.

While the developmental trajectory between language and imitation may be closely linked in children with TD, one cannot assume that this relationship is the same for children with ASD. Many researchers have demonstrated that children with ASD have imitation deficits and recent studies have examined the exact nature of these deficits in detail (Bernabei, Penton, Fabrizi, Camaioni, & Perucchini, 2003; Ingersoll, Schreibman, & Tran, 2003; Rogers, Hepburn, & Stackhouse, 2003; Rogers & Pennington, 1991; Scambler, Hepburn, Rutherford, Wehner, & Rogers, 2007). Rogers and colleagues (2003) found that preschoolers with ASD were impaired in gestural, oral-facial, and novel object imitations as compared to matched samples of children with Fragile X, other delays, and typical development. A study by Scambler et al. (2007) demonstrated that 2-year-olds with ASD were impaired at imitating facial expressions as compared to matched groups of children with TD and children with other delays. Several studies on individuals with ASD suggest that they may lack the social motivation or understanding and

perspective taking abilities to fully grasp the concept of imitation (Charman & Huang, 2002; Hobson & Lee, 1999; see Williams, Whiten, & Singh, 2004 for a review). Rogers and Williams (2006) posited that the imitation deficits found in children with ASD are related to: (1) difficulties representing the target action to be imitated; (2) difficulties executing the target action; (3) difficulties attending to the target action; (4) motivational problems; and (5) difficulties coordinating visual-spatial input with proprioceptive and kinesthetic output (i.e., cross-modal processing). Despite research supporting an imitation deficit in children with ASD, there is also research that clearly demonstrates that imitation abilities are linked to language development in children with ASD.

Carpenter et al. (2002) found that imitation (i.e., facial, gestural, and motor imitation) was the earliest developing social-cognitive skill in children with ASD and was positively correlated with referential language (i.e., spontaneous labeling of objects or actions). This suggests that children with ASD may use imitation skills before other early social-cognitive skills to build their vocabularies (see also Rogers & Pennington, 1991). Luyster and colleagues (2008) found a significant relationship between expressive language and imitation in children with ASD and noted that imitation skills may play an important role in social learning and acquiring shared communication strategies. Stone and Yoder (2001) found that motor imitation skills at 2 years of age was the only predictor of spoken language at age 4 when language skills at age 2 were controlled for in children with ASD (see also Charman et al., 2003). Despite this strong relationship between imitation and language abilities in young children with ASD, this phenomenon is not well understood and further research is needed to understand the relationship and its possible effects (see Hepburn & Stone, 2006 for a discussion).

While it is likely that the development and expansion of social-cognitive skills such as joint attention can only increase one's ability to acquire and further develop language, recent

research has suggested that imitation abilities may play a particularly important role in the development of language in children with ASD. Given the atypical developmental sequence of the early social-cognitive skills of joint attention and imitation in children with ASD, it is likely that children with ASD who learn language may use different skills or strategies than children with TD. For example, children with ASD may learn language more effectively through imitation while children with TD learn language more effectively through joint attention skills such as attention-following.

### *Current Study*

Very few studies have examined fast-mapping in children with ASD or have compared the word learning performance of preschoolers with ASD to that of preschoolers with TD. In addition, few studies have examined whether preschoolers with ASD apply common word learning constraints to successfully map new words. Lastly, no studies have examined how the social-cognitive abilities of joint attention and imitation affect the ability to fast-map a new word in children with ASD and children with TD.

The focus of the current study was to examine if preschoolers with ASD can utilize basic word learning constraints as a way to develop their vocabulary despite joint attention, social, and cognitive impairments. Despite the small sample size, another goal of the study was to examine the relation between word learning and the social-cognitive abilities of joint attention and imitation in children with ASD. Thus, joint attention skills (i.e., attention-following) and imitation skills (i.e., motor imitation and verbal imitation) and their effects on word learning abilities in 2 diagnostic groups were a secondary focus of the present study. The current study may provide knowledge into how preschoolers with ASD develop language and has wide implications for language interventions for preschoolers with ASD.

### *Research Questions*

1. Does fast-mapping occur at similar rates in preschool children with ASD as compared to preschool children with TD?
2. Do preschool children with ASD utilize word learning constraints (i.e., mutual exclusivity, taxonomy, and whole-object) to fast-map new words?
3. Explore the relationship between joint attention and imitation and the effects it has on the ability to fast-map in children with ASD. In children with ASD, it is predicted that joint attention abilities mediate the relationship between imitation and word learning. The idea that joint attention skills may moderate the relationship between imitation and word learning in children with ASD will also be explored. In children with TD, it is predicted that joint attention abilities and imitation abilities are independent predictors of word learning abilities and that joint attention has a stronger relationship with word learning.

## CHAPTER 2

### METHODOLOGY

#### *Participants*

Sixteen children with a diagnosis of ASD participated in the current study (see Table 1 for demographic and diagnostic information on all 3 participant groups). The mean chronological age for these children was 49.8 months (SD = 11.3; Range = 28 – 66 months). All participants in the ASD group received a previous diagnosis of an autism spectrum disorder, which was confirmed using the Autism Diagnostic Observation Schedule – Generic (ADOS-G: Lord et al., 2000) that is based on criteria in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR: American Psychological Association, 2000). The ASD group consisted of 15 males and 1 female.

The ASD group was recruited through preschool programs that provide early intervention services to children diagnosed with ASD. Eligibility requirements for participation included having an existing diagnosis of an autism spectrum disorder (i.e., autism, Asperger’s Syndrome, or PDD-NOS), a receptive language raw score that was equal to an age equivalence score between 20 and 68 months, and a chronological age between 20 and 68 months. Children with ASD were eliminated from participation if they no longer met criteria for autism according to the ADOS-G (N = 2), had a receptive language raw score that was indicative of skills below that of a 20 month old (N = 8), or were unable to pass the warm-up word learning tasks (N = 1).

Twenty-eight children with TD participated in the current study and were recruited from a university preschool program. Two groups of children with TD were created such that one group was matched to the ASD group on chronological age (i.e., TD group – Age) and another group was matched to the ASD group on receptive language raw score from the Mullen (i.e., TD group – Language). There was some overlap in participants between the two TD Groups (N = 6).

The TD group – Age had a mean chronological age of 44.9 months (SD = 10.0; range = 30 – 65 months). In addition, several analyses were conducted using the entire sample of TD participants to maximize statistical power (i.e., TD Group – All).

Children with TD were eliminated from participation if they had a receptive language raw score that was indicative of skills below that of a 20 month old (N = 1) or had received a diagnosis or services indicative of developmental delay or language delay (N = 1).

### *Diagnostic Measures*

*Autism Diagnostic Observation Schedule – Generic (ADOS-G)*. The ADOS-G (Lord et al., 2000), an assessment of social interaction, communication, play, and imaginative use of materials for individuals who may have ASD, was used to confirm diagnoses of participants in the ASD group. It is a 30-45 minute play session that measures a variety of behaviors associated with ASD including stereotyped/idiosyncratic use of words or phrases, unusual eye contact, quality of social overtures, initiation and response to joint attention, and unusual sensory or repetitive behaviors. Scores range from 0 to 3, with 0 indicative of no unusual behaviors and 3 indicative of behaviors highly consistent with ASD. Diagnosis is determined by using an algorithm to obtain a total score with specified cut-off scores needed for a diagnosis of either autism or autism spectrum. Research has shown that the ADOS-G has strong correlations of overall inter-rater reliability ranging from .82 to .93 in all 3 domains, and possesses strong diagnostic validity in that it differentiates ASD from non-spectrum disorders well.

*Modified Checklist for Autism in Toddlers (M-CHAT)*. The M-CHAT (Robins, Fein, Barton, & Green, 2001) is a parent-completed questionnaire that consists of 23 questions and is designed to identify children at risk of autism from the general population between 18 and 48 months of age. In the current study, parents of children with TD completed the M-CHAT to rule

out a diagnosis of ASD and parents of children with ASD completed the M-CHAT as an additional measure of autism symptomatology.

### *Cognitive and Language Measures*

*Mullen Scales of Early Learning (Mullen)*. The Mullen (Mullen, 1995) was used as a measure of participants' nonverbal abilities and receptive and expressive language abilities. The Mullen is a standardized developmental test for children between birth and 68 months of age and consists of 5 subscales: gross motor, fine motor, visual reception (i.e., nonverbal ability), receptive language, and expressive language. The gross motor subscale was not administered for the present study. The raw score from the receptive language subtest was used to match participants in the ASD group to participants in the TD group – Language. The raw score from the expressive language subtest was used as a measure of production vocabulary and the raw score from the visual reception subtest was used as a measure of nonverbal ability. There is evidence that the Mullen demonstrates good construct validity in that a child's raw score increases as their age increases.

*MacArthur Communicative Development Inventory (CDI)*. The CDI (Fenson et al., 1994) is a parent report questionnaire that was used to assess vocabulary comprehension and production. The CDI Infant Scale contains a vocabulary checklist of 396 words typically acquired by children between 8 to 16 months of age. Of the 396 words, there were 229 object nouns, which were used as measures of the size of children's comprehension and production vocabulary. Parents of children with TD did not consistently return this measure due to the lengthy process of filling the questionnaire out. As a result, the CDI measure was only used in analyses for the ASD Group.

### *Social-Cognitive Measures*

*Joint Attention Task.* Portions of the Early Social Communication Scales (ESCS: Mundy et al., 2003) were used to measure children's responses when the examiner used eye gaze or a point to direct children's attention (i.e., attention-following) to 3 posters and 3 stuffed animals placed throughout the testing room. This measure was adapted to include eye gaze in order to create a more comprehensive measure of joint attention (see MacDonald et al., 2005). Before administering trials the examiner ensured that children were engaged by tapping the table, calling their name, or touching them. The examiner administered 6 eye gaze trials and 6 pointing trials. For each of the 12 trials, the children had 3 opportunities to respond to the examiner's action (e.g., looking, turning head, eye gaze) and responses were scored as 2 – pass, 1 – emerging, and 0 – fail on the basis of the quality and accuracy of children's responses. Thus, scores could range from 0 – 24.

*Motor Imitation Scale (MIS).* The MIS (Stone et al., 1997) was used to measure motor imitation with and without objects and body gestures. The MIS consists of 16 single-step motor imitation activities and includes 8 items that elicit body movement or motor imitation with objects and 8 items that elicit body movement imitation without objects. For each of the 16 items, the child had 3 opportunities to imitate the examiner's action and responses were scored as 2 – pass, 1 – emerging, and 0 – fail on the basis of the quality and accuracy of the child's response. Thus, a child's scores on the action and body movement tasks could range from 0-16 and a child's total score could range from 0 – 32. Items for the action tasks included tapping a spoon on the table, shaking a noisemaker, pushing a car across the table, etc.; items for the body movement tasks included clapping, waving, pulling ear, etc.

*Verbal Imitation Measure.* Masur's (1995) experimental paradigm was used to measure verbal imitation. Four novel, unfamiliar words (e.g., "agnew," "nixon," "deter," and "kaz") and 4

familiar words (e.g., “car,” “book,” “dog,” and “apple”) were presented and repeated up to 3 times. For each of the 8 items, the child had 3 opportunities to imitate the examiner’s vocalization and responses were scored as 2 – pass, 1 – emerging, and 0 – fail on the basis of the quality and accuracy of the child’s response. Thus, a child’s scores on the familiar and unfamiliar verbal imitation task could range from 0-8 and a child’s total score could range from 0 – 16. Children were encouraged to imitate and were prompted by the examiner’s statement “You do it” after a novel word has been spoken.

### *Word Learning Conditions*

Four word learning conditions (i.e., Basic, Taxonomic, Mutual Exclusivity, and Whole-Object) were administered to assess the percentage of children that could correctly link novel labels to novel referents across the trials in each word learning condition. A pretest was administered to ensure that children understood the task expectation (i.e., choose the object labeled by the examiner). In the pretest, children were shown 1 familiar object (e.g., shoe) within a selection array of 2 other familiar distracter objects (e.g., car and bear) and asked to choose the object labeled by the examiner (e.g., “Give me the shoe.”). If the participant was unable to choose the correct object in at least half (i.e., 2 out of 4) of the warm-up tasks, they were excluded from the study.

The 4 word learning conditions were each presented 4 times across 4 blocks. In each block, all 4 word learning conditions were presented in a random order 1 time. Each block of word learning conditions was randomized. The trials within each word learning condition were counterbalanced across the 4 blocks.

*Basic Condition.* The first word learning condition examined a child’s ability to quickly link a novel label with a novel object (see Figure 1). In the experimental trial, the examiner placed a novel object between herself and the child and ensured that eye contact was established

before proceeding. Next, the examiner looked at the novel object and labeled it 3 times (e.g., “Look a clem. A clem. Look a clem.”), while alternating gaze between the child and the object. The novel object was then removed from the table 2-3 seconds after it has been labeled. In addition to the experimental trial, there was 1 control trial that was identical to the experimental trial except that the examiner simply commented on the novel object instead of labeling it (e.g., “Look. Look.”), while alternating gaze between the child and the object. The novel object was removed from the table after it had been commented on. After both objects had been labeled or commented on, the child was shown a selection array that contained the object that was commented on and the object that was labeled. The presentation side of these 2 objects was randomized. The examiner asked, “Can you help me find the clem? Which one is the clem?,” and the child then selected 1 of the 2 objects. The control trial was used to ensure that the child did not choose the target object because it was more familiar than the other objects seen during the test trials. Four trials of the Basic Condition were presented to each child, and the experimental and control trials were counterbalanced. If the child selected the target more often than the distracter among the 4 experimental trials, exposure could be ruled out as an explanation for choosing an object.

*Mutual Exclusivity Condition (MEC).* The second word learning condition examined a child’s ability to link a novel label with a novel object when it was presented with a familiar object (see Figure 2). The examiner placed a novel object on the table and ensured that eye contact was established before proceeding. Next, the examiner looked at the novel object and commented on it (e.g., “Look. Look.”), while alternating gaze between the child and the object. The novel object was then removed from the table 2-3 seconds after it was presented. The examiner then placed a familiar object (i.e., an item from the Mullen) on the table and ensured that eye contact was established before proceeding. Next, the examiner looked at the familiar

object and commented on it (e.g., “Look. Look.”), while alternating gaze between the child and the object. The familiar object was then removed from the table 2-3 seconds after it was presented. The presentation of the first object, either novel or familiar, was counterbalanced such that in 2 trials the novel object was presented first and in 2 trials the familiar object was presented first. The examiner then placed both the previously presented familiar object and the previously presented novel object between herself and the child and ensured that eye contact was established before proceeding. The presentation side of these 2 objects was randomized. The examiner then asked the child to “Give me the toma.” while being careful to ensure that she maintained eye contact with the child and did not look at any of the objects. Four trials of the MEC were presented to each child.

*Taxonomic Condition (TAX).* The third word learning condition examined a child’s ability to assume that novel labels should be extended to objects that are similar in shape (see Figure 3). In the experimental trial, the examiner placed a novel object between herself and the child and ensured that eye contact was established before proceeding. Next, the examiner looked at the novel object and labeled it 3 times (e.g., “Look a neby. A neby. Look a neby”), while alternating gaze between the child and the object. The novel object was removed from the table 2-3 seconds after it had been labeled. In addition to the experimental trial, there was a control trial that was identical to the experimental trial except that the examiner simply commented on the novel object instead of labeling it (e.g., “Look. Look.”), while alternating gaze between the child and the object. The novel object was removed from the table after it has been commented on.

After both objects have been labeled or commented on, the examiner placed 2 additional novel objects on the table. The presentation side of these 2 objects was randomized. The selection array contained 1 novel object that resembled the previously labeled object from the

experimental trial based on shape (e.g., larger or smaller). The selection array also contained 1 novel object that resembled the previously commented upon object from the control trial based on shape (e.g., larger or smaller). Thus, the selection array contained 1 novel object that resembled the novel object that was labeled and 1 novel object that resembled the novel object that was commented on. The examiner then instructed the child to “Find the neby” while motioning toward the 2 novel objects in the selection array and maintaining eye contact with the child. The child then selected 1 of the 2 objects. Four trials of the TAX condition were presented to each child, and the experimental and control trials were counterbalanced. In order to reduce the influence of object color, the selection array contained objects that were the same color as the 2 objects in the experimental trial (e.g., small red experimental object) and control trials (e.g., small blue control object), but the color of the objects were reversed (e.g., big blue experimental object and big red control object).

*Whole-Object Condition (WOC).* The fourth word learning condition examined a child’s ability to assume that novel labels refer to whole objects rather than parts or properties of an object (see Figure 4). In each trial, the examiner placed 1 unfamiliar novel object that consisted of a whole object (e.g., chrome tongs) that had a novel object-part (e.g., shower ring) attached to it between herself and the child. The examiner ensured that eye contact was established before proceeding. Next, the examiner looked at the novel object and labeled it 3 times (e.g., “Look a hafer. A hafer. Look a hafer”), while alternating gaze between the child and the object. The novel object was removed from the table 2-3 seconds after it has been labeled. The examiner then placed both the whole object (e.g., chrome tongs) and the object-part (e.g., shower ring) on the table. Thus, in the selection array there was a whole object and an object-part for the child to choose from. The presentation side of these 2 objects was randomized. The examiner then asked,

“Can you help me find the hafer? Which one is the hafer?,” and the child then selected 1 of the 2 objects. Four trials of the WOC condition were presented to each child.

### *Demographic Questionnaire*

A demographic questionnaire was given to each parent/guardian. The questionnaire was used to gather information regarding ethnicity; educational background; household income; current medications; and pre-existing psychiatric history, including diagnosis of ASD.

### *Stimuli for Word Learning Conditions*

Each word learning condition consisted of 4 trials such that there was a total of 16 trials, four trials in each of the four conditions (i.e., Basic, MEC, TAX, and WOC). Twelve familiar objects (e.g., shoe, car, ball, etc) were used during the pre-test as warm-up trials to determine if children could correctly choose a labeled object out of a selection array. For the Basic condition, 8 novel objects and 4 novel labels (e.g., “dax,” “kip,” “clem,” etc.) were used; for the MEC condition, 4 familiar objects, 4 novel objects, and 4 novel labels were used; for the TAX condition, a total of 16 novel objects (i.e., 4 novel objects for experimental trials, 4 novel objects that are similar in shape to the target objects for experimental trials, 4 novel objects for control trials, and 4 novel objects that are similar in shape to the target objects for control trials,) and 4 novel labels were used; and for the WOC condition 4 novel objects, 4 novel object-parts, and 4 novel labels were used. All novel objects were purchased from a local hardware store. Each novel object was brightly painted, and pilot testing with preschool children with TD determined that none of the novel objects were identifiable by name. The familiar objects consisted of objects that are highly familiar to preschool-aged children (e.g., spoon, shoe, cup, dog, cat, etc) and were taken from the Mullen, which each participant received before the word learning conditions.

### *Procedure*

Parents of participants signed a consent form allowing their child to participate in the research study. The various measures were gathered over the course of 3 sessions for the ASD Group and 2 sessions for the TD Groups (see Table 2 for a description and timeline of the tasks that each participant completed during the testing sessions). Each child was tested at a table in a quiet room at their preschool. All participants were given stickers and/or toys as a reward for their participation. Throughout all sessions, participants were given breaks and snacks to ensure that they were attentive and alert. The CDI, demographic form, and M-CHAT, which took 20-30 minutes to complete, were sent home to each parent to fill out and then return to their child's school. Parents were not present during testing. As a reward for their participation, all parents received a \$5 gift certificate to a local store and a report that outlined their child's performance on the standardized tests.

## CHAPTER 3

### RESULTS

#### *Calculation of Joint Attention and Imitation Scores*

For the ESCS joint attention measure, a composite joint attention score (i.e., Total Joint Attention) was calculated for the ASD Group because the eye contact and pointing tasks were significantly correlated with one another ( $r = 0.69, p = .003$ ). While eye contact and pointing tasks from the ESCS were not correlated for the TD Group – Language and TD Group – Age, the Total Joint Attention score was used in specific analyses to represent a composite joint attention score (refer to Tables 3 and 4 for the correlations in the TD Group – All and ASD Group).

For the Motor Imitation Scales (MIS) measure, a composite score (i.e., Total Imitation) was calculated for the ASD Group because the action and body tasks were significantly correlated with one another ( $r = 0.87, p < .001$ ). While MIS – body and MIS – action were not significantly correlated for either of the TD Groups, the Total Imitation score was used in specific analyses to represent a composite imitation score. Further, the TD Group – Age had a ceiling effect on the MIS – body task, and thus the MIS will not be discussed for that particular diagnostic group.

For the Verbal Imitation (VIM) measure, a composite score was not calculated for the ASD Group because the familiar and unfamiliar measures were not correlated. Both TD Groups had ceiling effects on the familiar task of the VIM and both groups had minimal variance on the unfamiliar task of the VIM. Thus, it was not possible to examine how verbal imitation of familiar and unfamiliar words was related to word learning performance, joint attention, and other imitation abilities in the TD Groups.

It is important to note that while the current sample size was determined to be large enough to detect moderate to large relationships in the analyses investigating diagnostic group differences in word learning, a larger sample would be ideal for the correlation and regression analyses that were conducted. More specifically, power analyses revealed that 19-25 participants would be needed in each group to detect medium or large effect sizes when using correlational analyses. Thus, the results of the regression and correlational analyses should be interpreted cautiously.

#### *Diagnostic Group Differences in Word Learning*

For each participant, 4 word learning scores (i.e., Basic, MEC, TAX, and WOC) were calculated by computing the percentage of trials in which the target object was correctly chosen in each of the 4 word learning conditions. A word learning score of 50% represents chance levels of performance.

The mean percentage of correctly chosen target objects for the Basic, TAX, MEC, and WOC conditions is presented in Table 5. The ASD Group had the following mean scores on the word learning conditions: Basic: 76.6% ( $SD = 28.1$ ); TAX: 62.5% ( $SD = 22.4$ ); MEC: 60.9% ( $SD = 30.2$ ); and WOC: 54.7% ( $SD = 29.2$ ). One sample t-tests were utilized to compare word learning performance in the ASD Group to chance performance of 50%. Results indicated that the ASD Group learned words at rates above chance in Basic,  $t(15) = 3.78, p = .002$ , and TAX conditions  $t(15) = 2.24, p = .04$ . The ASD Group did not perform at above chance rates in the MEC,  $t(15) = 1.45, p = .17$ , and WOC conditions,  $t(15) = .64, p = .53$ .

The TD Group – Language had the following mean scores on the word learning conditions: Basic: 71.9% ( $SD = 25.6$ ); TAX: 73.4% ( $SD = 17.0$ ); MEC: 73.4% ( $SD=23.2$ ); and WOC: 56.3% ( $SD = 26.6$ ). One sample t-tests were utilized to compare word learning performance in the TD Group - Language to chance performance of 50%. Results indicated that

the TD Group - Language learned words at rates above chance in Basic,  $t(15) = 3.42, p = .004$ , TAX,  $t(15) = 5.51, p < .001$ , and MEC conditions,  $t(15) = 4.04, p = .001$ . The TD Group - Language did not perform at above chance rates in the WOC condition,  $t(15) = 0.94, p = .36$ .

The TD Group – Age had the following mean scores on the word learning conditions: Basic: 79.7% ( $SD = 18.8$ ); TAX: 67.2% ( $SD = 23.7$ ); MEC: 82.8% ( $SD=19.8$ ); and WOC: 56.3% ( $SD = 29.6$ ). One sample t-tests were utilized to compare word learning performance in the TD Group - Age to chance performance of 50%. Results indicated that the TD Group - Age learned words at rates above chance in Basic,  $t(15) = 6.33, p < .001$ , TAX,  $t(15) = 2.91, p = .01$ , and MEC conditions,  $t(15) = 6.62, p < .001$ . The TD Group - Age did not perform at above chance rates in the MEC condition,  $t(15) = 0.85, p = .41$ .

The above results revealed that the 3 diagnostic groups did not perform at above chance rates in the WOC condition, suggesting that the task was not successful at measuring this type of word learning. Thus, the WOC condition was not included in analyses that compared word learning performance between diagnostic groups.

#### *Comparing Word Learning Performance in the ASD Group & TD Group - Language*

A t-test revealed no significant difference between performance in the Basic condition in the ASD Group and TD Group – Language,  $t(30) = -.49, p = .63$  (see Figure 5). A 2 X 2 ANOVA was conducted in which the 4 trials of the 2 word learning constraint conditions (i.e., MEC and TAX) were a within-subjects variable and the 2 diagnostic groups (i.e., ASD Group & TD Group - Language) were a between-subjects variable (see Figure 6). Effect size data is provided using Cohen’s guidelines (i.e., a partial eta-squared of .01 is a small effect, .06 is a moderate effect, and .14 is a large effect). There was no significant main effect of word learning condition,  $F(1,30) = .022, p = .88, \eta^2p = .001$ , and no significant interaction between word learning condition and diagnosis,  $F(1,30) = .022, p = .88, \eta^2p = .001$ . However, there was a

marginally significant main effect of diagnosis,  $F(1,30) = 3.26, p = .08, \eta^2p = .10$ , which indicated that the ASD Group tended to show decreased accuracy on the MEC and TAX conditions when compared to preschoolers matched on receptive language abilities. Because of the large effect size for the main effect of diagnosis, additional follow-up t-tests were used to measure whether performance in each of the 3 word learning conditions differed between the ASD Group and TD Group – Language. Results revealed no significant differences between performance in the Basic,  $t(30) = -.49, p = .63$ ; TAX,  $t(30) = 1.56, p = .13$ ; and MEC conditions,  $t(30) = 1.31, p = .20$ .

#### *Comparing Word Learning Performance in the ASD Group & TD Group - Age*

A t-test revealed no significant difference between performance in the Basic condition in the ASD Group and TD Group – Age,  $t(30) = .37, p = .71$  (see Figure 5). A 2 X 2 ANOVA was conducted in which the 4 trials of the 2 word learning constraint conditions (i.e., MEC, and TAX) were a within-subjects variable and the 2 diagnostic groups (i.e., ASD Group & TD Group - Age) were a between-subjects variable (see also Figure 6). There was no significant main effect of word learning condition,  $F(1,30) = 1.70, p = .20, \eta^2p = .05$ , and no significant interaction between word learning condition and diagnosis,  $F(1,30) = 2.54, p = .12, \eta^2p = .08$ . However, there was a marginally significant main effect of diagnosis,  $F(1,30) = 3.93, p = .06, \eta^2p = .12$ , which indicated that the ASD Group tended to show decreased accuracy on the MEC and TAX conditions when compared to preschoolers matched on chronological age. Because of the large effect size for the main effect of diagnosis, follow up t-tests were conducted to compare the ASD Group and TD Group – Age on performance in the 3 word learning conditions. Results revealed no significant differences between performance in the Basic,  $t(30) = .37, p = .71$  and TAX conditions,  $t(30) = .58, p = .57$ ; but there was a significant difference in the MEC condition,  $t(30)$

= 2.42,  $p = .02$ . Thus, it appears that the preschoolers with ASD demonstrated decreased accuracy on the MEC task compared to children with TD matched on chronological age.

#### *Comparing Overall Performance in the Word Learning Constraint Conditions*

An additional analysis was done to determine if combined performance in the TAX and MEC conditions differed between the ASD Group and TD Group – All. The TD Group – All was used to increase the power to detect significant differences in the use of word learning constraints between the groups. A Constraint Total score was calculated by adding together the performance in the TAX and MEC conditions for both groups. Thus, participants could have a minimum score of 0 and a maximum score of 8 on the Constraint Total. The ASD Group had a Constraint Total score of 61.7% ( $SD = 20.6$ ) and the TD Group – All had a Constraint Total score of 74.0% (16.1%). Both the ASD Group,  $t(15) = 2.27$ ,  $p = .04$ , and the TD Group – All,  $t(25) = 7.58$ ,  $p < .001$ , performed at rates significantly above chance. Additional analyses revealed that there was a significant difference in performance on the word learning constraints,  $t(40) = 2.16$ ,  $p = .04$ . Thus, the TD Group – All appears to be using the word learning constraints more efficiently than the ASD Group.

#### *Joint Attention Scores Across Diagnostic Groups*

##### *ASD Group & TD Group – Language*

To investigate the performance in the joint attention measure (i.e., ESCS), a 2 x 2 ANOVA was conducted in which the 2 joint attention tasks (i.e., following a point and following eye gaze) were a within-subjects variable and the 2 diagnostic groups (i.e., ASD Group & TD Group – Language) were a between-subjects variable. There was a significant main effect of ESCS tasks,  $F(1,30) = 12.54$ ,  $p = .001$ ,  $\eta^2p = .30$ , which indicated that both groups performed significantly better in the following a point task as compared to the following eye gaze task. There was a significant main effect of diagnosis,  $F(1, 30) = 5.91$ ,  $p = .02$ ,  $\eta^2p = .16$ , such that the

TD Group – Language performed better in both ESCS tasks as compared to the ASD Group. There was no significant interaction between diagnosis and performance on the ESCS tasks,  $F(1,30) = .56, p = .46, \eta^2p = .02$ .

#### *ASD Group & TD Group – Age*

A 2 x 2 ANOVA was also conducted in which the 2 joint attention tasks (i.e., following a point and following eye gaze) were a within-subjects variable and the 2 diagnostic groups (i.e., ASD Group & TD Group – Age) were a between-subjects variable. There was a significant main effect of ESCS tasks,  $F(1,30) = 9.91, p = .004, \eta^2p = .25$ , which indicated that both groups performed significantly better in the following a point task as compared to the following eye gaze task. There was a significant main effect of diagnosis,  $F(1,30) = 7.75, p = .009, \eta^2p = .21$ , such that the TD Group – Age performed better in both ESCS tasks as compared to the ASD Group. There was no significant interaction between diagnosis and performance on the ESCS tasks,  $F(1,30) = 2.30, p = .14, \eta^2p = .07$ .

#### *Imitation Scores Across Diagnostic Groups*

##### *ASD Group & TD Group – Language*

To investigate the performance in the MIS imitation measure, a 2 x 2 ANOVA was conducted in which the 2 MIS imitation tasks (i.e., imitating body actions and imitating actions on objects) were a within-subjects variable and the 2 diagnostic groups (i.e., ASD Group & TD Group – Language) were a between-subjects variable. There was a significant main effect of MIS tasks,  $F(1,30) = 5.90, p = .02, \eta^2p = .16$ , which indicated that both groups performed significantly better in imitating actions on objects as compared to imitating body actions. There was a significant main effect of diagnosis,  $F(1,30) = 8.75, p = .006, \eta^2p = .23$ , which illustrated that the ASD group had significantly lower scores on the MIS tasks as compared to the TD Group – Language. Lastly, there was a significant interaction between diagnosis and

performance on the MIS tasks,  $F(1,30) = 4.10, p = .05, \eta^2p = .12$ , which revealed that the ASD Group had significantly lower scores on the MIS tasks that measured imitating body actions, but performed more similarly to the TD Group – Language on the MIS tasks that measured imitating actions on objects.

#### *ASD Group & TD Group – Age*

To investigate the performance in the MIS imitation measure, a 2 x 2 ANOVA was conducted in which the 2 MIS imitation tasks (i.e., imitating body actions and imitating actions on objects) were a within-subjects variable and the 2 diagnostic groups (i.e., ASD Group & TD Group – Age) were a between-subjects variable. There was a marginally significant main effect of MIS tasks,  $F(1,30) = 3.75, p = .06, \eta^2p = .11$  which indicated that both groups performed better in imitating actions on objects as compared to imitating body actions. There was a significant main effect of diagnosis,  $F(1,30) = 8.93, p = .006, \eta^2p = .23$  which illustrated that the ASD group had significantly lower scores on the MIS tasks as compared to the TD Group – Age. There was also a significant interaction between diagnosis and performance on the MIS tasks,  $F(1,30) = 6.50, p = .02, \eta^2p = .18$ , which revealed that the ASD Group had significantly lower scores on the MIS tasks the measured imitating body actions, but performed more similarly to the TD Group – Age on the MIS tasks that measured imitating actions on objects.

#### *Correlation Analyses*

The bivariate correlations between joint attention (i.e., ESCS - point and ESCS - eye gaze), imitation (i.e., MIS – action and MIS – body), receptive language and expressive language (i.e., Mullen), nonverbal abilities (i.e., Mullen), performance in the 3 word learning measures, Total Imitation score, and Total Joint Attention score are presented in Table 3 for the TD Group – All and in Table 4 for the ASD Group. In addition, the correlations for the ASD Group contain

the Social and Communication total scores from the ADOS-G, the VIM – familiar and VIM – unfamiliar, and the comprehension and production scores from the CDI.

*TD Group – All*

Table 3 presents the correlations of interest for the TD Group - All. The variables of interest that correlated with performance in the word learning conditions are reported first. Performance in the Basic condition was correlated with Mullen nonverbal skills, Mullen receptive language, and ESCS – eye gaze, while performance in the MEC condition was correlated with Mullen nonverbal skills, Mullen receptive language, Mullen expressive language, and MIS – body. In regards to correlations among the word learning conditions, only the Basic condition was correlated with the MEC condition ( $r(26) = .39, p = .05$ ).

In regards to the relationship among nonverbal skills, receptive and expressive language, joint attention, and imitation, there were very few relationships found in the TD Group – All (see Table 3). Mullen nonverbal skills correlated with Mullen receptive language ( $r(26) = .89, p < .001$ ) and Mullen expressive language ( $r(26) = .89, p < .001$ ). In addition, Mullen receptive language was correlated with Mullen expressive language ( $r(26) = .93, p < .001$ ) and marginally correlated with ESCS-eye gaze ( $r(26) = .36, p = .07$ ). Lastly, Mullen expressive language was marginally correlated with ESCS-eye gaze ( $r(26) = .35, p = .08$ ).

Due to the some of the significant relationships between joint attention skills, imitation skills, and receptive and expressive language skills, two regression analysis were conducted in which Total Imitation (e.g., MIS-action and MIS-body) and Total Joint Attention (e.g., ESCS-point and ESCS-eye gaze) were continuous independent variables and receptive language (i.e., Mullen receptive language raw score) and expressive language (i.e., Mullen expressive language raw score) were the continuous dependent variables. Results indicated that Total Joint Attention and Total Imitation did not predict a significant amount of variance for Mullen receptive

language,  $F(2,25) = 2.14$ ,  $p = .14$ , R Square = .16, and did not predict a significant amount of variance for Mullen expressive language,  $F(2,25) = 1.92$ ,  $p = .17$ , R Square = .14.

### *ASD Group*

Table 4 presents the correlations of interest for the ASD Group. The variables of interest that correlated with performance in the word learning conditions are reported first. In particular, Mullen nonverbal skills, Mullen receptive language, Mullen expressive language, and CDI – production were correlated with performance in the Basic, TAX, and MEC word learning conditions. Further, CDI –comprehension was correlated with performance in the Basic ( $r(16) = .46$ ,  $p = .07$ ) and TAX ( $r(16) = .61$ ,  $p = .01$ ) conditions. VIM – unfamiliar was marginally related to performance in the Basic condition ( $r(16) = .49$ ,  $p = .06$ ). Further, performance in the TAX condition was the only word learning condition that correlated with joint attention (i.e., ESCS-point,  $r(16) = .56$ ,  $p = .03$ ) and imitation (MIS action,  $r(16) = .56$ ,  $p = .02$ ; MIS body,  $r(16) = .51$ ,  $p = .04$ ). In regards to correlations among the word learning conditions, only the Basic condition was marginally correlated to the MEC condition ( $r(16) = .47$ ,  $p = .07$ ).

In regards to the relationship among nonverbal skills, receptive and expressive language, joint attention, and imitation, several key relationships are indicated by the data. In particular, nonverbal skills were correlated with all language (Mullen and CDI), joint attention, and imitation variables. CDI – comprehension was significantly correlated with Mullen receptive language ( $r(16) = .63$ ,  $p = .008$ ), and CDI – production was significantly correlated with Mullen expressive language ( $r(16) = .81$ ,  $p < .001$ ). Additionally, Mullen expressive language was correlated with receptive language, CDI – production, ESCS – point, ESCS – eye gaze, MIS – action, and MIS – body. Both ESCS – point and ESCS – eye gaze were significantly correlated with both MIS – action and MIS – body (see Table 4). Lastly, the Social and Communication total scores from the ADOS-G were not correlated with any variables.

Due to the significant relationships between joint attention skills, imitation skills, and receptive and expressive language skills, two regression analysis were conducted in which Total Imitation and Total Joint Attention were continuous independent variables and receptive language (i.e., Mullen receptive language raw score) and expressive language (i.e., Mullen expressive language raw score) were the continuous dependent variables. Results indicated that Total Joint Attention and Total Imitation did not predict a significant amount of variance for Mullen receptive language,  $F(2,15) = 2.34, p = .14, R \text{ Square} = .27$ , but did predict a significant amount of variance for Mullen expressive language,  $F(2,15) = 10.97, p = .002, R \text{ Square} = .63$ .

*Mediation Model.* The Sobel tests of mediation (Sobel, 1982) were used to explore whether joint attention skills mediated the relation between imitation skills and the ability to fast-map a new word (i.e., in the Basic, MEC, or TAX word learning conditions) in the ASD Group. More specifically, the hypothesis that joint attention mediates the relationship between imitation and fast-mapping a new word in children requires that 4 criteria be met (Baron & Kenny, 1986): (1) the predictor variable must be significantly correlated with the outcome variable (e.g., total imitation skills must be related to performance in the word learning condition); (2) the predictor variable must be significantly correlated with the mediating variable (e.g., imitation skills must be related to joint attention skills); (3) the mediator must be significantly correlated with the outcome variable (e.g., joint attention skills must be related to fast-mapping performance in the word learning condition); and (4) the strength of the correlation between the predictor variable and the outcome variable must be reduced by removing the variance attributable to the mediator (e.g., the correlation between imitation skills and fast-mapping performance will be reduced to non-significance when variance attributable to the joint attention skills is included in the analysis). The Sobel test requires that 2 regression analyses be conducted: (1) the independent variable (i.e., imitation skills) predicts the mediating variable (i.e., joint attention skills) and (2)

the independent variable (i.e., imitation skills) and the mediating variable (i.e., joint attention skills) predict the dependent variable (i.e., fast-mapping performance in the Basic, TAX, or MEC word learning conditions).

The Total Imitation (i.e., MIS – body and MIS – action) and Total Joint Attention scores (i.e., ESCS – eye gaze and ESCS – point) were used in the mediator model. After examining the correlations that emerged within the ASD Group (see Table 4), it became clear that a mediation model was not supported for both the Basic and MEC conditions. More specifically, Total Imitation and Total Joint Attention were not significantly correlated with performance in the Basic and MEC conditions. However, while the first 3 criteria for the mediator model were met for the TAX condition (i.e., (1) Total Imitation was correlated with Total Joint Attention,  $r(16) = .78, p < .001$ ; (2) Total Imitation was correlated with performance in the TAX,  $r(16) = .55, p = .03$ ; and (3) Total Joint Attention was correlated with performance in the TAX,  $r(16) = .51, p = .04$ ), the Sobel test indicated that joint attention was not a significant mediator between imitation and performance in the TAX condition ( $z = .53, p = .60$ ).

#### *The Effects of Imitation and Joint Attention on Word Learning Performance*

A total of 6 regression analyses were conducted to examine the effects that imitation skills (i.e., Total Imitation) and joint attention skills (i.e., Total Joint Attention) had on word learning performance across diagnostic groups (i.e., ASD Group and TD Group – All). The Total Joint Attention and Total Imitation variables were conducted in separate analyses because they were highly correlated with one another in the ASD Group. Further, the TD Group – All was used to boost statistical power.

Imitation skills were not related to task performance in each of the three word learning conditions for either diagnostic group. In the model investigating imitation skills in the Basic condition across diagnostic groups, there were no significant results for the main effect of

imitation,  $F(1, 38) = .001, p = .99$ ; main effect of diagnosis,  $F(1, 38) = .03, p = .86$ ; and the interaction between imitation and diagnosis,  $F(1, 38) = .038, p = .85$ . In the model investigating imitation skills in the TAX condition across diagnostic groups, there were no significant results for the main effect of imitation,  $F(1, 38) = .07, p = .80$ ; main effect of diagnosis,  $F(1, 38) = .46, p = .50$ ; and the interaction between imitation and diagnosis,  $F(1, 38) = .47, p = .50$ . In the model investigating imitation skills in the MEC condition across diagnostic groups, there were no significant results for the main effect of imitation,  $F(1, 38) = .10, p = .75$ ; main effect of diagnosis,  $F(1, 38) = .01, p = .92$ ; and the interaction between imitation and diagnosis,  $F(1, 38) = .02, p = .89$ .

In contrast, joint attention skills were related to task performance in each of the three word learning conditions, but differed among diagnostic groups. More specifically, in the model investigating joint attention skills in the Basic condition across diagnostic groups, there were significant results for the main effect of joint attention,  $F(1, 38) = 11.8, p = .001$ ; significant results for the main effect of diagnosis,  $F(1, 38) = 8.44, p = .01$ ; and significant results for the interaction between joint attention and diagnosis,  $F(1, 38) = 8.17, p = .01$ . Thus, it appears that children with TD had increased joint attention skills and performed more successfully in the Basic condition as compared to the ASD Group (see Figure 7).

In the model investigating joint attention skills in the TAX condition across diagnostic groups, there were marginally significant results for the main effect of joint attention,  $F(1, 38) = 3.18, p = .08$ ; no significant main effect of diagnosis,  $F(1, 38) = .37, p = .55$ ; and no significant interaction between joint attention and diagnosis,  $F(1, 38) = .37, p = .55$ . These results appear to suggest that increased joint attention skills are related to performance in the TAX condition for both diagnostic groups (see Figure 8). Similarly, in the model investigating joint attention skills in the MEC condition across diagnostic groups, there were marginally significant results for the

main effect of joint attention,  $F(1, 38) = 2.80, p = .10$ ; no significant main effect of diagnosis,  $F(1, 38) = .35, p = .56$ ; and no significant interaction between joint attention and diagnosis,  $F(1, 38) = .45, p = .51$ . These results also appear to suggest that increased joint attention skills are related to performance in the MEC condition for both diagnostic groups (see Figure 9). Taken together, the regression analyses revealed that imitation was not related to word learning performance across the diagnostic groups, but joint attention played a role in word learning performance for both preschoolers with ASD and preschoolers with TD.

## CHAPTER 4

### DISCUSSION

The current study investigated whether preschoolers with ASD (ASD Group) were able to utilize basic word learning constraints to fast-map (i.e., quickly link a novel label with a novel referent) in a manner similar to children with TD matched on age (TD Group – Age) and receptive language (TD Group – Language). A further goal of the study was to examine the effects of joint attention, imitation, and receptive and expressive language skills on the ability to quickly learn new words.

#### *Word Learning Performance Across Diagnostic Groups*

Overall, results indicated that preschool-aged children with ASD and TD were able to learn novel words. Further, both groups showed evidence of applying word learning constraints in word learning episodes. More specifically, both TD Groups learned words at above chance rates in the Basic, Taxonomic (TAX), and Mutual Exclusivity (MEC) conditions, which is consistent with other studies that have demonstrated successful fast-mapping and efficient use of word learning constraints (see Woodward & Markman, 1998). Preschoolers with ASD also learned words at a similar rate as children with TD in the Basic condition, which replicates previous findings that children with ASD are able to engage in basic fast-mapping (see also Baron-Cohen et al., 1997; Williams, Klinger, & Scofield, 2007). Further, while preschoolers with ASD demonstrated above chance performance in the TAX word learning condition, they showed less efficient use of word learning constraints in both TAX and MEC conditions compared to children with typical development matched on receptive language abilities and chronological age. Children with ASD had particular difficulties using the MEC condition such that they did not show word learning at above chance levels and showed less word learning compared to children with typical development matched on chronological age.

While all preschoolers with ASD learned words in the Basic condition at above chance rates that were comparable to preschoolers with TD, it seems plausible that the association between the novel label and object may have been more salient in the Basic condition than in the other word learning conditions. More specifically, in the Basic condition children were only exposed to 2 novel objects and only one of those novel objects was labeled. Thus, children could have simply relied on the direct association between novel label and novel word to perform well in the Basic condition. This is in contrast to the other experimental conditions in which the word learning context was potentially made more complex (e.g., in the TAX condition children were exposed to objects of different size and color in the selection array). Future studies should strive to investigate whether children with ASD are able to fast-map in more complex word learning conditions that are more similar to the natural environment (e.g., increased distracter objects in the selection array).

The ASD Group's performance in the TAX condition demonstrated that they are able to use basic categorization principles (e.g., the shape of an object) to extend a newly learned word to other exemplar objects (see also Luyster, 2007); although they may be doing so less efficiently than children with typical development. Thus, while children with ASD may be somewhat impaired in their categorization abilities (see Klinger & Dawson, 1995, 2001), they have some ability to use the basic features of an object to extend a newly learned label for a novel object to similar exemplar objects. The understanding and utilization of the taxonomic word learning constraint is essential because without it, children with ASD would likely experience frustration and confusion as to why a single label (e.g., "cup") could potentially be linked to many objects (e.g., coffee mug, sippy cup). Interestingly, performance in the TAX condition was the only word learning condition that was also linked to both imitation skills and joint attention skills in children with ASD. Thus, the ability to understand and apply these social-cognitive skills may

also be linked to categorization abilities in children with ASD. For example, one aspect of imitation is forming an internal representation of what one observes and then reproducing these representations (Nadel & Butterworth, 1999). This aspect of imitation extends to the taxonomic constraint such that preschoolers with ASD may use imitation skills to first determine that 2 objects have similar properties (i.e., formation of an internal representation), and then decide to extend a label to include both objects due to their similarity (i.e., reproducing the internal representation). This same idea extends to echolalia in children with ASD such that repeating an adult's label for an object may lead to word learning, which may explain the commonly found relationship between imitation and expressive language in children with ASD (e.g., Luyster, 2007; Stone & Yoder, 2001).

Difficulties in the TAX condition in the current study may be further evidence of the early emergence of the categorization impairment that is often found in children with ASD. For example, a recent study by Tek and colleagues (2008) found that preschoolers with ASD have difficulties using the category of shape to extend novel labels to both novel and exemplar objects as compared to preschoolers with TD, despite the fact that the vocabularies of both groups consistently increased over each time point in which word learning was measured. The authors noted that while children with ASD appear to be able to learn and produce words, these early categorization difficulties may be indicative of future difficulties and may also provide a clue as to what perceptual characteristics children with ASD attend to over others in various learning contexts. Future studies should investigate whether children with ASD are able to use the taxonomic word learning constraint when both perceptually simple and perceptually complex objects are labeled.

Preschool-aged children with ASD did not consistently use the mutual exclusivity constraint during word learning. Specifically, their performance was not greater than chance and

preschoolers with ASD performed similarly to preschoolers matched on receptive language, but not chronological age. This suggests that preschool-aged children with ASD may need time and increased exposure to gain additional experience in their environment and in word learning episodes before being able to understand and apply the mutual exclusivity constraint. In support of the idea that increased practice or exposure to word learning constraints may increase one's understanding and use of them, Preissler and Carey (2005) found that school-aged children with ASD performed at similar rates to preschoolers with TD in a task that measured the ability to utilize the mutual exclusivity constraint.

Success in the MEC condition likely also required social-cognitive abilities such as theory of mind (i.e., understanding that the speaker was likely labeling the unfamiliar object because the familiar object already had a name), which is often impaired in individuals with ASD (Baron-Cohen, 2000). The current finding that preschoolers with ASD show inefficient use of the mutual exclusivity constraint supports the results of the Parish-Morris et al. (2007) study that found that children with ASD had fast-mapping difficulties when they were required to understand the social intent of the speaker. Interestingly, in the current study, children with ASD who had increased joint attention skills were more efficient at utilizing the MEC condition, supporting the hypothesis that joint attention and theory of mind abilities are closely linked. For example, children use eye gaze, head orientation, and gestures (i.e., joint attention behaviors) to monitor one's state of mind and perspective in a word learning episode. Thus, having intact joint attention or theory of mind skills may have increased one's ability to perform well in the MEC condition. Future studies need to examine the role that social intent (e.g., ability to understand it and apply it to one's environment) may have on one's language acquisition and development. Overall, preschoolers with ASD may need practice, direct instruction, experience, and an

understanding of social intent (i.e., joint attention and/or theory of mind) before being able to successfully apply the mutual exclusivity constraint to further develop their vocabulary.

The ASD Group and both TD Groups had significant difficulties in the WOC condition, such that none of the groups performed at above chance rates. This finding is particularly striking for the TD Groups because many studies have documented their ability to consistently utilize this constraint (Markman, 1990; Soja, Carey, & Spelke, 1991). No studies have examined the use of the whole-object constraint in children with ASD, so it is difficult to determine the reasons for their poor performance. However, several possibilities may explain the decreased performance on the WOC condition for all diagnostic groups. First, Markman and Wachtel (1988) suggested that children are more likely to associate a novel label with a whole object when the object is *unfamiliar*, but are likely to associate a novel label with a part of an object when the object is *familiar*. Thus, while the stimuli used in the WOC condition were believed to be unfamiliar to the children and pilot testing confirmed this, it is possible that any familiarity with or exposure to the whole-object in the WOC condition may have led children to link a novel label with the novel part of an object. Second, the WOC condition required social and cognitive skills such as theory of mind, implicit learning, central coherence, and the ability to shift one's attention. While these social and cognitive skills were likely not impaired in the children in the TD Groups, it may have significantly influenced performance for the ASD Group. Lastly, the examiner provided few cues (e.g., eye gaze, gestures) to the children during the WOC condition, which may have made led to increased ambiguity and uncertainty despite having knowledge and understanding of the whole-object constraint. Overall, future studies need to investigate the ability of preschool-aged children with ASD to utilize the whole-object constraint and determine what impairments or skill deficits may be inhibiting their use of the constraint.

### *The Role of Joint Attention on Fast-Mapping Abilities*

Various studies have implicated the importance of joint attention on language acquisition and development for preschoolers with ASD and TD (Mundy, 1995; Mundy & Gomes, 1998; Sigman & Ruskin, 1999). In the current study, both TD Groups had increased joint attention skills (i.e., following eye gaze, following a point) as compared to the ASD Group. Further, it appears that including tasks that measured one's ability to follow a speaker's eye gaze increased the variability of joint attention performance in all diagnostic groups and may be a more sensitive measure of joint attention than just measuring the ability to follow a speaker's point alone.

A preliminary research hypothesis was that joint attention skills would be a stronger predictor of performance in the word learning conditions than imitation skills for both TD Groups. Overall, the current results demonstrated that joint attention was related to successful performance in all 3 word learning conditions. More specifically, joint attention skills were related to performance in the Basic, MEC, and TAX conditions for children with TD. This hypothesis was further confirmed such that the ability to follow the speaker's eye contact was significantly related to performance in the Basic condition for both TD Groups, and was also related to performance in the TAX condition for the TD Group – Language. In contrast, imitation skills were not significantly related to performance in the word learning conditions for the TD group. Taken together, these results suggest that children with TD may be more sensitive to joint attention cues or use joint attention skills, rather than imitation skills, in word learning episodes. It also highlights the importance of joint attention skills in increasing one's receptive and expressive vocabulary throughout the preschool years.

Research has indicated that children with ASD who have increased joint attention skills have increased language acquisition as compared to children with ASD who have decreased joint

attention skills (see Sigman & Kasari, 1995). In the current study, joint attention was related to performance in the TAX and MEC conditions for the ASD Group, but was not related to successful word learning in the Basic condition. In regards to the link between joint attention skills and language, joint attention skills were correlated with receptive and expressive language for the ASD Group, but were only correlated with performance in the TAX word learning condition. The finding that joint attention is linked to performance in both word learning constraint conditions (i.e., TAX and MEC) suggests that preschoolers with ASD may be utilizing joint attention skills or strategies to learn new words, but to a lesser degree when compared to children with TD.

This difference in the social-cognitive skills that are recruited in word learning situations for preschoolers with ASD also indicates that other skills may be more readily accessible or easier to implement when a novel label is presented with a novel word. The current study sought to examine this further by investigating whether imitation skills would be utilized by children with ASD as a way to increase their vocabulary. Overall, results clearly indicated that imitation skills were not related to successful word learning in any of the conditions, which is similar to the pattern found in children with TD. Additional correlational results revealed that imitation skills were linked to performance in the TAX condition for the ASD Group, but were not consistently correlated with performance in the other word learning conditions (see additional discussion below). In conclusion, preschoolers with ASD seem to be utilizing joint attention skills or strategies in word learning episodes, and they likely provide some of the information needed to link a novel label with a novel object. However, children with ASD are using joint attention skills to a lesser degree when compared to children with TD, which suggests that other strategies or skills may be providing them with the information needed to fast-map. Future studies may need to measure and investigate a variety of mechanisms by which preschoolers

with ASD are learning new words so that these can be targeted in interventions and in one's natural environment to help build their vocabularies

The relationship between fast-mapping, language skills, and joint attention skills appears to be complex, and few studies have sought to understand the relationship between these language mechanisms and social-cognitive skills. McDuffie et al. (2006a) used a gaze latency word learning measure and found that fast-mapping abilities mediated the relationship between joint attention skills and receptive and expressive language skills in preschoolers with ASD. However, a limitation of their study was that the authors used a gaze latency task, which may be a less reliable measure of fast-mapping as compared to an object selection task (see Luyster, 2007 for a discussion). The current study sought to determine if joint attention skills predicted receptive and expressive language through the mechanism of fast-mapping (i.e., performance in the Basic, MEC, or TAX conditions) when an object selection task was used. However, this mediation model was not supported because joint attention was not significantly correlated to performance in the Basic or MEC conditions. While the first 3 criteria for the mediation model were supported for the ASD Group in the TAX condition, joint attention was not a significant mediator between imitation and performance in the TAX condition. However, the ASD Group's receptive and expressive language skills (as measured by the Mullen and CDI) were related to performance in the Basic, TAX, and MEC conditions. This finding also supports the idea that while joint attention is likely an important aspect of language development in children with ASD, other skills (i.e., current language skills) may also have an intricate relationship with the ability to learn new words and utilize word learning constraints.

#### *The Role of Imitation on Fast-Mapping Abilities*

For both TD Groups, there were no significant relationships between their imitation skills (as measured by the MIS) and language abilities, joint attention abilities, and performance in the

word learning conditions. As mentioned above, this appears to fit with the language research that posits that joint attention skills are necessary and critical components that are involved in the language acquisition and development in preschool-aged children with TD. However, use of imitation skills and strategies does not appear to be a critical or main strategy used by preschoolers with TD in word learning episodes. Additionally, despite not necessarily utilizing imitation skills to learn new words, both TD Groups performed significantly better on the tasks of the MIS as compared to the ASD Group, which suggests that body and action imitation skills are more impaired in children with ASD.

Carpenter and colleagues (2002) demonstrated that young children with ASD develop imitation skills before joint attention skills and suggested that they may rely more on imitation skills to build their receptive and expressive language vocabularies. While imitation was not related to performance in the word learning conditions for children with ASD, the current study found that imitation skills (as measured by the MIS) were related to expressive and receptive language skills and joint attention skills in the ASD Group (see also Luyster et al., 2008; Mundy et al., 1990; Sigman & Ruskin, 1999; Stone & Yoder, 2001). In addition, regression analyses revealed that imitation and joint attention skills were a significant predictor of expressive language abilities in children with ASD, but were not a significant predictor of receptive language abilities. These results appear to be in line with research findings that illustrate the often complicated and varying relationship between joint attention, imitation, and language in children with ASD (see Luyster et al., 2008; Murray et al., 2008 for recent findings). Future studies need to conduct longitudinal studies to clarify the relationship between these social-cognitive skills and determine how they predict current and future language skills and word learning abilities.

### *Overall Summary of Findings*

Previous research has clearly shown that children with ASD have impairments in joint attention (Mundy et al., 1986; Mundy, Sigman, & Kasari, 1993; Sigman et al., 1986) and imitation (Carpenter et al., 2002; Charman et al., 2003; Stone and Yoder, 2001), and that these impairments may lead to difficulties in utilizing common word learning strategies to develop one's vocabulary. The current study revealed that children with ASD can fast-map in a similar manner to children with TD, but appear to be utilizing word learning constraints in a less efficient and effective manner. Further, while receptive and expressive language skills were linked to successful word learning performance, imitation skills were not consistently related with successful word acquisition in all 3 word learning conditions for preschoolers with ASD. Additionally, while joint attention skills were linked to successful word learning in the MEC and TAX conditions for preschoolers with ASD, they were not related to word learning in the Basic condition. However, there does seem to be preliminary evidence to suggest that preschoolers are less likely to use joint attention in the Basic condition as compared to preschoolers with TD. This is an interesting finding because the Basic condition was likely most similar to actual word learning situations that children with ASD are exposed to in their natural environments (i.e., an adult speaker labels a novel object while alternating eye gaze between the child and the object). Regardless, it seems plausible to suggest that other strategies or skills (e.g., theory of mind, attention-following, social responsiveness, social intent) that were not measured in the current study may be critical factors in one's ability to learn new words and build one's receptive and expressive vocabulary.

### *Implications for Language Interventions in Preschoolers with ASD*

The findings of the current study are somewhat remarkable because research on children with typical development has emphasized the importance of social-cognitive skills in one's

ability to acquire language (Baldwin, 1995; Tomasello, 1995). While it is premature to state that joint attention and imitation skills are not critical or necessary for word learning in children with ASD, it seems plausible that children with ASD may benefit from word learning interventions that either minimize the amount of social cues in a word learning episode or may utilize the skills and strategies that they are already using to learn new words.

Currently, many language interventions seek to teach joint attention and imitation skills to children with ASD in order to facilitate the development of their vocabulary. Thus, behaviors such as imitating a caregiver's label for an object during a play session or following another individual's eye gaze or point are explicitly taught and reinforced in intervention programs. However, as noted above, it may be beneficial to implement language interventions that decrease dependence on teaching social-cognitive skills or increase the association between object and label pairings (e.g., following child's attentional focus, using multiple joint attention cues, repeating the label for an object many times, etc.). For example, Wetherby and Woods (2006) measured the changes in the social-communicative skills in 2-year-old children with ASD whose parents were enrolled in the Early Social Interaction (ESI) Project, which taught parents how to target social-cognitive and language skills in the natural environment. The results indicated that children with ASD who received ESI had increased joint attention skills (e.g., gaze shifts, gaze/point following) as compared to a comparison group who did not receive ESI. However, children who received ESI performed similarly to the contrast group on measures of communicative means (e.g., use of gestures, use of consonants, and inventory of words). Overall, Wetherby and Woods (2006) concluded that while maturation may influence or lead to gains in communicative means, interventions targeting social-cognitive skills may not lead to increased language skills. Thus, interventions for children with ASD that target joint attention or imitation skills may not lead to increases in language acquisition, which fits with the findings of the

current study. Perhaps social-cognitive skills such as joint attention and imitation are more related to the core social deficits of autism, which likely affect language acquisition, but may not be the most important or critical factors. Rather, it seems plausible that maturation, as well as skills such as attention-following, may play a large role in the vocabulary development of children with ASD. Potential components of interventions that may facilitate language development in children with ASD more effectively, and how they relate to the current study's findings, will be briefly discussed below.

*Attention Following and Attentional Focus.* Recent research has demonstrated the importance of teaching responsiveness skills to parents of children with ASD. Siller and Sigman (2002) conducted a longitudinal study of 25 preschoolers with ASD and found that increased synchronization, which they defined as following children's attentional focus and engagement with toys, led to increased joint attention skills 1 year after intervention and better language outcomes 10 and 16 years after intervention. The authors reported that the most significant predictor of language gains was attentional focus such that following children's attention to or engagement with toys/activities was related to increased language skills. The results of Siller and Sigman's (2002) study suggest that including the component of attention following in intervention may greatly increase language acquisition in children with ASD.

The potential importance of attentional focus on language development was also demonstrated in a study by Adamson, Bakeman, Deckner, and Ronski (2009). The authors found that preschoolers with ASD rarely engaged in coordinated joint attention with a partner and an object regardless of vocabulary size, but were able to engage with their caregivers 85% of the time during a play session. Thus, children with ASD are able to focus their attention and engage, but this occurs more frequently in preferred activities and when engaged with motivating objects. Adamson and colleagues suggested that creating and attending to interactions that are

child-directed, incorporate objects or activities that are intrinsically motivating for the child, and lessen the cognitive and affective demands placed on a child with ASD may facilitate language development (see also Bloom, 1993).

In the current study, attentional focus was likely a critical factor in the word learning conditions that introduced two novel objects, but only one novel label (e.g., Basic, TAX, and WOC). Attentional focus in these word learning conditions likely included factors such as attending to objects as they were labeled or commented on, shifting attention and focus from the previous word learning task, or shifting attention from salient or preferred novel objects that were previously presented. Lastly, in the current study, the examiner engaged the child in a word learning task that may have not been interesting or intrinsically motivating, which may have decreased their attentional focus and thus their ability to fast-map.

*Joint Engagement Between Caregiver & Child.* While it is closely linked to attentional focus, joint engagement occurs when a child and caregiver share focus and/or interest on an object or activity. For example, joint engagement may occur if a child is playing with shaving cream and the caregiver draws the letter “A” and labels it. Episodes of joint engagement are also enhanced when a child is motivated by the object or activity. Further, while joint engagement is fostered by joint attention skills (e.g., following a caregiver’s eye gaze, alternating eye gaze), it can also be facilitated and scaffolded by a caregiver to teach skills such as language. Kasari and colleagues (2008) found that preschoolers with ASD who received either a targeted joint attention intervention or a targeted symbolic play intervention had increased language skills as compared to a control group who did not receive either intervention. The authors posited that both interventions created a shared state of joint engagement between a child and caregiver while teaching targeted play or joint attention skills. In other words, creating a state of joint

engagement may be an ideal environment to teach new words to children with ASD regardless of their social-cognitive impairments.

In the current study, a state of joint engagement was theoretically created such that the examiner labeled or commented on a novel object only after eye contact had been established and the child's attention was focused on the novel object. However, the child's interest in the object or motivation to engage in an interaction with the examiner likely affected the state of joint engagement in the word learning episode and may have influenced word learning.

*Child-Directed Interactions.* In addition to creating a state of joint engagement, the above mentioned study by Kasari et al. (2008) also utilized child-directed strategies such as following the child's lead and interest in activities, talking about what the child was doing, repeating and expanding upon what the child said, sitting close to the child, and making eye contact with the child. These child-directed strategies likely facilitated and added to the state of joint engagement. Further, Aldred, Green, and Adams (2004) conducted an intervention study in which parents adapted their communication style such that actions made by the child were interpreted to have meaning and relation to their intentions and desires. Results indicated that parent report of expressive and receptive language skills increased and observed autism symptomatology (as measured by the ADOS-G) decreased. Aldred and colleagues (2004) noted that the language of children with ASD may increase if parent's can become more responsive and sensitive to their social-cognitive deficits and then adapt their own interactions and teaching style to meet their child's unique needs. Similarly, Ingersoll, Dvortcsak, Whalen, & Sikora (2005) utilized a developmental, social-pragmatic (DSP) model to teach language skills that emphasized the importance of the caregivers' responsiveness on the development of social-cognitive skills in the child with ASD. More specifically, common characteristics of the DSP model included: (1) following the child's lead or interest; (2) arranging the environment to encourage the child to

initiate interactions; (3) responding to all communicative attempts by the child; and (4) emphasizing emotional expressions and affect sharing by the caregiver. An intervention study comprised of 3 children with ASD indicated that the DSP model led to increased spontaneous expressive language with therapists that then generalized to the children's caregivers (Ingersoll et al., 2005). Thus, interactive, child-directed models of language intervention appear to be quite promising for children with ASD because they facilitate a state of joint engagement, lessen social-cognitive demands, and follow the child's lead and interests (see also Vismara, Colombi, & Rogers, 2008).

The word learning episodes that were created in the present study were entirely adult-directed and there were few opportunities for the examiner to follow the child's lead or interest. It seems plausible that allowing the child to explore objects on their own and labeling them in a more naturalistic manner (e.g., when the child demonstrates interest in or attention on a particular object) may be a more successful word learning strategy.

*Electronic Screen Media.* Many children with ASD appear to have a propensity for learning from video, television, and computer programming (Heiman et al., 1995; Nally et al., 2000), which may be partially due to their preference for visual stimuli (Charlop-Christy & Daneshavar, 2003; Schreibman et al., 2000; Shane & Albert, 2008). Learning that is delivered via electronic screen media may decrease the amount of social cues that need to be deciphered and may make associations between novel words and their labels more apparent. For example, on the television cartoon *Dora the Explorer*, the main character often uses common joint attention cues such as eye gaze and a point to label an object, and the novel object is often highlighted on screen in a very clear manner while it is paired with the novel label several times. Thus, the association between word and label is made obvious by the combination of social-cognitive cues, visual salience, and repetition. Further, research on children with typical

development has also demonstrated that they are able to learn new words that are presented via electronic screen media (Krcmar, Grela, & Lin, 2007; Rice et al., 1990; Rice & Woodsmall, 1988; Scofield & Williams, 2009), though additional research needs to be done to determine how these words generalize to the expressive vocabulary and other environmental contexts. In addition, Mineo and colleagues (2009) stated that that constrained viewing area of a television or computer may increase the ability of children with ASD to focus their attention and ignore irrelevant stimuli. The authors also noted that interventions delivered through electronic screen media are easy to produce, economical, and appear to be intrinsically interesting and motivating to individuals with ASD. While there has been little research on the effectiveness of language interventions delivered through television and media, it seems plausible that decreasing cognitive and attentional demands while increasing the salience of social-cognitive cues and object-label associations could be a potentially successful intervention to increase vocabulary in preschoolers with ASD.

Taken together, it is clear that there are many directions that language interventions for children with ASD could take and an abundance of strategies that they could utilize. In the current study, an adult-directed approach was used to teach children new words and potentially critical factors such as attentional focus and joint engagement may have been decreased or absent in the word learning episode. Future studies should compare children's ability to successfully learn new words in adult-directed and child-directed conditions. Further, it may be necessary to take into account that social-cognitive deficits are at the core of autism and that these deficits may also need to be addressed both directly (e.g., through explicit instruction) and indirectly (e.g., increasing joint engagement, child-directed strategies) in order to facilitate language acquisition and development.

### *Limitations and Future Directions*

While the current study's sample size was somewhat small (i.e.,  $N = 16$  for ASD Group), it is comparable to other studies that have investigated word learning in children with ASD, and significant relationships among word learning performance, language, imitation, and joint attention skills were still found. Further, the presence of several marginally statistically significant findings that had medium or large effect sizes suggests that an increased sample size would lead to statistically significant relationships between these variables. However, future studies should strive to not only include a larger sample of children, but also include more trials of the word learning conditions to better assess performance. Due to ceiling effects and lack of variability, the Verbal Imitation Measure was not included in the current study's analyses. Thus, future studies may benefit from having a more comprehensive or difficult verbal imitation task to better assess this skill in both diagnostic groups. Lastly, it was difficult to assess the effects of intervention (e.g., speech therapy, ABA, etc.) on the social-cognitive skills and word learning performance in children with ASD because parents did not consistently return this form or neglected to fill it out in its entirety. In the future, an in-person or phone interview about these areas may allow for accurate data collection of past and current interventions (e.g., duration, intensity, etc.).

Future research studies should investigate the emergence of social-cognitive skills and fast-mapping ability in children with ASD over time (see Landa & Garrett-Mayer, 2006 for an example of a prospective study of social-cognitive skills with siblings of children with ASD). For example, performance in the 4 word learning conditions and social cognitive skills such as joint attention, imitation, theory of mind, pretend play, and social responsivity could be continuously measured in preschoolers with ASD and preschoolers with TD from 18 – 60 months of age in 3-month intervals. The results of such a study would allow for comparison of

word learning ability, use of word learning strategies, and the influence of various social-cognitive skills over time in both diagnostic groups, and would shed light on what skills or abilities should be targeted in language interventions for children with ASD. The longitudinal study described above would also allow for exploration of the emergence of various social-cognitive skills in children with ASD and could be compared with the emergence of these same skills in children with TD. For example, previous research has shown that joint attention emerges before imitation skills in children with TD and that the reverse pattern is true for children with ASD (Carpenter et al., 2002). However, this finding needs to be replicated with a larger sample size to determine its validity and usefulness in interventions aimed to increase language and various social-cognitive skills.

In addition to measuring the emergence of social-cognitive skills in young children with ASD, it may also be useful to investigate qualities of caregiver responsiveness and interaction. For example, Ruble and colleagues (2008) developed and used a clinical observation tool (i.e., Social Interaction Rating Scale) that assesses qualities of parental responsiveness including contingency, initiation toward the child, movement with the child, affect, and maintenance of interaction with the child. The use of child-directed interventions to increase language acquisition in children with ASD may be most successful when caregivers understand and are responsive to their child's needs. Thus, it may be highly beneficial to determine how the responsiveness attributes of caregivers affect receptive and expressive vocabulary so that interventions could target the development of these responsiveness attributes through instruction, modeling, and practice.

The results of the current study suggest that more research on effective language interventions for children with ASD needs to be conducted. For example, interventions that utilize electronic screen media may decrease cognitive, attention, and social-cognitive demands

for children with ASD and may be effective at targeting language acquisition and development. In addition, interventions that teach parents to scaffold and support interactions with a child and/or utilize a child-directed or development, social-pragmatic (DSP) model to teach language need to be piloted on a larger and more diverse sample of individuals with ASD to determine its effectiveness. Lastly, it is important to note that interventions should continue to target joint attention and imitation skills because they are critical skills that do affect a child's progress across the lifespan. However, it seems plausible that an increase in joint attention and imitation skills may not necessarily lead to increased vocabulary if children with ASD are already utilizing alternative skills or strategies. While an abundance of research has focused on how the deficits and impairments in children with ASD may affect their language acquisition and development, little research has targeted their intact abilities or strategies that they may already be recruiting and applying to comprehend and produce new words. Language skills are an important predictor of future skills in preschoolers with ASD, which only highlights the importance of developing individualized interventions that address their unique set of strengths and difficulties.

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Table 1. Demographics and Diagnostic Data

	ASD Group (n =16)	TD Group - Language (n = 16)	TD Group - Age (n =16)
	<i>M</i> (SD)	<i>M</i> (SD)	<i>M</i> (SD)
Sex (Males: Females)	15:1	13:3	12:4
Chronological Age – in months	49.8 (11.3)	33.8 (11.1)***	44.9 (10.0)
Mullen Receptive Language Raw Score	29.1(7.8)	31.8 (5.9)	38.3(5.2)
Mullen Receptive Language Age Equivalent Score	32.4 (12.6)	36.0 (10.1)	46.6 (9.7)
Mullen Expressive Language Raw Score	30.0 (7.5)	31.9 (7.3)	39.1 (4.2)***
Mullen Expressive Language Age Equivalent Score	32.9 (11.2)	36.0 (10.5)	46.8 (7.0)
CDI Comprehension Vocabulary	179.3 (61.2)	221.4 (11.5)**	226.8 (4.7)**
CDI Expressive Vocabulary	158.9 (66.8)	210.1 (27.8)**	225.8 (4.8)***
ESCS – Pointing	10.7 (2.5)	11.9 (0.3)*	11.9 (0.3)*
ESCS – Eye Contact	9.4 (2.6)	11.1 (1.2)**	11.5 (0.7)***
MIS – Body	12.2 (4.7)	15.8 (0.5)***	16.0 (0.0)***
MIS – Action	13.6 (3.6)	15.9 (0.3)**	15.8 (0.5)**
VIM – Familiar	7.0 (2.2)	8.0 (0.0)*	8.0 (0.0)*
VIM – Unfamiliar	6.7 (2.4)	7.9 (0.5)*	7.8 (1.0)
Imitation Total	39.4 (11.4)	47.6 (1.0)***	47.6 (1.5)***
Joint Attention Total	20.1 (4.7)	23.1 (1.2)**	23.4 (0.8)***

*Note: p-values indicate a statistically significant difference between the specific TD Group and the ASD Group.*

\* $p < .10$

\*\* $p < .05$

\*\*\* $p < .01$

Table 2. Tasks each participant completed in experimental sessions.

	<b>ASD Group</b>	<b>TD Groups</b>
<b>Session 1</b>	<ul style="list-style-type: none"> <li>▪ ADOS-G</li> </ul>	<ul style="list-style-type: none"> <li>▪ Mullen</li> <li>▪ First half of the Attention-Following Task</li> <li>▪ 1<sup>st</sup> &amp; 2<sup>nd</sup> blocks of word learning conditions</li> </ul>
<b>Session 2</b>	<ul style="list-style-type: none"> <li>▪ Mullen</li> <li>▪ 1<sup>st</sup> &amp; 2<sup>nd</sup> blocks of word learning conditions</li> <li>▪ First half of the Attention-Following task</li> </ul>	<ul style="list-style-type: none"> <li>▪ Second half of the Attention-Following Task</li> <li>▪ Motor Imitation Scale</li> <li>▪ Verbal Imitation Scale</li> <li>▪ 3<sup>rd</sup> &amp; 4<sup>th</sup> blocks of word learning conditions</li> </ul>
<b>Session 3</b>	<ul style="list-style-type: none"> <li>▪ Second half of the Attention-Following Task</li> <li>▪ Motor Imitation Scale</li> <li>▪ Verbal Imitation Scale</li> <li>▪ 3<sup>rd</sup> &amp; 4<sup>th</sup> blocks of word learning conditions</li> </ul>	

Table 3. Correlations Between Nonverbal Skills, Language, Joint Attention, and Imitation Measures with Word Learning Conditions in TD Group - All (N = 26)

	Mullen Rec Lang	Mullen Exp Lang	Total Imitation	Total Joint Attention	Basic	TAX	MEC
Non-Verbal Skills	.89***	.87***	.12	.30	.34*	-.04	.45**
Mullen Rec Lang	--	.93***	.08	.35*	.39**	.01	.50**
Mullen Exp Lang		--	.05	.34*	.31	.04	.48**
Total Imitation			--	-.29	-.02	-.09	.06
Total Joint Attention				--	.64***	.24	.28
Basic					--	.08	.39**
TAX						--	.14

\*  $p < .10$

\*\*  $p < .05$

\*\*\*  $p < .001$

Table 4. Correlations Between Nonverbal Skills, Language, Joint Attention, and Imitation Measures with Word Learning Conditions in ASD Group (N = 16)

	Mullen Rec Lang	Mullen Exp Lang	CDI Comp	CDI Prod	Total Imitation	Total Joint Attention	Basic	TAX	MEC
Non- Verbal Skills	.78***	.93***	.72***	.78***	.79***	.68**	.47*	.44*	.53**
Mullen Rec Lang	--	.89***	.63**	.72**	.52**	.41	.46*	.51**	.58**
Mullen Exp Lang		--	.81***	.81***	.81***	.63**	.56**	.49*	.53**
CDI – Comp			--	.81***	.76***	.65**	.46*	.61**	.24
CDI - Prod				--	.53**	.38	.59**	.46*	.48*
Total Imitation					--	.78***	.22	.55**	.20
Total Joint Attention						--	.21	.51**	.38
Basic							--	-.03	.47*
TAX								--	.22

\*  $p < .10$

\*\*  $p < .05$

\*\*\* $p < .001$

Table 5. Performance in Word Learning Conditions Across Diagnostic Groups

	ASD Group <i>M</i> (SD)	TD Group - Language <i>M</i> (SD)	TD Group - Age <i>M</i> (SD)
Basic	76.6 (28.1)	71.9 (25.6)	79.7 (18.8)
Taxonomic	62.5 (22.4)	73.4 (17.0)	67.2 (23.7)
Mutual Exclusivity	60.9 (30.2)	73.4 (23.2)	82.8 (19.8)
Whole Object	54.7 (29.2)	56.3 (26.6)	56.3 (29.6)

Figure 1. Basic Word Learning Condition

<b>Experimental Trial</b>	<b>Selection Array</b>
	
<p><i>"Look a clem."</i></p>	
<b>Control Trial</b>	<p><i>"Where is the clem?"</i></p>
	
<p><i>"Look. Look"</i></p>	

Figure 2. Taxonomic Word Learning Condition (TAX)

<b>Experimental Trial</b>	<b>Selection Array</b>
	
<p><i>"Look a neby."</i></p>	
<p><b>Control Trial</b></p>	
	<p><i>"Where is the neby?"</i></p>

Figure 3. Mutual Exclusivity Word Learning Condition (MEC)

<b>Experimental Trial</b>	<b>Selection Array</b>
	
<i>"Look. Look."</i>	
<b>Control Trial</b>	
	
<i>"Look. Look"</i>	<i>"Where is the toma?"</i>

Figure 4. Whole Object Word Learning Condition (WOC)

<b>Experimental Trial</b>	<b>Selection Array</b>
	
<i>"Look a hafer."</i>	<i>"Where is the hafer?"</i>

Figure 5. Performance in the Basic Condition Across Diagnostic Groups (chance = 50%)

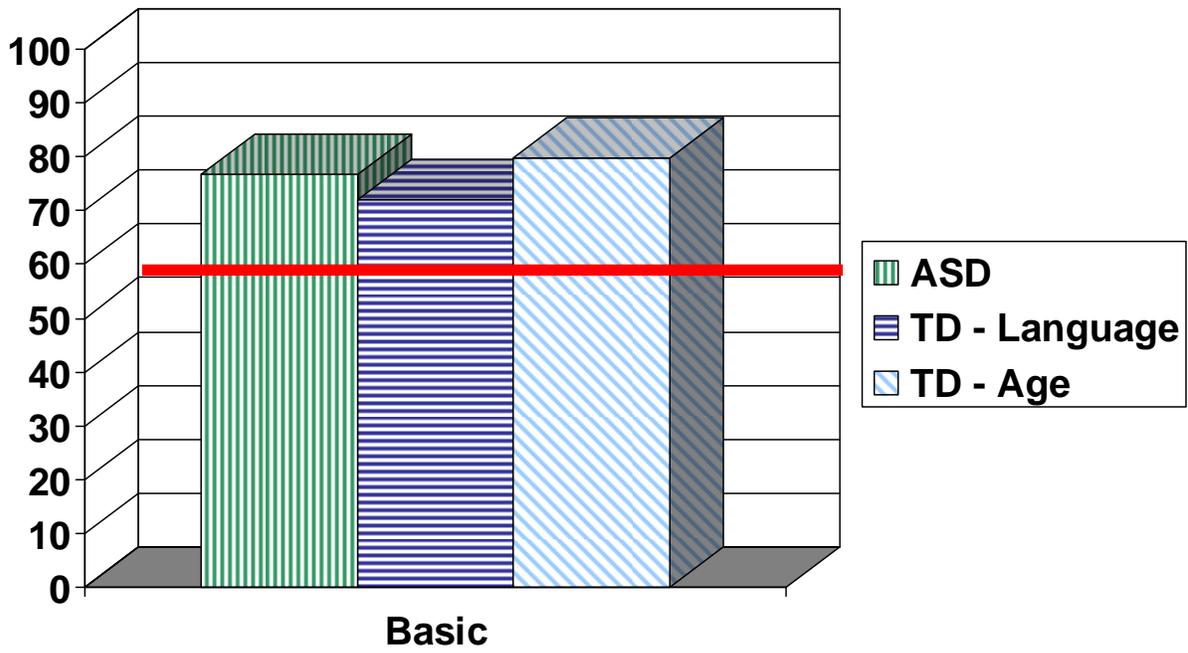


Figure 6. Performance in the MEC and TAX Conditions Across Diagnostic Groups (chance = 50%)

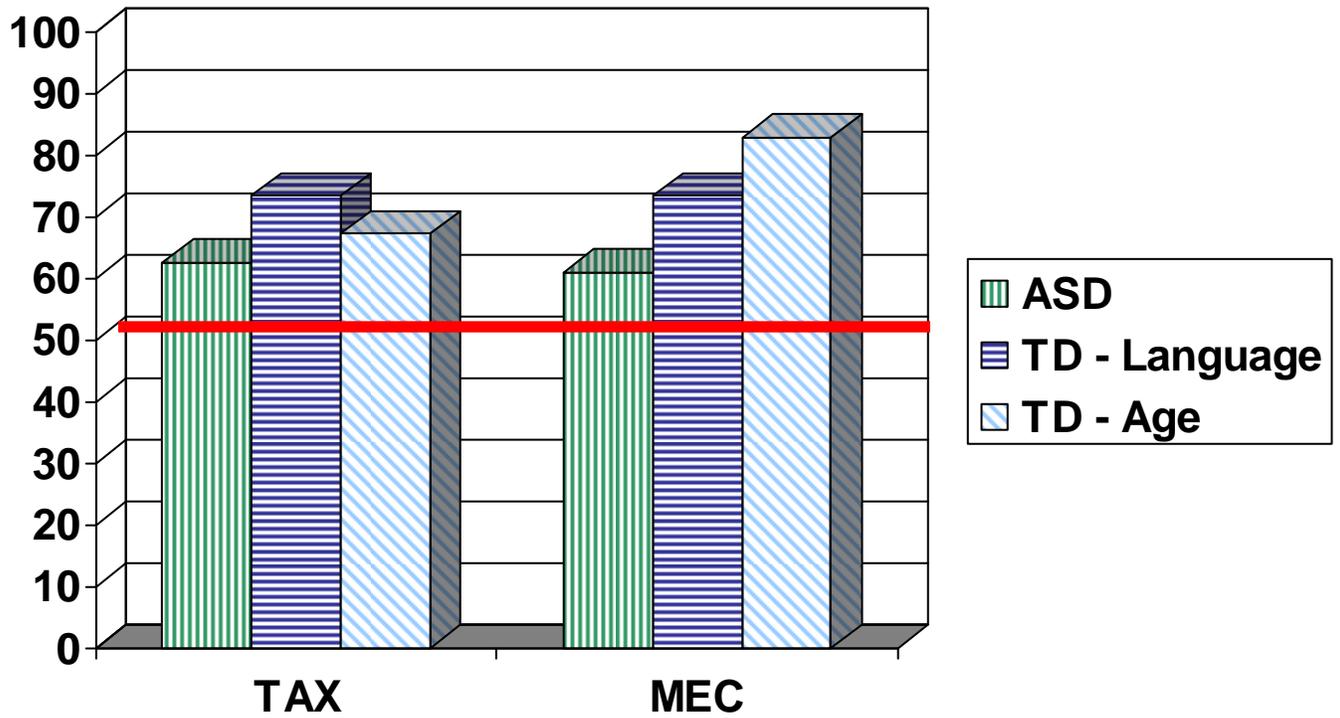


Figure 7. Regression of Performance in the Basic Condition on Joint Attention Skills Across Diagnostic Groups

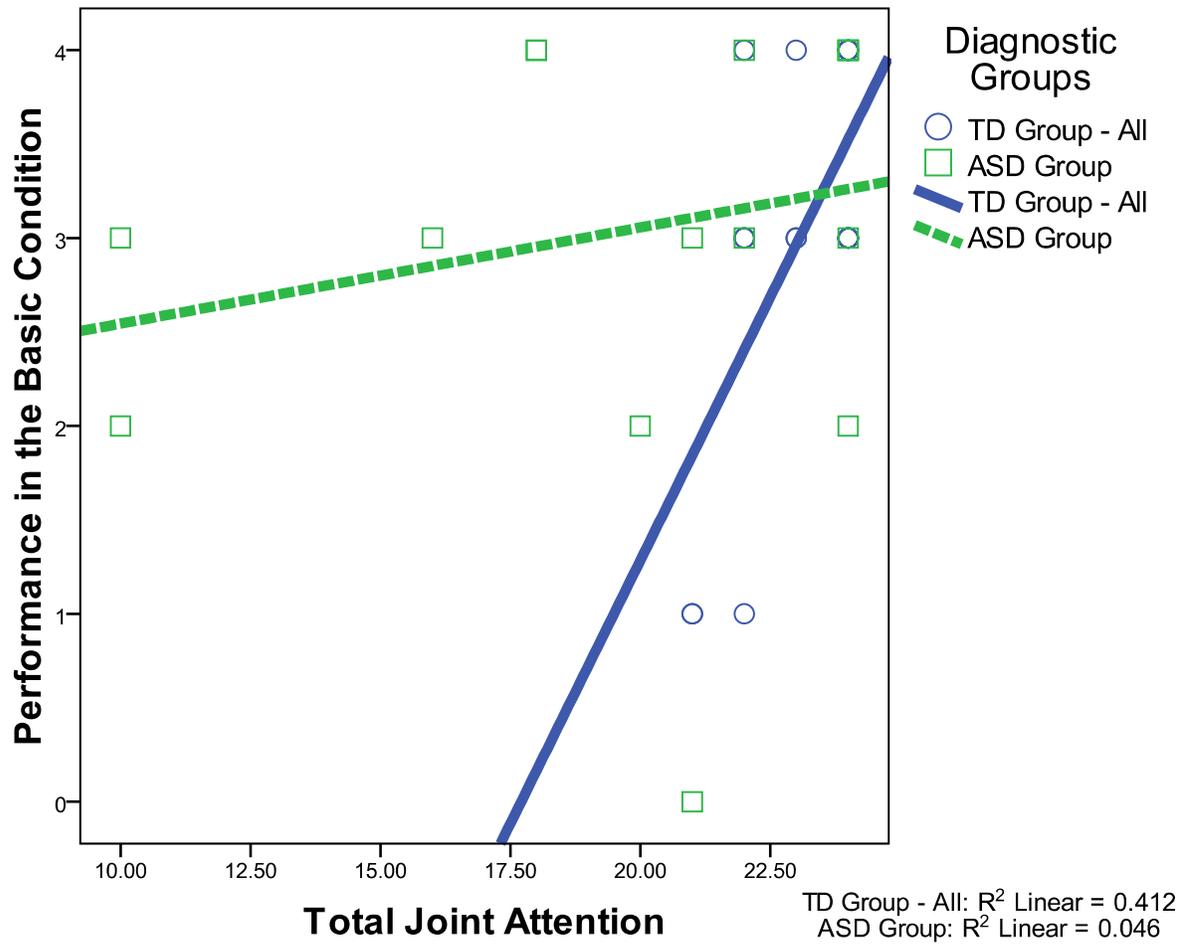


Figure 8. Regression of Performance in the TAX Condition on Joint Attention Skills Across Diagnostic Groups

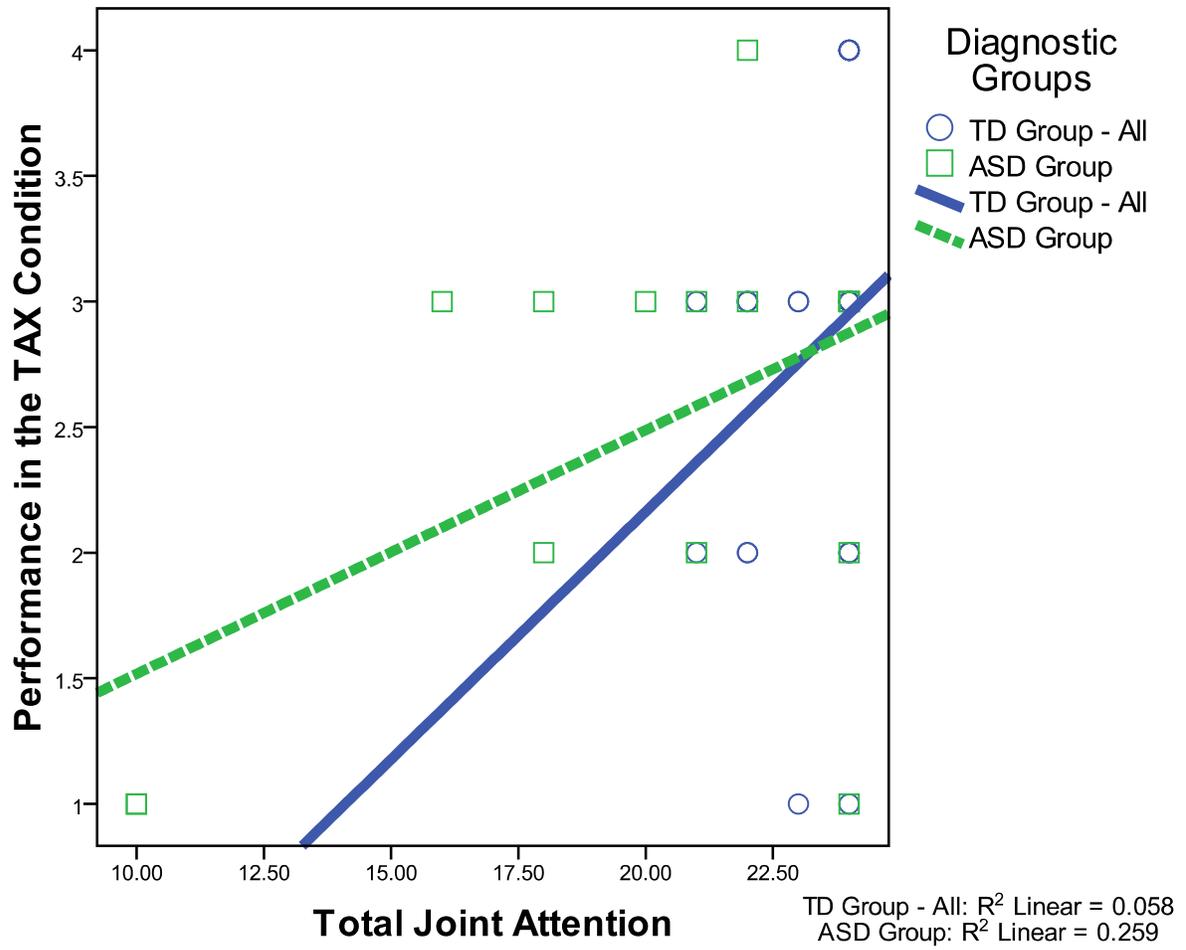


Figure 9. Regression of Performance in the MEC Condition on Joint Attention Skills Across Diagnostic Groups

