A LONGITUDINAL STUDY OF LEXICAL DEVELOPMENT

IN YOUNG CHILDREN WITH AUTISM SPECTRUM DISORDERS

by

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Abstract

Children with Autism Spectrum Disorders (ASD) have deficits in communication and delays in language development, but there have been few studies of their vocabulary. This study compared longitudinal parent report data from the MCDI collected for 49 children with ASD over three years with data from the MCDI norms. It focused on three aspects of lexical development: (1) change in lexical composition as evident in percentage of predicates/nominals; (2) order of emergence for predicate types and (3) predictive value of lexical variables for later grammatical development. ASD Groups were matched to typically developing group norms on total MCDI scores for each comparison. Subsequent analysis indicated: (1) no differences in the percentages of predicates/nominals for the two groups at 3 time points; and, (2) virtually identical orders of emergence for different predicate types with the exception of three meaning type categories—quantitative predicates, cognitive/affective predicates and predicates involving causal acts to change experiential states. Cognitive/affective predicates were found to come in somewhat later in ASD groups while quantitative predicates and predicates involving changes in experiential states came in earlier in ASD groups. This study also found (3) that lexical variables, especially number of predicates, strongly predicted grammatical complexity one year later, a process common in typical language development. The study concludes that lexical development in ASD follows the normal course, albeit later and more slowly. It also suggests that communication deficits in this population are rooted in challenges with social acts rather than from an inability to match meanings to words.

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For all the dreamers out there
who thought they might,
found out they could,
and surprisingly did…
this is for you.

CHAPTER ONE: BACKGROUND OF THE STUDY

Communication development in autism has been a focus of study over the years, yet many specific domains of language development in this population remain unexplored. It is the goal of this study to address one particular area of language acquisition—lexical development. Surprisingly few studies have looked at this aspect of communication in young children with autism and even fewer have done so with longitudinal data. The main goal of the study will be to address the question: How does the lexical development of children with autism match up to that of typically developing children? To do so, it will longitudinally compare three common trends found in the lexical development of typical children to that of children diagnosed with autism.

This paper will include four chapters detailing the specifics of the study including research goals, methodology, results, and a discussion of the relevance of the results. The upcoming initial chapter will set the background for the study and will include two major sections—a review of the relevant literature and the goals of the study. The literature review will present an overview of autism, followed by a summary of what is known on the general language development of children with autism, and trends in typical lexical acquisition. The chapter will end with a summary of the specific goals and research questions that the study will address.

Literature Review

Overview of Autism Spectrum Disorders

Autism has become one of the most widely recognized developmental disorders. A recent study reviewed surveys done on the prevalence of autism spectrum disorder (ASD) and found that 1 in 200 people in Canada have this diagnosis (Fombonne, 2003).

The number of Canadian children with this diagnosis is even higher, with prevalence estimated at 0.6% or 1 in 165 children (Fombonne, Zakarian, Bennet, Meng, & McLean-Heywood, 2006). These numbers only seem to be increasing as awareness and understanding of the disorder grows.

Given the growing prevalence of this disorder, there has been a push to increase our knowledge of what ASD entails. Finding such answers has been difficult given the nature of the disorder—as a spectrum, individuals with the diagnosis can vary greatly from one another. For instance, it is common to see children who are completely non-verbal diagnosed with ASD. It is equally standard to see children with the very same diagnosis talking fluently but lacking in social pragmatic knowledge. With such variability, the DSM IV-TR has emerged with a definition and some basic criteria for diagnosis. According to this manual, children with ASD have symptoms in the following three areas: 1) social interaction, 2) communication, and 3) restricted, repetitive and stereotyped patterns of behavior, interests or activity (American Psychiatric Association, 2000).

With such a broad and complex range of symptoms, there has been no lack of research on the causes and background of how ASD can present in such a wide array with varying levels of severity. A recent review of research on the etiology of this disorder found that there is growing support that ASD is largely genetically determined (Vitiello & Wagner, 2007). Involving multiple genes, it presents in a variety of ways depending on which genes or combinations of genes are involved (McCauley et al., 2005). Ongoing research is being conducted to confirm which specific genes are associated. Aside from looking at ASD from a genetic perspective, recent research has also found interesting

trends in the physiological development of children later diagnosed with ASD. They are said to have excessive head growth in the first year of life, but a deceleration in head growth in their second year, a time when clinical manifestations of the disorder begins to become apparent (Dawson et al., 2007). Despite these interesting findings, more research linking physiological growth and behavioral characteristics of this disorder are needed to allow for better overall understanding of the causes and nature of the disorder for earlier diagnosis.

Aside from research to focus on the nature and etiology of the disorder, there has been much discussion and debate with regard to how to approach treatment for families and children with such a diagnosis. Knowing that ASD affects a young child's development in three major areas—social interaction, communication, and restrictive/repetitive negative behaviours— current treatment research has focused on providing early intervention and the importance of involving a variety of team members. Treatment approaches have included a wide continuum of methods ranging from the behaviorist practices to social-pragmatic and developmental ones (Prizant & Wetherby, 1998). A recent survey conducted in the United States found that primary intervention service providers were using as many as 30 different treatments, but were rarely analyzing the research base for the programs they implemented (Stahmer, Collings, & Palinkas, 2005). Despite the many treatment options available, evidence based treatment practices have not yet been established, as intervention research has not been able to develop significant means to assess outcomes from treatments (Prizant & Wetherby, 1998). Given that research has not established a thorough understanding of the nature of the disorder coupled with the fact that ASD includes a wide range of deficits in three core

areas of development, it is not surprising that more research is needed in how to approach treatment.

Despite this rather bleak picture, there is one area of treatment for individuals with ASD that seems to be emerging as an integral part of an intervention program—speech and language therapy services. A survey, conducted worldwide with 7% of the respondents representing Canada, found that out of 111 possible intervention approaches, the most common treatment provider working with children with ASD was the Speech-Language Pathologist (SLP) (Green et al., 2006). This is not surprising given the nature of the disorder as having one of its core deficits in the area of communication and language.

Language Development in ASD

Despite the important role SLPs have in intervention plans for children with ASD, many SLPs do not have a thorough understanding of how language develops in children with ASD. The upcoming section will present current research trends that have been explored in this field as well as sum up what is known regarding the general language profiles that characterize this population.

Current Research in Language Development of Children with ASD

Current research has largely focused on early communication at the preverbal level and has emphasized the importance of these acts on later language development. Bono and colleagues (2004) found that joint attention skills such as using eye gaze, pointing or verbal comments with another individual to communicate about a toy or event, were associated with greater language development in children with ASD (Bono,

Daley, & Sigman, 2004). A more recent study involving young children with ASD found that motor imitation, along with joint attention skills, both predicted later growth in expressive vocabulary, but joint attention acts were the sole predictor for later vocabulary comprehension (McDuffie, Yoder, & Stone, 2005). Another study found that both number of hours of SLP services received and motor imitation skills in two year olds with ASD predicted expressive vocabulary at the age of four (Stone & Yoder, 2001). A longitudinal study by Smith and colleagues (2007) found three early predictors of later vocabulary growth in children with ASD—number of words prior to intervention, presence of verbal imitations and use of objects to pretend, and the number of gestures used to initiate joint attention (Smith, Mirenda, & Zaidman-Zait, 2007). Aside from predicting vocabulary development, joint attention skills have also been found to be related to later learning grammatical abilities in children with ASD (Rollins & Snow, 1998). Joint attention and other early preverbal acts such as motor and verbal imitation have all been established as important foundational elements for later language and communication development in this population. This is certainly an important piece of information for any professional working with children with ASD because it provides a starting point for many early intervention teams. Most of this research however, mainly focuses on early social interaction deficits in children with ASD and although this is certainly tied together with deficits of communication, it does not provide SLPs with direct information about the actual progression of language development in these children.

Research on the Language Profiles of Children with ASD

In general, it has been observed and that many children with ASD are often very slow to acquire words and multiword utterances, and will speak very little until later in the preschool years (LeCouteur, Bailey, Rutter, & Gottesman, 1989). However, there is some degree of variability with the research that has been found on the language development of these children—with some studies finding relative preservation of language skills and others finding that language skills are very severely delayed. What is commonly agreed upon is that language acquisition in ASD is variable given the subgroups of individuals within the spectrum (Paul, Chawarska, Klin, & Volkmar, 2007).

Deficits in Language Abilities. One study that aimed at creating a broad language profile of children with ASD sampled 44 children ranging in age from 4 to 14 and administered several standardized and non-standardized language measures (Condouris, Meyer & Tager-Flusberg, 2003). They found that, overall, average scores on standardized measures (Clinical Evaluation of Language Fundamentals, Peabody Picture Vocabulary Test-Third Edition, & Expressive Vocabulary Test) assessing lexical and morphosyntax abilities were more than one standard deviation below the mean. They found comparable results when analyzing spontaneous speech samples through SALT (Systematic Analysis of Language Transcripts), MLU (Mean Length of Utterance), NDWR (a measure of lexical diversity) and IPSyn (an alternative measure of syntactic and morphological development). MLU and NDWR scores were found to be two standard deviations below the mean in the SALT reference database. These results confirmed that both lexical and morpho-syntactic development in children with ASD are below age-level expectations.

Some researchers have found that the broad language problems in children with ASD are not limited to their expressive abilities. Charman and colleagues (2003) found that, in preschool aged children with ASD, the comprehension of words lagged behind their expressive abilities as measured through scores on MCDI parent report checklists. The combination of these receptive language delays with their characteristic deficits in verbal abilities add support to the already existing notion that overall language abilities are disordered in children with ASD.

Relative Preservation of Language Skills. Some researchers suggest that even though communication deficits are a defining characteristic of ASD, and language is very commonly delayed amongst these children, early deficits in specific language domains are not universal in ASD (Paul et al., 2007). For instance, Tager-Flusberg (1981) reviewed several studies completed on the syntactic, phonological, semantic, and pragmatic development of children with ASD and found that the research agreed that both syntactic and phonological abilities followed the general pattern of typically developing children, but at a slower rate while semantics and pragmatics were found to be deficient. More recently, researchers sampled 89 children diagnosed with ASD found a quarter of this sample to have relatively "normal" scores on several standardized language measures. In addition, amongst verbal children with ASD, basic form and content of language were comparable to that of mental-age-matched peers, with some exceptions in the area of words involving social knowledge of others' internal states (Kjelgaard & Tager-Flusberg, 2001). Given this, recent researchers have been interested in examining what characteristics in specific language domains may be preserved or deviant in children with ASD.

Specific Domains of Language Skills in Children with ASD

Morpho-Syntax. Of the studies that have looked specifically at the morpho-syntactic development of this population, there have been variable result which is not surprising, given the variability with which individuals in the spectrum present. Tager-Flusberg (1981) found that some syntactic abilities were preserved in this population and later on found that some subgroups of children with ASD had syntactic development that resembled that of children with Specific Language Impairment (Roberts, Rice, & Tager-Flusberg, 2004). This conclulsion is corroborated by Bartolucci and colleagues (1980) and Howlin (1984) who found that children with ASD tend to omit certain morphemes, including articles, auxiliary, and copula verbs and tense markings, when compared to both typically developing children and children with mental impairments. Some have found that children with ASD also have particular trouble with pronoun reversals (Fay, 1969), though others have suggested this challenge is in part attributed to echolalia (Paul et al., 2007). Echolalia, the repetition of words or phrases, is a common language characteristic of children with ASD and is thought to serve a communicative purpose, for example, as a means for responding when one has a limited ability to respond appropriately (Paul et al., 2007). In summary, it seems as though children with ASD are capable of acquiring morpho-syntactic abilities, but struggle with some particular concepts.

Phonology. One area of language development that seems to be a relative strength amongst children with ASD is that of speech sound development (Paul et al., 2007). Prosody, however, has been found to be unusual in this population with

descriptions including odd vocal quality, inappropriate intonation, and stress patterns (Rutter, Mawhood & Howlin, 1992).

       <u>Language Use.</u> Use of language seems to be, by far, the most difficult area for children with ASD. Preschool aged children rarely use language for comments, showing off, acknowledging the listener, initiating social interaction, or requesting information, though they may respond appropriately in highly structured situations (Landry & Loveland, 1989; Wetherby & Prutting, 1984). In general, these children seem to have deficits in the social, rather than the regulatory uses of language (Wetherby, 1986). Several other studies have looked at the narrative abilities of children with ASD, finding that these children had particular trouble with central coherence in story telling (Diehl, Bennetto & Young, 2006; Loveland & Tunali, 1993; Norbury & Bishop, 2003). There seems to be a common finding that use of language and social pragmatics is a common challenge for children with ASD.

<div align="center">Lexical Development in ASD</div>

       One aspect of language that has not been extensively studied in children with ASD is that of lexical development. A few studies have taken an in-depth look at the progression of how children begin acquiring words. This is surprising given that the number of hours of SLP service between the ages of two and three—a period that is ordinarily dominated by vocabulary learning—predicted positive language outcomes (Turner, Stone, Pozdol, & Conrad, 2006). There is a clear need for SLPs to have a more extensive knowledge of vocabulary development to provide better service for children with ASD.

Trends in the Study of Lexical Development in ASD

Receptive vs. Expressive Vocabulary. A longitudinal study by Charman and colleagues (2003) was interested in looking at the particular discrepancy between understanding meaning of words and expressing words in very young children with ASD. They found, through administering MCDI- Words and Gestures parent report forms, that word production exceeded that of word comprehension in this population. This is an interesting trend given that typical children tend to show greater receptive vocabularies before they are able to start expressing words. However, the comprehension scale on the MCDI parent-report checklist has been found to be less reliable in comparison to its value as an expressive language measure (Tomasello & Mervis, 1994).

Another study assessed 120 older children ranging in age from 5;6 to 19;7 (Jarrold, Boucher & Russell, 1997) and found conflicting results. The researchers administered standardized language tests (British Picture Vocabulary Scale, Test of Reception of Grammar, Action Picture Test, Word Finding Test & Coloured Progressive Matrices), looking at receptive and expressive language skills. They found that the generative use of expressive language was not superior to language comprehension— trends that parallel the progression of how typically developing children learn language, comprehension occurring prior to production. They did, however, find that children with ASD had slightly better performances when expressing single words than when asked to comprehend single words.

Lexical Composition. Of the studies that have looked at vocabulary development in children with ASD, some have noticed this population's preference for acquiring nouns ahead of other parts of speech. A study by Williams (1993) looked at the vocabulary

development of a boy diagnosed with autism from the ages of 2;6 until he reached 3;9, a time when his vocabulary size was around 250 words. Through the use of parent reports, the researcher found that the majority of the words being used by the boy at this time included nouns. Interestingly enough, the second most frequent class of words in his vocabulary included modifiers and not action words (Williams, 1993). Despite these interesting findings, little work has looked at how verbs, describing words, and other vocabulary items develop in children with ASD.

Tager-Flusberg and colleagues (1990) compared children diagnosed with autism in contrast to children with Down Syndrome, with each group ranging in age from 3;3 to 6;9 at the start of the study. Groups were matched on chronological age and language level through MLU scores. These researchers collected language samples bi-monthly over a period of 12 to 26 months. Language samples that were a minimum of 100 utterances were transcribed, entered into SALT and analyzed in terms of MLU, IPSyn, lexical diversity, and form class distribution. In terms of vocabulary, they found that both children with ASD and Down syndrome had a dominance of nouns in their transcripts. They did, however, notice trends in their use of nouns in relation to other aspects of language development. They found that as MLU increased, the proportion of nouns used decreased in both groups. At the same time, they found that verbs and function words increased as language became more advanced—a trend that is similar to the literature found in typically developing children.

A more recent study (Parisse, 1999) found some similarities in proportion of nouns when comparing transcribed language sample data of children with ASD, Down Syndrome, SLI, and normal development (all matched on MLU scores) interacting with a

parent. Parisse (1999) found that children with ASD had a large number of nouns in their language sample transcripts, but this was a common characteristic across all of the comparison groups. Parisse was particularly interested in looking at the influence of parent speech on the language output of these groups. Interestingly enough, the children with ASD were the group that adhered most closely to the linguistic output of parents. Parisse speculated that this may have been due to deficits in semantics and a difficulty for children with ASD to be flexible enough to build classifications and link knowledge from multiple sources.

Lexical Meanings. Other studies have looked further into the possibility of a deficit in lexical meanings in children with ASD, including ambiguous terms and relational meanings. Menyuk and Quill (1985), in their book discussing early communication patterns in autism, postulated that children with ASD had significant challenges with relational terms including verbs, prepositions, and adjectives given their difficulty with shifting perspective. They acknowledged, however, that there have been no studies that have looked exclusively at verb acquisition in this population (Menyuk & Quill, 1985).

More recently, Norbury (2005) was interested in looking at the ability of older children ranging from 9 to 17 years of age to decipher meaning between ambiguous lexical nouns (e.g. "bank" as a place to store money and "bank" as a river bank) both in a single word-picture matching task and in a sentence context. Norbury compared children with language impairment, children with ASD and language impairment, children with ASD and normal scores on standardized language measures, and typically developing children. Groups were matched for non-verbal intelligence. Norbury found that all children knew both meanings of the ambiguous word, but children with language

impairment and children with ASD and language impairment had more errors on the less familiar meanings of the ambiguous word than both typically developing children and children with ASD and no language impairment. This suggests that for some children with ASD, there may be a specific language component that makes it difficult to process some areas of lexical semantics. The study focused on the meaning of ambiguous nouns, but suggested further research is needed in lexical semantics in children with ASD, looking at individual differences in language skill and verb processing in particular (Norbury, 2005).

Summary. The area of lexical development in children with ASD has been difficult to study, different studies have had conflicting results for a variety of reasons. One of the primary difficulties of studying the acquisition of vocabulary in this population is the wide variability among this population. As can be seen from the aforementioned studies, children with the ASD diagnosis can present as highly verbal, with normal scores on standardized language tests, to below age range in all aspects of language. The problem with several of these research studies is that they compare small subgroups of children with ASD, many of whom fall into the "high functioning" category as they are the ones who can perform on standardized language tests that are used for many research studies. Studies that exclude children with limited verbal abilities or who are unable to perform on such tests may have results that do not give a complete picture of all children in the spectrum.

There is a need for more rigorous research comparing individual differences across the entire spectrum of the disorder, particularly addressing the progression of how children with ASD compare to typical language learners in terms of acquiring words.

Furthermore, there are few studies that have looked at lexical development using longitudinal data with young children and as such there is not enough knowledge to say whether the process of word acquisition in ASD is delayed, disordered, or comparable to children with typical development. The current study aims to address these issues by comparing lexical development in ASD to typically developing (TD) groups using longitudinal data that spans over four years.

Typical Vocabulary Development

The literature on vocabulary is rich and diverse. If we focus especially on the early stages, when single word utterances predominate, we find three lines of research that could provide insight into the language development of children with ASD: (1) developmental changes in the proportion of different types of words, (2) the predictive value of specific word types for later language achievement, and (3) the order of acquisition of words other than nouns. Each one of these will be discussed briefly in the sections below.

Proportion of Words

This is one area of vocabulary development that has been studied extensively over the years. The one class of words that children generally start to acquire is that of nominals. An early diary study by Nelson (1973) looked at first 50 words in young children's vocabulary and found that two thirds (65%) of these words were made up of both common and proper nouns. The remaining third included describing or demanding action words (14%); modifiers (9%); personal-social words such as "please", "yes", "no" (8%); and function words (4%).

A detailed look at the how the proportion of word types progresses as typical children develop is provided by Bates and colleagues (1988). These researchers studied 27 typical children longitudinally at the ages of 13, 20 and 28 months. Data were collected twice, once in the home and once in a laboratory and both sessions involved using a mixture of parental interviews and observations of free play. The researchers found that on average, typical children at 13 months say about 12 words whereas by the age of 20 months they say an average of 142. At the age of 28 months, children produced roughly the same number of words in sessions as they did at 20 months of age, but had developed a sudden spurt in their grammatical development—combining words and lengthening utterances.

In terms of the actual composition of these vocabularies, Bates and colleagues (1988) also found some interesting trends. They found that children progress from acquiring a greater proportion of nouns at the age of 13 months to expanding to all open class words (i.e. nouns, verbs, adjectives), particularly verbs, at the age of 20 months. At the age of 20 months, 46.8% of total words were made up of nouns, verbs made up 8.3% and adjectives made up 7.5%. At the age of 28 months, the proportion of nouns to total words decreased to 31.6%, while verbs increased to 15.6% and adjectives made up 5.5%. Bates and colleagues noted the importance of the increase in verbs at this age, given that they coincide with a spurt in grammatical complexity. Given these trends, it seems that typical children begin to use nouns and then expand to use a variety of words, with predicate words (such as verbs and modifiers) coinciding with a large vocabulary spurt. Also, as predicate words begin to be used more often in children's vocabularies, there seems to be a related decrease in the proportion of nouns being used.

Predictive Value of Word Types

Another aspect of vocabulary development that has been studied is how early vocabulary growth is related to later growth in other areas of language development. Bates and Goodman (1999) found strong correlations between a vocabulary spurt at 20 months of age and later MLU scores at 28 months of age, suggesting that early grammar is dependent on vocabulary size in typically developing children. These researchers proposed a link between the emergence of lexical predicates[1] (particularly verbs) and the transition from single to multiword speech (Bates & Goodman, 1999). This suggests that predicates, rather than nouns, are particularly important in vocabulary development and could potentially become the foundation upon which later grammatical structures are built. Pinker (1989) proposed a similar idea, finding that predicates, specifically verbs, have particular properties that influence and direct learning of grammar. Bates and colleagues (1988) particularly identified verbs and other closed class morphology as essential for the expansion of sentence structure because of their ability to express relational information. Predicates, primarily led by verbs, express relationships to other words and seem to be the foundational elements upon which later sentence structure is built.

Predicate Typology and Order of Acquisition of Predicates

Aside from predicates being important lexical elements for grammatical development, they have clear importance in conveying relational meanings in sentences. Two influential research teams have argued further that certain relational meanings are

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[1] Lexical predicate: Words that encode the logical predicate; may be members of virtually any syntactic class (Johnston, ASHA 1986)

expressed earlier than others. One way by Lois Bloom and her associates (1970), and the other way by Gordon Wells and a group of researchers in Bristol (1985). Of these, Wells' analysis scheme is the more detailed. He found that children generally start off with unstructured utterances that involve calls for attention or requests. How children proceed to convey subsequent meanings is complex and Wells has noted some patterns that children typically begin to follow.

In terms of experiential meanings, children typically acquire wanting predicates before all others. They also acquire physical and perceptual states that are unchanging (e.g., see, hear, etc) before they acquire the affective experiential states (e.g., hate, love, etc). Children tend to acquire these unchanging states before expressing that agents cause change in the physical or cognitive states. Wells also found that children typically are able to comment about communicative events (e.g., read, say, show) before they are able to express how agents or events can cause change in physical, cognitive, or affective states (e.g., listen, think).

Similarly, in terms of function meanings, Wells found that the first categories to emerge are that of agent function, patient function, and agent function on a patient. Agents causing patients to function seems to emerge somewhat later as these are meanings that involve embedded clauses.

In terms of location and possession, he noticed that children tend to express locative relations before possessive relations. He also noted that children express relational meanings of agents causing change in existential or physical states and locative (e.g., build, clean, cook) or possessive states (e.g., give, share, take) before they are able to express quantitative predicates (e.g., big, each, empty).

In terms of expressing meanings of time, Wells noted that temporal predicates (e.g., yesterday, tonight) are generally one of the last meanings that children learn to express appropriately (Wells, 1974).

Goals of the Present Study

The goal of the present study is to take a more in depth look at lexical acquisition in children with ASD, focusing on predicates and using longitudinal observations. The study compared data from children with ASD to trends seen in typically developing children from normative assessment measures and/or reported in the literature in the following areas:

1) Developmental change in the composition of the lexicon, as indexed by the proportion of nouns to predicates.

2) The value of predicate use for predicting later grammatical development as indexed by both diversity and number.

3) The order of acquisition of predicate types.

Few researchers have explored lexical development in children with ASD but as mentioned above, some researchers (Tager-Flusberg et al., 2003; Williams, 1993) have found some interesting similarities between these children and those with typical development. Given this, the current study hypothesized that children with ASD will have similar lexical development patterns as typically developing groups in each of the above listed areas.

CHAPTER TWO: METHODS

Overview

The main purpose of this study was to provide an extensive look at vocabulary development in children with ASD. To do so, it looked at: 1) the composition of vocabulary and how it changes over time in relation to typically developing children; 2) predicate use as it predicts later grammatical development; and 3) the order of emergence of specific predicate types. This chapter presents the two sets of data involved in this study—children with ASD and their typically developing peers—and the measures used to analyze each of these groups. The bulk of this chapter focuses on how data were analyzed in both of the groups for each of the three research questions.

Participants

This study analyzed data from two subject pools—children with ASD and their typically developing peers. Data collection methods for each of these groups will be presented below.

Typically Developing Group

All data used to analyze language development in the typical developing (TD) group was accessed from the CDI CLEX (Cross-Linguistic Lexical Norms) Online Database. This database includes month by month norms from 16 to 30 months of age on the typical word production and word comprehension of young children learning English. All norms in the database are from scores on the MacArthur Bates Communicative Developmental Inventories (MCDI). These norms were generated from a norming study conducted by Dale and Fenson (1996) involving 1,130 children whose parents completed

MCDI forms. This current study made use of a variety of different time points from the CDI-CLEX database, depending on need for answering specific research questions. These time points will be specifically defined in relevance to each question in the upcoming sections.

<div align="center">ASD Group</div>

The ASD data for this study was accessed from an archived database established by the Autism and Developmental Disabilities (ADD) Laboratory at the University of British Columbia. This database was gathered for a project examining early intervention outcomes for children with ASD and their parents in British Columbia, Canada. Seventy children participated in this project and were seen for language, cognitive and social assessments on an annual basis from 2001 to 2006. The study that is presented in this paper is part of a larger set of studies analyzing language relevant data from this ASD database.

Selection Criteria for ASD Group

The current study included those children from the larger study who had English as their primary language spoken in the home and who were also reported to be "verbal" at a minimum of two time points in the archived database. Verbal children were operationally defined as those with an expressive vocabulary of at least 30 words as indexed by scores on either the MacArthur-Bates Communicative Developmental Inventories-Words and Sentences (MCDI-WS) or Words and Gestures (MCDI-WG) forms.

Organization of ASD Longitudinal Data

After participants had been selected using the criteria described above, the data were organized to reflect developmental patterns. Before testing vocabulary hypotheses, the subjects were equated on a pertinent general developmental variable to ensure that they were at the same stage of language development. As age has been found not to be the most useful measure when dealing with longitudinal vocabulary data (Smolik, 2004), this study used total vocabulary size as the measure by which to organize the data developmentally. For analysis purposes, the first time point (T1) was redefined as the point in the larger study at which each subject met the inclusion criteria for the present study. The succeeding three time points were of data that was collected annually after they reached this initial level. In other words, the second time point in the current data (T2) was data collected one year after T1, the third time point (T3) was two years after T1, and the fourth time point (T4) was three years after T1. Organizing the data by vocabulary size, rather than by age or date, removed non-verbal children from the group, facilitated comparisons with the TD group, and was more appropriate for the current research questions. These developmentally organized time points were used for all analyses involving the ASD data.

ASD Data Specifics

Data at T1[2] consisted of 49 children (7 females, 42 males) whose parents had completed either the MacArthur-Bates Communicative Developmental Inventories-Words and Sentences form (MCDI-WS) or Words and Gestures form (MCDI-WG). 12

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[2] All data time points (i.e. T1, T2, T3, T4) referenced in the text refer to the developmentally organized time points based on vocabulary size and not the data collection time points used in the original archived database.

of these 49 had received treatment to meet the inclusion criteria. At T2, the sample size

remained constant at 49 children, while at T3 it dropped down to 37 and at T4 it dropped

even further to 20.   Further detail on subjects' mean age, non-verbal IQ, autism severity,

and vocabulary size are provided in the table below.

Table 2.1 ASD Group Specifics at T1

	Mean of Group	SD	Range of Scores
Age in Months	52.84	11.22	28 – 75 (2;4-6;3)
Non-Verbal IQ	48.98	16.57	38 - 101
CARS-Autism Rating	34.62	5.89	21 - 46.5
Total Vocabulary Size	222.24	195.19	32 - 663

Measures

The primary data for this investigation came from a standardized measure of

language development—the MCDI—that was administered to each child at each of the

data points.   Some additional measures, including an autism severity rating (Childhood

Autism Rating Scale) and a cognitive early learning assessment (MULLEN Scales of

Early Learning) were also administered.

MacArthur-Bates Communicative Development Inventories (MCDI)

The MCDI are parent report forms primarily composed of word checklists aimed

to establish a child's vocabulary inventory. All vocabulary data from both ASD and TD

groups used in this study comes from these parent report forms. The MCDI forms

provided a detailed look at the composition of each child's vocabulary. There are two

different types of MCDI forms that were used in this study—WG and WS—and each of these are described below.

MCDI-Words and Sentences (WS)

The MCDI-WS vocabulary checklist is organized into several categories including animals, animal sounds, vehicles, toys, food and drink, clothing, body parts, small household items, furniture and rooms, outside things, places to go, people, games and routines, action words, descriptive words, words about time, pronouns, question words, propositions and locations, quantifiers and articles and connecting words. It includes a total of 680 words. It also includes a second section on the child's ability to use sentences and grammar, including checklists of word endings, irregular word forms, and sentence patterns.

MCDI-Words and Gestures (WG)

The MCDI-WG has the same categories as the MCDI-WS form, but with fewer words in each of the categories as it is geared towards younger children. The total number of words on the MCDI-WG is 396, about 60% of the total words on the MCDI-WS. The MCDI-WG form does not have a section on sentences and grammatical development, but rather focuses on early communicative skills including sections for parents to note a child's use and understanding of gestures and other early communicative and play skills. Data from both forms were used for the group comparisons in the present study.

Rationale for the MCDI

The MCDI was a valuable measure in this study as it provided a valid and reliable basis for vocabulary comparisons between the ASD population and those with typical development. This parent report form has been found to be a valid measure of vocabulary development in typical populations (Fenson et al., 1993), particularly for when examining expressive, rather than receptive vocabulary (Tomasello & Mervis, 1994). It has also been found to be particularly useful in research with children with ASD (Condouris & Tager-Flusberg, 2003) given the unique behavioral, motivational and attentional issues that often interfere with standardized testing.

<center>Childhood Autism Rating Scale (CARS)</center>

The Childhood Autism Rating Scale (Schopler, Reichler, DeVellis, & Daly, 1980) is a rating scale originally designed to help diagnose children with ASD from other developmental delays. It includes a 15 item rating scale wherein a child is rated on a scale of 1 to 4 (with 1 being a level of low severity and 4 being a level of higher severity). The 15 items include: 1) relating to people, 2) imitation, 3) emotional response; 4) body use; 5) object use; 6) adaptation to change; 7) visual response; 8) listening response; 9) taste, smell, and touch response and use; 10) fear or nervousness; 11) verbal communication; 12) nonverbal communication; 13) activity level; 14) level and consistency of intellectual response; and 15) general impressions. This scale has been found to be reliable and valid (Schopler et al., 1988) and has been found to be superior to other measures such as the Autism Behaviour Checklist (Eaves & Milner, 1993). Further information on how this measure was used in the current study is presented below.

Mullen Scales of Early Learning

The Mullen Scales of Early Learning (Mullen, 1995) is a normed measure of both non-verbal and verbal cognitive abilities for infants and children up to the age of 68 months. It includes five scales: gross motor, fine motor, visual reception, expressive language, and receptive language. This measure allows researchers to calculate T-scores, percentile ranks, and age equivalent scores for each of the scales. It has also been used by past researchers for children diagnosed with ASD (Anderson et al., 2007; Lord, Risi & Pickles, 2004). Further information on the relevance of this test to the current study is presented below.

Data Preparation

This study aimed to create an extensive profile of early vocabulary growth in children with ASD by focusing on three areas of lexical development—proportion of nouns to predicates, predictive value of lexical predicates for later grammatical development, and the order of acquisition of predicate types.

The Proportion of Nouns to Predicates

As one index of the changing composition of the child's vocabulary, data from the MCDI was used to calculate the proportion of predicates and nominals in the overall list of words the child was reported to have spoken. This was completed for both the ASD and TD groups.

TD Group

     Longitudinal time points. To look at how the composition of vocabulary in typically developing children compares with the ASD group, this study used data from three time points in the CDI-CLEX Database. These three time points were selected because the mean total vocabulary size at these points matched the total vocabulary means for T1, T2, and T3 in the ASD group (see Table 2.2).

Table 2.2 ASD and TD Groups Matched on Mean Total Vocabulary Size

	ASD Grp at T1	TD Grp at 21 Mos.	ASD Grp At T2	TD Grp at 29 Mos.	ASD Grp at T3	TD Grp at 30 Mos.
Mean Total Vocab Size	222	208	431	433	518	519
SD	195	157	192	174	185	125

     Coding. All words on the MCDI forms were coded as either a "nominal", "predicate", or "other". Nominals included all words in the animals, vehicles, toys, food and drink, clothing, body parts, small household items, furniture and rooms, outside things, places to go, and people categories. Predicates included all words from the action words and descriptive words categories. Predicates also included some words from the words about time, quantifiers and articles, prepositions and locations, helping verbs, and question words categories. Predicates were classified as such on the basis of their potential to convey a logical predicate meaning in a sentence and their grammatical function mostly as verbs, adjectives, and prepositions. All other words on the MCDI form that were not coded as predicates or nominals were considered as "other" and these mostly included animal sounds, social words for games and routines, some articles and

connecting words (e.g. "an", "the", "but"). Please refer to Appendix A for a list of all words and their codes.

Analysis. Once coding was completed for all words on the MCDI forms, norms for the number of words coded as predicates or nominals were generated from subjects in the three matched time points in the CDI-CLEX online database. The total number of spoken words, total number of nominals, and total number of predicates were ascertained for each of the selected age groups (i.e., 21, 29, and 30 months). Proportion of nominals and predicates was then calculated as a function of total vocabulary size.

ASD Group

Longitudinal time points. To look at how the composition of vocabulary changes in children with ASD, this study looked at the MCDI scores from the ASD group at three of the developmentally organized time points—T1, T2, and T3.

Coding. Each word reported as spoken on a child's MCDI form was coded as a predicate, nominal, or "other" as described above (see Appendix A).

Analysis. Following coding, the researchers calculated the proportion of nominals and predicates reported as spoken by each child as a function of the total number of words spoken as reported in their MCDI form. Reliability checks for these calculations was completed on 25% of the subjects. Reliability for this proportion of the sample was at 95%. Once these individual proportions were deemed as reliable, group proportions were then calculated and compared with the mean values of the typically developing groups.

Comparative Analysis of ASD and TD Groups

Figures were generated to descriptively compare the mean proportion of predicates and nominals in both of these groups and their trends over time. It was not possible to determine whether groups significantly differed from each other using statistical analyses since there was no way to calculate variance in the TD data. Further analysis was possible, however, for the ASD group data. Given this, a repeated measures one-way ANOVA was conducted in order to examine trends in the proportion of predicates and nouns over the three time points in the ASD group.

Predictive Value of Predicates for Later Grammatical Development

Prior research indicates a statistical link between the emergence of lexical predicates (particularly verbs) and the transition from single to multiword speech, suggesting that these words are significant in the emergence of multi-word combinations (Bates & Goodman, 1999). Given this, the present study was interested in determining whether or not such links exist in children with ASD.

ASD Groups and Predicate Value

Regression analyses were conducted to determine whether predicate use was linked to grammatical development in this population. The predictive strength of other factors that may play a role in language learning was also tested. Total vocabulary size, number of predicates, number of nominals, autism severity ratings, age, and non-verbal IQ were all considered as potential variables that may play a role in later grammatical development. All data for the independent variables were accessed from T1 of the ASD data set. Definition for these factors were as follows:

Total vocabulary size. This variable was defined as the total number of words that a parent reported as spoken on either the MCDI-WS or WG forms.

Total number of predicates and nominals. These variables were defined as the total number of predicates (or nominals) that a parent reported as spoken on either the MCDI-WS or WG forms. Predicates/nominals were defined and identified as above (see Appendix A). Total number of predicates/nominals was used rather than percentages of predicates/nominals because the percentage computation yields different proportions as is expected given the variation of vocabulary size in the sample. Total number of predicates/nominals was thought to give a more accurate description of use of predicates/nominals.

Autism severity. This variable was defined as the child's total score on the Childhood Autism Rating Scale.

Age. This variable was defined as the child's chronological age in months at the time that their parents completed the MCDI-WS or WG forms.

Non-verbal IQ. This variable was defined as a child's visual reception and fine motor t-scores on the Mullen Scales of Early Learning. These tests have been used as "non-verbal" measures in previous research studies (Anderson et al., 2007).

Dependent Variable

Later syntactic development was the dependent variable of study for determining the predictive value of predicates. Syntactic development was defined as the average MLLU (mean length of longest utterance) from parent's report of their child's longest three utterances. This score was generated from Section D in the Sentences and Grammar portion of the MCDI-WS form, which requires parents to write down the three

longest sentences that they have recently heard their child say. MLU for each sentence was calculated using the guidelines described in the 2007 MCDI manual (Fenson et al., 2007). These guidelines are based on Brown's system for computing MLU, but have particular rules on how to compute MLLU. Once MLU was scored for each sentence, the mean MLU for all three sentences was obtained and this was the score used to define each child's syntactic development. There was a large variability in length of utterance some ranging from short and very simple utterances such as "I want cookie" (MLU=3) to long and very complex utterances such as "Blade sorcerer is my imaginary friend who is also magical and has a lot of cool powers that can capture bad guys." (MLU=23). All data on MLLU was accessed from MCDI-WS forms at T2 (one year after collection of the predictive variables).

Analysis

A correlational analysis was conducted to determine if grammatical development at T2 correlated with each of the described independent variables at T1. Once these correlations were conducted, a further multiple regression analysis examined the links between all independent variables that were found to correlate with grammatical development at T2.

Order of Acquisition of Predicate Types

The order of acquisition for relational meanings was investigated by examining groups of predicates defined by meaning type. This was completed in both ASD and TD groups to determine whether or not there are differences between the groups in the order of acquisition for major meaning types.

TD Group

Longitudinal time points. To look at how predicate types emerge in typically developing children compared with the ASD group, this study used data from 15 time points—16 to 30 months—from the CDI CLEX Database. Predicate words at each of these time points were further analyzed.

Coding. All words from the MCDI list that had been coded as predicates (see Appendix A and the discussion above) were further grouped by meaning type (Wells, 1983). Each predicate was coded using a version of the Predicate Coding System (PCS), a categorized lexicon that included 700 surface predicates found in the speech of children 0-5 years of age. The PCS was originally developed by the Berkeley Cross-Linguistic Project (Antinucci et al., 1973; Wells, 1985) and was supplemented with information from the general literature on child language by Johnston (2001). The words in the PCS belong to different syntactic classes such as verbs, adjectives, prepositions, adverbs or conjunctions but all express judgments about states and relationships. The present study used a 16 predicate category coding system, a version of the PCS that had been developed by Johnston and colleagues for clinical use (Johnston, Miller & Tallal, 2001). These codes represented the consensus view of 12/16 linguists and graduate students of linguistics. Approximately 2/3 of the predicates on the MCDI were listed in the original PCS and assignment of these words to meaning type categories was maintained from the original scheme. The remainder of the predicates were assigned by the current researchers in an analogous fashion.

The 16 predicate categories were as follows: (1) Modals-notions of possibility, necessity and intentionality; (2) Experiential States-physical and perceptual; (3)

Experiential States-affective and cognitive; (4) Changes in cognitive, perceptual or physical experience; (5) Agents or events causing changes in affective, cognitive, perceptual or physical experiences; (6) Communicative events (a subset of type 5); (7) Activities-movements and actions of agents or objects without concern for resultant end-states; (8) Agents causing activity in other objects or agents; (9) States-physical, categorical, dispositional, existential, locative; (10) States-quantitative; (11) Changes in States (9 and 10 above); (12) Agents causing changes in state-existential, physical or quantitative; (13) Agents causing change in state-locative or possessive; (14) Self-Movement (arguably a subset of Type 13); (15) Temporal; and (16) Negatives.

Each predicate on the MCDI was coded into one of these categories of meaning. After all predicates had been coded into a category, it was found that no predicates existed for Category 4, only one existed for Category 8, and none of the words in category 16 were present on both of the MCDI-WG and WS forms. Given this, these categories were not used for further data analysis. It was also found that Category 9 included a very large number of predicates and this category was split into two—(9P) States-physical, categorical, existential, dispositional and (9L) States-locative—for further analysis. Please refer to Appendix B for a list of all predicate words used for analysis and their respective meaning types.

Analysis. Using this coding system, norms from the CDI CLEX database were generated for words belonging to each predicate type discussed above. All words in each category were inputted into the database website which created tables of the norms for those words. It specifically generated the average number of words reported as spoken in each predicate category for each month between the ages of 16 to 30 months. A "general

occurrence" criteria was set such that at least three words from a given meaning category were required to be reported as spoken by children at a given age in order to conclude that that meaning category was being generally expressed. (This criteria was lowered to two words for predicate type 6—communicative event predicates—as there were only four members of that class; all other classes had at least six members.) Once each predicate type was established as being expressed or not at each time point, researchers were able to look at order of emergence by seeing which predicate types occurred at earlier ages and which emerged at later ages. This order of emergence was then compared with the ASD group.

ASD Group

Longitudinal time points. To look at the order in which predicates emerge in children with ASD, this study looked at the MCDI word checklists from the ASD group at T1, T2, T3, and T4.

Coding. All predicates on the MCDI forms were coded using the version of the PCS described above (see Appendix B). The words that each child was reported to use at T1, 2, 3, and 4 were noted and grouped by meaning type. A customized computer program was written to assign words to categories as described above, but prior to this categorization it was necessary to enter each item checked off for each child's MCDI form. Reliability checks of this data entry task were completed on 25% of the sample and indicated 95% accuracy.

Analysis. Following this assignment of predicates to a meaning type, each child's MCDI data at each of the time points was used to determine the order of emergence of the different meaning types. "General Occurrence" of a meaning category again required

the presence of at least three members of the class (two members in the case of category 6). This allowed the researchers establish an overall level of acquisition for each of the meaning types that would include children who had smaller vocabulary sizes. Note that in addition to indicating some level of general use for the spectrum of subjects, this decision rule allowed the researchers to use data from both the MCDI-WG and WS forms.

Once the predicate types that occurred in each child's MCDI data had been identified, a further criteria was set to determine whether or not a predicate type had been "acquired" by the ASD group. All predicate types that met the occurrence criteria for at least 60% of the subjects in the sample were considered as acquired. Order of emergence was then established by noting which categories of meaning had been generally used by at least 60% of the ASD children at a given time point.

Comparative Analysis of ASD and TD Groups

Figures were generated to descriptively compare the order of predicate type emergence in each of the groups; this was aided by Guttman Scale Analysis of the ASD data.

Summary

This chapter focused on the main coding and analysis procedures that were used to answer the research questions posed in the previous chapter. It has described how these steps were completed for both the data from children with ASD and children with typical development. The next chapter will focus on the results and comparative analyses that were completed between both groups.

CHAPTER THREE: RESULTS

Overview

This study provides a detailed look at lexical development in children with ASD using normative data from the MCDI parent report vocabulary measure. The previous two chapters described the rationale and methodological procedures that were conducted in order to answer the three specific research questions posed in this paper: (1) Does the composition of the lexicon—in terms of the proportion of nouns and predicates—differ in children with ASD as compared with a typically developing group at a similar level of language development?; (2) Does use of lexical predicates predict later grammatical development in children with ASD?; and, (3) Do children with ASD acquire different types of predicates in the same order as typically developing children?. This chapter will present results from data analyses that were designed to answer each of these research questions.

Question 1: The Proportion of Nouns to Predicates

To look at how vocabulary development might differ in typically developing children and children with ASD, this study first examined the composition of each group's lexicon by comparing the proportion of nouns and predicates at three longitudinal points for each of these populations.

TD and ASD Group Comparisons

Data from the MCDI were used to calculate the proportion of predicates, nominals and "other" words in the overall list of words each subject was reported to have

spoken. Only the proportions of predicates and nominals were analyzed since they have been the focus of other child language research.

Comparison of Mean Proportions

     As described in Chapter 2, groups were matched on total vocabulary size prior to comparing proportions of nouns and predicates between the two groups. Total vocabulary size at T1, T2, and T3 in the ASD groups was compared to three age groups in the TD database that best matched each of the ASD time points on total vocabulary size. Group means for each time point are presented in Table 3.1 and Figure 3.1 below.

Table 3.1 Average Proportion of Predicates and Nominals Reported as Spoken in ASD and TD Groups

	T1		T2		T3	
	TD- 21 mos.	ASD- T1	TD- 29 mos.	ASD- T1+12mo	TD- 30mo	ASD- T1+24mo
Nominals	63.42%	61.16%	56.79%	58.34%	56.39%	56.99%
Predicates	23.76%	22.29%	31.79%	29.99%	32.48%	30.48%
Total Vocab	208	220	433	431	519	518

Figure 3.1 Average Proportion of Predicates and Nominals in ASD and TD Groups Over Time
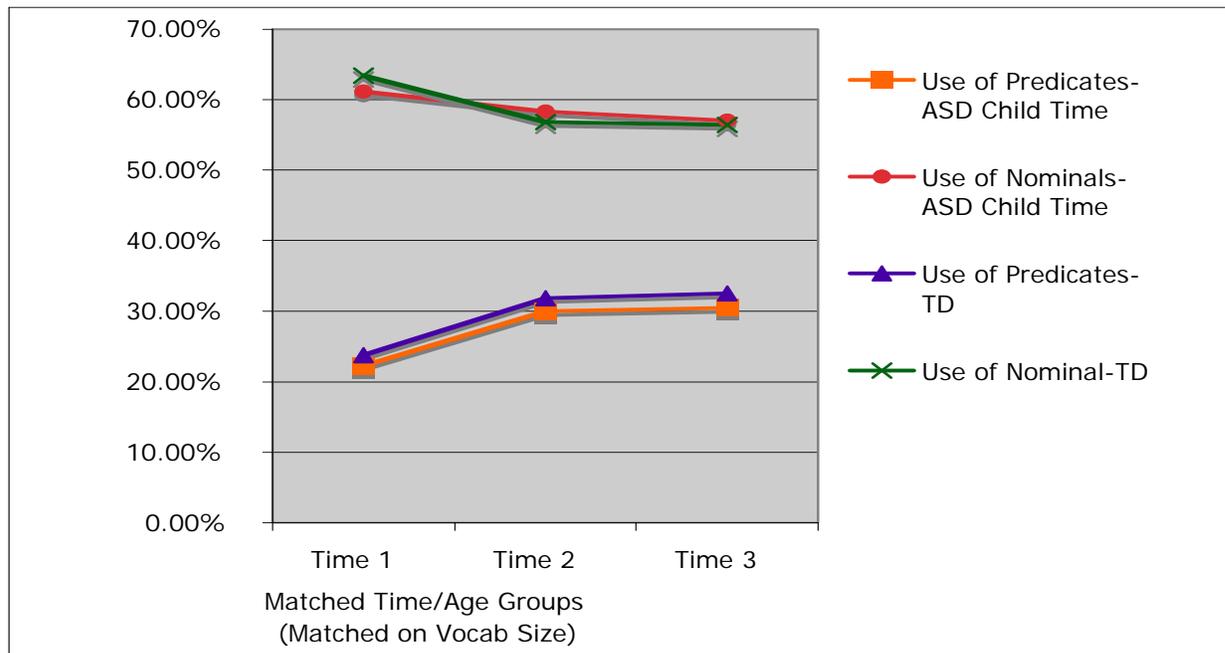
As can be seen, the proportion of predicates and of nominals is virtually identical at each time point for the ASD and TD groups when total vocabulary size is equated. Both ASD and TD groups showed trends wherein the proportion of nouns decreased with time and the proportion of predicates increased with time, although not dramatically.

Group differences are clearly evident, however, when passage of time and actual age are taken into account. A second graph was generated in order to capture the age and time interval differences between data collection points in each of these groups. From T1 to T3, the ASD and TD groups achieved the same growth in proportion of predicates and nouns, but at T1 the age difference between the two groups was 31 months (ASD Mean CA = 53mo, TD Mean CA = 21 mo) while at Time 3 the age difference was 44 months (ASD Mean CA = 74 mo, TD Mean CA = 30 mo). These figures indicate not only a significant delay in lexical development by children in the ASD group, but a rate of

learning that appears to be slowing over time instead of showing the rapid acceleration

seen in the TD data. During this phase of development, the TD children are initially

reported to be learning roughly 30 words/month but increase to a rate of some 80

words/month. The children in the ASD group, in contrast, move from a reported rate of

20 words/month to a rate of less than 7 words/month (see Figure 3.2). More rigorous

statistical tests of group differences were not possible given the unavailability of

individual scores from the typically developing group, but there seems little doubt that

while the general composition of their lexicon may be normal, the ASD group showed

evidence of serious delays and difficulties with this learning task.

Figure 3.2 Vocabulary Size Growth in ASD and TD Groups Over Time
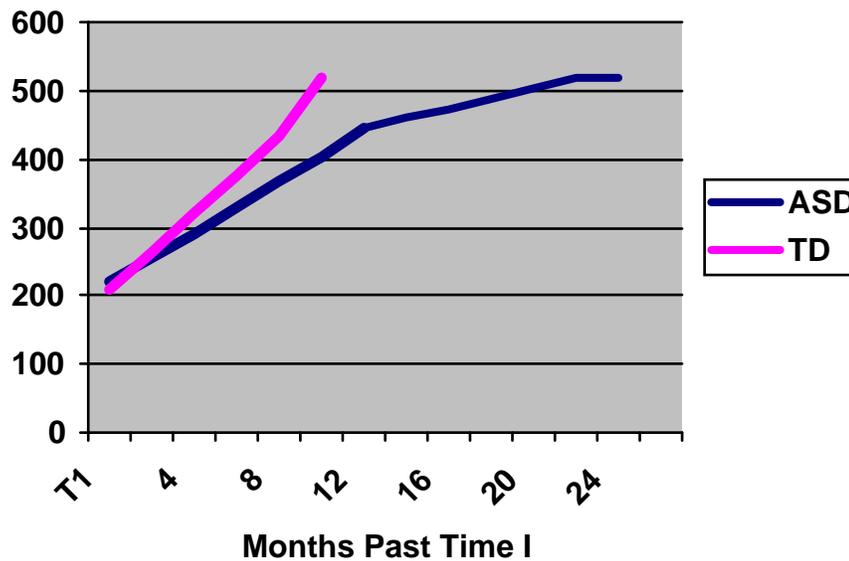
ASD Analysis. Two repeated measures one-way ANOVAs were completed in

order to look at trends in the growth of predicates and nouns over time for the ASD

group. Significant differences were found for the proportion of nominals $F(2, 72) = 5.93$,

$p = 0.004$ and the proportion of predicates $F(2, 72) = 35.66$, $p = 0.00$. Post hoc Tukey

tests revealed significance differences between the proportion of predicates when comparing T1 with both T2 and T3 using $p < 0.01$. No significant differences were found for the proportion of predicates between T2 and T3. Similarly, significant differences were found for the proportion of nominals when comparing T1 with both T2 and T3 using $p < 0.05$. No significant differences were found for the proportion of nominals between T2 and T3.

<div align="center">Post hoc Analyses</div>

Split Groups

Another aspect of interest was the wide range of variability present in the range of ASD scores (see Table 1). Recall that T1 was defined as the first test point at which a child's total vocabulary exceeded a minimum of 30 words. At this time point, vocabulary size in the ASD group ranged from 32 to 663 with a mean of 222 and a SD of 195. Given such variability, there was the potential to split the group for further analysis.

The ASD group was split into three different groups—low group, mid group, and high group—based on the total number of words reported as spoken on the MCDI forms at T1. The low group had under 75 total words reported as spoken, the mid group had 75 to 250 total words reported as spoken and the high group had over 250 words reported as spoken. Group averages on the proportions of nouns and predicates were computed and results are available in Table 3.2.

Table 3.2 Proportions of Nominals and Predicates in Low, Mid and High Vocabulary ASD Groups

| | Low Vocab Group | | | Mid Vocab Group | | | High Vocab Group | | |
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Nominals	57.40	60.23	58.65	68.34	59.22	57.67	59.74	55.82	54.42
Predicates	16.92	26.20	29.32	19.15	30.01	31.92	29.92	33.75	33.87

The low group (N=18) was of particular interest given that these subjects were potentially comparable to earlier TD groups (See Table 2). The low group had a very different total vocabulary size from the matched TD group used in the initial analysis of predicates and nominals. Given this, a younger comparison TD group was selected for the "low" ASD children at T1 to determine whether the low group followed a pattern reflecting earlier development. Groups were re-matched on total vocabulary size as reported on the MCDI. The three TD groups that closely matched the 3 low group time points were 16 months, 22 months and 28 months. Please see Table 3.3 for matched group specifics.

Table 3.3 Low ASD Group and TD Groups Matched on Mean Total Vocabulary Size

| | Matched Group 1 | | Matched Group 2 | | Matched Group 3 | |
	Low Grp at T1	TD Grp At 16 Mos.	Low Grp At T2	TD Grp at 22 Mos.	Low Grp At T3	TD Grp at 28 Mos.
Mean Total Vocab Size	46	59	285	257	425	414

Once groups were matched, proportions of nominals and predicates were generated for the new age TD groups. The average proportion of nominals reported as

spoken by this new TD group was 62.67% at 16 months, 61.53% at 22 months, and 58.88% at 30 months. The average proportion of predicates reported as spoken was 14.68% at 16 months, 26.34% at 22 months, and 30.19% at 28 months. These results were plotted in Figure 3.3 along with the average proportions for the low vocabulary ASD group. The low ASD group does follow a pattern seen in earlier normal development. As can be seen there is a high level of agreement between groups.

Figure 3.3 Proportions of Nominals and Predicates in Low ASD Group and Re-Matched TD Groups
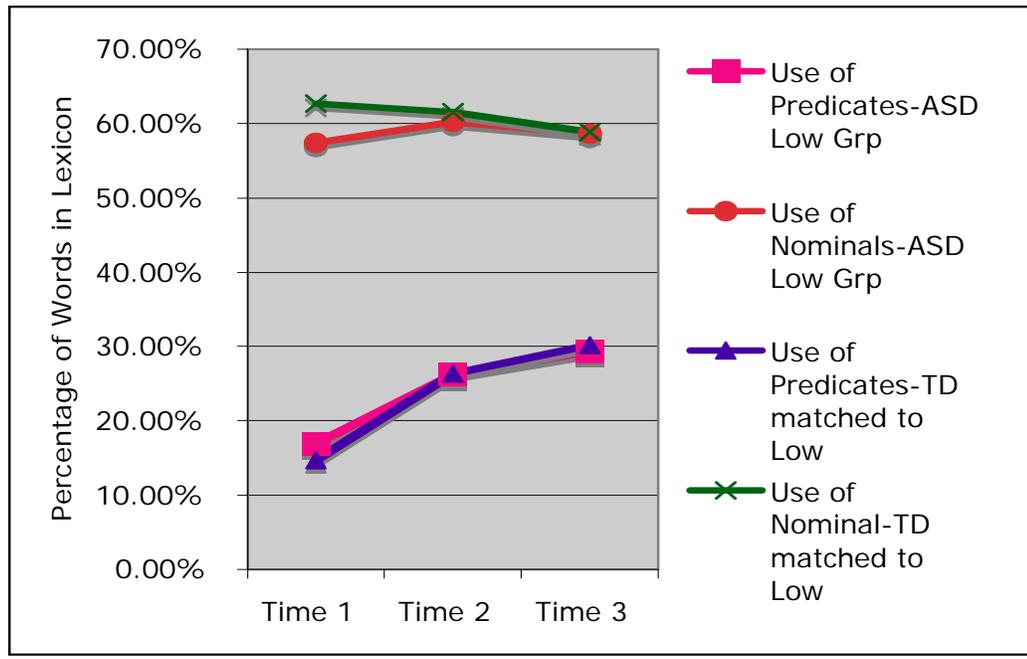
Question 2 : The Predictive Value of Early Predicates for Syntactical Development

To determine whether predicates in the lexicon have any connection to later grammatical development in children with ASD, several correlational and regression analyses were performed. Comparable TD group data was unavailable in the CDI CLEX Database and as such, only ASD group data were used in these analyses.

Correlational Analysis

Correlation analyses were completed between age, non-verbal IQ, autism severity, total vocabulary size, total nominals, and total predicates to determine if a relationship existed between these variables and syntactic development at a later age. Significant correlations were found to exist between later grammatical development at T2 as indexed by MLLU and the following variables at T1: non-verbal IQ, total vocabulary size, total number of nominals, and 4) total number of predicates. No significant correlations were found between chronological age or autism severity (CARS) at T1. Table 3.4 presents a list of all Pearson's *r* values.

Table 3.4 Correlation Coefficients between Independent Variables at T1 and Syntax Development at T2

$r(40), p < .05$	Independent Variables at T1					
	Age	Non-Verbal IQ	Autism Severity	Total Vocab Size	Total Nominals	Total Predicates
MLLU at T2	0.13	0.43*	-0.29	0.65*	0.63*	0.70*

Multiple Regression Analysis

A multiple regression analysis was conducted to further analyze whether predicates, as opposed to other correlating variables, predicted later grammatical development. The multiple regression included all factors that were found to correlate with grammatical development at T2; namely, non-verbal IQ, total vocabulary size, total number of predicates, and total number of nominals. This linear regression $F(4, 38) =$

9.37, p < .05 revealed that, once the variance attributable to number of predicates (b = 0.96, p = .03) was removed, there were no further significant predictors of later grammatical development.

Question 3 : The Order of Emergence of Lexical Predicates

The order of acquisition for categories of predicate meanings was investigated by looking at groups of predicates defined by meaning type. This was completed in both ASD and TD groups using a set coding and criteria system designed to identify the order of meaning type emergence in each of the groups.

TD Group

Using norms available through the CDI CLEX database, this study looked at the order of emergence for categories of spoken predicates in typically developing children from 16 to 30 months of age. Criteria and coding systems, including assignment of a predicate to a category based on the PCS and calculating each predicate category's "occurrence" based on the presence of at least three members of a given class (see details in previous chapter), were applied to the group data provided in the database. Predicate types and the ages at which they emerged are presented below in Table 3.5.

Table 3.5 Age of Emergence of Spoken Predicate Types in Typically Developing
Children

Age in Months	Predicate Type	Predicate Type Description
17	7	Activity Predicates
19	3	Experiential States: Affective and Cognitive
	9P	Physical States
	9L	Locative States
21	10	Quantitative States
	12	Agents or Objects Causing Change in Physical States
	13	Agents or Objects Causing Change in Locative States
	14	Self-Movement Predicates
23	2	Physical and Perceptual States
	5	Agents or Events Causing Change in Experiential States
	15	Temporal Predicates
26	6	Communicative Event Predicates
	11	Changes in Physical States
30	1	Modals

Predicate types at each of the four time points from the ASD Data were analyzed using the coding and criteria systems described in the previous chapter. At T1, the ASD group had only acquired two predicate types-7 (Activity Predicates) and 9L (Locative States). By Time 2, however, they had acquired all predicate types except for Type 1 (Modals). They only acquired Type 1 predicates by Time 4. This is shown in Figure 3.4 below.

Figure 3.4 Development of Predicate Types in ASD Group at 4 Time Points
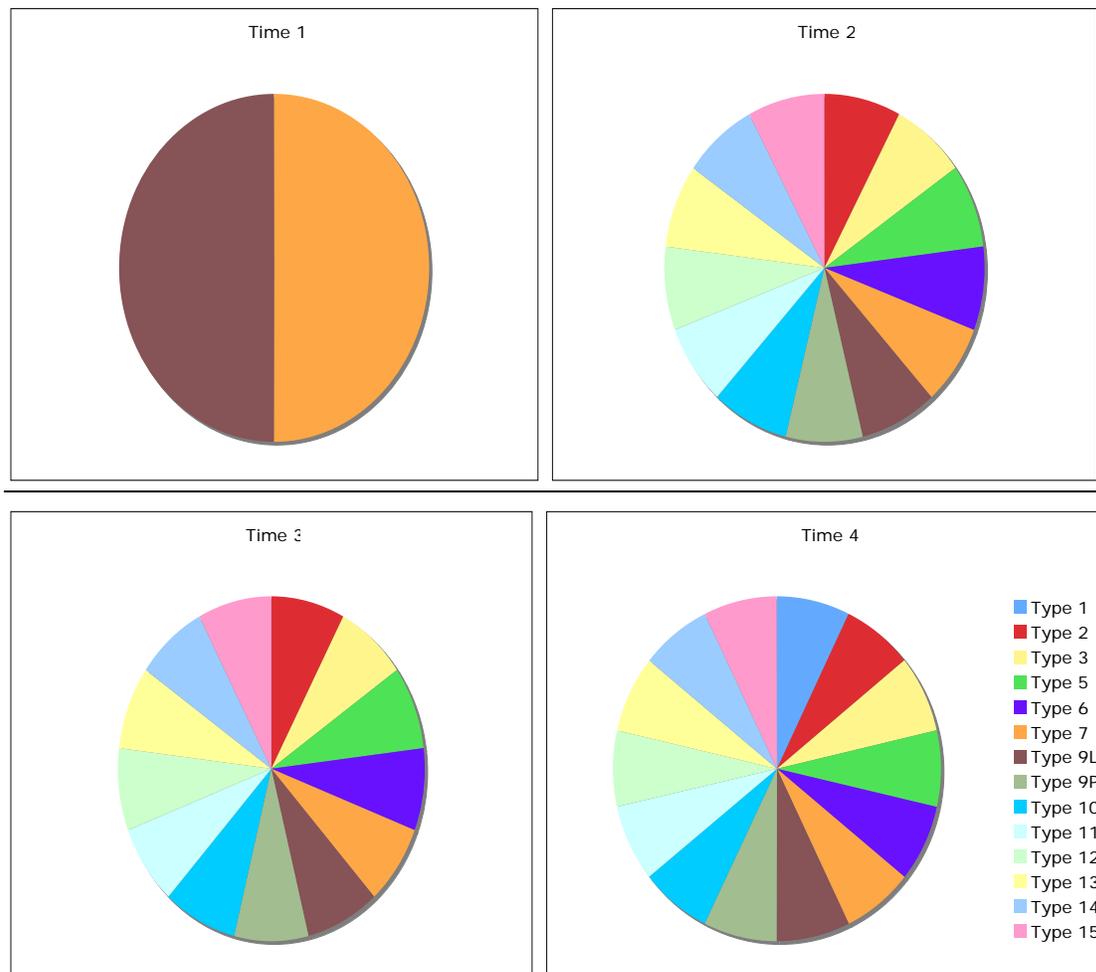
This analysis did not reveal any significant order of emergence because in between T1 and T2, this group had acquired all but one of the predicate types. Further analysis was conducted to look at specific predicate type order.

Post Hoc Analysis of ASD Data

Given that all predicate types had been acquired by T2 in the ASD group, further analysis solely focused on T1 of this population. To determine the order of emergence, all predicate types meeting the criteria of the presence of at least three members of its class were further sorted into an order. The order was established on the basis of total number of children meeting the occurrence criteria. For instance, if a predicate type had more subjects meeting the occurrence criteria than did another predicate type, it was considered to be an earlier emerging predicate type. This sorting system allowed the study to determine an order of predicate type emergence at T1. Please refer to Figure 3.5 for the order of acquisition based on total number of subjects meeting predicate acquisition criteria.

Figure 3.5 Order of Predicates Types Based on Total Number of Predicates Acquired
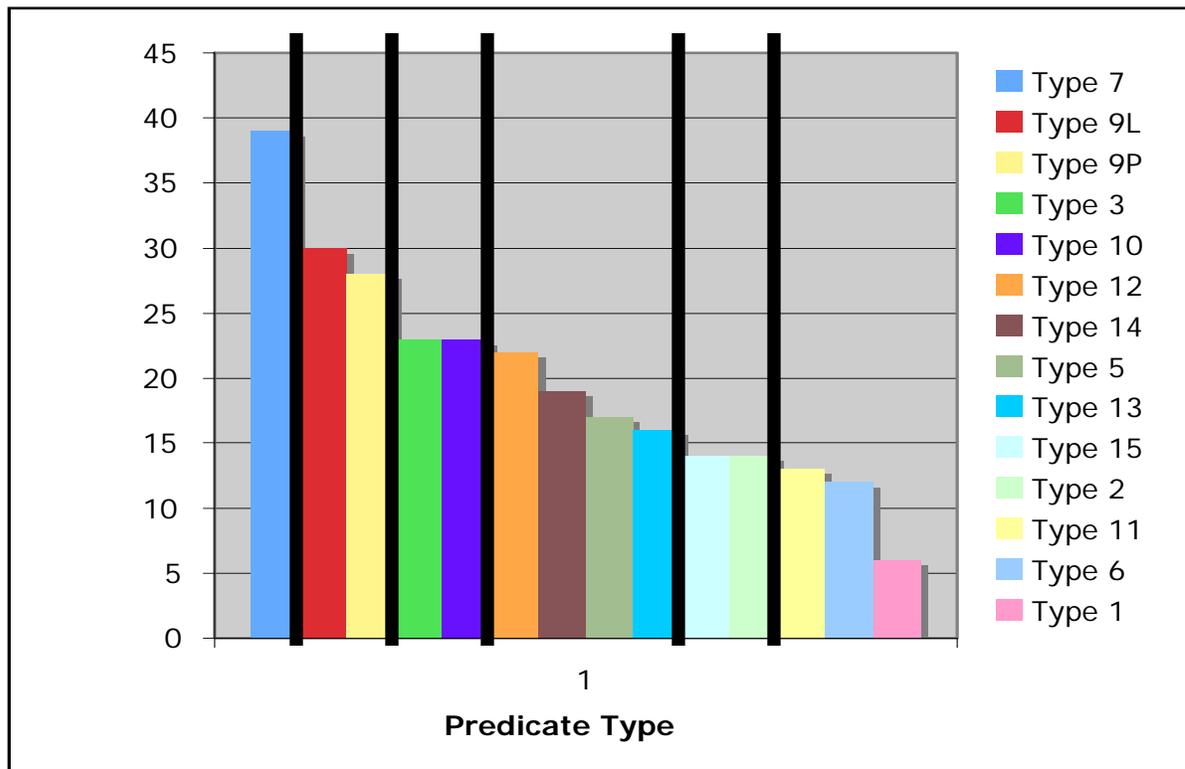
Once this order was established, a Guttman Scale Analysis (Guttman, 1950; Levelt,

Schiller, & Levelt, 2000; Sandhofer & Smith, 1999) was used to determine whether the

order of development implicit in these grouped data did in fact capture the subject-wise

order of emergence for this set of meaning types. Several orders compatible with Figure

3.5 were evaluated. The order of development that showed the highest degree of

predictive strength was one in which categories 9L-9P, categories 3-10, categories 12-13,

categories 15-2 and categories 11-1 were treated as unordered sets (i.e., that emerged in a

predictable order between but not within sets), but otherwise was the same as portrayed

in Figure 3.5 demarked by vertical black lines. The order of each of these sets was

determined through looking at the individual variability of scores. The Guttman Scale

allowed examination of the points at which individual scores became more stable and

these are the points at which sets were determined. The coefficient of reproducibility for this scale was .94, indicating that it was highly likely that if a child was expressing three meaning types, it would be the first three categories listed. Likewise, if a child was expressing four meaning types it would be type 7, 9L, 9P plus one other from the next set and so forth through the whole system. This scale thus seems to approximate the underlying order of acquisition of meaning types for the ASD group. Please refer to Appendix 3 for details of the final Guttman Scale. This analysis was also repeated removing children who had received therapy at T1 (12 children). The order of acquisition and coefficient of reproducibility did not change.

Comparative Analysis

After establishing order of emergence for predicate types for the ASD group at T1 and for the TD group, the study compared the orders in both groups. A Spearman rank order correlation coefficient was computed to determine the degree of similarity shared in the order of emergence of predicate categories between these two groups. Predicate category emergence rank order was found to be highly correlated in both TD and ASD groups given a Spearman rank correlation coefficient value of $r_s = .96$ with $p < .05$.

Despite the strong similarities, the orders had some slight differences between them. Further inspection of the ordered categories indicated that three meaning types were responsible for the small degree of difference that existed—these were predicate categories 3 (cognitive and affective states), 5 (agents or events causing change in experiential states), and 10 (quantitative predicates). Predicate category 3 emerges "later" in the ASD group. In the TD group, category 3 came in with category 9, but in the ASD group, it came in after category 9—thus making it "delayed" in children with

ASD. Predicate category 5 emerges "earlier" in the ASD group. In the TD group, category 5 comes in after categories 12, 13, and 14; but in the ASD group, it comes in along with these three categories. Similarly, category 10 also seems to emerge "earlier" in the ASD group. In the ASD group, category 10 comes in before categories 12, 13, 14, but in TD comes in with these three categories.

When predicate emergence order for the two groups were compared excluding these exceptional categories (i.e. categories 3, 5, and 10), the orders of acquisition for major meaning types in the two groups were virtually identical as can be seen in Table 3.6.

Table 3.6 Order of Emergence of Predicate Types in TD and ASD Groups

	Predicate Type	
Emergence Order	ASD	TD
I	7	7
II	9L, 9P	9L, 9P
III	12, 13, 14	12, 13, 14
IV	2, 15	2, 15
V	11, 6	6, 11
VI	1	1

Post Hoc Analyses Comparing Specific Early Emerging Word Types in Both Groups

Further analysis was completed to look into the potential differences between ASD and TD groups in terms of specific words for each of the predicate categories. Researchers compared early emerging words in each of the predicate categories for both

groups. For the TD group, a word belonging to a predicate category was considered early emerging if it was one of the first three words from the predicate category that were being spoken by at least 60% of the subjects. For the ASD group, only subjects who had 1 to 3 words present in the predicate category were considered as "early emerging" candidates. Once these subjects were identified, their individual words were analyzed and the three words that were expressed by the most number of "early emerging candidates" were considered as "early emerging words". Upon completing this task, it was discovered that majority of the subjects had over 3 words for categories 7, 9L, and 9P and as such could not be considered as "early emerging" any longer. The opposite was true for Category 1, wherein only majority of the subjects had not yet acquired any of these words. Given this, these four categories (1, 7, 9L, and 9P) were excluded from this early emerging word analysis.

Both ASD and TD lists of these early emerging words from each predicate category is available in Table 3.7 below. This comparison showed strong agreement with the early words being expressed for children in both groups for all of the predicate categories.

Table 3.7 TD and ASD Early Emerging Words from Predicate Categories

Predicate Type	ASD	TD
2	See	See
	Sleepy	Hungry
	Tired, Hungry, Sick, Thirsty[3]	Asleep

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[3] All of words separated by a comma in this table had an equal number of responses from the early emerging candidates

Table 3.7 TD and ASD Early Emerging Words from Predicate Categories

3	Yucky	Yucky
	Happy	Happy
	Good	Love
5	Look	Look
	Tickle	Tickle
	Touch	Hurt
6	Read	Read
	Say	Hide
	Hide	Show
10	Allgone	Allgone
	More	More
	Big	Big
11	Fall	Fall
	Out	Out
	Find	Find, Say
12	Open	Open
	Wash	Wash
	Close, Clean	Break
13	Splash	Hold
	Throw	Slide
	Wipe, Slide	Throw

Table 3.7 TD and ASD Early Emerging Words from Predicate Categories

14	Go	Go
	Push	Ride
	Pull	Hit
15	Fast	Fast
	Finish	Wait
	Wait	Now

Summary

This chapter presented the results obtained from the statistical analyses, both planned and post hoc, that were conducted to answer each of the three research questions. The main results of this study focused on three aspects of vocabulary development in children with ASD—general composition of vocabulary, predictive value of predicates, and order of emergence of predicate types. It was found that TD and ASD groups had comparable percentage of predicates/nominals when matched on vocabulary size, but children with ASD acquired their vocabulary later and at a notably slower rate. Predicates were also found to be significant predictors of later syntactic development in children with ASD. Finally, order of emergence of various predicates types were found to be comparable in both ASD and TD groups with a high level of similarity in the examples of early learned words. The upcoming chapter will discuss the implications of these statistical analyses and provide significant connections between previous research and the findings of this current study.

CHAPTER 4: DISCUSSION

Overview

The studies looking at specific trends in early vocabulary acquisition in children with ASD have been few and far between. Though it is characteristic of these children to have delays in communicative abilities, some researchers have found that there is some relative preservation of the formal aspects of language in these children. Tager-Flusberg (1981) was a pioneer in suggesting that children with ASD had relative preservation of their formal aspects of language such as phonology, syntax, morphology, with deficits in the area of pragmatics and semantics. More recently, a study that sampled 89 children and administered a variety of standardized language measures found that, among the verbal children diagnosed with ASD (about a quarter of their sample), basic form and content of word knowledge were comparable to mental age; but higher order semantic skills, with special attention to the use of mental and affective mental states, was particularly challenging (Kjelgaard & Tager-Flusberg, 2001). Furthermore, one longitudinal study that compared the development of vocabulary and syntax in six children with ASD, found that only one tended to follow an atypical pathway of development in terms of lexical composition and growth of MLU (Tager-Flusberg et al., 1990). These findings are not widely acknowledged, however, and the more common view is that children diagnosed with ASD have primary deficits in their ability to communicate (Paul et al., 2007), causing them to learn words very slowly and to not combine words until their later preschool years (LeCouteur et al., 1989).

The main goal of this study was to contribute to the resolution of these conflicting claims by further comparing early vocabulary development of children diagnosed with

ASD to that of children with typical development. It did so by comparing data from TD groups to ASD groups and examining three trends in lexical development: change in the composition of the lexicon, the predictive value of predicates, and the order of emergence of meaning types. Unlike previous studies looking at language in ASD, this study was unique in the fact that it had a relatively large sample including 49 subjects with varying levels of verbal ability, and made use of longitudinal data over a span of four years.

In this final chapter, the main objective will be to state the significance of the research findings of the study and what each of these findings tell us about the lexical development in young children with ASD. It will begin with a summary of the research findings presented in the previous chapter. Following this, each research question will be addressed by presenting how each answer informs us about lexical development and what this adds to the knowledge of ASD. The chapter will end by presenting implications these findings have both for future research studies in this field as well as for clinicians working with this population.

Discussion of Research Findings

Three aspects of lexical development were selected for comparison between ASD and TD groups: (1) the change in lexical composition over time; (2) the predictive value of lexical predicates; and (3) the order in which major relational and stative meanings emerge over time. Each of these will be considered in turn in the following sections of this paper.

Question 1: Change in Lexical Composition (Proportion of Nouns and Predicates)

Similarities in ASD and TD Groups

Ratio of Lexical Composition Over Time. The main goal for this question was to determine whether or not ASD and TD groups differ in the composition of their lexicon as indicated by the proportion of nouns to predicates and changes in this ratio over time. Children in the TD and ASD groups were matched on total vocabulary size at three time points and were found to have similar proportions of nouns and predicates at each of the three time points. These longitudinal findings indicate that not only are ASD and TD groups similar in the ratio of nouns to predicates at a single point in lexical acquisition but both share a common trend in the way this ratio changes and develops over a period of time.

Differences between ASD and TD Groups

Despite these significant similarities between these groups, there are also some key differences in the ASD and TD data. When looking at demographics at T1 for both the ASD and TD groups, the average age for each was widely divergent. Children with ASD had an average age of 53 months at T1, while children in the TD group were all 21 months of age at T1—a difference of 32 months. These findings suggest a significant delay in lexical acquisition.

Delay in Rate of Vocabulary Learning. This delay could be due to a slower rate of word learning and the longitudinal data of this study allow us to determine whether or not such is the case. Comparing the results, the TD group acquired new words initially at a rate of 20 words per month, but this quickly accelerated to a rate of some 80 words per month over the span of 9 months. The children with ASD, on the other hand, started off

at a rate of 26 words per month, but instead of increasing, this rate drops to 8 words per

month over the span of 2 years.

This decrease in rate of learning was evidenced for the ASD group not only in

terms of vocabulary size, but also in the proportion of predicates and nouns. Post hoc

analyses compared proportions of nouns and predicates of children with ASD at T1, T2,

and T3. Results from a one-way ANOVA indicated that the proportion of nouns and

predicates significantly differed from each other when comparing T1 to T2, but not

between T2 and T3. In other words, the proportions for children with ASD developed

significantly within a year, but this rate of learning seemed to slow down after this point.

It was not possible to determine whether similar trends occur in TD groups since we did

not have data for individual children given the nature of the data available through the

CDI-CLEX database for typical lexical norms. The accelerated rate of learning implicit

in the three ages chosen as comparison points do seem to suggest that there is an increase,

rather than a decrease in the three TD age groups rate of learning. This is particularly

evident when recalling that it initially took the TD group a span of 8 months (vs. one year

for the ASD group) and then 1 month (vs. another full year for the ASD group) to achieve

what it took the ASD group 2 years to achieve.

Delay in Onset of Lexical Development. It seems likely that a delay in lexical

development reflects both a late onset of word learning as well as a slower rate of growth

in acquiring expressive words. The strongest evidence pointing in this direction comes

from T1 data. Post hoc analysis of the data suggested that both late onset and slow rate

of learning contribute to this delay. T1 was defined as the first point at which a child had

at least 30 words listed in the expressive section of the MCDI. The variance in

vocabulary size at this point was quite high in this initial group (SD=195), so further analysis was conducted focusing on 19 children who had 75 words or less at T1. The children in this "low" group were on average 50 months of age. Comparatively, children in the TD group who had 30 to 75 words were an average of 16 months of age. This vast age difference clearly suggests a delay in vocabulary acquisition for children with ASD. However, this low group also argues a case that this delay is due to a later onset of word learning. Children typically develop their first words at some point during the ages of 10 to 16 months (Fenson et al., 1994), usually around the time of their first birthday. Assuming children with ASD also begin learning words at this point in their development (the age of 12 months), then it would mean it takes them close to 40 months to reach under 75 words, an incredibly slow rate of 1.24 words a month. Given that they are not necessarily learning that slowly, it argues the case that vocabulary delay in at least some subgroups of children with ASD is partly due to later onset of vocabulary development.

Comparison to Relevant Literature

Proportions of Nominals Dominate Over Predicates. Although few prior studies exist, the findings from this study are compatible with other reports on the different lexical classes found in young children. Two of these studies considered the vocabulary composition of children with ASD. The first was a case study of a young boy with ASD that found comparable results when examining the content of his emerging lexicon—that is, nouns were the most frequent class of words in his vocabulary of approximately 250 words (Williams, 1993). A second study comparing children with ASD to children with Down Syndrome found again that nouns were the most common lexical class in the speech of both these developmentally delayed populations (Tager-Flusberg et al., 1990).

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Studies of other atypical groups, such as "late talkers" found that between the ages of 2 and 3, 61% of their lexicon were nouns (Rescorla, Alley & Christine, 2001). The fact that nouns seem to dominate across a variety of special populations suggests that these trends reflect a general pattern in the language learning process.

Research on typical early lexical development have similarly found that a majority of the early words spoken by young children are nouns; with nouns dominating over predicate words by comprising over 60% of the lexicon (Nelson, 1973; Fenson et al., 1993; Rescorla et al., 2001). Child language theorists have explained that children learn nouns early on because nouns are object-reference terms and as such they are easily mapped to the perceptual-conceptual world (Gentner, 1982). Gentner, after looking at cross-linguistic studies and patterns of language teaching, came to the conclusion that nouns, as object concepts, are readily available in the child's world and as such are easily learned one at a time. Predicates, as action-relational concepts, must first be discovered by the child before he/she can begin to match such concepts with words. The fact that the current study found a dominance of nouns in children with ASD—a population characterized as having language and communication deficits—adds support for the notion that nouns have a more transparent semantic mapping in comparison to predicates.

Change in Ratio of Predicates to Nominals Over Time. As this was a longitudinal study, it allowed examination of the proportions of nouns and predicates in both TD and ASD groups over time. In both groups, over the span of 3 years, the proportions of nouns, while consistently dominating over the proportion of predicates, slowly decreased as the amount of predicates increased. These results echo previous findings from Tager-Flusberg and her colleagues (1990) who found—when looking at the longitudinal

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language development of six children with autism—that proportion of verbs and function words increased as language became more advanced. This is also a trend found in typical language development (Bates et al., 1988). This is significant when taking into account that even children with ASD—who are considerably challenged learners—have to contend with predicates because of their essential role in organizing language and propositional expression. Considering the hypothetical case of not increasing their proportion of predicates is untenable because children with ASD would not be able to express meanings or expand their language beyond labeling and we find this is not the case.

Delay in Onset of Lexical Development. Few studies have been able to explore the early stages of lexical acquisition in children with ASD. One case study of a young boy with ASD followed his speech and language capabilities from the time he was 2;8 up until he was 4;5 (Williams, 1993). At his initial assessment, this child was already considered delayed in his expressive language because his linguistic skills were tested using the Griffiths Scale of Mental Development and found to be at the 1 year old level, already indicating a delay of 20 months. This suggests that even very early on, the delay in language learning is in part due to a later onset of this process. Williams' study is one of the few that have been able to document the very early progression of vocabulary acquisition in this population. That being said, it lacks strength in its conclusions given that it is only a case study of one child with ASD. However, taking Williams' findings together with that of the current study which included a larger sample size, supports the theory that language delay in ASD is due to a later onset of vocabulary acquisition.

Delay in Rate of Vocabulary Learning. This study found that the rate at which children with ASD learn words seems to slow after reaching a particular level. Few studies have examined the rates of vocabulary acquisition in children with ASD. Reviews of the literature in children with autism have made general statements and observations that the rate of language learning is slow (Paul et al., 2007). Researchers have also explained that findings regarding language delays and rates of learning in this population have been variable, given the diversity with which this disorder presents (Roberts, Rice, & Tager-Flusberg, 2004). One study looked at vocabulary acquisition in five children with ASD using growth trajectories over a period of 3 years and found that vocabulary learning was indeed variable and dependent on early pragmatic skills including joint attention and communicative intent (Rollins, 1999). One of the children had a fast and steady rate of learning words, another a slower and steady rate, one had a relatively flat rate with a later vocabulary spurt, while the other two had relatively flat learning curves. Given that Rollins' study (1999) included only five children, it is difficult to make any assumptions regarding vocabulary learning rates for these children. The current study, however, with its larger sample size, allows for stronger argument that there is a decrease in the number of words being acquired by children with ASD in comparison to TD groups who have a steady increase in vocabulary size.

Summary

While children with ASD have some clear delays in their ability to acquire vocabulary, they share some key similarities with TD groups in this language learning process. The current study, given its large sample size, strengthens Tager-Flusberg and colleagues' conclusion that children with ASD may have more similarities in the

development of their early lexical composition to TD groups despite their characteristic

deficits in communication.

<div align="center">Question 2: Predictive Value of Predicates</div>

Research Findings

The goal for this research question was to determine whether or not predicate

words in the lexicon of young children with ASD were predictors of later syntactical

abilities. This was selected as a goal based on previous research with TD children which

has found that lexical predicates are associated with later multiword combinations in

language development (Bates & Goodman, 1999). This current study was focused on

determining if a similar relationship existed for young children with ASD as well.

The results indicated that total number of predicates were a significant predictor

of later syntactical development as indexed by a child's MLLU score. Though other

factors, including non-verbal IQ, total vocabulary size, and total number of nominals,

were also found to be significantly correlated to later development of multiword speech,

total number of predicates was the only factor that remained a predictor when all these

related variables were factored in. These results add support to the growing literature on

the unique value of predicates in connection with development of multiword utterances.

Comparison to Previous Literature

The findings from the current study found similarities between ASD groups and

the literature on TD language development in the significance of predicate words to later

length of multiword speech (a common measurement of syntactical and grammatical

abilities). Though this current study lacked a control group to measure this process in TD

populations, the rich literature on early language development in typical populations can be used as a means of comparison. Research in TD groups has long found a significant connection between vocabulary size and advancing grammatical development (Bates & Goodman, 1999). Child language theorists have long speculated that it is specifically the increasing number of verbs and closed class parts of speech that contribute to an increase in MLU and more advanced language abilities (Bates et al., 1988). The current study supports this theory finding that vocabulary size does indeed have a connection to later multiword combinations, but it specifically found that the acquisition of predicates has a particular significance to these later syntactical abilities.

Only one previous study has examined this relationship in children with ASD. Tager-Flusberg (1990), examined longitudinally the language abilities of six children with ASD and found that the proportion of nouns in the speech of all the children decreased as their MLU increased. This decrease in the proportion of nouns naturally coincided with an increase in the number of verbs and closed class parts of speech. Tager-Flusberg, however, did not specifically look at the correlation between these verbs and later MLU. The current study takes this correlation one step further by factoring out other related variables and found that it was predicates alone that remained as a significant predictor of later grammatical development.

Taking both the current study's findings with that of Tager-Flusberg (1990), adds support to Pinker's (1989) theory that verbs and predicate words have a unique role in the building of more complex speech and grammar in both TD and language-delayed children. Additionally, both findings together, support the idea that the development of

early language abilities of children with ASD follows a more similar pathway to TD than might be expected.

<p align="center">Question 3: The Order of Emergence of Predicate Types</p>

Research Findings

  The third goal for this research question was to determine whether or not TD and ASD groups followed similar patterns in terms of their order of emergence of predicate types. Both TD and ASD groups were analyzed using comparable methods in order to determine the order in which these types were acquired. The results indicated that several aspects of the emergence order were strikingly similar between both the ASD and TD groups, though the ASD group was delayed in its acquisition of certain predicate types.

  Order of Emergence of Predicate Types in TD Groups. Given that vocabulary growth was rapid; that observations, while frequent, were not continuous; and that only grouped data were available, it was not possible to determine the order of acquisition for each of the individual meaning types. The data did indicate a reliable order of acquisition for six sets of predicate types, although an order of acquisition for the types *within* each set could not be determined.

  Results indicated that the first set of predicates to be acquired was that of activity type predicates (e.g., cry, dance, hug). These were then followed by cognitive/affective experiential states (e.g., love, bad), physical states (e.g., cold, dirty) and locative states (e.g., up, in). The next group of predicates included that of quantitative states (e.g., more, big), causal and self-movement (e.g., bring, go), and agent/object causing a change in physical state (e.g., cut, wipe). The fourth set of predicates to emerge included

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physical/perceptual experiential states (e.g., sleepy, tired), agent/object causing a change

in experience (e.g., pretend, touch) and temporal states (e.g., wait, before). The

penultimate set of predicates to emerge included the communicative event predicates

(e.g., show, read) and predicates involving potentially non-agentive changes in state (e.g.,

find, stay). The last of all predicate types to emerge was that of modals (e.g., can, gotta).

Order of Emergence of Predicate Types in ASD Groups. Similarly, the order of

emergence of predicate types in ASD groups was also more reliable when considered in

sets rather than as individual meaning types. In the case of the ASD children, the interval

between observation points proved a bit long, even for slow learners. This meant that

more than one new meaning type was likely to be listed at each successive observation

point, and there was no way to determine which of the new arrivals had been learned

first. Strikingly enough, with the exception of three meaning categories, the order of

emergence of the sets was the same.

The three meaning types which were different were predicate categories 3, 5, and

10. Meaning type 3 includes cognitive and affective states, and was found to come in

later in children with ASD. In the MCDI, however, the majority of the terms refer to

affective states. Words such as yucky, happy, and good were the words most likely to

appear in the data for these children. The next exception is category 5 which is changes

in experiential states (including physical, affective and cognitive states) and was found to

come in "earlier" in the ASD group. Typical examples in this category were look, tickle,

and touch. Interestingly enough, think, listen , and pretend—the terms from category 5

which are considerably related to theory of mind—were the more rare samples found in

the ASD data. The third exceptional category was that of category 10 which includes

quantitative predicates. This category was also found to be somewhat "early" in children with ASD. Frequent examples of words from this category included more and big.

Comparison to Previous Literature

Order of Emergence of Predicate Types in TD Groups. The literature on how children begin to use predicate terminology to convey meanings is rich and complex. It is significant to mention that, given the nature of the data used in the current research study (i.e., word checklists), it was not possible to capture the manner in which a child used the actual word, only whether or not the word was reported to be spoken by the child. Given this, it is difficult to determine exact relational meanings that the child might have been using a word to mean which limits any direct comparison between the current data or the previous literature on emergence of predicate meaning types.

Despite this, it was possible to find common elements between the findings from the TD populations in the current study in comparison to ones before it. Previous literature by Wells (1985) has emphasized that unchanging states, including physical and affective predicate types, emerge before those that include some change or an agent causing change in a particular state. These findings were replicated in the current study, with activity, physical and locative state predicate types emerging before those that involved change in state (i.e., inchoatives) or agents causing changes state (i.e., causals).

There were, however, several differences in findings. Wells (1985) found that predicates involving an agent causing change were more likely to emerge before quantitative predicates. This however, was not the case in the current study, wherein quantitative and changing predicates were found to emerge at approximately the same time period. This could largely be due to the fact that certain words in the MCDI

checklist that were coded as quantitative terms including "more" and "big", tend to emerge very early on and drive the category to be defined as "acquired". Wells in contrast may have coded such terms, particularly "more", in a class of very early predicates that involves meanings of requests, wants, and needs rather than any other significant meaning. Wells (1985) also found that children typically are able to comment about communicative events (e.g., read, say, show) before they are able to express how agents or events can cause change in physical, cognitive or affective states (e.g., clap, play, jump). These findings were also not replicated in the current study, which found that communicative event predicates were actually one of the later sets of predicates to emerge even in TD groups. A final difference between the TD data of the current study and Wells' order of emergence involved the physical/perceptual states and the cognitive/affective states. Wells found that physical and perceptual predicate meanings typically emerged before cognitive and affective meanings. From the TD groups in the present study, it was found that such was not the case. Looking more closely at the words in the cognitive and affective category, the majority of them are more affective attributes including yucky, good, and love which would explain the early emergence of this meaning type category in the current data.

Though not all the findings from the current study's TD groups replicated the findings from previous literature on the acquisition of relational meaning, the results from the current study remain useful as a comparison for the ASD group.

Order of Emergence of Predicate Types in ASD Groups. Few studies have been conducted looking at the early lexicon of children with ASD, and none specifically have examined the emergence of specific predicate types, despite the fact that predicates are

uniquely linked to the development of later multiword speech. Knowing that current

research in children with ASD has more recently found more similarities than differences

in their language development even at the preschool level (Tager-Flusberg, Paul, & Lord,

2005), it is not surprising that the current study also found the order of emergence for

predicate words to be comparable in both TD and ASD groups.

The current study did, however, find some interesting exceptions in the ASD

group when comparison to the TD group in their order acquiring certain predicate

types—particularly with regards to cognitive/affective predicates (Type 3), quantitative

predicates (Type 10), and predicates involving changes in experiential states including

physical, affective and cognitive states (Type 5).

Type 3 predicates included those that involve cognitive and affective meanings

and were found to come in later in children with ASD than those in the TD group.

Majority of the terms in this category included affective attributes such as good, love,

yucky. This is not all that surprising considering that previous research has found that

children with ASD have struggled with words involving affect. Kjelgaard and Tager-

Flusberg (2001), in a study looking at the language profiles of 89 ASD children

administered a variety of standardized language tests, also found similar results reporting

that more abstract semantic skills, particularly the use of affective and mental state words

were more challenging for children with ASD. Furthermore, delay in these more social

and affective predicate types is not surprising given the social interaction deficits that are

characteristic for this population.

Category 10 included predicates that involved quantitative meanings and these

were found to come in early in ASD as compared to the TD group. The most frequent

words in this category included "more" and "big" in both the TD and ASD groups. These quantitative states coming in ahead in the ASD group could be a reflection of advanced age and cognitive capabilities given that they were 2 years older and have had more experiences and exposure to these concepts.

Meaning category 5 included those predicates involving changes in experiential states (including physical, affective, and cognitive states) and this was also found to come in earlier in the ASD group in comparison to the TD group. This is not all that surprising considering it could again be related to the fact that these words reflect an area where we might expect to see a 4 year old acting differently than a 2 year old. This category also includes some higher cognitive skill words such as think, listen, pretend, and some might be surprised to find that these such cognitive state terms are "early" in this population given their characteristic deficits in Theory of Mind tasks even at a young age (Baron-Cohen, 1993). Further examination of the most frequent examples of this meaning category from children with ASD included look, tickle, and touch. None of these are cognitive state terms and have to do with more physical and sensory issues which are common across children with ASD. In fact children with ASD have been found to frequently have sensation seeking behaviors (Myles et al., 2004), which could potentially explain the commonality of "tickle" in this meaning type.

It is worth mentioning that these exceptionalities in the order of acquisition of predicate type could very well simply be caused by limitations in the data set. For instance these are a reflection of the early stages of vocabulary learning and the meaning type categories are large. Furthermore, close to a quarter of these children had received some form of early intervention and results could be a reflection of treatment affects.

Despite this, however, these interesting findings provide remarkable insight into the early world of children with ASD.

Summary of Findings

In general, this study found that children with ASD follow similar patterns of lexical development as TD children, albeit with delays and exceptions in certain areas and with an overall slower rate of learning. A more detailed summary of the findings is presented in Table 4.1 below. The following sections will present a more detailed look at how these findings significantly add to our growing knowledge of ASD.

Table 4.1 Summary of Research Findings

Question 1: Change in Lexical Composition	Question 2: Predictive Value of Predicates	Question 3: Order of Predicate Emergence
Proportion of nouns and predicates in ASD did not differ from TD when groups matched on vocabulary size.	Significant correlations between non-verbal IQ, total vocabulary size, total nouns, total predicates and MLLU 1 year later	TD and ASD did not differ on order of emergence of major predicate types, except for: - type 3: delayed in ASD - type 5: early in ASD - type 10: early in ASD
TD learned up to 80 words/month while ASD learned words much later and at a rate of 26 words/month	Only total predicates predicted MLLU 1 year later when others factors were controlled	TD and ASD did not differ in specific words learned within each category of meaning

Relevance of Findings to Theory: What Do We Now Know About ASD?

Knowing now that the early lexicon of children with ASD follows similar, albeit delayed, patterns of development to TD groups in regards to each of the abovementioned aspects of lexical development, it is the goal of this paper to understand what such

information adds to the understanding of autism. There seems to be an emerging trend of finding some relative preservation of language abilities in ASD when comparing this population with mental-age-matched peers (Kjelgaard & Tager-Flusberg, 2001). This knowledge instigates more questions than answers: Why is it that children with ASD are capable of acquiring words and tend to learn similar word classes as typically developing children, but are still unable to be successful in more functional aspects of language and communication? Furthermore, why is this acquisition of words so severely delayed in this group?

To attempt to answer these questions, there is a need to look through the literature on typical language and communication development. Clearly, there is something happening in typically developing children that is not happening in children with ASD. According to Nelson (1996), there are some necessary contributions in order for language to develop into a useful communication system: 1) the biological basis of acquiring a linguistic system; 2) the psychological process that enables the child to construct a particular language system; 3) the social process that both provides and sustains a language system. It is the interaction of each of these contributions that drives the emergence of higher levels of linguistic, social and cognitive functioning that is characteristic in the later part of early childhood (Nelson, 1996).

Applying this to the current research findings suggests that children with ASD may have some aspects of these processes intact. Considering that the current findings indicate that children with ASD do tend to follow typical patterns of lexical development in terms of the proportion of words they acquire and even the specific word types they acquire, it is plausible to assume that children with ASD are capable of acquiring the

basis of a linguistic system. It also seems reasonable to assume that the majority of children with ASD do also have the psychological process that allows them to construct a language system, given the fact that they are capable of mapping words onto appropriate meanings. Furthermore, previous research studies have also found that children with ASD also use semantic groupings in typical ways to categorize and retrieve words (Boucher, 1988; Tager-Flusberg, 1985)—again suggesting that an underlying psychological process to construct language may be intact.

It is worth mentioning however, that ASD includes a broad range of varying communication deficits, and as such, individual children may vary in the degree to which they possess these two abilities in order to build a language system. Though the children included in this study were all verbal at some point during the study, it is significant to note that by equating all the children on a similar developmental level (i.e. the initial point at which they have a minimum of 30 words in their expressive vocabularies), this study included several ASD participants who were very late talkers as well as those who were quite precocious in their lexical development.

Having said that, what appears to be the common "missing link" across all children with ASD is the social process that is necessary to provide and sustain a language system. Knowing now that children follow typical lexical development to some degree, why is it that they cannot build on such abilities to have more "normal" use of language? There is a rich history of finding social deficits in this population, with past researchers suggesting that the pragmatic oddities that are characteristic of the speech of children with ASD only increases the more that they speak (Tager-Flusberg et al., 2005). A deficit in the social process necessary to learn and build a useful communication

system is not a novel concept in this area of the field. There is a rich literature on the deficits in early social pre-communicative acts in children with ASD—namely their challenges with joint attention, early gestures, imitation abilities—which have been found to be relevant for later language learning abilities (Bono et al., 2004; McDuffie et al., 2005; Smith et al., 2007; Stone & Yoder, 2001). Knowing that children with ASD follow a typical, though delayed, pattern of lexical development leads to the consideration that these social deficits may play a larger role in children's ability to sustain and functionally use a language system than originally considered. It is these social acts that may be the driving force behind the language acquisition delays/deficits in ASD, rather than an inability to match meanings to words or use word meanings appropriately.

Furthermore, another piece of the puzzle that may be missing in children with ASD is that of the interaction that the social, cognitive, and linguistic areas play in fostering a typical communication system. There seems to be a dissociation in the child with ASD to connect social acts to words; a connection so well established in typical children, that it may make children with ASD appear as though their language skills are on a completely divergent path from TD groups.

Which leaves us with some final food for thought: Why do researchers insist that it is important to ascertain that these children are more normal than not? Should we be considering these children as exceptional, and how would an answer to such a question play out in one's everyday work with these children?

Implications for Future Research

Replication of Findings from Current Study

Research Design

Given the limited research that exists on the lexical development of young children with ASD, there is a clear need for future studies to further examine these aspects of the very early language development in this population. The researchers acknowledge that this examination was somewhat irregular in its research design and data collection methods, leaving room for future studies to replicate its findings. For instance, comparison groups between TD and ASD populations were not always comparable given that there was no individual subject data available for TD group comparison—thus, limiting data analysis options. Having said that, however, this study accessed a large database including over 1000 typically developing children in order to produce comparable and valid longitudinal lexical norms to which to compare with the ASD groups in the study—a feat that would have not been possible if the researchers had opted to collect their own data for TD groups. Given this, there are no serious concerns in the validity of the current study's findings, but it does leave room for future studies to replicate its findings.

Data Collection Methods

Aside from an irregular research design, this study based most of its findings on a parent report form, which may not have been the most ideal means of measuring a child's lexical use, particularly for the analysis of lexical predicate emergence. As mentioned

before, it was not possible to analyze the accurate use of the predicate words given that access to how the word being used in context was unavailable. As such, identifying the exact semantic relation that the child used the word for was not possible. Acknowledging this, the researchers recommend attempting to replicate these findings, particularly for the research question involving the order of predicate type emergence, using language sample data or data wherein one can easily interpret which semantic relational meaning the child is referring to. Replicating these findings using language sample data would also enable access to a better understanding of the social/pragmatic deficits that may be hindering children with ASD. Having recognized the value of language sample data as rich for further study, it does not discredit the current findings. Parent report data has been used by researchers in the past and is considered an adequate measure of lexical development, particularly for this population wherein testing procedures are not always possible (Charman et al., 2003; Condouris & Tager-Flusberg, 2003).

Future Areas of Lexical Research in ASD

Aside from replicating the findings from the current study, there are some recommendations for future studies in this field. This study found some striking resemblances between TD groups and ASD groups in terms of their proportion of predicates and nouns, predictive value of predicates and order of emergence of predicate types. There are other areas of lexical research that could also be explored to help strengthen the argument that more similarities than deviances exist between these two populations. For instance, given the literature on typical development suggesting that children typically acquire a certain amount of nominal terms before they begin to acquire predicate words, one might further analyze the growth curves in terms of proportions of

nouns and predicates to determine if this process also exists in children with ASD. Another idea might be to further examine the predictive value of predicates by looking at whether they predict language abilities other than MLU. More research linking and comparing lexical development of children with ASD to TD groups will help further an understanding of why language and communication is delayed in this population.

Further research in the social and cognitive areas are also necessary to determine whether developmental dissociations exist between the linguistic and the social development of these individuals. Social deficits seem to be emerging as the driving force behind the communicative delays characteristic of individuals with ASD, and there is a need for future studies to examine and determine which specific aspects of these are relevant in ASD. Aside from this, there needs to be more research in both TD and ASD to better understand how cognition, language, and social development as foundational elements interact and link with each other to create a functional communication system and foster learning.

<div align="center">Implications for Clinical Practice</div>

SLPs are the most common treatment providers of children with ASD (Green et al., 2006); yet, many of these professionals do not know how children with ASD learn words. Given this, there is the potential for SLPs to assume that children with ASD—who have characteristic deficits in communication and social interaction—develop their lexicons very differently from typically developing children. This current research investigation has clarified whether or not such assumptions are true. Furthermore, by providing an overview of how the lexicon develops in children with ASD, the findings

from this study has given us new insight into how the young child with ASD makes sense of her world and attempts to communicate in it.

Knowing now that the lexical development of children with ASD is comparable to that of typical development has important considerations for any professional working with this population. For one thing, these findings validate the use of typical language developmental milestones as a guideline for selecting appropriate intervention goals. Given the specific findings from the current research questions, that might entail building up appropriate proportions of nouns and predicate words in a child's lexicon and targeting predicates in therapy as stepping-stones for achieving multiword utterances. It is worth mentioning, however, that though these children may eventually achieve the same lexical goals as TD children, it is probable that the manner in which these goals is met is very different. This is the piece of the puzzle that would most likely be of most useful to clinicians working with children with ASD.

Given the knowledge that it is the social piece, rather than the language or cognitive piece that is challenging for these individuals, it makes sense for clinicians to attempt to address these in therapy. For instance, one might tend to emphasize social/affective terminology in the lexicon or build on early pre-communicative acts. Aside from this, however, there is an additional piece that children with ASD struggle with—namely how to interact and use their linguistic system in order to communicate on a social level. It is the task, then, of the clinician to determine how to inspire such a process to happen. Finding the motivation to express oneself is key to any language intervention program—in ASD the importance of this is even more emphasized because of their social deficits.

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MCDI Words and Lexical Class Codes

__Nominals__	__Predicates__	__Other__
Animals	**Action Words**	**Sound Effects and Animal Sounds**
alligator		
animal	bite	
ant	blow	baa baa
bear	break	choo choo
bee	bring	cockadoodledoo
bird	build	grr
bug	bump	meow
bunny	buy	moo
butterfly	carry	ouch
cat	catch	quack quack
chicken	chase	uh oh
cow	clap	vroom
deer	clean	woof woof
dog	climb	yum yum
donkey	close	
duck	cook	**Games and Routines**
elephant	cover	
fish	cry	bath
frog	cut	breakfast
giraffe	dance	bye
goose	draw	call (on phone)
hen	drink	dinner
horse	drive	give me five!
kitty	drop	gonna get you!
lamb	dry	go potty
lion	dump	hi
monkey	eat	hello
moose	fall	lunch
mouse	feed	nap
owl	find	night night
penguin	finish	no
pig	fit	patty cake
pony	fix	peekaboo
puppy	get	please
rooster	give	shh/shush/hush
sheep	go	shopping
squirrel	hate	snack
teddybear	have	so big!
tiger	hear	thank you

MCDI Words and Lexical Class Codes

turkey	help	this little piggy
turtle	hide	turn around
wolf	hit	yes
zebra	hold	
	hug	**Words About Time**
Vehicles	hurry	
	jump	day
airplane	kick	morning
bicycle	kiss	night
boat	knock	time
bus	lick	
car	like	**Pronouns**
firetruck	listen	
helicopter	look	he
motorcycle	love	her
sled	make	hers
stroller	open	him
tractor	paint	his
train	pick	I
tricycle	play	it
truck	pour	me
	pretend	mine
Toys	pull	my
	push	myself
ball	put	our
balloon	read	she
bat	ride	that
block	rip	their
book	run	them these
bubbles	say	they
chalk	see	this
crayon	shake	those
doll	share	us
game	show	we
glue	sing	you
pen	sit	your
pencil	skate	yourself
play dough	sleep	
present	slide	**Question Words**
puzzle	smile	
story	spill	what
toy	splash	who
	stand	
Food and Drink	stay	**Preposition and Locations**
	stop	
apple	sweep	to

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MCDI Words and Lexical Class Codes

applesauce	swim	**Quantifiers and Articles**
banana	swing	
beans	take	a
bread	talk	an
butter	taste	the
cake	tear	
candy	think	**Helping Verbs**
carrots	throw	
cereal	tickle	am
cheerios	touch	are
cheese	wait	be
chicken	wake	did/did ya
chocolate	walk	do
coffee	wash	does
coke	watch	is
cookie	wipe	was
corn	wish	were
cracker	work	
donut	write	**Connecting Words**
drink		
egg	**Descriptive Words**	but
fish		
food	allgone	
french fries	asleep	
grapes	awake	
green beans	bad	
gum	better	
hamburger	big	
ice	black	
ice cream	blue	
jello	broken	
jelly	brown	
juice	careful	
lollipop	clean	
meat	cold	
melon	cute	
milk	dark	
muffin	dirty	
noodles	dry	
nuts	empty	
orange	fast	
pancake	fine	
peanut butter	first	
peas	full	
pickle	gentle	
pizza	good	

MCDI Words and Lexical Class Codes

popcorn	green	
popsicle	happy	
potato	hard	
potato chip	heavy	
pretzel	high	
pudding	hot	
pumpkin	hungry	
raisin	hurt	
salt	last	
sandwich	little	
sauce	long	
soda/pop	loud	
soup	mad	
spaghetti	naughty	
strawberry	new	
toast	nice	
tuna	noisy	
vanilla	old	
vitamins	orange	
water	poor	
yogurt	pretty	
	quiet	
Clothing	red	
	sad	
beads	scared	
belt	sick	
bib	sleepy	
boots	slow	
button	soft	
coat	sticky	
diaper	stuck	
dress	thirsty	
gloves	tiny	
hat	tired	
jacket	wet	
jeans	white	
mittens	windy	
necklace	yellow	
pajamas	yucky	
pants		
scarf	**Words About Time**	
shirt		
shoe	after	
shorts	before	
slipper	later	
sneaker	now	

MCDI Words and Lexical Class Codes

snowsuit
sock
sweater
tights
underpants
zipper

Body Parts

ankle
arm
belly button
buttocks/bottom
cheek
chin
ear
eye
face
feet
finger
hair
hand
head
knee
leg
lips
mouth
nose
owie/boo boo
penis
shoulder
tooth
toe
tongue
tummy
vagina

Small Household Items

basket
blanket
bottle
box
bowl
broom
brush

today
tomorrow
tonight
yesterday

Question Words

how
when
where
which
why

Prepositions and Locations

about
above
around
at
away
back
behind
beside
by
down
for
here
inside/in
into
next to
of
off
on
on top of
out
over
there
under
up
with

Quantifiers and Articles

all
a lot

MCDI Words and Lexical Class Codes

bucket	another	
camera	any	
can	each	
clock	every	
comb	more	
cup	much	
dish	not	
fork	none	
garbage	other	
glass	same	
glasses	some	
hammer	too	
jar		
keys	**Helping Verbs**	
knife		
lamp	can	
light	could	
medicine	don't	
money	gonna/going to	
mop	gotta/got to	
nail	hafta/have to	
napkin	lemme/let me	
paper	need/need to	
penny	try/try to	
picture	wanna/want to	
pillow	will	
plant	would	
plate		
purse	**Connecting Words**	
radio		
scissors	and	
soap	because	
spoon	if	
tape	so	
telephone	then	
tissue/Kleenex		
toothbrush		
towel		
trash		
tray		
vacuum		
walker		
watch		
Furniture and Rooms		

basement		
bathroom		
bathtub		
bed		
bedroom		
bench		
chair		
closet		
couch		
crib		
door		
drawer		
dryer		
garage		
high chair		
kitchen		
living room		
oven		
play pen		
porch		
potty		
refrigerator		
rocking chair		
room		
shower		
sink		
sofa		
stairs		
stove		
table		
TV		
washing machine		
window		
Outside Things		
backyard		
cloud		
flag		
flower		
garden		
grass		
hose		
ladder		
lawn mower		
moon		

MCDI Words and Lexical Class Codes

pool		
rain		
rock		
roof		
sandbox		
shovel		
sidewalk		
sky		
slide		
snow		
snowman		
sprinkler		
star		
stick		
stone		
street		
sun		
swing		
tree		
water		
wind		
Places to Go		
beach		
camping		
church		
circus		
country		
downtown		
farm		
gas station		
home		
house		
movie		
outside		
park		
party		
picnic		
playground		
school		
store		
woods		
work		
yard		
zoo		

MCDI Words and Lexical Class Codes

People		
aunt		
baby		
babysitter		
babysitter's name		
boy		
brother		
child		
clown		
cowboy		
daddy		
doctor		
fireman		
friend		
girl		
grandma		
grandpa		
lady mailman		
man		
mommy		
nurse		
child's own name		
people		
person		
pet's name		
police		
sister		
teacher		
uncle		

MCDI Predicate Words and Predicate Category (Meaning Type) Codes

Predicate Category	Words	MCDI Classification
1 - Modals	can could gonna / going to gotta / got to hafta / have to will would	Helping Verbs Helping Verbs Helping Verbs Helping Verbs Helping Verbs Helping Verbs Helping Verbs
2 - Physical and Perceptual States	hear see asleep awake hungry sick sleepy thirsty tired	Action Words Action Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words
3 - Experiential States: Affective and Cognitive	hate like love wish bad better cute fine good happy mad naughty nice poor pretty sad scared yucky	Action Words Action Words Action Words Action Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words Descriptive Words

MCDI Predicate Words and Predicate Category (Meaning Type) Codes

	need / need to wanna / want to	Helping Verbs Helping Verbs
5 – Agents or Events Causing Change in Experiential States	listen look pretend taste think tickle touch wake watch hurt	Action Words Action Words Action Words Action Words Action Words Action Words Action Words Action Words Action Words Descriptive Words
6 – Communicative Event Predicates	hide read say show	Action Words Action Words Action Words Action Words
7 – Activity Predicates	bite blow chase clap cry dance drink drive eat help hug hurry jump kiss lick play run shake sing skate sleep smile swim	Action Words Action Words

MCDI Predicate Words and Predicate Category (Meaning Type) Codes

	swing	Action Words
	talk	Action Words
	walk	Action Words
	work	Action Words
	careful	Descriptive Words
	gentle	Descriptive Words
	how	Question Words
9P – Physical States	black	Descriptive Words
	blue	Descriptive Words
	broken	Descriptive Words
	brown	Descriptive Words
	clean	Descriptive Words
	cold	Descriptive Words
	dark	Descriptive Words
	dirty	Descriptive Words
	dry	Descriptive Words
	green	Descriptive Words
	hard	Descriptive Words
	heavy	Descriptive Words
	hot	Descriptive Words
	loud	Descriptive Words
	noisy	Descriptive Words
	orange	Descriptive Words
	quiet	Descriptive Words
	red	Descriptive Words
	soft	Descriptive Words
	sticky	Descriptive Words
	wet	Descriptive Words
	white	Descriptive Words
	windy	Descriptive Words
	yellow	Descriptive Words
9L – Locative States	fit	Action Words
	sit	Action Words
	stand	Descriptive Words
	high	Descriptive Words
	stuck	Prepositions and Locations
	above	Prepositions and Locations
	around	Prepositions and Locations
	at	Prepositions and Locations
	behind	Prepositions and Locations
	beside	Prepositions and Locations
	by	Prepositions and Locations

MCDI Predicate Words and Predicate Category (Meaning Type) Codes

	down	Prepositions and Locations
	here	Prepositions and Locations
	in / inside	Prepositions and Locations
	next to	Prepositions and Locations
	off	Prepositions and Locations
	on	Prepositions and Locations
	on top of	Prepositions and Locations
	over	Prepositions and Locations
	there	Prepositions and Locations
	under	Prepositions and Locations
	up	Prepositions and Locations
10 - Quantitative States	allgone	Descriptive Words
	big	Descriptive Words
	empty	Descriptive Words
	full	Descriptive Words
	little	Descriptive Words
	long	Descriptive Words
	tiny	Descriptive Words
	all	Quantifiers and Articles
	a lot	Quantifiers and Articles
	another	Quantifiers and Articles
	any	Quantifiers and Articles
	each	Quantifiers and Articles
	every	Quantifiers and Articles
	more	Quantifiers and Articles
	much	Quantifiers and Articles
	none	Quantifiers and Articles
	some	Quantifiers and Articles
	too	Quantifiers and Articles
11- Changes in Physical, Locative, & Experiential States	fall	Action Words
	find	Action Words
	stay	Action Words
	away	Prepositions and Locations
	into	Prepositions and Locations
	out	Prepositions and Locations
12 – Agents or Objects Causing Change in Physical States	build	Action Words
	break	Action Words
	clean	Action Words
	close	Action Words

	cook	Action Words
	cover	Action Words
	cut	Action Words
	draw	Action Words
	dry	Action Words
	fix	Action Words
	make	Action Words
	open	Action Words
	paint	Action Words
	rip	Action Words
	tear	Action Words
	wash	Action Words
	write	Action Words
13 – Agents or Objects Causing Change in Beneficiary or Locative States	buy	Action Words
	catch	Action Words
	drop	Action Words
	dump	Action Words
	give	Action Words
	hold	Action Words
	pick	Action Words
	pour	Action Words
	put	Action Words
	share	Action Words
	slide	Action Words
	spill	Action Words
	splash	Action Words
	sweep	Action Words
	take	Action Words
	throw	Action Words
	wipe	Action Words
14 – Self Movement Predicates (with and without affected objects)	bring	Action Words
	bump	Action Words
	carry	Action Words
	climb	Action Words
	go	Action Words
	hit	Action Words
	kick	Action Words
	knock	Action Words
	pull	Action Words
	push	Action Words
	ride	Action Words

MCDI Predicate Words and Predicate Category (Meaning Type) Codes

15 – Temporal Predicates	finish	Action Words
	wait	Action Words
	stop	Action Words
	fast	Descriptive Words
	first	Descriptive Words
	last	Descriptive Words
	new	Descriptive Words
	old	Descriptive Words
	slow	Descriptive Words
	after	Words About Time
	before	Words About Time
	later	Words About Time
	now	Words About Time
	today	Words About Time
	tomorrow	Words About Time
	tonight	Words About Time
	yesterday	Words About Time
	when	Question Words
	back	Prepositions and Locations
	try / try to	Helping Verbs
	then	Connecting Words

Guttman Scale Analysis of Predicate Type Emergence Order in ASD Group

The table in Appendix C-2 is a Guttman Scalogram Analysis showing the "emergence" order of each category type for each of the 49 participants in the ASD group at T1.

To initially create this scale analysis, all predicate categories were ordered by the number of subjects who had met the acquisition criteria. In other words, the predicate categories on the columns on the right have more subjects who have "acquired" these types than those on the left.

Each row in the table represents an individual subject and the categories that he/she had "acquired" at T1. A ' + ' indicates that the child met the acquisition criteria for that predicate category while a ' – ' indicates that he/she did not.

To determine an order of predicate category acquisition, a line was drawn showing the point at which majority of the subjects met the acquisition criteria for each predicate type. Once this line was drawn, determining a potential set of meaning types that emerge together, a coefficient of reproducibility was computed to determine whether these ordered sets were reliable. All subjects who fell outside of this line were identified (indicated through the red boxes). These subjects were counted and were used to compute the coefficient of reproducibility.

Coefficient of Reproducibility was at 0.94, indicating a reliable order.

Final Emergence Order:

Emergence Order	Predicate Type
I	7
II	9L, 9P
III	3, 10
IV	5, 12, 13, 14
V	2, 15
VI	11, 6
VII	1

Guttman Scale Analysis of Predicate Type Emergence Order in ASD Group

Predicate Category/Meaning Type

7	9L	9P	10	3	12	14	5	13	15	2	11	6	1
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
+	-	-	-	-	-	-	-	-	-	-	-	-	-
+	-	-	-	-	-	-	-	-	-	-	-	-	-
+	-	-	-	-	-	-	-	-	-	-	-	-	-
+	-	-	-	-	-	-	-	-	-	-	-	-	-
+	-	-	-	-	-	-	-	-	-	-	-	-	-
+	-	-	-	-	-	-	-	-	-	-	-	-	-
-	+	-	-	+	-	-	-	-	-	-	-	-	-
+	+	-	-	-	-	-	-	-	-	-	-	-	-
+	+	-	-	-	-	-	-	-	-	-	-	-	-
+	+	-	-	-	-	-	-	-	-	-	-	-	-
+	-	+	-	-	-	-	-	-	-	-	-	-	-
+	+	-	-	-	-	-	-	-	-	-	-	-	-
+	-	+	-	+	-	-	-	-	-	-	-	-	-
+	+	+	-	-	-	-	-	-	-	-	-	-	-
+	+	+	-	+	-	-	-	-	-	-	-	-	-
+	+	-	+	+	-	-	-	-	-	-	-	-	-
+	+	+	-	-	+	-	-	-	-	-	-	-	-
+	+	+	+	-	-	+	-	-	-	-	-	-	-
+	+	+	+	+	-	-	-	-	-	-	-	-	-
+	-	+	-	-	+	+	+	+	-	-	-	-	-
+	-	+	+	-	+	+	+	-	-	-	-	-	-
+	+	+	+	-	+	+	-	-	-	-	+	-	-
+	+	+	+	+	+	-	-	+	-	-	-	-	-
+	+	+	+	+	+	-	-	+	-	-	-	-	-
+	+	+	+	+	+	-	-	-	+	+	-	-	-
+	+	+	+	+	+	+	+	-	+	+	-	-	-
+	+	+	+	+	+	+	+	-	+	+	-	-	-
+	+	+	+	+	+	+	+	+	+	+	-	-	-
+	+	+	+	+	+	+	+	+	-	-	+	+	-
+	+	+	+	+	+	+	+	+	-	+	+	-	-

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Guttman Scale Analysis of Predicate Type Emergence Order in ASD Group

+	+	+	+	+	+	+	+	+	+	-	+	+	-
+	+	+	+	+	+	+	+	+	+	+	+	+	-
+	+	+	+	+	+	+	+	+	+	+	+	+	-
+	+	+	+	+	+	+	+	+	+	+	+	+	-
+	+	+	+	+	+	+	+	+	+	+	+	+	+
+	+	+	+	+	+	+	+	+	+	+	+	+	+
+	+	+	+	+	+	+	+	+	+	+	+	+	+
+	+	+	+	+	+	+	+	+	+	+	+	+	+
+	+	+	+	+	+	+	+	+	+	+	+	+	+
+	+	+	+	+	+	+	+	+	+	+	+	+	+
39	**30**	**28**	**23**	**23**	**22**	**19**	**17**	**16**	**14**	**14**	**13**	**12**	**6**