THE ABILITIES AND DIFFERENTIAL DIFFICULTIES OF CHILDREN WITH AUTISM SPECTRUM DISORDER AND CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT TO USE SEMANTIC AND SOCIAL CONTEXTS TO INFER AND RECALL NOVEL WORDS

by

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Abstract

THE ABILITIES AND DIFFERENTIAL DIFFICULTIES OF CHILDREN WITH AUTISM SPECTRUM DISORDER AND CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT TO USE SEMANTIC AND SOCIAL CONTEXTS TO INFER AND RECALL NOVEL WORDS

by

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Two studies assessed the ability of 12 pre-school children with Autism Spectrum Disorder (ASD; N = 7) or Specific Language Impairment (SLI; N = 5) to use semantic context and eye gaze to infer the meanings of novel nouns, and to recall those meanings after a 24-hour delay. In Experiment 1, the children heard statements containing a familiar, transitive verb and a novel noun (e.g., "Daddy eats the artichoke"). Children were asked to point to the picture of the correct referent which was presented with 3 other novel items. On day 2, they were asked to point out the correct novel referents (e.g., "Show me the artichoke") that were now rearranged in different displays and were requested without reference to the previous semantic context. In Experiment 2, the children saw a representation of a face with eyes oriented to one of 4 items, each located in a different quadrant around the face. Children were asked about the cartoon face's desires based on the social cues provided by the eye gaze (e.g., "Sully makes the bouquet. Show me the bouquet"). On Day 2, the children were asked to point to the previously labeled items that were arranged in a new display without reference to the previous social context. All participants performed better using semantic context than eye gaze, but the children with ASD had greater difficulty with eye gaze than those with SLI. Recommendations for future training and intervention based on the results of both experiments are provided.

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CHAPTER I. INTRODUCTION

Young children, between the ages of 18 months and five years, typically acquire novel words very rapidly at a rate of about five to nine words every day (Carey, 1978). Researchers have investigated vocabulary acquisition and have tried to determine how children accomplish this feat. One proposal is fast mapping. If a label, or word, is unknown and a previously unnamed visible referent is presented, children can infer that the referent of the new word is the unnamed object. They also use fast mapping to figure out the terms for attributes of objects. In the example provided by Carey and Bartlett (1977), a child is presented with two identical objects, one that is red and another that is a color with an unknown label to that child. With the phrase "Give me the chromium one, not the red one", the child will be able to infer that chromium is a color word that does not refer to the color red. The child can quickly infer the meaning of the new word "chromium" and remember it later. Additionally, 2- and 3-years olds can infer the referent of a novel word by monitoring the speaker's direction of gaze (Baron-Cohen, Baldwin & Crowson, 1997). For example, if a speaker says the word "kitten" while looking at a kitten, a young child will infer that the word "kitten" refers to the little cat in the middle of the room, even if it is the child's first time hearing the word. The child is using what Baron-Cohen and his colleagues call a Speaker's Direction of Gaze (SDG) strategy.

Children with autism, however, often appear to have language deficits and/or delays pertaining to the acquisition and comprehension of novel words. Autism is a behavioral disorder of neurological and higher-order cognitive functioning, with onset by 3 years of age (Rapin, 1998). As defined in the American Psychiatric Association Diagnostic and Statistical Manual of Mental Disorders, *DSM-IV-TR*, (2000), a child with autism is characterized by differences from typical children in three specific areas: (1) Repetitive, or restricted, patterns of interest; (2) Qualitative impairments in social functioning and interaction, and; (3) Qualitative impairments in language and communication development. Because the severity of the above characteristics is so variable among individuals, the *DSM- IV-TR* (2000) refers to the full complement of those diagnosed with autism as a spectrum disorder (ASD), also labeled pervasive developmental delay (PDD).

Impairments such as difficulties in comprehension of what others say, constructing coherent sentences and recalling words are also a hallmark of children with Specific Language Impairment (SLI). The *DSM-IV-TR* includes the requirement that diagnosis of SLI be dependent on a substantial discrepancy between language and non-verbal skills, although “substantial” is undefined. Specifically, SLI is characterized by poor performance using syntax and on tests of non-word repetition rather than on vocabulary per se (Kjelgaard & Tager-Flusberg, 2001). Children with SLI develop normally in all other developmental aspects, which distinguish them from children with ASD (Williams, Botting & Boucher, 2008).

Yet many children with diagnosed with ASD or SLI have age-appropriate vocabularies but show difficulties in nonverbal and pragmatic communication (Loucas, Charman, Pickles, Simonoff, Chandler, Meldrum, & Baird, 2008). As such, many children with language deficits and/or processing delays have often been misdiagnosed as having an autism spectrum disorder (ASD). Conversely, many children that could be diagnosed with autism spectrum disorder have been given the diagnosis of Specific Language Impairment (SLI). The general commonality among children with these disorders is that language development is not occurring at the same rate as it does for typically developing children (Kjelgaard & Tager-Flusberg, 2001; Loucas et al. 2008), causing some discrepancies in classification. A study by Jarrold, Boucher, and Russell (1997) found that out of 120 children exhibiting DSM-IV criteria for autism, only half received the diagnosis of autism and ten received a diagnosis of Asperger's syndrome (the mildest form of ASD). The remaining children received formal diagnoses of severe communication and language disorder, semantic-pragmatic disorder, or Pervasive Development Disorder- Not Otherwise Specified (PDD-NOS, another mild form of ASD). Because of the problem with diagnostic complexity and the considerable variability in language performance and comprehension in children with ASD and SLI, there have been very few studies concentrating on the similarities and differences in language acquisition and development in children with ASD compared to those with SLI. The current study is the first to examine the commonalities and differences between children with ASD and SLI in their abilities to use processes shown by young, typically developing children to acquire new words.

Overview of the Dissertation Sections

The introduction reviews previous research in language acquisition and development in young typically developing children, and in those with language impairments with ASD or SLI. Section 1 outlines cognitive theories of the processes young children use in the initial acquisition of novel words. Section 2 provides overview of the neurological processes that may be implicated in ASD and SLI. The acquisition of novel nouns by children with developmental disabilities is examined in Section 3 in terms of fast-mapping using semantic context and social word-learning skills (i.e. gaze-following). Section 4 summarizes the purpose and goals of the current investigation.

The dissertation research is presented in Chapter II and is divided into two experiments. Section 1 examines the use of semantic context by children with ASD and SLI (Experiment 1) to infer the meaning of novel words, and compares the results with previous studies of young typically developing children. Section 2 investigates the use of social context as provided through eye gaze by children with ASD and SLI (Experiment 2) to infer the meaning of novel words. Recall of the newly learned words is assessed after a 24-hour delay in both experiments. A comparison of the results for Experiment 1 and Experiment 2 is provided in Section 3.

Chapter III (General Discussion) explains the results of the studies as compared to previous research discussed in Section 1. Section 2 compares performance of the participants in this study with the typically developing toddlers in other studies of fast mapping and eye gaze. Section 3 includes recommendations on how the current results may impact future training and intervention for children with ASD and SLI. Sections 4and 5 conclude the dissertation with suggestions for future research and a brief summary.

I.1 Novel Word Acquisition by Typically Developing Children

Cognitive research has focused on fast mapping as one of the paradigms for language acquisition by children. Mapping is a process by which a child infers that an unfamiliar word can be attributed to an unfamiliar object or action based on a cue. Carey (1978) describes such mapping as the restructuring of the conceptual and lexical domains of the word with partial mapping (incorporation of a novel word) occurring rapidly, but with the full coordination of the conceptual and lexical domain occurring more slowly.

Carey and Bartlett (1978) examined the extent to which a novel word can be mapped onto a familiar conceptual domain. All the participants (three-year-olds) were able to use color words to refer to the correct colors. A new word labeled “chromium” (olive green) was presented to the participants across various conditions. The children varied in their mapping of a novel word to a color, with those children with prior experience with other color terms able to successfully map the word when given the instruction to “bring the chromium one, not the red one.” Carey (1978) noted that the instruction provided participants with syntactic and lexical cues in that chromium was a color word so that they could then use the contextual cues to appropriately infer the correct meaning of chromium.

In order to comprehend novel words, young children must limit, or prioritize, the method by which to incorporate new words into their correct domains (Markman, 1991). Two of the learning constraints proposed are the "whole object" constraint and the "taxonomic assumption." Initially infants apply a label to a whole-object, rather than to specific parts or another dimension of an object. Thereafter, an extension of the label can be given to another object because young children identify these objects through their common taxonomic class. Markman and Hutchinson (1984) refer to this as taxonomic assumption, and found that children identify novel words more readily through their taxonomic relation than through their thematic relation. For example, a monkey and a bear are taxonomically related because they are both animals, whereas a monkey and banana are thematically related because monkeys eat bananas. When no label is provided as a referent, children choose a thematic relation but when given a label they choose the taxonomic relation. The authors concluded that infants (around 18 months) use abstract meaning to constrain classification of a (whole-object) noun to a taxonomically related category resulting in the beginnings of rapid language acquisition (see also Graham & Poulin-Dubois, 1998; 1999; Welder & Graham, 2001).

The mutual exclusivity assumption maintains that young children of around 24 months old will label an object with one label alone (a one object-one label rule). According to Markman (1991), the mutual exclusivity assumption provides children with the necessary information to begin categorization. In a series of studies conducted by Markman and Wachtel (as cited in Markman, 1991) on labeling a familiar and unfamiliar object, the researchers found that young children use the whole-object, taxonomic assumption first to try to establish the meaning. The mutual exclusivity assumption is used when the child matches a novel label with a novel object, after rejecting that same label for the familiar object.

Whereas it seems that children are helped in early language acquisition by these constraints, these can also lead to problems. According to Markman (1991), conflicts between the whole-object, taxonomic and mutual exclusivity constraints are sometimes found in children's language repertoires. For example, Au and Glusman (1990) pointed out that children will suspend the mutual exclusivity assumption when the item comes from categories at different levels (such as animal and lemur) versus the same level (such as lemur and seal). Children also violate the mutual exclusivity assumption if provided contextual information that allows multiple labeling of the same object. For example, a child presented with a dog might respond "dog" if asked "Is this a cat?" while responding "animal" if asked "Is this a plant?" (Waxman and Hatch, 1992). In this way one object is labeled both as "dog" and "animal" thus overriding the mutual exclusivity assumption.

Clark (1983) proposes that words have different meanings (i.e., no synonyms) and, therefore, they cue identification of different concepts. This is similar to the concept of mutual exclusivity, yet allows some objects to have more than one label. For example, "Rover", "animal", and "beagle" can all refer to the same entity but each word carries a different meaning. As such, children will take a novel word presented by an adult and attempt to use the rules they are familiar with (conventionality) or contrast it with familiar words. That is, children will try to use a word to fill in a gap for a salient meaning. When children hear a new word, they will contrast the meaning of that word with the meanings of familiar words in the same domain. This proposal remedies some of the shortcomings of mutual exclusivity.

Another proposal for the rapid acquisition of words is semantic bootstrapping. Poulin-Dubois and Forbes (2002) states that it is semantic bootstrapping that is necessary for the fast mapping of verbs. Siskind (1996) describes an example of semantic bootstrapping as occurring when children first learn meanings of referent words so that they may categorize them before applying grammatical constraints. For example, a child maps nouns to things and verbs to events. Verbs provide information about an event in that they refer to a state or movement of an object over time. Children are thus able to fast map a novel verb to an activity based on the appearance of the action. For example, if an adult propelled an object and said the word "throw", the child would use the word "throw" the next time an object was propelled, but not when the arm motion was to hit.

As Carey and Bartlett (1977), and Poulin-Dubois and Forbes (2002) suggest, children use semantic context for comprehension of novel words, such as when lexical contrast is used. Echols (1992) found that labeling of an object (noun) or action (verb) to infants at 14-months old resulted in increased attending to the labeled stimuli. This implies that very young infants are sensitive to semantic context. However, syntactic information differs between nouns and verbs and this difference is not fully realized until later in development (Tomasello & Merriman, 1995).

Goodman, McDonough and Brown (1998) conducted a study to determine whether young children use semantic context to infer the meaning of a novel noun. Results indicated that two-year old children were able to map an unfamiliar noun based on information provided by a familiar verb when the sentence structure was simple (active-declarative sentence). That is, young children learn novel words when the context is understandable. For example, they presented the sentence, "Daddy drinks the mead" and then the child was asked to "Show me the mead" from one of four pictures. The children were able to select the correct picture at a significantly higher level than chance. Results indicated that children could map the novel noun to the appropriate novel object even though it was shown along with 3 other novel objects. They could do this based on their categorical knowledge that guided their recognition of which object was "drinkable." Goodman et al. further found that children were generally able to retain the novel word/referent mapping after a 24-hour delay for about 3 out of 4 novel nouns. Note that a correction procedure was used when the child did not respond correctly. The experimenter would point to the correct picture and say "Daddy drinks the mead. See this is the mead." This procedure used ostensive definition to correct word any learning errors, but the results suggested that this kind of information alone (pointing to the correct referent) was not particularly effective in guiding recall.

In a second experiment, Goodman et al. (1998) examined whether young children could match pictures of unfamiliar objects to actions using an imperative sentence, such as; "Show me something to drink." The children pointed to a picture from either a group of 4 novel or a group of 4 familiar pictured objects. Results indicated that the children were able to point correctly to both the unfamiliar and familiar objects at levels significantly greater than chance. These results show that very young children can use the meanings of verbs they know to infer the referent of a novel noun.

Young, typically developing children use a multitude of cues, including linguistic and social, to establish mappings between words and objects (Echols, 1992; Golinkoff, Hirsh-Pasek & Mervis, 1994; Graham, Nilsen & Nayer, 2007). Children use social cues provided via eye gaze as a means to fast map a novel noun onto its referent. Research has shown a positive correlation between infant monitoring of a speaker's gaze and that infant's comprehensive language at 18 months of age (Baldwin, 1993; Meltzoff & Brooks, 2007). That is, infants at 18 months are able to reliably map a new label onto the object the speaker is intent upon. Moreover, Baldwin (1993) showed that a speaker's gaze direction can override object salience as a cue for novel word learning in children as young as 24 months of age. More recently, the use of direction of eye gaze to infer the meaning of an unknown word has been investigated in children with autism and will be discussed below with the review of autism literature.

I.2 Neural Correlates in Language Acquisition

In typically developing young children, speech production and word comprehension are not localized in a single structure or region of the brain. Mills, Plunkett, Prat, and Schafer (2005) proposed that initially there are bilateral differences in auditory event-related potentials (ERPs) as infants are exposed to language. As these infants become familiar with a word, hemispheric specialization occurs. So in early language acquisition, there is a greater distribution across the brain to learn words, until the left hemisphere emerges as the area to process familiar and novel words. Bates, Thal, and Janowsky (1992) also note that synaptogenesis increases greatly between one to three years of age, and that language acquisition may not yet be localized in typically developing young children. Furthermore, the distribution of metabolic activity in various regions indicates that even in young children neural activity across many brain regions is found in language-learning tasks, followed by some localization in the frontal-parietal region (beginning around 8- to 10-months of age). Because there is wide distribution of activity across the brain associated with early language acquisition, many hypotheses have been proposed regarding the neural correlates that are implicated in the impaired language learning of children with ASD and SLI.

Just, Cherkassky, Keller, Kana, and Minshew (2007) examined cortical under-connectivity in high-functioning individuals with autism (IQ in normal range) through the use of fMRI. The participants in the study were children with ASD who were matched by IQ, chronological age, and gender with a control group of typically developing peers.

In both groups, the same areas of the cortex were activated in a language task. Nevertheless, Just et al. (2007) found differences between the two groups that indicated under-connectivity: The degree of synchronization between the frontal and parietal lobes in time series correlations differed between the two groups, and the size of the corpus callosum was reduced in the children with ASD in the area implicating frontal-parietal bilateral activity. Reduction in the size of the corpus callosum suggests that there is an overgrowth of white matter in the cortex that can, but does not always, lead to apraxia (Herbert et al. 2005). The implication of the corpus callosum as an area of brain difference in children with ASD is supported by the high prevalence of the co-morbid diagnosis of motor and speech apraxia in those diagnosed with ASD (see Ming, Brimacombe, & Wagner, 2007). The findings by Just et al. (2007) also suggest that children with ASD do not process early speech bilaterally as well as their typical peers in infancy due to connectivity issues across the brain hemispheres.

Furthermore, Just, Cherkassky, Keller, & Minshew, (2004) found that issues of connectivity have an effect on later development of language as well. In this study, adolescents with ASD participated in a language comprehension task and were compared to a control group of typically developing adolescents. The participants with autism compensated for deficiencies in comprehension with activation of basic cognitive processes more frequently in posterior brain regions (Wernicke's area) as compared to their typically developing peers where activation occurred more frequently in the frontal regions (Broca's area). Additionally, synchronization across both areas as measured through time series correlation was decreased in the adolescents with ASD. The findings of both studies by Just and colleagues (2004; 2007) indicate that a problem in connectivity across bilateral regions of the brain may result in impaired language acquisition early in development and compensation in other areas of the brain later in development as compared to typically developing individuals.

Courchesne (2001) suggested that differences between individuals with ASD and typical peers are not only based on underconnectivity in parts of the brain, but also abnormal brain volume in those with ASD. The findings indicate that the head circumference of many children with autism is larger than their typical counterparts early on. This may be due to overgrowth of white matter in the fusiform gyrus (an area used in face processing), the frontal lobes (critical for social stimuli processing), and the cerebellum. Some individuals with autism have shown decreased performance in facial expressiveness and face recognition tasks, and comprehension of facial expression, emotional expression, and social communication, which would implicate a decrement in the neural development within both the fusiform gyrus and the frontal lobes, among other regions of the brain.

Recently, there has been more published literature examining the neural correlates of language acquisition in typical children and children with developmental language disorders such as ASD and SLI (Just, Cherkassky, Keller, & Kana, 2007; Williams, Goldstein & Minshew, 2006; Whitehouse & Bishop, 2008). The research as cited supports the idea that differences between children with ASD or SLI and their typically developing peers may be due to delays in processing language cues. The difficulty in attending to social and communication cues due to increased processing time because of less synchronization presents challenges to acquiring novel words for individuals with ASD and SLI. Whitehouse and Bishop (2008) conducted a study to look at cerebral lateralization in a language-memory task with language-disordered adults, including a Typically Developing (TD) group, an SLI group, and an ASD group. The findings were that the ASD group more closely resembled the TD group in that activation occurred more in the left hemisphere. In contrast, the SLI group showed either more brain activation in the right hemisphere or else a more even bilateral distribution. These findings suggest that even though similar language impairment may exist in both children with SLI and ASD, there appears to be some differences in the processing of words by the two groups.

Additionally, neuropsychological research in memory functions suggests that even though there are differences in the spatial organization of working memory in individuals with autism, semantic encoding and other measures of verbal working memory are not deficient in children with autism (Williams, Goldstein & Minshew, 2006; Whitehouse, Maybery & Durkin, 2007). In the past, memory dysfunction had been hypothesized as the basis for the social and language impairments of individuals with autism (Boucher, 2007; Tager-Flusberg, 1991). Furthermore, it had been hypothesized that individuals with autism have difficulty in recalling stimuli that share a common semantic trait, and that poor performance is a result of semantic encoding difficulties (Tager-Flusberg, 1991).

Whitehouse, Maybery and Durkin (2007) examined semantic versus phonetic encoding using a recall procedure for typical adolescents and those with autism. Results indicated that both groups performed better with semantic than phonological cues, and that there was no significant difference between the two groups. Whitehouse et al. (2007) concluded that there may be an age difference in acquisition of semantic encoding skills, suggesting a quantitative delay rather than a difference in the processes involved of acquiring language in that those with autism may attend to semantic information provided by verbal stimuli at similar levels to their mental-age matched typically developing peers. The conclusions drawn by Whitehouse et al. (2007) are further supported by Williams, Goldstein and Minshew(2006) who found that when comparing older children and adolescents with autism to age-matched typical peers, poor memory was found for complex visual and verbal information, but not for associative learning ability or verbal recognition.. So it would appear that some memory problems are apparent.

In contrast to individuals with autism, Whitehouse & Bishop (2008) maintain that verbal working memory, particularly phonological perception, is impaired in individuals with SLI. Lum, Gelgic, & Conti-Ramsden (2010) also found that children with SLI performed more poorly on verbal memory tasks as compared to age-matched peers than on visual memory tasks, using a Serial Response Time paradigm.

Neuropsychological research suggests that there are some differences in the way that individuals with ASD and SLI process linguistic information as compared to typically developing individuals, but there also may be differences in language processing that distinguishes ASD from SLI. Specifically, the processing of social cues, rather than semantic cues, may be impaired in ASD, while memory is implicated in SLI.

I.3Novel Word Acquisition by Children with Language Impairment

Studies examining the language deficits of children with developmental disabilities, including those with autism spectrum disorder (ASD), mental retardation (MR), and specific-language impairment (SLI), have often been comparative in nature. That is, comparisons of language acquisition in typically developing children with children with developmental disabilities have yielded some information about notable differences.

Charman, Baron-Cohen, Swettenham, Baird, Drew & Cox, (2003) attributed language delays in individuals with ASD to more global problems in understanding the social and communicative cues present in the environment. The authors examined longitudinal correlations between language outcomes in preschool ASD children and their early social-communication deficits. They found positive correlations among language acquisition, imitation and joint attention performance, but not with play and goal-directed behaviors. Results suggested that language acquisition in children with ASD may be associated with early social-communicative development, rather than an existing separate deficit. Results of the Charman et al. (2003) study further indicates that language acquisition in children with ASD may be delayed, but also may be qualitatively impaired.

Nevertheless, the method by which children with developmental disabilities, particularly those with ASD, acquire novel words requires further examination. McDuffie, Yoder, & Stone (2006) examined fast mapping in children with autism in the context of following an adult's attention focus. An unknown wooden object ("modi") was labeled for the participants (mental ages under four years old) with ASD. The children were then asked to "show the modi" when another unknown object was presented. Attending was measured by average latency before first looking at the target object. The authors found that there was considerable variability in attending to the objects, but those participants with a shorter latency fast-mapped accurately, while the other participants were less accurate.

As evidenced by McDuffie et al. (2006), children with ASD can use a fast-mapping process to acquire novel nouns, as do their typical peers. This study indicates that the deficit for children with ASD is not necessarily in language acquisition itself, but in the prerequisite skills necessary to attend to referents. Preissler and Carey (2005) further examined the issue of referential intent in novel word acquisition by examining children with ASD. They asked whether a speaker's intent provides the constraints necessary to be able to map a novel word when there is ambiguity in referential conditions. Preissler and Carey (2005) found that children with ASD were able to map novel words to objects to the same degree as typically developing two-year-olds under the condition that the participants are looking at the object. Yet the participants with ASD exhibited a deficit in monitoring the speaker's intent when the speaker was holding the labeled object while at the same time the participant was holding a different object. As in McDuffie et al. (2006), the language-learning deficit can be attributed to other social-communicative issues found in ASD.

Other studies on the ability to use social cues to learn the meaning of a novel word have also concentrated on children with autism (Baron-Cohen et al. 1995, 1997; Parrish-Morris, Hennon, Hirsh-Pasek, Golinkoff & Tager-Flusberg, 2007). The findings of these studies suggest that children with autism are capable of learning the meaning of a novel word when they themselves are attending to a particular referent. However, the aforementioned studies also conclude that children with autism, even those who are high-functioning, have greater difficulty in monitoring speaker's intent through gaze cues and using these social cues to map novel words to novel objects. That is, even in children with autism who have the cognitive ability to orient and attend to a shift in gaze direction there may still be difficulties in attending to the speaker's intentions though monitoring the speaker's eye gaze (Chawarska, Klim & Volkmar, 2003).

Little research has been conducted on how children with SLI use social cues to learn the meaning of a novel word, however, in contrast to those with ASD, pragmatic language has not been found to be a problem in children with SLI (Gray, 2003) and their social development appears to be typical. Eyer and Leonard (2001) investigated the ability to assign nonsense words to novel actions in preschool children with SLI, as compared to their younger but typically developing peers. When the figure performing the action was known, there was no difference in performance in fast-mapping a novel verb. When only morpho-syntactic cues were provided, both groups of children were able to identify a novel object, but not a novel action. The authors concluded that morpho-syntactic context may not be sufficient to acquire a novel verb for both typically developing and children with developmental disabilities (see Fisher, 2002). McDonough and Goodman (1995), who also provided two-year-olds with syntactic cues, showed fast mapping of verbs. The salient cue the children used that more likely guided their performance, however, was object category knowledge.

Mixed results have also been found regarding impaired memory function in individuals with ASD and its subsequent effect on language acquisition and communication in that some studies show memory deficits and others do not (Boucher & Lewis, 1981; Minshew & Goldstein, 1993; McDonough, Stahmer, Schreibman & Thompson, 1997). For individuals with SLI, there appears to be a decrement in performance on working memory language tasks (Riccio, Cash, & Cohen, 2007). Because of the mixed results in evaluating the abilities and differences in language tasks, including those related to memory, and neuropsychological studies of the brain of children with autism or SLI, some researchers have concluded that the disorders should be considered as having overlapping phenotypes (Tager-Flusberg, 1991; Kjelgaard & Tager-Flusberg, 2001). Other researchers suggest that there is enough dissimilarity that there is not a common etiology for ASD and SLI (Charman et al. 2008; Whitehouse & Bishop, 2008). Nevertheless, no study has compared children with ASD or SLI who have successfully developed age-appropriate vocabulary to understand if the underlying processes thought to be used by typically-developing toddlers in acquiring language are also used by those with ASD and/or SLI. Additionally, no study has been conducted to examine the extent to which children with ASD or SLI retain the meanings of words once inferences are made.

I.4 Purpose of this Dissertation

The purpose of the present research is to examine the process of fast mapping in children with ASD or SLI by addressing the following questions: (1) Do children with ASD and children with SLI have the same difficulties in acquiring new words?; (2) Can these children use semantic context to infer the referent of a novel noun?; (3) Do these children differ in their use of eye gaze to make inferences about the referent of a novel noun; (4) Can these children recall their inferences after a 24-hour delay?

The results of this study are noteworthy for several reasons. First, although we know that children with ASD or SLI are able to engage in some forms of fast mapping, we do not know whether children with ASD or SLI with age-appropriate vocabulary may have acquired their vocabularies by using either semantic or social context, or both, to infer meaning. Second, monitoring of referential intent has been suggested as one of the reasons that children with ASD have difficulty acquiring language. But little is known about the differences between children with ASD and children with SLI as far as attending to social-pragmatic cues. Third, retention of novel words by children with ASD and children with SLI will be assessed as a critical aspect of vocabulary acquisition in this study. Poor recognition and recall of words has already been implicated in the SLI

(Whitehouse & Bishop, 2008). The recall of novel words learned through fast mapping has been examined in typically developing young children (Goodman, McDonough & Brown, 1998), but not in children with ASD or SLI.

CHAPTER II. DISSERTATION STUDY

Method

Participants and Setting

Twelve children, two girls and ten boys, were participants in this study. All were students in a pre-school, self-contained classroom for young children with five children having language delays and/or processing issues assessed as Specific Language Impairment (SLI), and seven children having been classified as having Autism Spectrum Disorder (ASD) prior to entry in the school. The mean chronological age of the participants was 4 years, 6 months (*range* 3; 6 -5; 6), with the participants with ASD (M = 4; 6, *range* 3; 6 – 5; 5) having the same mean age as the participants with SLI (M = 4;6, *range* 3; 7 – 5; 5). The experimenter was naïve to the participants' diagnostic information until after the data from both experiments had been collected.

The classroom was located within a private preschool designed for working with children who have developmental disabilities, with the goal of allowing them to mainstream into an integrated classroom when appropriate. Requirements for inclusion in this classroom were receptive and some expressive language skills. All of the participants exhibited these prerequisite skills upon observation, although some were more verbal than others.

Assessment

To assess vocabulary comprehension as well as to assure that each participant was able to follow directions given by the experimenter to select a picture, the Peabody Picture Vocabulary Test-Version III (PPVT-III) was administered prior to initiation of the study. The PPVT-III was used to test language comprehension by showing the child a page with 4 pictures on it and asking the child to point to or place a colored block on the correct item after a label was verbally presented. The number of correct responses was then scored. Both a norm score (standardized M = 100), and a developmental age-equivalent score were then derived from the raw score for each child.

The norm scores for the PPVT-III tests ranged from 79 to 110, with 9 participants under the average and 3 above. All the participants had a developmental age-equivalent for receptive language within a year plus or minus their chronological age (Table 1). The PPVT-III norm scores for the children diagnosed with ASD ranged from 92 to 110, while the scores for the children with SLI ranged from 79 to 97. The PPVT-III scores indicated that the children were within the range for receptive vocabulary necessary to participate in this study, and were able to follow the instructions to select a picture from a set of four, a procedure similar to the one followed in the present experiments. Nevertheless, the children with ASD had slightly higher scores than did the children with SLI. That is, even though the mean chronological age was the same for the participants with ASD in comparison to their peers with SLI, the participants with ASD had slightly better receptive vocabulary as indicated by the higher age-equivalent mean.

Table 1. Demographic Information and PPVT-III Assessment Scores

Participant	**Age**	**PPVT-score**	**Age-equivalent**
ASD			
1	4;6	92	3;.11
2	3;6	105	3;11
3	4;1	86	2;.9
4	4;5	110	5;3
5	5;5	94	4;11
6	5;1	109	5;9
7	4;9	93	4;1
MEAN	4;64	98.4	4;1
SLI			
8	4;5	84	3;9
9	3;7	91	2;9
10	5;5	79	3;7
11	5;5	86	4;6
12	4	97	3;11
MEAN	4;61	87.4	3;6
Overall Means	4;6	93.8	3;9

Informed consent was obtained from a parent of each participant. Assent was obtained from each participant prior to entry into the testing room for each session across all experiments, and was monitored during the session to make certain the children were comfortable and readily cooperative. All participants complied with the instructions for all sessions.

General Setting and Materials

All experimental sessions were conducted during the morning in a conference room across from the children's educational classroom. This room contained a short semi-circle shaped table with a small chair for the participant. The experimenter sat in a larger chair directly across from the participant. An independent coder sat behind and to the side of the participant in order to prevent interference with the session. Each session lasted for a maximum of 15 minutes. Testing of the participants occurred over a six-week period of time.

Three sets of stimuli used for this study were specifically designed to examine the abilities of preschool children with ASD or SLI to: (1) use the semantic context of a familiar verb to infer the referent of a familiar or novel noun; (2) use eye gaze to infer the referent of a familiar or novel noun; and (3) recall the previously inferred novel nouns after a 24-hour delay using a new array of pictures. The stimuli consisted of pictures of referents to four words, presented in quadrants on a page encased in plastic. Each page depicted 4 objects that were either familiar or novel to the participants. Prior to initiation of the study, the classroom teacher completed a checklist containing familiar and novel nouns and indicated whether the participants knew the label of the objects. The stimuli were adjusted and arranged in familiar or novel groupings according to the checklist.

Participants were asked either to point to or put a colored block on the picture of the object appropriate for a sentence. The reason the block was sometimes used in lieu of the gestural point was that some children with developmental delays exhibit fine-motor skill deficits. Also, the study participants were aware of the opportunity to use the block to indicate a picture because it had been used when conducting the preliminary PPVT-III testing.

An independent coder scored the participant's performance by indicating the first item selected. If the participant selected more than one picture, the coder scored the first and second responses and the order of their selection.

II.1. EXPERIMENT 1: Inferences and recall using semantic context

Experiment 1 examines whether pre-school children who have ASD or SLI are able to use semantic context to infer the referent of a novel noun, as do typically developing toddlers. Because the participants in the study have acquired a developmentally appropriate comprehensive vocabulary as gauged by the PPVT-III scores, it was expected that verbal cues to the meaning of a novel word would be salient for these participants. This first experiment follows a similar procedure used by Goodman, McDonough and Brown (1995) that assessed the abilities of 24- to 30- month olds to infer the referent of a novel noun based on a known verb and recall it after a 24-hour delay.

Procedures

In this inference task, eight active-declarative sentences were constructed with a familiar subject noun as agent (e.g., Daddy), and a familiar, transitive verb to denote an action that constrains the referent to the object noun (e.g., eats [a food item]). The constraining verbs were originally selected based on published reports of children's early words (Thorndike & Lorge, 1944) and used by Goodman et al. (1998). Each child participated in two test conditions. In the Familiar Noun condition, pictures of four familiar objects were displayed in quadrants on a page (e.g., apple, bicycle, newspaper, pencil). The experimenter presented an incomplete active-declarative sentence, such as "Daddy eats the_____," and the participant was asked to select the picture of the object that best completes the sentence (i.e., apple). In the Novel Noun condition, pictures of four atypical objects were displayed in quadrants on a page (e.g., artichoke, sloth, stein, and chandelier). The experimenter presented an active-declarative sentence (e.g., "Daddy eats an artichoke"), after which the participant was asked to select the picture of the novel object word with a verbal instruction (i.e., "Show me the artichoke.") A list of the stimuli is provided in Table 2. Target pictures were randomized such that they appeared in each of the four quadrants equally often across trials.

Table 2. Stimuli for Experiment 1 inference and recall

A. Familiar Inference Condition

Verb	**TARGET**	**DISTRACTOR 1**	**DISTRACTOR 2**	**DISTRACTOR 3**
Eats	Banana	Ball	Flower	Lamp
Reads	Book	Bike	Bird	Banana
Wears	Shoes	Book	Flower	Cat
Opens	Door	Juice	Lamp	Teddy bear
Drinks	Juice	Apple	Pig	Ball
Rides	Car	Key	Hammer	Cat
Feeds	Pig	Teddy bear	Juice	Hammer
Pets	Cat	Banana	Car	Key

B. Novel Inference Condition

Verb	**TARGET**	**DISTRACTOR 1**	**DISTRACTOR 2**	**DISTRACTOR 3**
Feeds	Sloth	Windmill	Pogo stick	Lasso
Rides	Metro	Sawhorse	Ornament	Vise
Pets	Ferret	Bagpipes	Stirrup	Crater
Drinks	Mead	Snowshoe	Sabot	Hook
Wears	Cape	Sputnik	Microscope	Besom
Eats	Artichoke	Sloth	Stein	Chandelier
Opens	Stein	Crutch	Scythe	Hurdle
Reads	Scroll	Hasp	Mead	Sloth

C. Recall Condition

TARGET	**DISTRACTOR 1**	**DISTRACTOR 2**	**DISTRACTOR 3**
Metro	Stein	Hasp	Sawhorse
Sloth	Cape	Lasso	Horseshoe
Cape	Ferret	Sputnik	Candelabra
Ferret	Stein	Hasp	Stirrup
Scroll	Mead	Chandelier	Hingelock
Artichoke	Metro	Urn	Clamp

Half of the participants received the Novel Noun condition first followed by the Familiar Noun condition. The order of presentation was reversed for the other half of the participants. During each session, the sentences containing the eight different verbs per experimental condition were presented using a counterbalanced design. For example, in the first part of the session, four familiar nouns were tested with four verbs and then four novel nouns were tested with the remaining 4 verbs. A short play period of approximately 5 minutes with a "Lite Brite" toy was provided after 8 trials to reinforce appropriate responding (i.e., indicating a choice via gestural point or placement of a block on a picture), regardless of whether or not the choices were correct. During the second half of the session, the four other familiar and novel nouns were presented with the same verbs but with reversed pairings (e.g., "eats" was used with a novel noun in the first half of the session and then eats was used with a familiar noun in the second half of the session).

At the end of each selection, if the participant indicated the correct picture, the experimenter would say for example, "Great job, Daddy eats the artichoke, that is the artichoke!" if the participant indicated the correct picture. Given that children with ASD or SLI sometimes have shorter attention spans and may respond impulsively without looking at all the pictures presented, a correction procedure was used if an incorrect response was made. For example, the experimenter would say "Oops, listen again, Daddy eats the artichoke." After a delay of 10 seconds to provide sufficient time for the participant to look again at the pictures, the participant was then asked to point or put the block on that picture. A correct response was reinforced with the statement, "That's right. That is the artichoke." If after two trials with the same target, the participant was unable to fast map the label onto its referent, the experimenter provided additional information and feedback as to the correct response, by saying "Daddy eats the artichoke. This is the artichoke" and pointing to the correct picture (i.e., an ostensive definition was given). The experimenter then moved to the next trial item.

Scoring was conducted on line by the experimenter and a second coder. Inter-coder reliability was 100%.

As in Goodman et al. (1998), recall of the novel words was assessed after a 24-hour delay. The goal of this component of Experiment 1 was to examine the extent to which children with language processing delays due to ASD or SLI can retain the mappings between novel words and their referents over time. The six target words that resulted in the best overall performance by most of the participants were selected from the Novel Noun Inference condition and presented to the participants the next day. Six words were selected because young children have great difficulty in recalling more than 3 out of 4 novel words after a 24-hour delay (Goodman et al., 1998).

For each memory trial, four pictures were presented to the participants in a different combination and position than presented previously. Each presentation included: the target picture in a different quadrant than the previous day; a distractor of another target item previously presented in Experiment 1; a second distractor that was previously presented in Experiment 1 but not paired with the target item; and a completely novel picture (See Table 2). As such, the test items were in a different location and contextual surround than they were on the previous day. The participants were given 6 verbal statements containing each one of the 6 novel nouns, but without the identifying verbs. For example, the participants were requested to “Show me the artichoke” and would then be asked to select a picture. The order of the presentation of the six novel nouns was counterbalanced. As in the inference task, participants were allowed two opportunities to select the correct picture. For both the inference and recall tasks, coding was conducted in the same manner. Inter-coder reliability was 100%.

Results and Discussion

Accuracy of Inferences and Recall of Novel Words

We conducted t-tests to determine the accuracy of the participants’ inferences for first choice data and compared to chance (p=.25, or 1 opportunity out of 4 to make a correct choice). If the participants understood the meaning of the verbs, performance on the Familiar Noun condition should have exceeded chance. Had the participants not been able to use the constraining verbs appropriately with familiar objects, one would expect that the participants would also have difficulty using the verbs to infer which of the novel objects were the correct referents. We also would expect that there would be a decrement in performance during the recall condition as forgetting happens.

The mean number of correct first choices for the Familiar Noun condition was 7.0 (out of 8); SE =.35. The participants selected the correct choice at a significantly higher level than expected by chance, $t(11) = 14.36$, $p < .01$. The results indicated that the participants were familiar with the verbs. In the Novel Noun condition, the mean number of correct first choices was 5.4 (out of 8); SE =.40. Again, the participants selected the correct choice at a level significantly higher than chance, t (11) = 8.58, $p < .01$. The participants were able to infer the referent of the novel labels for objects based on the semantic context provided by the familiar, constraining verbs.

It would be expected that if the participants were able on their first opportunity to select the correct picture, the first and second choices combined would occur at a level significantly higher than chance as well ($p = 0.5$, with 2 out of 4 opportunities on 8 trials). As expected, the results mirrored the first choice alone data, in that the participants selected the correct pictures at a significantly higher level than chance for the Familiar Noun condition; M = 7.4; SE = .19; t (11) = 28.07, $p < .01$. For the Novel Noun condition, results also mirrored first choice alone data; M = 7.2; SE = .24; t (11) =4.70, $p < .01$.

In the Recall condition tested after the 24-hour delay, the mean number of correct first choices was 4.5 (out of 6 trials); SE = .23. The participants selected the correct picture at a rate higher than expected by chance, t (11) = 7.42, $p < .01$. The results when examining first and second choice data again mirror the first choice alone data: M= 5.2; SE = 0.37; t (11) =21.44 $p < .01$. These results indicate that the participants were able to retain the meaning of the novel label after 24 hours, even without presentation of the constraining verb.

Comparison of Performance between Conditions

We then conducted t-tests to determine if significant differences in performance exist between the Familiar Noun and Novel Noun conditions. Recall that the presentation of the familiar object label and novel object label differed between the conditions: For the familiar noun, there was an open-ended, fill-in condition requiring the understanding of the verb, while a full statement was presented for the novel noun. The cognitive requirements were different for the two conditions in that under the Familiar Noun condition, the verb "eats" indicated the food item, while in the Novel Noun condition, the participant had to access the verb "eats" and actively apply it to make a correct inference for a specific food item with an unfamiliar label. In this condition, the participant also needed to recognize an unfamiliar item in terms of the category to which it belongs.

The mean number of correct first choices under the Familiar Noun condition was 7.0, and under the Novel Noun condition was 5.4. A significant difference was found between the performance under the two conditions; $t(11) = 3.17, p < .05$. These results support the argument that even when the verbs are familiar, the participants either sometimes fail to use the meaning of the verb to infer the referent of the novel noun, had some difficulty with the novel pictures or their categorical knowledge was limited.

To assess whether the order of task presentation had an effect on performance, a repeated measures Analysis of Variance (ANOVA) was conducted, with order of presentation as the between-subjects factor and task condition (familiar/novel) as the within-subjects factors. No significant main effect was found; F (1, 10) = 1.1, $p > .05$, nor a significant interaction; F (1,10) = .06, $p > .05$. zx

In order to compare the novel inference condition and the recall condition, proportional means were used (Table 3.) The recall task was a subset of the novel inference condition in that of the 8 trials for novel inference, only 6 were selected for the recall task. No significant differences were found in the novel inference versus recall conditions using proportional means; t (11) = -1.16, $p > .05$.

Table 3. Descriptive Statistics and Proportional Means for Novel Inference and Recall in Experiment 1

Type	Condition	M	SE	Percentage
Overall	Novel Inference	5.4 (out of 8)	.40	65%
	Recall	4.5 (out of 6)	.33	75%

It was expected that performance on the PPVT-III as a measure of acquired receptive vocabulary would be a good indicator of the ability to perform fast-mapping. Pearson product-moment correlation coefficients were computed between the PPVT-III standardized scores and the novel inference condition; r = .225, $p > .05$. These findings indicate that PPVT-III scores were not indicative of the ability to make novel inferences, but recall that there was not great variability in standardized scores on the PPVT-III as all the participants performed at or close to the mean of 100.

An item analysis was also conducted to determine if there were performance differences with any of the items under each of the conditions. No significant differences were found among the verb/noun combinations under the three conditions.

Performance of Participants with ASD Compared With Participants with SLI

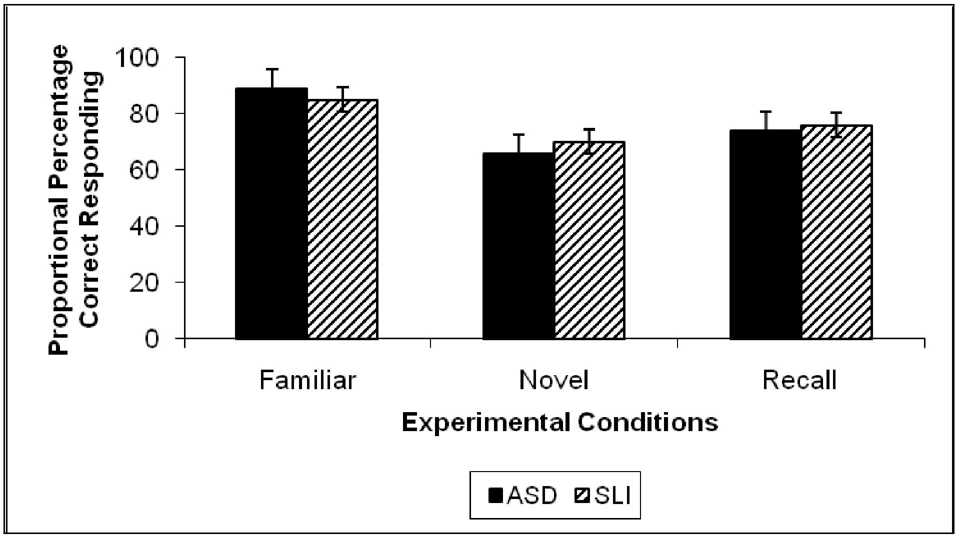
After the data were collected, the diagnosis of each participant was provided to the experimenter. Further analyses were conducted to compare the abilities or differences between the children with ASD and the children with SLI to use semantic context. A repeated measures Analysis of Variance was conducted, with diagnostic classification of ASD or SLI as the between-group factor. Familiar versus Novel inference and Novel inference versus Recall (Table 4) were the within-subject factors. As a reminder, we did not test recall for the familiar test condition because we intentionally used items for which the children already knew the labels. No significant differences were found based on the classification of ASD or SLI; $F(1, 10) = 2.3$, $p > .05$.

Table 4. ***Descriptive Statistics and Proportional Means based on Diagnostic Classification of ASD or SLI***

Type	Condition	M	SE	Percentage
ASD	Familiar Inference	7.1 (out of 8)	.69	89%
	Novel Inference	5.3 (out of 8)	.47	66%
	Recall	4.4 (out of 6)	.48	74%
SLI	Familiar Inference	6.8 (out of 8)	1.8	85%
	Novel Inference	5.6 (out of 8)	.75	70%
	Recall	4.6 (out of 6)	.51	76%

The percentage of correct responding in the inference conditions (out of 8 trials) and in the recall condition (out of 6 trials) indicate that performance for the participants with ASD and the participants with SLI was highly similar (Figure 1.).

Figure 1. Percentage of Correct Responses by children with ASD and children with SLI in Experiment 1.



If the participants made a correct inference during Experiment 1, they were likely to retain the meaning of the word over a 24-hour period. These results suggest that making a correct inference provides linguistic information to children with ASD or SLI and that this information is retained for at least a period of 24 hours. If the participant did not make a correct inference with two opportunities, an ostensive definition was provided. Nevertheless, even when an ostensive definition was given when an incorrect inference was made, it was not sufficient to predict recall.

In summary, the results of Experiment 1 indicate that children with ASD or SLI can develop vocabulary through the process of fast-mapping. Semantic context provides information to children with language impairments and helps them increase their vocabulary. Moreover, children with ASD and SLI are able to recall the meaning of the novel nouns after a delay, even without the supporting information provided by semantic context.

II.2 EXPERIMENT 2: Inferences and recall using social context

The main finding of Experiment 1 is that children with ASD and SLI both are clearly able to use familiar verbs to infer the referents of novel nouns. But is using semantic context sufficient to explain the development of the preschool-age vocabulary of the participants as assessed through the PPVT-III? One assumption is that young children with language and/or processing delays or with ASD in particular have difficulties in being able to monitor the eye gaze of others in order to evaluate their intentions. This view is based on research showing that use of eye gaze to interpret social intentions allows children to more effectively monitor what a speaker is talking about, which in turn aids in the acquisition of language (Baldwin, 1993; Brooks and Meltzoff, 2005).

The findings of Preissler and Carey (2005), using a different fast mapping context than in the present experiment, show that children with ASD can use semantic context to fast map a novel word to an appropriate referent, but they have difficulties following the gaze of a speaker to infer which object the speaker is labeling (see also McDuffie, et al. 2006; Baron-Cohen, et al. 1997). Yet, when one considers that both groups of children tested in Experiment 1 have similar vocabularies, one wonders if their abilities to use eye gaze as a social cue to the referent of an unknown word are similar. One possibility is that both groups have language delays but these delays are due to poor use of eye gaze strategies. That is, eye gaze works but just not as well or not as often as it does for typically developing children. To date, we do not have data on the use of eye gaze for children with SLI. Alternatively, the children with SLI may be quite adept at using eye gaze while those with ASD are not, and the problems these two groups have with language acquisition are different possibly due to encoding or memory problems. That is, children with ASD have difficulties using social cues to infer the meaning of a novel word (as found in previous research) but can use other cues to learn language and children with SLI can make the appropriate inferences using eye gaze but may have difficulties remembering what they had previously inferred. In fact, it is not clear how effective eye gaze is in the long run for vocabulary building as this has not been tested. Another consideration is that it is possible that children whose social skills are typically compromised (such as those with ASD) may have improved their skills as a result of learning language itself. Although we often think of eye gaze and joint attention skills as precursors to language acquisition as has been clearly shown in typically developing children (Graham, Nilsen & Nayer, 2007), it is also possible that the result of learning language and using it (a social act itself), may increase children's abilities to use a cue such as eye gaze. That is, the relation between eye gaze and language acquisition may be bi-directional; improvement in one skill leads to improvement in the other.

Experiment 2 examined whether children with ASD and SLI who have developed age-norm vocabularies use eye gaze to assist in an appropriate inference of the meaning of a novel label. Furthermore, we examined whether the children with ASD and SLI are able to retain the meanings of the novel nouns after a 24-hour delay.

Procedure

The procedure used is similar to that used by Baron-Cohen et al. (1995) to monitor referential intent in children with autism. Five simulated faces on Styrofoam plates with eye gaze in different directions to point towards the target word, but identical in all other respects, were drawn. The face plates consisted of an introductory face with eyes fixed centrally and four additional faces with eyes looking in four diagonal directions: up-left, up-right, down-left, and down-right. Participants were introduced to the face with the eyes fixed centrally and the statement “This is our friend Sulley. Sulley likes to look at pictures. Let’s look at pictures with Sulley.”

Similar to Experiment 1, eight active-declarative sentences were constructed for the two inference test conditions: Novel Noun and Familiar Noun. The eight sentences for each condition all used Sulley as the agent and contained a familiar verb to denote an action that did NOT constrain the referent to the object noun (e.g., to make). The verbs used in Experiment 2 could have referred to any of the four pictures, thus causing the child to have to refer to another cue, in this case direction of eye gaze to infer the referent of the novel word. As in Experiment 1, verbs were selected based on published reports of children’s early words (Thorndike & Lorge, 1944). A list of the stimuli is displayed in Table 5.

Table 5. Stimuli for Experiment 2 inference and recall:

A. Familiar Inference Condition

Verb	**TARGET**	**DISTRACTOR 1**	**DISTRACTOR 2**	**DISTRACTOR 3**
Takes	Bread	Camel	Purse	Plant
Makes	Bed	Popcorn	Cake	Garbage
Needs	Ladder	Award	Dinosaur	Gloves
Plays	Drums	Broom	Bird	Rope
Holds	Broom	Ladder	Scissors	Sausage
Wants	Plant	Cookies	Flower	Bed
Brings	Gloves	Apples	Drums	Bread
Likes	Puppy	Hotdog	Guitar	Vase

B. Novel Inference Condition

Verb	**TARGET**	**DISTRACTOR 1**	**DISTRACTOR 2**	**DISTRACTOR 3**
Holds	Transistor	Anchor	Crank	Accordion
Wants	Draperies	Compass	Gazebo	Banjo
Brings	Confection	Caribou	Bouquet	Mallet
Likes	Opossum	Megaphone	Gear	Harp
Takes	Compass	Hook	Confection	Funnel
Makes	Bouquet	Breaker	Mosaic	Stitching
Needs	Megaphone	Observatory	Pedal	Mandolin
Plays	Accordion	Drillbit	Anteater	Draperies

C. Recall Condition

TARGET	**DISTRACTOR 1**	**DISTRACTOR 2**	**DISTRACTOR 3**
Confection	Draperies	Caribou	Nozzle
Accordion	Compass	Drillbit	Whisk
Bouquet	Megaphone	Mosaic	Ladle
Opossum	Transistor	Gear	Spatula
Draperies	Confection	Funnel	Tongs
Compass	Accordion	Gazebo	Jackal

Also as in Experiment 1, pictures of objects were displayed in four quadrants but on a larger poster page, with a space between the quadrants to put the face in the middle. In the Familiar Noun condition, pictures of four familiar objects were displayed in the quadrants on the poster page (e.g., bed, popcorn, cake, garbage). The experimenter placed the face whose eye gaze pointed in the direction of the target word in the center of the quadrants on the poster page and presented an incomplete sentence, such as "Sulley makes the ____". The participant was asked to select the picture that best completed the sentence. The correct choice was the picture in the directional gaze of Sulley's eyes, although the participants were not provided explicit directions to look at Sulley's eyes. In the Novel Noun condition, pictures of four atypical objects were displayed in quadrants on the poster page (e.g., bouquet, mosaic, stitching, breaker). The experimenter provided the active-declarative statement for example, "Sulley makes the bouquet," after which the participant was asked to select the picture of the novel object word (i.e., "Show me the bouquet.").

Half of the participants received the Novel Noun condition first followed by the Familiar Noun condition. The order of presentation was reversed for the remaining participants. During each session, the sentences containing the eight different verbs were presented using a counterbalanced design. For example, in the first part of the session, four familiar nouns were tested with four verbs and four novel nouns were tested with the other four verbs. A short play period of approximately 5 minutes with a "Lite Brite" toy was provided after 8 trials to reinforce appropriate responding (i.e., indicating a choice via gestural point or placing the block on one picture). During the second half of the session, the four other familiar and novel nouns were presented with the same 8 verbs but with reversed pairings (e.g., "makes" was used with a novel noun in the first half of the session and with a familiar noun in the second half of the session).

At the end of each correct selection, the experimenter would say, "That's right, Sulley makes the bouquet. That is the bouquet," if the participant selected the correct picture. As in Experiment 1, a correction procedure was used if the participant made an incorrect response. The experimenter would repeat the statement initially made. For example, "Sulley makes the bouquet. Show me the bouquet." The intonation was placed on the agent Sulley. If after two trials with the same target, the participant was unable to use the eye gaze correctly to infer the referent of the familiar or novel noun, the experimenter provided additional information and feedback as to the correct response., by saying "Oops, listen again. Sulley makes the bouquet" while pointing to the appropriate picture (i.e., an ostensive definition was given). The experimenter then moved to the next trial item.

Recall of the novel words was assessed after a 24-hour delay. The goal of the present experiment was to examine the extent to which children with ASD or SLI can retain the mappings between novel words and their referents over time. The six target words that resulted in the best performance were selected from the Novel Noun condition in Experiment 2 and presented to the participants the next day. For each recall trial, four pictures were presented to the participants in a different combination and position than presented during the inference task. The "Sulley" face was not placed in the center of the pictures for the recall test. Each presentation included: the target picture in a different quadrant than the previous day; a distractor of another target item previously presented in Experiment 2; a second distractor that was previously presented in Experiment 2 but not paired with the target item; and a completely novel picture (See Table 5). As such, the test items were in a different location and contextual surround than they were on the previous day.

The participants were given a verbal statement containing the six novel nouns, but without the previously used verbs. For example, the participants were given the statement "Show me the bouquet" and were asked to select a picture. Presentation of the 6 novel nouns was counterbalanced.

As in the inference task, participants were allowed two opportunities to select the correct picture. For both the inference and recall tasks, coding was conducted in the same manner. Inter-coder reliability was 100%.

Results and Discussion

Accuracy of Inferences and Recall

As in Experiment 1, we conducted t-tests to determine the accuracy of the participants' inferences for first choice data against chance expectation (p =. 25, or 1 opportunity out of 4). If the participants monitored the eye gaze of "Sulley", performance on both the Familiar Noun and Novel Noun conditions should exceed chance. Had the participants not been following the eye gaze of the agent (Sulley), it would be expected that the participant would randomly select any of the four pictures, as the non-constraining verb provided no valuable linguistic information. That is, the non-constraining verb could apply to any of the four pictures. The only relevant cue was the eye gaze direction of the agent.

The mean number of correct first choices for the Familiar Noun condition was 4.6 (out of 8); SE= .51, with the participants selecting the correct choice at a significantly greater level than expected by chance, $t(11) = 5.02$, $p < .05$. The results indicate that the participants were able to select the correct picture by following eye gaze, rather than simply making a random selection. In the Novel Noun condition, the mean number of correct first choices was 4.5 (out of 8); SE = .70, with the participants selecting the correct choice at a level significantly greater than chance, $t(11) = 3.56$, $p < .05$. Again, the participants followed the eye gaze information provided by the agent and mapped the novel noun to its referent rather than randomly selecting one of the four pictures.

When examining first and second choices combined, the results mirrored the first choice alone data, in that the participants selected the correct picture at a significantly greater level than that expected by chance, M = 6.1; SE = .42; $t(11) = 13.44$, $p < .05$ for the Novel Noun condition, and M = 5.75; SE = .52; $t(11) = 10.02$, $p < .05$ for the Familiar Noun condition.

For the Recall condition tested after a 24-hour delay, the mean number of correct first choices was 3.42 (out of 6); SE = .23, with the participants choosing the correct picture at a rate higher than expected by chance, $t(11) = 7.42$ $p < .05$. As expected, when looking at first and second choices combined, with M = 4.83 (out of 6); SE = .30, the participants selected the correct choice at a rate greater than chance, $t(11) = 14.58$, $p < .01$. The results for Experiment 2 indicate that the participants were able to retain the meaning of the novel label 24 hours after exposure, even without presentation of the face providing social information.

Comparison of Performance between Conditions

We conducted a t-test to determine if significant differences in performance exist between the Familiar Noun and Novel Noun conditions. The participants had to rely on looking at the gaze of Sulley to determine the referent of either the novel or familiar word because the verb did not constrain the objects or provide any linguistic information. As such, it was expected that there would NOT be significant differences in performance for the Familiar Noun and Novel Noun conditions. The mean number for correct first choices under the Familiar Noun condition was 4.6; SE = .51, and for the Novel Noun condition was 4.5; SE = .40. There were no significant differences between the means for the two conditions; $t(11) = -0.18$, $p > .05$. Even when looking at first and second choices combined, with the mean number for the Familiar Noun condition at 5.75 and for the Novel Noun condition at *6.08*, no significant differences existed; $t(11) = 0.84$, $p > .05$. These results suggest that when information is provided by social cues alone, children must attend to the agent whether they have previous experience with the noun or not.

To assess whether the order of task presentation had an effect on performance, a repeated measures Analysis of Variance (ANOVA) was conducted, with order of presentation as the between-subjects factor and task condition (familiar/novel) as the within-subjects factors. No significant main effect was found; $F(1, 10) = 1.5, p > .05$, nor a significant interaction; $F(1, 10) = .36, p > .05$.

Because a subset of words (6) from the Novel Noun inference condition (8) were tested for recall, the proportional means were examined in order to compare inference and recall scores (Table 6).

Table 6 Descriptive Statistics and Percentage Means for Novel Inference and Recall in Experiment 2

Type	Condition	M	SE	Percentage
Overall	Novel Inference	4.5	1.47	56%
	Recall	3.4	.44	57%

The descriptive statistics for the Novel Noun (inference) and the Recall conditions are shown in Table 6 with the proportional means at 0.56 and 0.57 respectively. No significant differences were found in novel inference versus recall; $t(11) = 0.54, p > .05$.

Particularly because of the nature of the language impairments of the participants in the current study, it was expected that performance on the PPVT-III as a measure of acquired receptive vocabulary would be a good indicator of the ability to perform fast mapping in Experiment 2. Pearson product-moment correlation coefficients were computed between the PPVT-III standardized scores and the novel inference condition;

r = .05, p > .05. These findings indicate that PPVT-III scores were not indicative of the ability to make novel inferences.

An item analysis was conducted to determine if there were performance differences among items within each of the conditions. No significant differences were found for any verb/noun combination under the three conditions.

Performance of Participants with ASD Compared With Participants with SLI

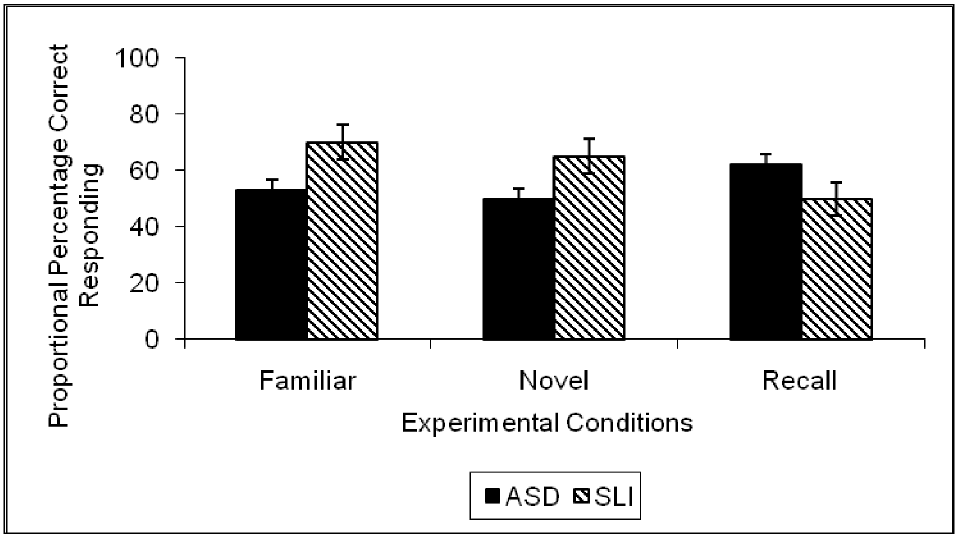
Further analyses were conducted to compare the abilities between the children with ASD and the children with SLI to use social context as provided via eye gaze. A repeated measures Analysis of Variance (ANOVA) was conducted, with Diagnostic classification of ASD or SLI as the between group factor. Familiar versus Novel inference and Novel inference versus Recall were the within subject factors. (See Table 7). As a reminder, we did not test recall for the familiar inference condition because we intentionally used items for which the children already knew the labels. There was a significant difference in performance between the children with ASD and the children with SLI in the Novel inference condition; F (1, 10) = 5.86, p < .05.

Table 7. ***Descriptive Statistics and Proportional Means based on Diagnostic Classification of ASD or SLI***

Group	Condition	M	SE	Percentage
ASD	Familiar Inference	4.3	0.90	53%
	Novel Inference	4.0	0.94	50%
	Recall	3.7	0.14	62%
SLI	Familiar Inference	5.6	0.81	70%
	Novel Inference	5.2	1.14	65%
	Recall	3.0	0.49	50%

The proportional means for the familiar and novel inference conditions respectively were 0.53 and 0.50 for participants with ASD/ 0.70 and 0.65 for those with SLI. The reverse was found, however, for the Recall condition in that the participants with ASD had a mean of 0.62 while those with SLI had a mean of *0.50*. The differences in proportional means for the two groups are illustrated in Figure 2. There was a significant difference in performance between the children with ASD and the children with SLI in the Familiar Inference condition; $F(1,10) = 7.01$, $p < .01$, and the Novel Inference condition; $F(1, 10) = 5.86$, $p < .05$. There was also a significant difference in the proportional means for the recall condition between the participants with ASD versus SLI; $F(1,10) = 4.98$, $p = .05$.

Figure 2. Percentage Correct Responding by Diagnostic Classification of ASD or SLI in Experiment 2



The results replicate previous findings (Baron- Cohen et al. 1995; Preissler & Carey, 2005; McDuffie et al. 2006) that following eye gaze to make correct inferences about the referent of a novel noun, and even to provide additional information about familiar objects, is difficult for children with ASD. Performance in the inference tasks was significantly less for those with ASD than for the children with SLI. Conversely, impaired memory for words is a hallmark of SLI (Kjelgaard & Tager-Flusberg, 2001) and the children with SLI had greater difficulty with retaining the novel words after a 24-hour delay than did children with SLI.

II.3. Comparisons Between Experiments 1 and 2

Familiar vs. Novel Inference Data

For the first comparison, the results from Experiments 1 and 2 will be compared in a mixed-design Analysis of Variance (ANOVA), with Diagnostic classification (ASD, SLI) as the between-group factor and Context (Experiment 1: semantic; Experiment 2: eye gaze) and Test condition (Familiar, Novel) as the within-subjects factors. There was a main effect for Context, $F(1,10) = 8.16$, $p < .05$, indicating that the participants were more successful using semantic context (M = 6.2; SE = .38*)* than eye gaze (M = 4.5; SE = .61). A main effect of Test condition was also found; $F(1,10) = 11.18$, $p < .01$. Children performed significantly better with familiar inference (M = 5.9; SE = .32*)* than with novel inference (M = 5.0; SE = .40*)*. An examination of the data shows that this was particularly true for the semantic context task for familiar nouns (M = 7.0; SE = .35*)* than for the novel noun inference (M = 5.4; SE = .40*)*. There was a counterintuitive, but predicted, finding of similar performance for the eye gaze task for familiar nouns (M = 4.6; SE = .51*)* than for the novel noun inference (M = 4.5; SE =.70*)*. As a reminder, the participants had to rely on looking at the gaze of Sulley to determine the referent of either the novel or familiar word in the eye gaze test because the verb did not constrain the objects or provide any linguistic information. However, the interaction was not statistically significant.

Novel test condition comparing inference and recall

For the next analysis, the inference and recall factors were compared for the novel test condition only. As a reminder, we did not test recall for the familiar test condition because we intentionally used items for which the children already knew the labels. Diagnostic classification (ASD, SLI) was the between-group factor, with Context (semantic, eye gaze) and Test (inference, recall) as within-subject factors. Given that the maximum number of inference items was greater than the maximum number of recall items (8 vs. 6), proportion data were used as the dependent measure.

A marginally significant interaction was evident between Diagnostic classification and Test; $F(1,10) = 4.55$, $p = .06$m. An examination of the data showed that for the ASD group, fewer correct inferences were made in the eye gaze context ($M = 0.46$; $SE = .11$) than in semantic context ($M = 0.66$; $SE = .06$), but this difference was only marginally significant; $t(6) = 2.92$, $p = .07$m. However, the recall data of the SLI group was significantly greater in semantic context ($M = 0.80$; $SE = .06$) than in eye-gaze ($M = 0.52$; $SE = .07$); $t(4) = 2.92$, $p < .05$. This finding is interesting in light of the fact that inferences in the two conditions for the SLI group did not differ (0.70 vs. 0.73).

Thus, when one compares the findings of the two experiments, it becomes clear that the children with ASD had more difficulties with the eye gaze task than the semantic context task when it came to making inferences, but their recall was equally robust across both tasks (both M's = 0.74). This suggests that the experimenter's prompts made through the use of ostensive definition to help correct the inferences made by the children with ASD in the eye gaze task were effective in helping them to recall the novel words. In contrast, the children with SLI made approximately the same number of inferences using semantic and eye gaze contexts but showed better recall using semantic context. Whereas social cues such as eye gaze would be problematic for the children with ASD (as this is indeed a critical component of the diagnoses), memory for newly learned words was difficult for children with SLI using social context alone. This too is consistent with their diagnoses. Note however that those with SLI used eye gaze for inferences, and they received an ostensive definition after making incorrect choices but neither was effective in guiding recall in this condition.

CHAPTER III: GENERAL DISCUSSION

The purpose of the present study was to examine the processes by which children with ASD or SLI may have developed receptive vocabulary within their age norms (as measured by the PPVT-III.) Two such processes used by typically developing children to learn novel words is through inferring the meaning of a novel noun via the use of semantic context, and through social cues provided by eye gaze.

The results indicate that pre-school children with ASD and SLI can use familiar, constraining verbs to infer the meaning of a novel word. When given four pictures of familiar objects and an open-ended statement (i.e., Daddy eats ….), the participants selected the picture of the food item at a rate exceeding chance. Moreover, when given four pictures of novel objects, the participants were able to correctly pair the novel word (i.e., artichoke) with the novel picture at a level greater than chance. Operating under the principles of conventionality and contrast (Clark, 1978), the participants were able to rule out the three remaining alternatives by using semantic context offered by the familiar, constraining verb.

The results of Experiment 1 show that once a child with ASD or SLI learns a verb, he or she can infer the semantic relations between that verb and a noun that follows it. That is, when a child with ASD or SLI learns a constraining verb, he or she can use that verb to infer any noun that follows it. For example, the constraining verb “eats” allows both typically developing toddlers (Goodman et al., 1998) and children with ASD and SLI to infer that the referent must be a food item, even when the food item is present with many other items. As such, we can conclude that the developmental process for language acquisition of novel words using the principle of lexical contrast and semantic context is similar for children with ASD or SLI. Nevertheless, the process appears to be delayed, in that the participants in this study were older than the typically developing children in the Goodman et al. (1998) study.

Furthermore, the participants were able to retain the meanings of the novel words after a 24-hour delay when presented without the context provided by the familiar verb. The results of the current study suggest that while the performance in the recall task by the participants with both ASD and SLI were not as strong as the typically developing toddlers in Goodman et al. there is not a general memory deficit for recall of novel words once an inference is made based on semantic context. Not only did the participants fast map the novel noun onto its referent, but also retained the mappings over a delayed period of time. The results of Experiment 1 suggest that both children with ASD and SLI are both able to learn the association between verb and novel noun and retain the referent-word pairing (see Carey and Bartlett, 1978). These findings contrast with the implication that verbal memory and recognition of words is impaired in children with SLI. However, it is possible that the semantic context provided in the Novel inference task was robust enough to assist the participants with SLI in recalling the words after the 24-hour delay.

The results of the present study also replicate the findings of Baron-Cohen et al. (1997), Preissler and Carey (2005) and McDuffie et al., (2007) because significant differences were found in the performance of the participants with ASD in making inferences based on eye gaze (Experiment 2) than when using semantic context. That is, there was a decrement in the performance of the children with ASD in Experiment 2, even though performance exceeded chance. No significant difference was found for participants with SLI in making inferences between Experiment 1 and Experiment 2.

In contrast, the children with SLI performed significantly worse on Experiment 2 (recall) than did the participants with ASD. While the participants with SLI did monitor the eye gaze of the agent (Sulley) to infer the meaning of a novel noun both at a level greater than chance and on the first choice, they had greater difficulty retaining the word meaning after a 24-hour delay. There are two reasons that can explain the results found in Experiment 2 for children with SLI: (1) Children with SLI have impaired "working memory" compared to children with ASD or; (2) Children with SLI require more than one repetition of a word to retain its meaning. Both these explanations have been supported in other research studies (Gray, 2003; Gray, 2005; Riccio, Cash & Cohen, 2007). Nevertheless, recall was not found to be significantly different in Experiment 1 between the participants with SLI and those participants with ASD.

Why did both groups of children perform significantly better in Experiment 1 than in Experiment 2? We know by the nature of the developmental disability that children with ASD have difficulties in the social-communicative domain, and that children with SLI have impaired verbal memory and poor performance on word recognition tasks. Nevertheless, in Experiment 2 we measured ability to make inferences and recall a novel noun via social context. Following eye gaze has been used as a measure of understanding social intention in children with autism (see Baron-Cohen et al., 1995,1997). As in the Baron-Cohen et al. (1995, Experiment 2) study, a cartoon representation of a face was used. In the present study (also Experiment 2), the face was drawn on a plate. In Baron-Cohen et al. and in the present study, however, social context was minimal in that the experimenter did not interact directly with the participants and the intentional quality of an inanimate object in the form of a face was poor. Baron-Cohen et al. (1997), Preissler and Carey (2005) and McDuffie et al. (2007) used a different measure of social intention in that the experimenters did interact with the participants and found that the children with autism did fast map when they themselves were attending to the object, but not when the speaker (experimenter) was gazing at an object. Nevertheless, the younger participants with ASD in the present study outperformed the participants with autism in Baron-Cohen et al. (1997) and Preissler and Carey's studies, but more poorly than did typically developing toddlers.

Furthermore, eye gaze is only one cue of many that provides information on social intent. For example, the facial expressions of the speaker and novelty of an object, play a role in providing social context (Siller and Sigman, 2008). For the participants with SLI, making successful inferences as to the referents of novel nouns based on eye gaze did not translate to retaining the meanings after a 24-hour delay. Although an association of word to object was made initially, the singular social cue of eye gaze in Experiment 2 was not as robust a source of information as semantic context was to insure that the referent-word pairing was encoded. Nevertheless, the results of the present study support previous research that children with language impairments, such as ASD and SLI, differ from typically developing toddlers in using information supplied by eye gaze to learn novel words.

According to Kjelgaard and Tager-Flusberg (2001), however, children with ASD and children with SLI can still acquire language at levels that are comparable to typically developing children. Moreover, the authors state that there is a great deal of commonality in language acquisition between individuals with ASD and SLI. Furthermore, Kjelgaard and Tager-Flusberg suggest that a subgroup of individuals with ASD may have a co-morbid incidence of SLI and this explains the similarity in language testing between the experimental groups, as compared to typically developing individuals. Some studies, have indicated that differences in the way language is processed separate SLI from those with ASD (Williams, Goldstein & Minshew, 2006; Whitehouse and Bishop; 2008; Williams, Botting and Boucher, 2008).

The results of the current study support both Kjelgaard and Tager-Flusberg (2001), and the brain activation studies of Williams et al, (2006) and Whitehouse & Bishop (2008). There are no significant differences between the performance of participants with ASD and the performance of participants with SLI in using semantic context to infer the meaning of a novel word which supports the idea that language acquisition/processing delays between ASD and SLI have a similar phenotype. Nevertheless, the differences that were found are important from the treatment standpoint. That is, children with SLI attend to social cues, while children with ASD do not use eye gaze as well to make inferences about the meaning of a word.

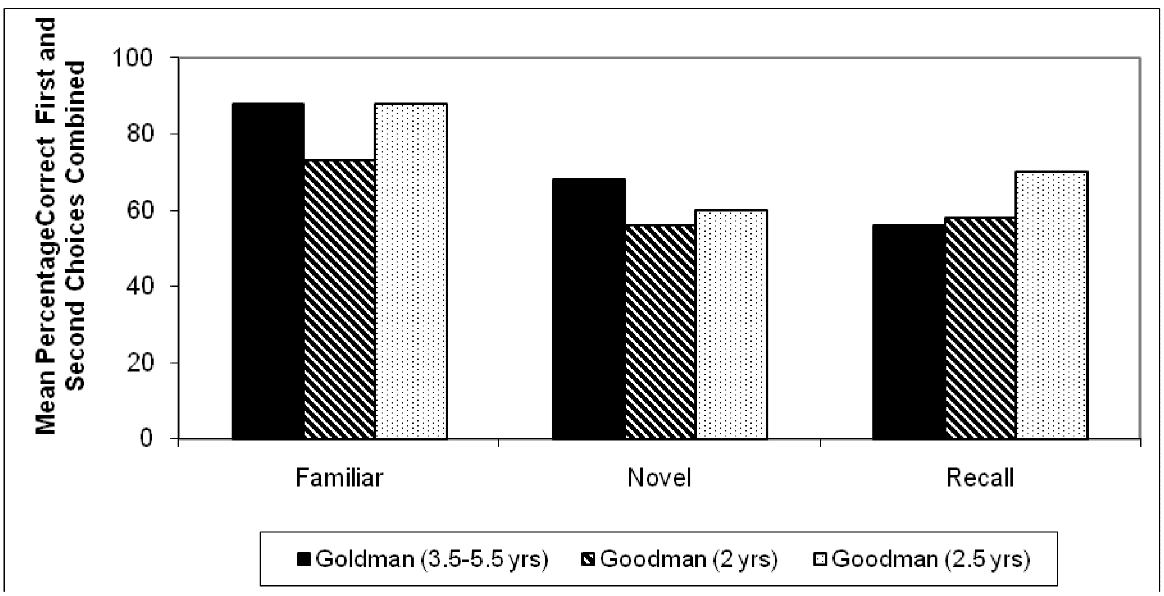
The participants of the current study were able to develop (at least a) receptive vocabulary of preschool age. Although they were delayed in their fast-mapping skills as compared to typically-developing children, both groups exhibited the ability to gather the information from semantic context to limit the referent of a novel noun when provided with a familiar verb. Both groups of participants were also able to retain the meanings of the novel nouns after a delayed period of time. The results of the study suggest that children with language acquisition/processing issues follow a similar developmental trajectory as typically developing toddlers in acquiring language, though there may be a delay. Nevertheless, the results of the current study also suggest that clinicians involved in language training may be able to adopt techniques to facilitate acquisition of novel words.

III. 1 *Performance of Younger, Typically Developing Children vs. Participants*

We know that language acquisition is delayed for children with ASD and SLI as compared to typically developing younger peers. Because the participants had preschool-age receptive vocabulary as measured by the PPVT-III, it was expected that the participants in this study would be able to fast map a novel noun onto its referent when given a familiar verb at a rate similar to younger, typically developing children under the hypothesis that the language acquisition process remains developmentally similar, although delayed. Of course, this is an indirect indication given we do not have language histories of these children. Nevertheless, we might expect to see similar percentages of correct responding when we compare the older participants of this current study to the younger, typically developing participants in the study by Goodman et al. (1998).

Overall, the mean percentage of correct first and second choices (combined) for the participants of this study compared to the participants of the Goodman et al. (1998) study were similar (Figure 3.)

Figure 3. Comparative Mean Percentage of Correct First and Second Choice Responses

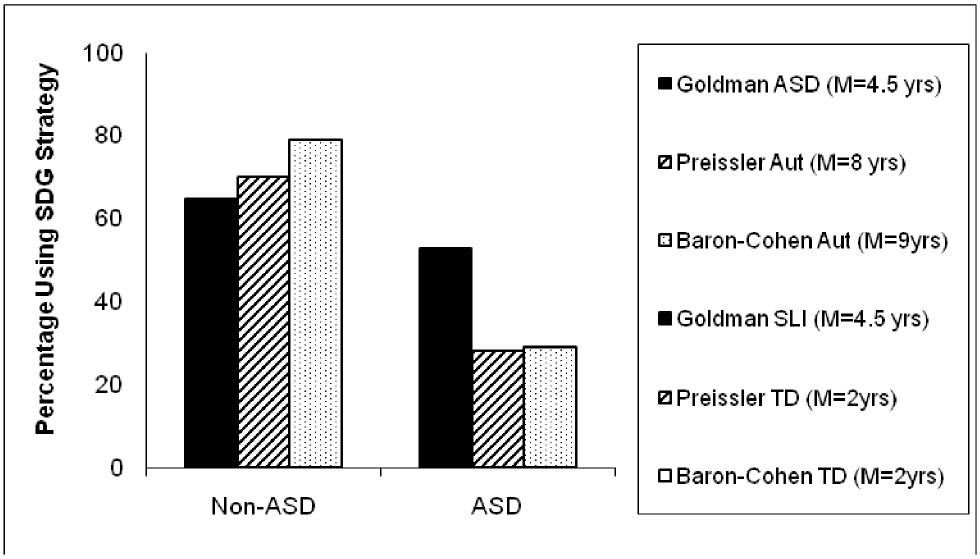


Specifically, the participants in the current study (Mean age = 4.5 years) exhibited responses equivalent to the children aged 2.5 years in the Familiar Noun condition (called Verb Comprehension condition in the Goodman et. al. study); 88 % for both groups as compared to 73% for the 2 year-old age group. The participants in the current study exhibited a slightly higher rate of correct inference (68%) in the Novel Noun condition, than either of the two age groups in the Goodman et al. study (56% and 60%). For the Recall condition, the participants in the current study exhibited retention of meaning at a rate similar to the younger age group of the Goodman et al. (1998) study, 56% and 58%, respectively. The 2.5 year-old group of typically developing children in the Goodman et al. study had a correct responding rate of 70%. These results indicate that the participants with ASD or SLI recalled the referents of novel words in a manner similar to younger, typically developing children.

The comparison of the participants in Experiment 2 of the current study versus typically-developing children in other studies was more problematic than for Experiment 1. The comparison studies (Baron-Cohen et al. 1997; Preissler & Carey, 2005) examined the monitoring of intent rather than novel word acquisition per se. Nevertheless, Preissler and Carey found that children with autism were able to fast-map a novel, nonsense word to an object when they themselves were looking at the object. The current study used real words. Additionally, Preissler and Carey used a more direct measure of social interaction in that the human experimenter's eye gaze was used. Both Baron-Cohen and the current study used a simulation of a face to substitute as the speaker. Finally, the current study categorizes the participants with SLI as non-ASD and compares performance with typically developing toddlers because the classification of SLI suggests no other developmental issues other than language development. The children with ASD in the current study are compared to those with autism in the Baron-Cohen and Preissler and Carey studies.

It was expected that the participants in this study would have greater difficulty in monitoring social context using the eye gaze of an agent to fast map a novel noun onto its referent than their younger, typically developing peers. One of the hallmarks of ASD, in particular, are deficits in social-communicative arenas. Even though the participants in this study have a preschool-age vocabulary as assessed via the PPVT-III, we were anticipating based on the results of previous studies with children with ASD (Baron-Cohen et al. 1997; Preissler & Carey, 2005) that monitoring referential intent would be difficult. The aforementioned studies examined differences between typically developing toddlers and older children with autism by determining whether the participants were able to name an item when the experimenters were looking at it (called the Speaker's Direction of Gaze, or SDG strategy) versus when the participants themselves were looking at it (called Listener's Direction of Gaze, or LDG strategy). The cartoon representation of Sulley served for monitoring eye gaze to map the referent of a noun so that the participants in the current study were using the SDG strategy when making the correct choice. Comparisons between all the groups are provided in Figure 4.

Figure 4. Comparative Percentage Using SDG Strategy in Experiment 2



The participants in the current study outperformed their older peers with autism in percentage of correct responding under the inference conditions (Familiar Noun and Novel Noun) using the SDG strategy, with a mean percentage of 50% for the participants with ASD, (67.5 % for the participants with SLI) versus approximately 29% in the Preissler & Carey (2005) and Baron-Cohen et al. (1997) studies. Nevertheless, the younger, typically developing toddlers with a mean age of 2 years, used the SDG strategy (mean percentage of 70% in Preissler & Carey, 79% in Baron-Cohen) to a much greater extent than did the participants in either group in the present study. Recall that the participants in this study are children who are either diagnosed as ASD or with SLI, but do have both receptive and productive verbal skills. They are also much younger than those with autism in the Preissler and Carey and in the Baron-Cohen et al. studies. One possibility is that the children in the present study have more advanced language skills. Another is that these younger children are receiving intervention at an earlier age and it is more effective than the interventions that may have been available to the older children in the other studies. Nevertheless, some impairment in using eye gaze to determine the referent of an object for both those with ASD or SLI is found in comparison to typically developing toddlers, with the children with ASD showing more difficulties than those with SLI.

III.2 Implications for Language Training

Traditionally, comprehensive behavioral research and intervention programs have concentrated on explicitly training both receptive and expressive language to children with autism and other developmental disabilities through imitation procedures and syntax training (Guess, Sailor, Rutherford, & Baer, 1968; Guess, 1969; Garcia, Guess, & Byrnes, 1973). Repetitive exposure to novel words has been shown to increase the vocabulary for both children with ASD or SLI (Gray, 2005; Riccio, Cash & Cohen, 2007). While most of the aforementioned studies do not concentrate on the context provided by the surrounding words in a sentence, or the inferential processes of the participants to derive meaning of the novel words, behavioral procedures may have a collateral effect of increasing attending to verbal instructions.

All of the participants in the present study showed the ability to use semantic context to infer and remember the meaning of a novel word. As such, language training programs should enrich word-training by surrounding novel nouns with familiar, constraining verbs. For example, our participants were able to use the principle of lexical contrast to infer the meaning of a novel noun when provided a familiar verb in Experiment 1. As such, familiar verbs can serve as a foundation for increasing understanding of nouns and, therefore, rapid building of vocabulary. This procedure could be successfully used by teachers in a setting with language-impaired students, such as those with ASD or SLI

One of the best predictors of positive language outcomes in children with autism is joint attention (Charman et al. 2003; Siller and Sigman, 2008). It is possible to teach children with ASD to attend to social cues, such as eye gaze, by using joint attention procedures (Dawson, Toth, Abbott, Osterling, Munson, Estes & Liaw, 2004). Rovito-Gomez, McDonough & Cohen (2009) demonstrated that children with autism can be taught to attend to eye gaze. By requiring children with ASD to attend to the eye gaze of the speaker, and then confirm that the children are limiting the possible referent to the novel noun before allowing access to a preferred activity paired with social praise, the children with ASD may become conditioned to monitor referential intent and respond to social praise more effectively.

III.3 *Limitations and Future Research*

One of the limitations of this research is that there were a small number of participants (N = 12; 7 with ASD and 5 with SLI). The participants were selected based on the fact that they had all developed some receptive vocabulary, but the experimenter did not know the diagnostic classification from the Individualized Education Plan (IEP) until after the data had been collected. The experimenter was not privy to the actual medical history and diagnosis of the child. Furthermore, an accepted method of diagnostic classification, such as the ADI or ADOS, was not allowed to be conducted at the school by the experimenter. Such an assessment tool might have confirmed the diagnostic classification for each of the participants. It might have also allowed the experimenter to find additional participants to evenly match the groups (ASD or SLI).

The age analysis and PPVT-III assessment indicated that the ASD and SLI groups were similar in terms of chronology, but a larger sample size would have increased the power of the study, and may have revealed some more subtle effects. For example, it was expected that a correlation exists between acquired vocabulary and ability to use eye gaze to infer the meaning of a novel noun. However, the results of the Pearson product-moment correlation were not significant for either Experiment 1 or, more surprisingly, Experiment 2. A larger group of participants with ASD and SLI and one with more varied vocabulary and language ability might assist in answering this type of question and resolving further the comparison of language similarities and differences between those with ASD and those with SLI.

Additionally, the PPVT-III indicated that the children with SLI had slightly lower scores than the children with ASD. Again, the experimenter was naïve to the diagnostic classifications of the children until after the study had been completed, but do the PPVT-III score differences have an effect on performance using semantic or social context to infer and recall novel words? A more or less evenly-matched participant pool might have indicated some greater differential ability in inference and recall when semantic context was provided. For Experiment 1, the familiar verbs used to constrain the familiar and novel nouns were directly replicated from Goodman et al. (1998). Would the ability to use semantic context to fast map the referent to a novel noun by these participants differ had there been different verbs? Would there still be significant differences in the effect of context between Experiments 1 and 2? Recall that the verbs used in the active-declarative statements in both Experiments 1 and 2 came from a list of commonly used words in early language acquisition compiled by Thorndike and Lorge (1944). Nevertheless, changing the verb/noun referent pairing in Experiment 1 to see the effect on fast mapping warrants further investigation.

The children with ASD performed equally well on the recall task when learning novel words based on semantic cues or eye gaze. Because results of research studies on memory and autism has been mixed (see Boucher, 1997; McDonough et al, 1997), further research should be conducted as to recall of language and developmental disabilities. Moreover, the children with SLI were able to recall the novel nouns after a 24-hour delay significantly better when provided with semantic context than when provided social context through eye gaze. The use of a more direct measure of social context than eye gaze (of a representative face) may provide further insight as to the use of social cues by children with ASD and SLI in learning new words.

Future research in language development for those with acquisition/processing delays and impairments should seek to coordinate evidence from the neuropsychological, developmental, cognitive and behavioral areas of psychology. The present study indicates that although there are similarities between the way children with ASD and children with SLI infer the meanings of novel nouns and recall these words after a short delay, there are also differences, particularly in terms of attending to and learning from social cues. Further insight will allow the tailoring of appropriate intervention programs.

III.4 Summary and Conclusions

Findings from this dissertation study replicate previous results, particularly about ASD and the use of eye gaze in fast mapping tasks (Baron-Cohen et al, 1995, 1997; Preissler and Carey, 2005; McDuffie et al, 2007), as well as provide new insights into the nature of learning novel words by children with ASD and SLI. First, children with ASD or SLI both are able to infer the referent of a novel noun when provided with semantic context in the form of a familiar verb. Additionally, both groups were able to recall the meanings after a 24-hour delay. When compared to the typically developing toddlers in a study by Goodman et al, 1998, the participants of the current study, although older, performed similarly. The results of Experiment 1 show that semantic context provides children with ASD and SLI sufficient linguistic information to increase vocabulary.

The results of Experiment 2, however, highlight some of the language deficits inherent in the definition of ASD and SLI (*DSM-IV-TR)*. That is, the children with ASD had greater difficulty in making inferences about both familiar and novel nouns when having to monitor eye gaze. Nevertheless, the children with ASD were able to recall the meaning of the novel nouns by selecting the picture of the object after a 24-hour delay.

Conversely, the children with SLI were able to make inferences about the referent of the familiar and novel nouns by using the eye gaze of an agent (cartoon face) at a rate similar to performance using semantic context. However, the children were not able to recall the meaning of the novel noun as well when social context was provided. Both groups in the present study did not perform as well using eye gaze as the typically developing toddlers, but better than the older children with autism, in other studies (Baron-Cohen et al, 1995; Preissler and Carey, 2005).

The results of this dissertation study suggest that children with ASD and SLI may have some strengths that will permit better language acquisition, even though it may be delayed. That is, providing semantic context when teaching novel words in an educational setting, may benefit both children with ASD and SLI, in learning those new words. Furthermore, training and intervention programs should concentrate on ways to help both children with ASD and SLI to attend to social cues, but not just eye gaze, in order to acquire language as typically developing children do. Nevertheless, we must acknowledge the similarities and differences between the way children with ASD and SLI make inferences and recall words in order to teach them effectively. Rather than treat language acquisition for ASD and SLI as the same, a targeted approach for increasing word acquisition should be used at a young age to insure better, positive outcomes.

APPENDIX A: Sample Stimuli and Prompts for Experiment 1: Inference and Recall Using Semantic Context.

Familiar Noun Condition

"Daddy feeds the____. Show me what daddy feeds."

Novel Noun Condition

"Daddy feeds the ferret. Show me the ferret."

Appendix B: Sample Stimuli and Prompts for Experiment 2: Inference and Recall Using Social Context.

Familiar Noun Condition

“Sulley makes the____. Show me what Sulley makes.”

Novel Noun Condition

"Sulley needs the megaphone. Show me the megaphone."

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