

THE INFLUENCE OF LANGUAGE PHENOTYPE ON PREDICTORS OF EMERGENT
LITERACY IN CHILDREN WITH AN AUTISM SPECTRUM DISORDER

by

Olivia Boorum

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Director of Thesis: Marianna Walker, Ph.D.

Major Department: Communication Sciences and Disorders

The development of emergent literacy skills in children with Autism Spectrum Disorders (ASD) is a growing subject of inquiry in the field of communication sciences and disorders; however, few studies have investigated the relationship between oral language skills and emergent literacy as a function of various language phenotypes of children with ASD. The purpose of this study was to investigate the relationship between oral language abilities in various domains and emergent literacy skills as a function of two language phenotypes, ASD Language Normal (ALN) and ASD Language Impaired (ALI). These phenotypes were determined based on the standardized test scores of a nonword repetition measure of phonological memory. Domains of oral language assessed included semantics (definitional vocabulary and lexical retrieval), morphology, syntax, and pragmatics (receptive/expressive language). Emergent literacy skills assessed in this study include phonological awareness and print knowledge. The participants consisted of 11 children diagnosed with ASD between the ages of 4 years 0 months and 5 years 11 months. Of those 11 participants, 4 were classified in the ALN phenotype and 7 in the ALI phenotype. Significant positive correlations were found between the oral language skills of definitional vocabulary, syntax, morphology, and pragmatics, and phonological awareness. No significant correlations were found between print knowledge

and oral language skills with the exception of lexical retrieval. Furthermore, phonological awareness performance was found to be significantly different as a function of phenotype, while print knowledge was not. ALN participants demonstrated greater abilities in phonological awareness than ALI participants, while print knowledge skills were strong in both phenotype groups. These results demonstrate a significant relationship between phonological awareness performance and oral language domains, as well as ASD language phenotype. Overall, participants in the ALN phenotype had significantly higher scores in measures of vocabulary, syntax, morphology, pragmatics, and phonological awareness. Scores on these standardized tests indicate a distinct emergent literacy profile for both ALN and ALI participants, with oral language domains that are significantly related to phonological awareness ability. These profiles and their relationship with measures of oral language should be considered when evaluating and formulating treatment goals for preschool aged children with ASD.

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Olivia Boorum

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Olivia Boorum

APPROVED BY:

DIRECTOR OF THESIS: _____
Marianna M. Walker, Ph.D.

COMMITTEE MEMBER: _____
Balaji Rangarathnam, Ph.D.

COMMITTEE MEMBER: _____
Kevin O'Brien, Ph.D.

COMMITTEE MEMBER: _____
Christy Walcott, Ph.D.

CHAIR OF THE DEPARTMENT OF COMMUNICATION SCIENCES AND DISORDERS:

Jamie L. Perry, Ph.D.

DEAN OF THE GRADUATE SCHOOL:

Paul Gemperline, Ph.D.

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TABLE OF CONTENTS

LIST OF TABLES	viii
LIST OF FIGURES	ix
CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW	1
Introduction	1
Autism	1
Overview and Diagnosis	1
Literacy and the Language Impaired Population	4
Emergent Literacy Development	5
Print Knowledge	5
Alphabet Knowledge	6
Phonological Awareness	6
Autism and Language	8
Language Profiles in Children with Autism	8
Language Phenotypes	10
Autism and Literacy	15
Autism and Emergent Literacy	18
Factors Affecting Pre-Literacy Skills in Autism Spectrum Disorder	20
Purpose of Study	22
Research Questions	23
CHAPTER II: METHODS	24
Participants	24

Gilliam Autism Rating Scale – Third Edition	24
Testing Conditions	25
Testing Session 1	26
Comprehensive Test of Phonological Processing – Second Edition	26
Criteria for Group Inclusion	26
Test of Language Development – Primary: Fourth Edition	27
Comprehensive Assessment of Spoken Language	27
Testing Session 2	28
Test of Preschool Early Literacy	28
Comprehensive Test of Phonological Processing – Second Edition	28
Statistical Analysis	29
CHAPTER III: RESULTS	30
Research Questions	41
ASD Phenotype	44
Relationship of Oral Language to Emergent Literacy Skills	44
Semantics	46
Syntax/Morphology	49
Pragmatics	51
Emergent Literacy Performance by Phenotype	53
CHAPTER IV: DISCUSSION	56
Research Question One	57
Research Question Two	60
Semantics	61

Syntax and Morphology	62
Pragmatics	63
Limitations	65
Future Research	66
Clinical Implications	67
Summary	68
REFERENCES	71
APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL FORM	76
APPENDIX B: INFORMED CONSENT FORM	78
APPENDIX C: GARS-3 TEST SCORES	80
APPENDIX D: ORAL LANGAUGE EXPERIMENTAL TEST SCORES	81
APPENDIX E: EMERGENT LITERACY EXPERIMENTAL TEST SCORES	82

LIST OF TABLES

1. Mean and Standard Deviations for Oral Language Test Scores as a Function of Group (ALN and ALI)	42
2. Mean and Standard Deviations for Early Literacy Test Scores as a Function of Group (ALN and ALI)	43
3. Correlation Between Lexical Retrieval, Definitional Vocabulary, and Emergent Literacy Measures (Phonological Awareness, Print Knowledge, Early Literacy Index)	48
4. Correlation Between Syntax and Morphology, and Emergent Literacy Measures (Phonological Awareness, Print Knowledge, Early Literacy Index)	50
5. Correlation Between Pragmatics and Emergent Literacy Measures (Phonological Awareness, Print Knowledge, Early Literacy Index)	52
6. Correlation Between Phonological Awareness, Print Knowledge, and Early Literacy Index	54

LIST OF FIGURES

1. <i>Gilliam Autism Rating Scale – Third Edition</i> Scores as a Function of Phenotype.....	31
2. <i>Comprehensive Test of Phonological Processing – Second Edition</i> Nonword Repetition Subtest Scores as a Function of Phenotype.....	33
3. <i>Test of Language Development: Primary – Fourth Edition</i> Syntactic Understanding Subtest Scores as a Function of Phenotype.....	34
4. <i>Test of Language Development: Primary – Fourth Edition</i> Morphological Completion Subtest Scores as a Function of Phenotype	35
5. <i>Comprehensive Assessment of Spoken Language</i> Pragmatic Judgment Subtest Scores as a Function of Phenotype	36
6. <i>Test of Preschool Early Literacy</i> Definitional Vocabulary Subtest Raw Scores as a Function of Phenotype	37
7. <i>Test of Preschool Early Literacy</i> Print Knowledge Subtest Scores as a Function of Phenotype	38
8. <i>Test of Preschool Early Literacy</i> Phonological Awareness Subtest Raw Scores as a Function of Phenotype	39
9. <i>Comprehensive Test of Phonological Processing – Second Edition</i> Rapid Object Naming Subtest Scores as a Function of Phenotype	40
10. <i>Test of Preschool Early Literacy</i> Early Literacy Index Scores as a Function of Phenotype	45
11. Correlations Among Oral Language and Emergent Literacy Test Scores	47

Chapter 1

Introduction and Literature Review

Introduction

While much is known about the factors that affect emergent literacy development in typically developing children, less is known about how early reading ability develops in children on the autism spectrum and how development differs within this population. The emergent literacy period is considered to be the time between birth and kindergarten, or the beginning of formal education (Kamhi & Catts, 2012). Literacy knowledge acquired in this period through activities such as joint book reading, literacy toys and artifacts in the home, and print exposure can affect future reading proficiency, making it a popular topic of research (Kamhi & Catts, 2012). In recent years, research on emergent literacy in the Autism Spectrum Disorder (ASD) population has focused on comparing skills or growth to typically developing peers and gathering influential data on the early literacy profile of children with ASD as a whole (Westerveld, Trembath, Shellshear, & Payntar, 2016; Davidson & Ellis Weismer, 2014; Jacobs & Richdale, 2013).

Autism

Overview and Diagnosis

The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (DSM-V) defines Autism Spectrum Disorder through two distinct diagnostic criteria; deficits in social communication and interaction, and restricted and repetitive behavior, that are present in early development and cause a clinically significant impairment (Simms & Jin, 2015).

Autism is considered a spectrum disorder because deficits in social communication and restrictive behavior can vary in severity from mild to severe impairment. Intelligence can also vary from average or above average intelligence to severe intellectual disability (Boehm, 2016). While social communication and interaction deficits are a necessary diagnostic criterium for ASD, individuals on the spectrum can range from mild pragmatic deficits to severe language impairment or an inability to develop spoken language (Boehm, 2016). Common features of ASD in young children may include but are not limited to selective hearing, diminished interest in or difficulty engaging with peers, fixated interests, delayed developmental milestones or regression of developmental milestones, difficulty maintaining eye contact, and stereotyped motor movements such as flapping or repetitive vocalizations (Luciano 2016).

According to the Center for Disease Control and Prevention, approximately 1 in 68 children in the United States has been identified as having an Autism Spectrum Disorder, equating to about 1.5% of the US population of children (New Data on Autism, 2016). In a recent study consisting of 58,467 four- year old children in the Early Autism and Developmental Disability Monitoring Network, 13.4 per 1000 children were identified as having Autism Spectrum Disorder (Christensen et al. 2016). Of those children, 46% had scores on pre-existing cognitive assessments consistent with cognitive impairment (Christensen et al. 2016). Causative factors of ASD include genetic factors, heredity, and other risk factors such as older parents and low birth weight (Simms & Jin, 2015).

Diagnosis of ASD typically occurs around 4 years of age, according to a recent study by Zuckerman, Lindly, and Chavez, which analyzed Centers for Disease Control's data of 722 children from ages 6 to 11 with ASD (Zuckerman et al., 2017). Zuckerman and colleagues (2017) also discovered a mean diagnostic delay of 2.2 years between the initial discussion of

parent concern with a primary care provider and the official diagnosis. While the average age of diagnosis for children on the spectrum is approximately 4 according to Zuckerman et al., it should be noted that children on the higher functioning end of the autism spectrum may not be diagnosed until well into formal schooling when social communicative demands increase and reveal underlying symptoms (Boehm, 2016).

Autism Spectrum Disorder is typically diagnosed by a clinical professional trained on the DSM-5 such as a clinical psychologist, however information required to make an autism diagnosis is gathered by an interdisciplinary team of professionals such as psychologists, speech-language pathologists, pediatricians, occupational therapists, and neuropsychologists (Boehm, 2016). Parents who express concern about possible autism symptoms to their child's pediatrician can receive a developmental or autism screening, such as the *Modified Checklist for Autism in Toddlers, Revised with Follow-up* (M-CHAT-R/F®), in order to determine need for referral (Boehm, 2016). Children who are referred for further testing will receive a comprehensive evaluation including an autism diagnostic evaluation given by a trained clinical professional, a developmental assessment, a cognitive assessment and an adaptive behavior assessment administered by a clinical psychologist, and a speech-language assessment administered by a speech-language pathologist (Boehm, 2016).

Since social communication deficits are a hallmark characteristic of Autism Spectrum Disorders, it is important to understand how these deficits relate to literacy development, especially for those children who exhibit comorbid language impairments.

Literacy and the Language Impaired Population

The prevailing theory of reading ability cited by researchers who study literacy development is the simple view of reading (Davidson & Ellis Weismer, 2014; Westerveld et al., 2016; Nation, Clarke, Wright, & Williams, 2006). This theory states that there are two components that result in reading comprehension; decoding, which includes the skills required for word recognition, and linguistic comprehension (Davidson & Ellis Weismer, 2014). Hoover and Gough (1990) define linguistic comprehension as “the ability to take lexical information (i.e., semantic information at the word level) and derive sentence and discourse interpretations”. Since linguistic comprehension is integral to overall reading comprehension, those with deficits in oral language are at increased risk for deficits in reading ability (Davidson & Ellis Weismer, 2014). In examining the influence of decoding and comprehension on reading comprehension, Hoover and Gough (1990) assessed 254 children from kindergarten to fourth grade on decoding, reading comprehension, and listening comprehension tasks. They found that the product of index scores from the decoding and listening comprehension tasks accounted for significant proportions of variance in reading comprehension index scores, demonstrating that decoding and listening comprehension skills significantly impact success in reading comprehension (Hoover & Gough, 1990). Based on this theory, an individual can either have decoding deficits, comprehension deficits, or weaknesses in both areas. Therefore, when assessing literacy, both decoding and comprehension skills must be assessed to get a comprehensive view of reading ability and identify the relevant deficit.

The American Psychiatric Association’s *Diagnostic and Statistical Manual of Mental Disorders* (DSM-V) defines language disorder as “persistent difficulty in the acquisition and use of language across modalities (i.e., spoken, written, sign language, or other) due to deficits in comprehension or production” that are substantially below age expectations (Simms & Jin,

2015). The American Speech-Language-Hearing Association (ASHA) defines a language disorder as an “impaired comprehension and/or use of spoken, written and/or other symbol systems. The disorder may involve (1) the form of language (phonology, morphology, syntax), (2) the content of language (semantics), and/or (3) the function of language in communication (pragmatics) in any combination” (ASHA, 1993).

Emergent Literacy Development

Emergent literacy refers to the prerequisite skills that are needed for conventional reading and writing that are typically acquired before entry into formal schooling and are often influenced by exposure to literacy and interest in reading (Kamhi & Catts, 2012; Lonigan, Burgess, & Anthony, 2000). These skills include print knowledge, alphabet knowledge, and phonological awareness. In Leigh Rohde’s Comprehensive Emergent Literacy Model (2015), she defines emergent literacy as “the skills that children develop prior to conventional reading and writing as well as conceptual knowledge of print and how it functions”. According to her model, emergent literacy consists of four components that overlap and interact with each other; oral language development, phonological awareness, print awareness, and early writing (Rohde, 2015).

Print Knowledge

Print knowledge is defined as the understanding of the conventions and functions of print, such as the difference between pictures and words, top-to-bottom and left-to-right orientation of print, and the understanding of print to tell a story (Lonigan et al., 2000). Print awareness and knowledge has been shown to predict both decoding and reading comprehension performance

when controlling for vocabulary and metalinguistic awareness. These print knowledge skills have been found to be critical to emergent literacy development (Lonigan et al., 2000). The term print awareness is often used to describe both print knowledge and alphabet knowledge, since both skills contribute to overall awareness of written language and future decoding success (Rohde, 2015).

Alphabet Knowledge

Alphabet knowledge, or the ability to recognize letters, is a crucial skill for developing readers and presupposes the ability of children to make accurate sound-letter correspondence (Kamhi & Catts, 2012). Letter recognition is a foundation skill that is necessary for future word recognition and decoding and children who lack appropriate alphabet knowledge are shown to have difficulty reading and comprehending in the future (Kamhi & Catts, 2012). Not only is alphabet knowledge a stable Letter knowledge is highly predictive of phonological sensitivity, oral language skill, environmental print awareness and concepts about print knowledge in preschool aged children (Lonigan et al., 2000). In a study of 96 younger preschoolers between the ages of 25 and 61 months, and 97 older preschoolers between the ages of 48 to 64 months, phonological sensitivity and letter knowledge accounted for 54% of the variance in decoding ability (Lonigan et al., 2000).

Phonological Awareness

Phonological awareness can be defined as the general awareness of the syllabic structure of words (Otaiba, Kosanovich, & Torgesen, 2012). Children as young as two years may begin to demonstrate knowledge of sound systems and begin to develop skills such as rhyming, phoneme manipulation, also known as elision, alliteration, and nonsense word play (Kamhi & Catts,

2012). Rhyming is one of the first indicators of early phonological awareness and represents a shift from awareness of word meaning to awareness of word sounds (Rohde, 2015). Elision can be defined as “deleting discrete units of sound from words to create new words” (Hipfner-Boucher, Milburn, Weitzman, Greenberg, Pelletier, & Girolametto, 2014, p. 183). Hipfner-Boucher et al. (2014) examined the relationship between oral language development and phonological awareness by assessing 89 children between 46 and 71 months on measures of nonverbal reasoning, alphabet knowledge, word reading, phonological awareness, vocabulary, narrative retell, and narrative generation. Through fixed-order regression analysis they found that phonological memory, alphabet knowledge, word reading, vocabulary, and narrative structure were significantly related to phonological awareness and accounted for 65% of the variance in phonological awareness skill (Hipfner-Boucher et al., 2014). These results supported their hypothesis that oral language skills and phonological awareness development are interrelated in 4- and 5-year-old children (Hipfner-Boucher et al., 2014).

Phonemic awareness, or the awareness of the sound structure of words, may not formally develop until kindergarten or first grade, although formal instruction is not necessary to develop relatively sophisticated phonemic awareness skills such as elision and blending. (Kamhi & Catts, 2012). Kenner, Terry, Friebling, and Namy (2017) examined early phonemic awareness ability by assessing twenty-five 2.5-, and twenty-five 3.5-year-old children in receptive phonemic awareness tasks. Results from these tasks demonstrated that initial phoneme discrimination skills were evident in the 3.5-year-old group, supporting the theory that phonemic awareness is emergent in children under 4 years old (Kenner et al., 2017).

In determining how these skills develop and differ in preschool aged children with ASD, it is important to understand the general language characteristics and profiles of individuals on the spectrum.

Autism and Language

Language Profiles in Children with Autism

Significant research contributions have been made to better understand the language characteristics of the broader population of children with autism (Wilkinson, 1998; Volden & Lord, 1991) and more recently ASD (Loucas et al., 2008; Davidson & Ellis Weismer, 2017). Davidson and Ellis Weismer (2017) used longitudinal data from 64 late-talkers and children with ASD at 30, 44, and 66 months to examine differences in receptive and expressive abilities in these populations. Standard scores from the *Preschool Language Scale, Third Edition (PLS-3)* for the late-talkers, the *Preschool Language Scale, Fourth Edition (PLS-4)* for the ASD group, *Mullen Scales of Early Learning*, *Bayley Scales of Infant Development, Second Edition (Bayley-II)* for the late-talker group and *Bayley Scales of Infant Development, Third Edition (Bayley-III)* for the ASD group revealed a distinct comprehension-production discrepancy profile in the ASD group that did not exist in the late-talker group (Davidson & Ellis Weismer, 2017). Even when controlling for nonverbal cognition, expressive language (production) standard scores were significantly higher than auditory comprehension (comprehension) standard scores on the PLS in the ASD group, while in the late-talker group the opposite was true, comprehension was significantly stronger than production (Davidson & Ellis Weismer, 2017). This ASD specific language profile, which differs from age and cognition matched peers who are at risk for language disorder, suggests a distinct pattern of early language development with relative

strengths in production and relative weaknesses in comprehension (Davidson & Ellis Weismer, 2017).

Children with ASD not only differ from other populations in their receptive vs. expressive language skill, but they are known to have unique language characteristics in the various domains of oral language (Wilkinson, 1998; Volden & Lord, 1991; Tager-Flusberg, 2000; and Loucas et al., 2008). It is well documented that individuals with ASD tend to exhibit deficits in pragmatic functions and discourse skills, which affect conversational turn-taking, appropriate eye contact, gestures, and topic maintenance (Wilkinson, 1998, Tager-Flusberg, 2000). Impairments in joint attention are also noted and have proven to be an effective distinguishing marker between children with autism and typically developing children (Wilkinson, 1998).

Echolalia, or the “immediate or delayed repetition of words and phrases”, is another characteristic of the ASD population, and not only affects the individual’s pragmatic function, but is often characterized by atypical vocal quality and prosodic patterns of speech (Wilkinson, 1998). Echolalic behavior is often present in individuals across the spectrum of autism severity, and even when other language skills are acquired or improved across the lifespan, these behaviors and the subsequent impairments in prosody tend to persist, demonstrating how atypical vocal quality and prosody are syndrome-specific characteristics of ASD (Wilkinson, 1998).

Semantic deficits have also been noted in the ASD population, specifically with regards to metaphoric or idiomatic language, even when they may excel at naming and categorization tasks (Wilkinson, 1998). Individuals with ASD may have a range of semantic skills based on autism symptomatology. Volden and Lord (1991) studied semantic and syntactic deficits in 80 children between 6 and 18 years old who were divided into four equal groups; high functioning

autistic, typically developing, low functioning autistic, and mentally handicapped (intellectually disabled) children (Volden & Lord, 1991). Using two language samples transcribed and coded based on linguistic features and rating of “oddness”, they found that the high functioning and low functioning autistic groups had the highest frequency of semantic errors (e.g., substituting “bald” for “naked”). The high functioning autistic group also made the highest frequency of non-developmental syntax errors, and the two autistic groups combined used neologisms, or non-words, at a higher rate than the mentally handicapped or TD groups (Volden & Lord, 1991). Based on this data Volden and Lord (1991) concluded that neologisms were most commonly used by autistic speakers, and that individual autistic participants presented with variable skill in length of utterance, semantic complexity, and syntactic complexity; however, they concluded that further investigation is needed to confirm the relationship between these semantic and syntactic abilities and use of neologisms.

While these areas of language represent common deficits in children with ASD, a homogeneous and typical language profile for this population does not exist. Children with ASD represent a heterogeneous combination of strengths, weakness, and behavioral patterns in the area of speech and language, and while many researchers have contributed to narrowing down this language profile, much of language intervention still relies on closely examining the specific areas of deficit for each child (Wilkinson, 1998).

Language Phenotypes

In an effort to create more specific and accurate language profiles for children with ASD, researchers (Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg & Joseph, 2003; Tager-Flusberg, 2006; Lanter et al., 2012) have focused on defining two distinct language phenotypes;

Autism Language Normal (ALN) and Autism Language Impaired (ALI). Understanding specific language profiles in children with ASD will assist clinicians in making differential diagnoses and choosing treatment approaches that align with certain patterns of language impairment.

Kjelgaard and Tager-Flusberg (2001) investigated the receptive and expressive language skills in 89 children between 4 and 14 years old with autism using the *Goldman Fristoe Test of Articulation* (GFTA), the *Peabody Picture Vocabulary Test-III* (PPVT-III), the *Expressive Vocabulary Test* (EVT), the *Clinical Evaluation of Language Fundamentals* (CELF), and the Repetition of Nonsense Words subtest of the *Developmental Neuropsychological Assessment* (NEPSY) (Kjelgaard & Tager-Flusberg, 2001). Results revealed no significant differences between performance on the PPVT (receptive lexical task) and the EVT (expressive lexical task) among the 80 children who completed both tests: however, significant differences were found between the expressive and receptive subtests of the CELF (Kjelgaard & Tager-Flusberg, 2001). Subtest scores ($M=10$, $SD=3$) on these subtests showed that the group of children that successfully completed the CELF ($n=44$) had significantly higher expressive language abilities on these language tasks than receptive language abilities (Kjelgaard & Tager-Flusberg, 2001).

In the Kjelgaard and Tager-Flusberg study (2001), the participants were divided into three groups (“impaired”, “borderline” and “normal”) based on the total language summary score of the CELF ($M=100$, $SD=15$). Participants were placed into the “normal” group if their CELF standard scores were 85 or higher, “borderline” if their scores were between 70 and 84, and “impaired” if standard scores were below 70 (Kjelgaard & Tager-Flusberg, 2001). Researchers noted that some participants were not able to complete the CELF battery Overall, the researchers found that across all groups, articulation abilities tended to be within normal limits; however, the difference in vocabulary performance among these groups was significant ($p < .0001$) and

corresponded closely to total language scores. Combined standard scores from the PPVT and the EVT of the “normal” group fell within normal limits, the “borderline” group around one standard deviation below the mean, and the “impaired” group greater than one standard deviation below the mean (Kjelgaard & Tager-Flusberg, 2001). While the mean subtest standard score for the repetition of nonsense words varied across the three groups, the differences were not statistically significant (Kjelgaard & Tager-Flusberg, 2001) While the “normal” language group had standard scores within normal limits, both the “borderline” and “impaired” groups had scores more than one standard deviation below the mean and had greater variability ($SD=10.85$, $SD=12.15$, respectively) (Kjelgaard & Tager-Flusberg, 2001). These findings demonstrate how language abilities significantly vary across individuals with ASD, even among participants who were able to complete a more complex language battery (CELF) and begin to reveal more systematic language profiles within the ASD population.

These profiles allude to a larger complexity in differentially diagnosing children with Language Disorder, ASD, and other communication disorders such as Social Pragmatic Communication Disorder. Simms and Jin (2015) discuss the integral role of the speech-language pathologist in teasing through overlapping symptoms such as expressive language, social interaction, repetitive behaviors, and nonverbal communicative behaviors. They note that very few of these characteristics and symptoms are unique to one specific disorder, and that children with autism may exhibit more generalized communication deficits in social interaction that are not diagnostically in line with a Language Disorder (Simms & Jin, 2015). However, some researchers have argued that specific subgroups of children with ASD have overlapping characteristics with those diagnosed with Language Disorders, which may illuminate how these deficits overlap and interact with each other for greater diagnostic clarity.

Researchers have shown that the impaired language profile of children with ASD often closely mirrors the language profile of school aged children with Specific Language Impairment (SLI) (Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg and Joseph, 2003). While these authors both note that children with SLI represent a heterogenous group, and that the language profiles of children with ASD and SLI are not perfect mirrors of each other, they argue that there are patterns of similarities that show a possible overlapping symptomatology in these two disorders. Tager-Flusberg and Joseph (2003) have specifically discussed and acknowledged similarities in non-word repetition performance between children with SLI and the ASD language impaired group from Kjelgaard and Tager-Flusberg's 2001 study. Non-word repetition is used to measure phonological processing and phonological memory, which was shown to be an area of impairment in the language impaired autism phenotype in the 2001 study. Nonword repetition measures are "highly sensitive to the diagnosis of SLI" and children with the language impaired autism phenotype are likely to make similar errors in non-word repetition tasks as children with SLI (Tager-Flusberg, 2006). Tager-Flusberg and Joseph (2003) explored grammatical morphology deficits in 62 participants between the ages of 4 and 14 from their original sample in the 2001 study by administering two experimental morphology tasks to elicit both regular and irregular past-tense forms and third person present tense forms (Tager-Flusberg & Joseph, 2003). The differences between language impaired and language normal ASD subtypes were statistically significant in expressive morphological skill for verb tenses. According to an error analysis of the ASD language impaired sub-type's responses, the most frequent errors made on the past-tense task, was an omission of any morphological marking. This error type has been reported to be one of the most frequent morphological errors reported in children with SLI (Tager-Flusberg & Joseph, 2003). The authors discuss these results as

demonstrating an “overlapping” subtype of children with autism and SLI, and while more research may be required to make this claim, their findings are consistent with the theory that certain individuals with ASD have overlapping characteristics with common language deficits found in SLI (Tager-Flusberg & Joseph, 2003).

Tager-Flusberg (2006) further examined the use of ASD language phenotypes in her 2006 study and defined two clear language phenotypes; the Autism Language Normal (ALN) phenotype, and the Autism Language Impaired (ALI) phenotype. She assessed 35 participants between the ages of 7 and 14 with ASD and average cognitive ability (average nonverbal IQ score = 83) by administering three phonological awareness subtests of the *Comprehensive Test of Phonological Processing* (CTOPP) including memory for digits, rapid automatic naming, and non-word repetition (NWR), which was used to separate participants into ALI and ALN phenotypes. The participants were also administered a cognitive test (*Differential Ability Scales*), the *Expressive Vocabulary Test* (EVT), and the *Peabody Picture Vocabulary Test* (PPVT) (Tager-Flusberg, 2006). Participants were judged to be in the normal/borderline language group if they scored a subtest score of 7 or higher on the NWR subtest, and in the impaired group if they scored a 6 or lower. Tager-Flusberg found that performance on the NWR subtest significantly correlated to rapid automatic naming and expressive vocabulary (EVT) ($r(32) = .44, p < .01$, and $r(32) = .50, p < .01$, respectively) (Tager-Flusberg, 2006). According to error analysis of the NWR subtest, which classified errors into phoneme deletion and phoneme substitution groups, the children in the ALI group ($n=20$) made phoneme deletion errors at a higher rate than the ALN group ($n=15$), which is consistent with previous findings related to NWR errors in children with SLI (Tager-Flusberg, 2006).

Research conducted by Tager-Flusberg and colleagues (Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg & Joseph, 2003; Tager-Flusberg, 2006) are consistent with the theory that two distinct language phenotypes in the ASD population exist, and that the ALI phenotype represents a similar pattern of language impairment as SLI (Tager-Flusberg, 2006). Knowing that oral language comprehension is closely related to literacy, per the simple view of reading, researchers have continued to investigate these ASD phenotypes in regards to reading ability (Jacobs & Richdale, 2013; Lucas & Frazier Norbury, 2014).

Autism and Literacy

A rich line of research has developed in understanding reading ability in school aged children on the spectrum (Jacobs & Richdale, 2013; and Lucas & Frazier Norbury, 2014). Lucas and Frazier Norbury (2014) investigated reading comprehension profiles in children with ASD in both the ALN and ALI phenotypes. In this study, that consisted of fifty children (ALN $n = 25$, ALI $n = 25$) between 7 and 14 years of age, the following tests/tasks were administered: the Matrix Reasoning sub-test of the *Wechsler Abbreviated Scales of Intelligence*, the *Expressive One-Word Picture Vocabulary Test*, the *Receptive One-Word Picture Vocabulary Test*, the *Test of Word Reading Efficacy* (Sight Word Efficiency and Phonemic Decoding Efficiency subtests), the Recalling Sentences subtest of the *Clinical Evaluation of Language Fundamentals* (CELF), the *Neale Analysis of Reading Ability Second Revised British Edition* (NARA-II) and a sentence processing task created by the authors to assess sentence level comprehension (Lucas & Frazier Norbury, 2014). They found that standard scores on the NARA-II were significantly predicted by vocabulary knowledge ($p < .001$) and decoding ability ($p = .026$), rather than autistic symptomatology ($p = .790$). Data from the sentence processing task also failed to show a sentence-level semantic processing deficit among the ASD participants, leading researchers to

conclude that deficits in comprehension may be linked more to linguistic ability rather than ASD diagnosis (Lucas & Frazier Norbury, 2014).

In a 2017 study, McIntyre, Solari, Grimm, Lerro, Gonzales, and Mundy investigated reading profiles in school aged children and adolescents with high functioning autism. In the 100 individuals who participated in the study between the ages of 8 and 16 years, all had an IQ greater than or equal to 75, and were administered portions of the *Comprehensive Test of Phonological Processing, Second Edition* (CTOPP-2), the *Gray Oral Reading Test- Fifth Edition* (GORT-5), the *Clinical Evaluation of Language Fundamentals, Fourth Edition* (CELF-4), the *Test of Auditory Processing Skills, Third Edition* (TAPS-3), the *Wide Range Assessment of Memory and Learning, Second Edition* (WRAML2), *Test of Word Reading Efficiency, Second Edition* (TOWRE-2), and the *Weschler Abbreviated Scales of Intelligence-II* (WASI-2) (McIntyre et al., 2017). While the participants as a whole had mean standard scores and scaled subtest scores in the average range for word recognition, expressive vocabulary, and elision, mean scores for reading comprehension were in the low average range, demonstrating a discrepancy between some oral language skills and reading comprehension in this group as a whole (McIntyre et al., 2017). The authors were able to identify four distinct reading profiles based on these scores; Average Readers (32.1% of sample), Comprehension Disturbance (20.6%), Global Disturbance (33.2%), and Severe Global Disturbance (14.1%). These distinct profiles show that while some individuals in this sample had global deficits in language and literacy, approximately a third of the sample demonstrated average language and literacy abilities, while another portion of the sample demonstrated average expressive language and linguistic abilities with relative deficits in auditory reasoning and reading comprehension (McIntyre et al., 2017). Overall, this study provides evidence that individuals with ASD may

possess variable literacy abilities that may or may not be in line with their overall expressive language skill.

Jacobs and Richdale (2013) examined and compared predictors of literacy ability in typically developing (TD) children and adolescents with high functioning autism (HFASD), defined as individuals with an ASD diagnosis who have an IQ greater than 70 (Jacobs & Richdale, 2013). They examined 84 children (42 in the HFASD group and 42 TD) between the ages of 6 and 8 years by comparing scores on the *Wechsler Pre-School and Primary Scale of Intelligence – Revised*, the *Comprehensive Test of Phonological Processing*, the *Peabody Picture Vocabulary Test-III*, the *Expressive Vocabulary Test*, the *Clinical Evaluation of Language Fundamentals-Third Edition*, the *Renfrew Bus Story*, the *Pragmatics Profile of Everyday Communication Skills in School Aged Children*, the *Test of Visual-Perceptual Skills (non-motor) – Revised*, the Attention and Memory Battery of the *Leiter-R*, the *Woodcock Reading Mastery Tests – Revised*, and the *Neale Analysis of Reading – Third Edition* to assess all domains of both language and literacy ability (Jacobs & Richdale, 2013). Participants were included in the HFASD group if they had a preexisting diagnosis of HFASD or ASD, and a verbal IQ and full-scale IQ in the average or above average range (Jacobs & Richdale, 2013). Simple linear regression showed that phonological awareness, phonological memory, rapid naming, and syntax predicted decoding ability in the HFASD group, with phonological memory being the strongest predictor, accounting for 52% of the variance in decoding ability, while for the TD group phonological awareness was the strongest single predictor at 40% of variance (Jacobs & Richdale, 2013). This is significant not only due to the discrepancy between TD and HFASD groups, but because phonological memory tasks such as non-word repetition have been shown to accurately separate ASD participants into ALI and ALN phenotypes (Tager-Flusberg, 2006).

Full scale IQ, phonological awareness, phonological memory, syntax, and rapid naming predicted reading comprehension in the HFASD group, with syntax being the strongest predictor of reading comprehension in both groups, explaining 61% of the variance in comprehension ability in the HFASD group and 43% of the variance in the TD group (Jacobs & Richdale, 2013). In their study, Jacobs and Richdale (2013) investigated the predictability of reading ability in children with average cognition and language ability; however, knowing the heterogeneous nature of the ASD population and the variance in oral language ability, it can be assumed that predicting factors of reading ability will vary across language phenotype.

Autism and Emergent Literacy

The relationship of emergent literacy skills as a predictor of future reading abilities has well documented in the literature and as a result, development of such skills is widely supported in evidence-based practice and education with children prior to entering kindergarten. Researchers are now beginning to examine emergent literacy skills in the ASD population and the development of these skills which are necessary to acquire conventional literacy skills. Various research studies have investigated the differences in emergent literacy skills between children diagnosed with autism spectrum disorder and typically developing (TD) children. Dynia, Brock, Logan, Justice, and Kaderavek (2016) compared alphabet knowledge and print knowledge in 35 TD and 35 ASD children between the fall of the preschool year and the spring of kindergarten by measuring both their knowledge and rate of acquisition in these two domains. The two groups were administered two subtests from the *Phonological Awareness Literacy Screening* (PALS) to assess alphabet knowledge (uppercase and lowercase subtests) and the *Preschool Word and Print Awareness* (PWPA) test to assess print-concept knowledge (Dynia et al., 2016). Raw scores from the PWPA revealed that in comparison to TD peers, the ASD

participants had lower print-concept knowledge at all time points of testing. In the spring of kindergarten, the ASD group achieved a mean raw score of 7.48, while the TD group achieved a mean raw score of 12.65 (Dyonia et al., 2016). Both groups demonstrated comparable alphabet knowledge indicating a possible relative weakness in print-concept knowledge and a relative strength in alphabet knowledge in children with ASD when compared to TD children (Dyonia et al. 2016).

Other studies have found similar weaknesses in print knowledge among children with ASD. Westerveld, Payntar, Trembeth, Webster, Hodge, and Roberts (2017) studied emergent literacy skills in preschoolers with ASD and found relative weaknesses in print knowledge and meaning related measures such as comprehension, while they found relative strengths in code-related measures such as alphabet knowledge. Westerveld et al. (2017) also found relative strengths in phonological awareness based on scores on the beginning sound awareness subtest of the *Phonological Awareness Literacy Screening for Preschoolers (PALS-PreK)*, with 75.4% of the 57 participants scoring at or above the expected developmental range. Within the group of participants, the mean nonverbal cognition standard score was 79.11, and the mean standard score on the *Peabody Picture Vocabulary Test-4 (PPVT-4)* was a 90.0, indicating that as a group, nonverbal cognition was slightly below average while vocabulary knowledge was in the average range (Westerveld et al., 2017). However, the PPVT-4 and the *Vineland Adaptive Behavior Scales-II (VABS-II)* were the only language tests used to provide a description of the language abilities of the group, and a more comprehensive language battery examining all language domains may provide a more detailed picture of the oral language abilities of participants.

When children with ASD are separated based on language phenotype, different profiles of emergent literacy begin to develop. Lanter, Watson, Erickson, and Freeman (2012) assessed

emergent literacy skills in 41 children diagnosed with ASD between the ages of 4;1 and 7;10. Standard scores on the *Test of Early Language Development-Third Edition* (TELD-3) were used to group participants into typical language (TL), mild-moderate language impairment (LI) and severe impaired language (severe LI) subgroups. Participants were considered to have typical language if their composite scores ($M = 100$, $SD = 15$) were at or above 1.5 SD from the mean. Participants were placed in the mild-moderate impaired language group if their composite scores were between 2.5 and 1.5 SDs below the mean, and in the severe LI group if their composite scores were 2.5 SD below the mean (Lanter et al., 2012). Emergent literacy skills were assessed using the *Emergent Literacy Profile* (ELP), consisting of performance on subtests including Letter Name Identification, Letter-Sound Correspondence, Environmental Print, Print Concepts, and Emergent Writing. Results revealed that medium group differences existed between the TL and LI groups in the area of total emergent literacy; however, differences in individual subtest scores across groups were not significant (Lanter et al., 2012). These results demonstrate how overall emergent literacy abilities may vary across autism language phenotypes much like oral language; however, the nature of these discrepancies across specific literacy skills is not clear.

Factors affecting pre-literacy skills in Autism Spectrum Disorder

Few studies have examined the skills that predict emergent literacy performance in preschool children with ASD, with the exception of Westerveld et al., who used correlational analysis in their 2017 study to identify factors that were strongly associated with both code related and meaning related emergent literacy skills. They assessed 57 children between the ages of 4 years, 0 months and 5 years, 10 months using the *Mullen Scales of Early Learning, Social*

Communication Questionnaire, *Vineland Adaptive Behavior Scales-II* (VABS-II), the *Peabody Picture Vocabulary Test Fourth Edition* (PPVT-4), the *Phonological Awareness Literacy Screening for Preschoolers* (PALS-PreK), the rapid automatic naming subtest of the *Woodcock Reading Mastery Tests-Revised*, *Oral Narrative Comprehension* and *Oral Narrative Quality* scores, and a home literacy questionnaire (Westerveld, et al., 2017). The factors that were significantly associated with emergent literacy performance included autism severity (SCQ), socio-economic status, frequency of book reading in the home, the VABS-II communication domain, nonverbal communication assessed through the *Mullen Scales of Early Learning*, and the emergent literacy measures. Their analysis showed that receptive vocabulary, as assessed through the PPVT-4, was significantly correlated ($B = 0.093$, $t = 3.459$, $p = .001$) with all emergent literacy skills. Based on multiple regression analysis, autism severity, nonverbal cognition, VABS-II communication domain scores, and receptive vocabulary (PPVT-4) explained 34.3% of variance in code related performance (i.e. letter name knowledge, letter sound knowledge, phonological awareness, print and word awareness, and rapid automatic naming). These combined factors together significantly predicted code-related ability scores, and the PPVT-4 alone was the only significant single predictor of code-related performance (Westerveld et al., 2017). Significant predictors of meaning-related skills (i.e. receptive vocabulary, oral narrative comprehension, and oral narrative quality) included autism severity, nonverbal cognition, home literacy, and the VABS-II communication domain. Together, autism severity, nonverbal cognition, and the VABS-II communication scores accounted for 40.7% of the variance in meaning-related skills, and each factor was also considered a significant individual predictor (Westerveld et al., 2017).

Westerveld et al. (2017) further concluded from this study that frequency of book reading was not strongly correlated to code-related emergent literacy skills and was only mildly significantly correlated to oral narrative quality ($r = 0.274, p < .05$). These results related to home literacy environment are not consistent with previous research by Dynia et al. (2014), who found that both alphabet knowledge and print knowledge were positively correlated with frequency of book reading within the home in a group of 70 children (ASD $n=35$, TD $n=35$) between 36-67 months of age with varying language abilities in the ASD group. These conflicting results could be due to lack of variability in the home literacy practices of the sample, and the method of data collection for this variable, a questionnaire, which is susceptible to response bias.

While it less clear whether home literacy environment is associated with emergent literacy skills in children with autism, strong associations between nonverbal cognition, autism severity, and oral language performance, and the emergent literacy skills have been documented for preschool children with ASD (Westerveld et al., 2017). However, the measure of oral language performance used by Westerveld et al., the VABS-II, only measures broad language ability, which the authors cite as a limitation of their study (Westerveld et al., 2017). A more comprehensive oral language battery may provide a greater understanding of how oral language abilities relate to emergent literacy in children with ASD.

Purpose of Study

This study will investigate the influence of language phenotype in predicting emergent literacy skills in children with autism spectrum disorder. This study will investigate the influence of participant group (ALN and ALI phenotypes), morphological knowledge, syntactic

knowledge, pragmatic knowledge, and vocabulary knowledge, on print knowledge, phonological awareness, and total Early Literacy Index scores. Based on previous research in the areas of emergent literacy in children with ASD and language phenotypes within the ASD population, it is expected that children exhibiting an ALN phenotype will demonstrate different predictors of emergent literacy skills than children exhibiting the ALI phenotype.

Research Questions

This study poses the following research questions:

For a sample population of preschool aged children diagnosed with autism spectrum disorder and divided into ALN and ALI phenotypes:

- 1) Do children in the ALN and ALI phenotypes perform differently on measures of emergent literacy (phonological awareness and print knowledge)?
- 2) Do predictors of emergent literacy performance (i.e. vocabulary, morphology, syntax, pragmatics, and lexical retrieval), vary based on phenotype (ALN and ALI)?

Chapter 2

Methods

Participants

11 preschool age children with autism were recruited from a Pitt County public preschool in Eastern North Carolina to participate in this research study. All children in the four self-contained autism classrooms at this preschool were invited to opt in to this research study. 20 children returned informed consent forms signed by their parents to be included in the study, and 11 of those children met all inclusion criteria. The following criteria were used for inclusion in the study: (a) between the ages of 4:0 and 5:11 years, (b) an existing diagnosis of Autism Spectrum Disorder according to criteria outlined by the DSM-V, (c) no reported prior history of significant hearing loss or visual impairment, and (d) no prior exposure to kindergarten level curriculum to control for level of instruction. Participants with a reported history of speech sound disorders were not excluded from the study, but this information was noted when evaluating testing results. All information regarding inclusion criteria was obtained through the *Gilliam Autism Rating Scale – Third Edition* (GARS-3; Gilliam, 2014) which was administered to teachers before experimental test administration.

An informed consent form was approved by the Institutional Review Board, providing an overview of the purpose and procedures of the study (see Appendix B). After informed consent was provided by each participant's parent/guardian, the first testing battery was administered to gather preliminary information on participants.

Gilliam Autism Rating Scale – Third Edition

The *Gilliam Autism Rating Scale – Third Edition* (GARS-3; Gilliam, 2014) was completed by each participant’s preschool teacher in person to confirm previously reported autism diagnosis and to assess level of autism severity. The GARS-3 is a survey that is divided into six subtests including Restricted/Repetitive Behaviors, Social Interaction, Social Communication, Emotional Responses, Cognitive Style, and Maladaptive Speech. Scaled scores on these subtests are combined to create an Autism Index score, and an Autism Index score ≥ 55 indicates “probable” or “very likely” probability of ASD. Autism Index scores between 55-70 are consistent with DSM-5 Severity Level 1 “requiring minimal support”, scores between 71-100 are consistent with DSM-5 Severity Level 2 “requiring substantial support”, and scores ≥ 101 are consistent with DSM-5 Severity Level 3 “requiring very substantial support”. Scores on this survey ≥ 55 are required to proceed with standardized testing.

Testing Conditions

A series of standardized tests in the areas of semantics (vocabulary, retrieval), morphology, syntax, pragmatics, lexical retrieval, print knowledge, and phonological awareness, was completed with each participant by the primary investigator or research assistant within two testing sessions. The order of administration of the tests/subtests was randomized for each participant.

Testing was performed in the classroom setting for approximately 20 minutes in the first testing session and 30 minutes in the second testing session. Session 2 was completed between one to four weeks after the first testing session for each participant to avoid testing fatigue. Age appropriate games and positive reinforcement was used between assessments to maintain engagement and attention to task.

Testing Session 1

Comprehensive Test of Phonological Processing-Second Edition

The Nonword Repetition (NWR) subtest of the *Comprehensive Test of Phonological Processing-Second Edition* (CTOPP-2; Wagner R. K., Torgesen, J. K., Rashotte, C. A., Pearson, N. A., 2013) was administered to assess nonword repetition skills. The NWR subtest requires verbal repetition of a series of nonsense words (e.g. “teeg”) provided verbally through a recording. Scores on this subtest are converted to scaled scores with $M=10$ and $SD=2$ (Wagner et al. 10). Percentile ranks and standard scores were used to determine proficiency on this phonological processing subtest.

Criteria for Group Inclusion

The standard score on the Nonword Repetition task of the CTOPP-2 was used to divide participants into one of two groups; Autism Language Normal (ALN) and Autism Language Impaired (ALI). This nonword repetition task has been shown to be highly sensitive to identifying children with the ALI phenotype (Tager-Flusberg, 2006). A subtest scaled score of 6 or lower ($M = 10, SD = 2$) was required on this subtest to qualify for inclusion in the ALI group. In this sample of 11 children, 4 children scored a subtest scaled score of 7 or higher and were designated as having the ALN phenotype, while 7 children scored at or below a subtest scaled score of 6 and were designated as having the ALI phenotype.

Test of Language Development-Primary: Fourth Edition

Two subtests from the *Test of Language Development-Primary: Fourth Edition* (TOLD-P:4; Newcomer & Hammill 2008), Syntactic Understanding and Morphological Completion, were administered to assess participants' morphological and syntactic knowledge. The Syntactic Understanding subtest requires receptive identification of a picture that matches a spoken sentence (e.g. "Point to the picture that matches 'There are many dogs'"). (Newcomer et al. 11) The Morphological Completion subtest requires verbal completion of a spoken sentence using correct morphological endings (e.g. "Bill is a boy and John is a boy. They are both ____"). (Newcomer et al. 15) Both of these subtests were converted into scaled scores with a mean of 10 and a standard deviation of 2 and were given descriptive terms ranging from "very poor" to "very superior". Percentile ranks and standard scores were used to determine proficiency on these morphology and syntactic understanding subtests.

Comprehensive Assessment of Spoken Language

The Pragmatic Judgment subtest of the *Comprehensive Assessment of Spoken Language* (CASL; Carrow-Woolfolk, 1999) was administered to assess participant's pragmatic use of language. The Pragmatic Judgment subtest requires participants to exhibit various appropriate pragmatic functions when prompted in a situational context. Scores on this subtest were converted to a standard score with a M=100 and a SD= 15. Percentile ranks and standard scores were used to determine proficiency on this pragmatic judgment subtest.

Testing Session 2

Test of Preschool Early Literacy

The *Test of Preschool Early Literacy* (TOPEL; Lonigan, Wagner, Torgesen, & Rashotte, 2007) was administered to assess participant's early literacy knowledge through three subtests; Print Knowledge, Definitional Vocabulary, and Phonological Awareness. The Print Knowledge subtest assesses alphabet knowledge, print knowledge, and word knowledge, and requires participants to receptively and expressively identify specific letters, words, and sounds associated with letters. The Definitional Vocabulary subtest assesses depth and breadth of vocabulary and requires verbal identification of pictures as well as additional information on each picture (e.g. "What is it for?", "What does it do?") based on use or characteristic. The Phonological Awareness subtest assesses word elision and blending and requires both receptive and expressive response to two different tasks; phonological and phonemic elision, and phonological and phonemic blending. Scores on these subtests were converted to a standard score with a $M=100$ and a $SD=10$. The sum of these scores was also converted into an Early Literacy Index with a $M=100$ and a $SD=10$. Percentile ranks and standard scores were used to determine proficiency on these emergent literacy subtests.

Comprehensive Test of Phonological Processing-Second Edition

The Rapid Object Naming subtest of the CTOPP-2 (2013) was administered to measure rapid lexical retrieval abilities. Participants are provided names of objects during a practice phase, and then asked to verbally name objects during the testing phase. Scores on this subtest

were converted to scaled scores with $M=10$ and $SD=2$ (Wagner et al. 10). Percentile ranks and standard scores were used to determine proficiency on this lexical retrieval subtest.

Statistical Analysis

The dependent variables for this study include standardized test score data (both standard scores and subtest scores) on print knowledge, vocabulary, phonological awareness, lexical retrieval, syntax, morphology, and pragmatics. Correlational analysis was used to determine possible relationships between dependent variables of oral language ability (i.e. vocabulary, lexical retrieval, syntax, morphology, and pragmatics) and dependent variables of early literacy ability (i.e. print knowledge and phonological awareness). Independent samples exact Mann-Whitney U tests were used to analyze relationship between dependent variables and group membership (i.e. ALN or ALI phenotypes) to determine whether oral language and emergent literacy performance was significantly different between phenotype groups.

Chapter 3

Results

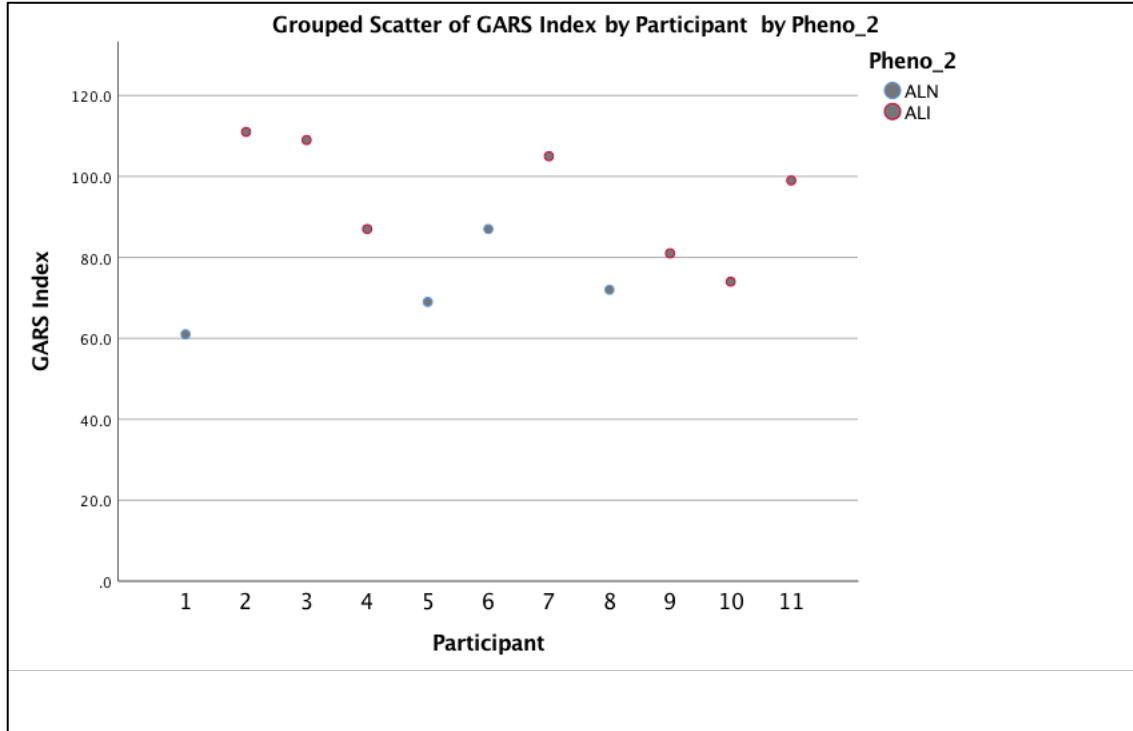
Research in the area of emergent literacy is necessary for speech pathologists, educators, and parents alike to understand the impact that literacy knowledge in a child's early years has on their literacy development later in life. The current body of research in emergent literacy has a primarily focus on typically developing children, and those studies that investigate early literacy in children with autism spectrum disorders (ASD) have focused on the ASD population as a whole, while less is known about how individuals in this population differ from each other. One method in classifying children on the spectrum of different abilities is to use language phenotypes, such as those identified by Tager-Flusberg et al. (2006). The current research study sought to examine the emergent literacy abilities of children with ASD of different phenotypes, as well as investigate the oral language abilities that may affect emergent literacy and their relationship to emergent literacy performance in children with ASD.

The participants for this study included 11 children with a previous diagnosis of Autism Spectrum Disorder (ASD) (*mean age = 4.86 years*). All participants included in this study were male, and all were between the ages of 4 years 0 months and 5 years 11 months.

To verify the previous diagnosis of ASD, the *Gilliam Autism Rating Scale – Third Edition* (GARS-3) was administered to each participant's preschool teacher prior to initiation of testing. Distribution of GARS-3 scores across all participants is presented in Figure 1.

Figure 1

Gilliam Autism Rating Scale – Third Edition Scores as a Function of Phenotype



Individual scores for each participant on the GARS-3 are presented in Appendix C. During the first testing session, each participant was administered the Pragmatic Judgment subtest of the *Comprehensive Assessment of Spoken Language* (CASL), the Syntactic Understanding and Morphological Completion subtests of the *Test of Language Development: Primary – 4th Edition* (TOLD:P-4), and the Nonword Repetition (NWR) subtest of the *Comprehensive Test of Phonological Processing – Second Edition* (CTOPP-2) in order to assess language abilities. Distribution of scores across all participants for the Nonword Repetition subtest of the CTOPP-2 are presented in Figure 2. Distribution of scores across all participants for the Syntactic Understanding subtest are presented in Figure 3. Distribution of scores for the Morphological Completion subtest are presented in Figure 4. Distribution of scores for the Pragmatic Judgment subtest of the CASL are presented in Figure 5. The Nonword Repetition subtest of the CTOPP-2 was used to assign participants into the Autism Language Impaired (ALI) or Autism Language Normal (ALN) phenotype groups. The ALI phenotype group included 7 children with ASD who scored a 6 or below on the CTOPP Nonword Repetition subtest (*mean age* = 4.79 years). The ALN phenotype group included 4 children with ASD who scored a 7 or higher on the CTOPP NWR subtest (*mean age* = 4.96 years).

During the second testing session, the *Test of Preschool Early Literacy* (TOPEL) and the Rapid Object Naming subtest of the CTOPP-2 was administered to each participant. Distribution of scores across all participants for the Definitional Vocabulary subtest is presented in Figure 6, distribution of scores for the Print Knowledge subtest is presented in Figure 7, distribution of scores for the Phonological Awareness subtest is presented in Figure 8, and distribution of scores for the Rapid Object Naming subtest of the CTOPP-2 is presented in Figure 9.

Figure 2

Comprehensive Test of Phonological Processing – Second Edition Nonword Repetition Subtest

Scores as a Function of Phenotype

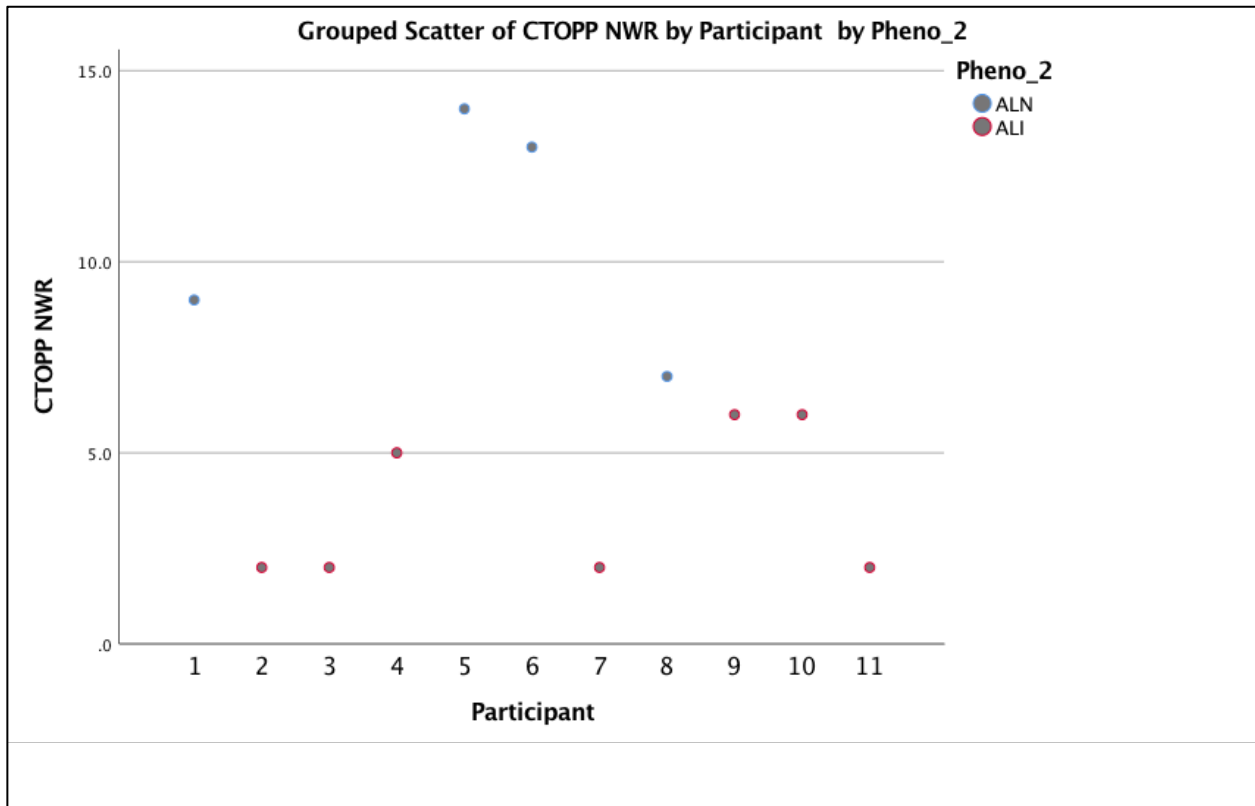


Figure 3

Test of Language Development: Primary – Fourth Edition Syntactic Understanding Subtest

Scores as a Function of Phenotype

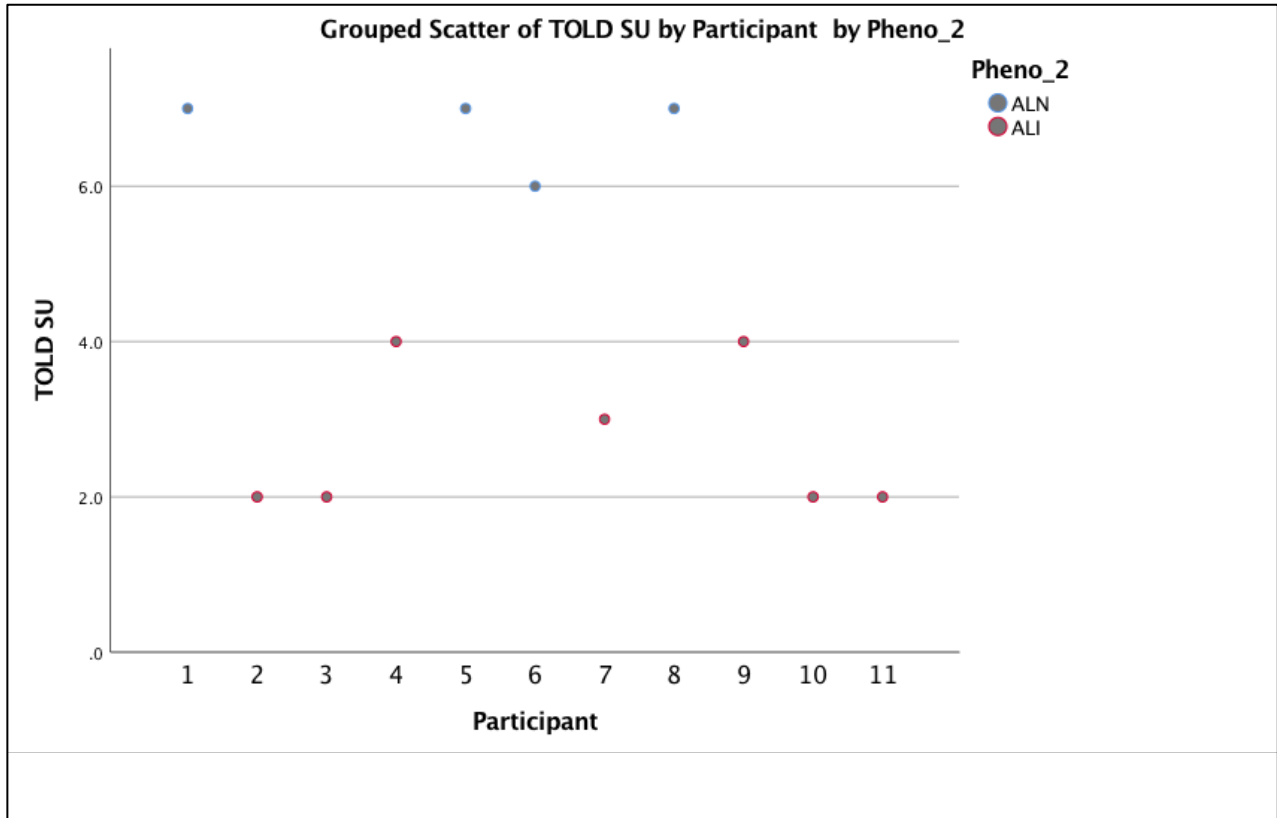


Figure 4

Test of Language Development: Primary – Fourth Edition Morphological Completion Subtest

Scores as a Function of Phenotype

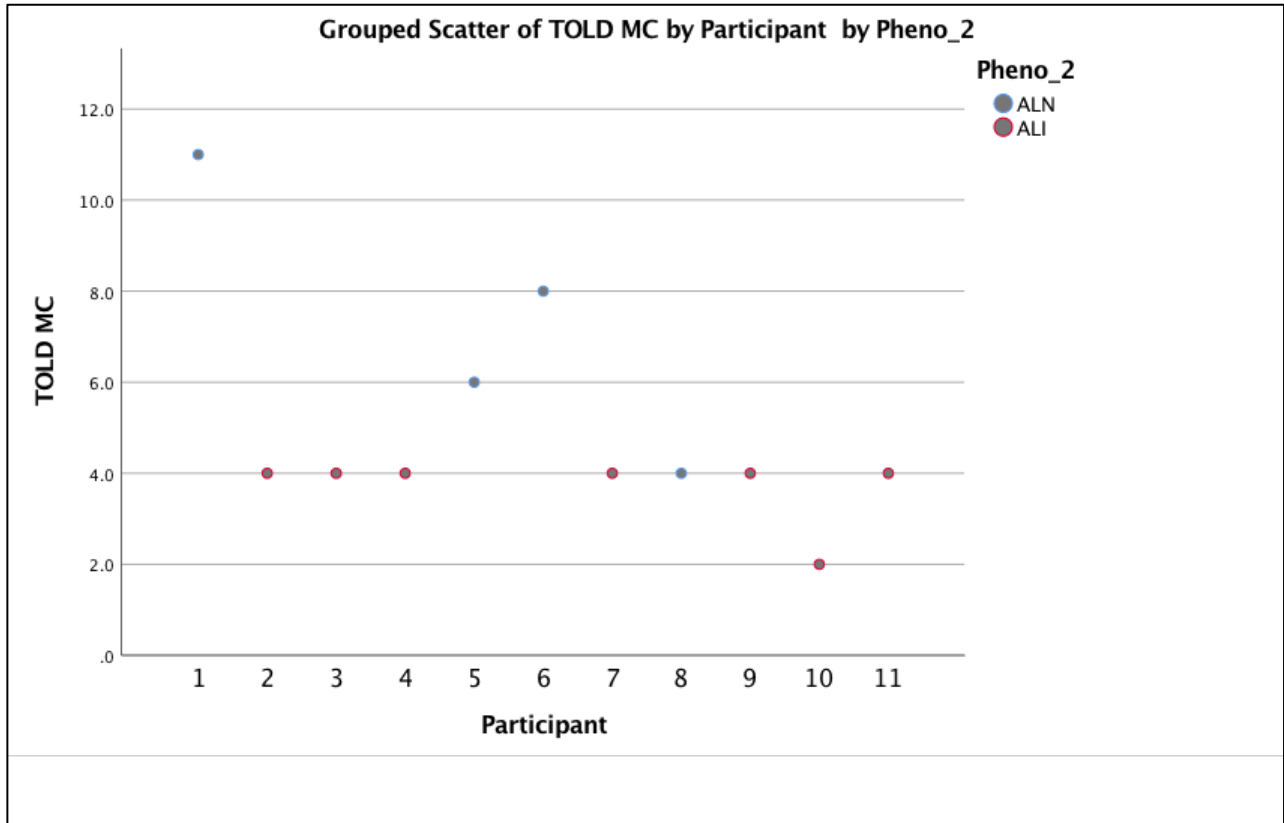


Figure 5

Comprehensive Assessment of Spoken Language Pragmatic Judgment Subtest Scores as a Function of Phenotype

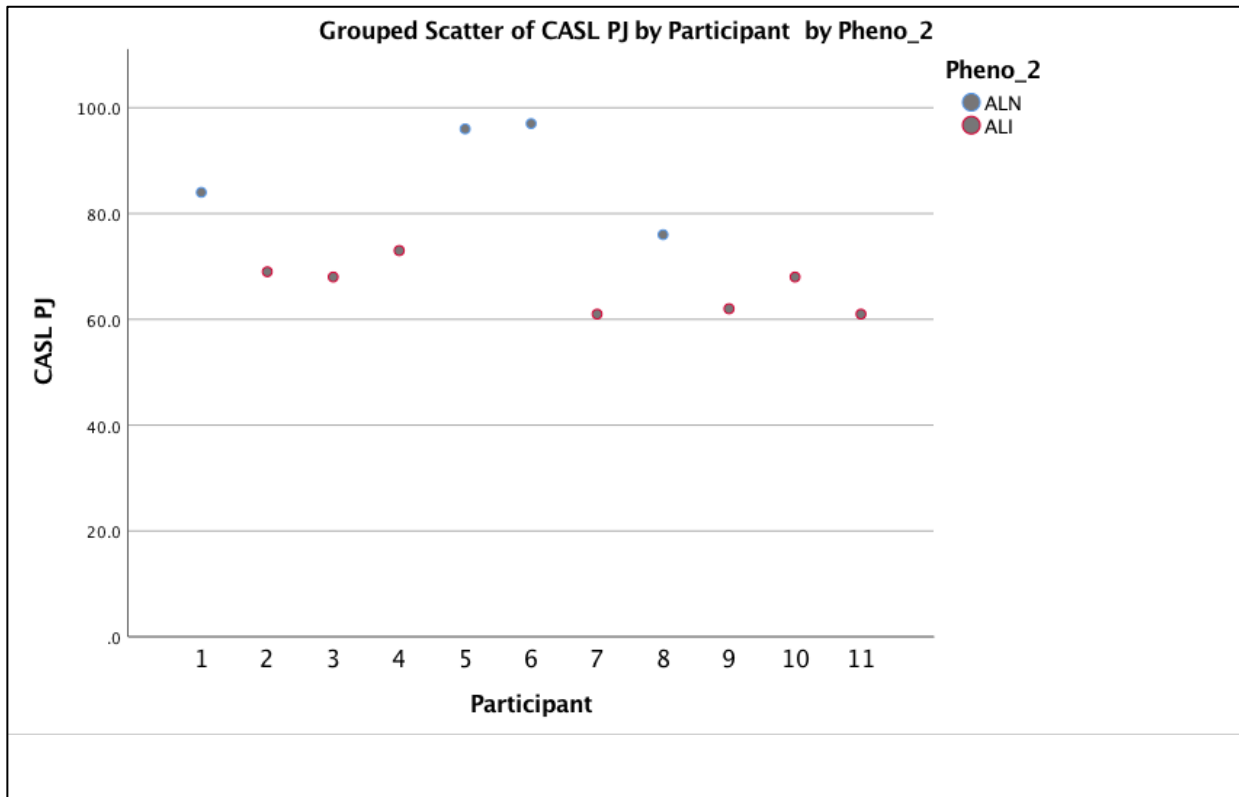


Figure 6

Test of Preschool Early Literacy Definitional Vocabulary Subtest Raw Scores as a Function of Phenotype

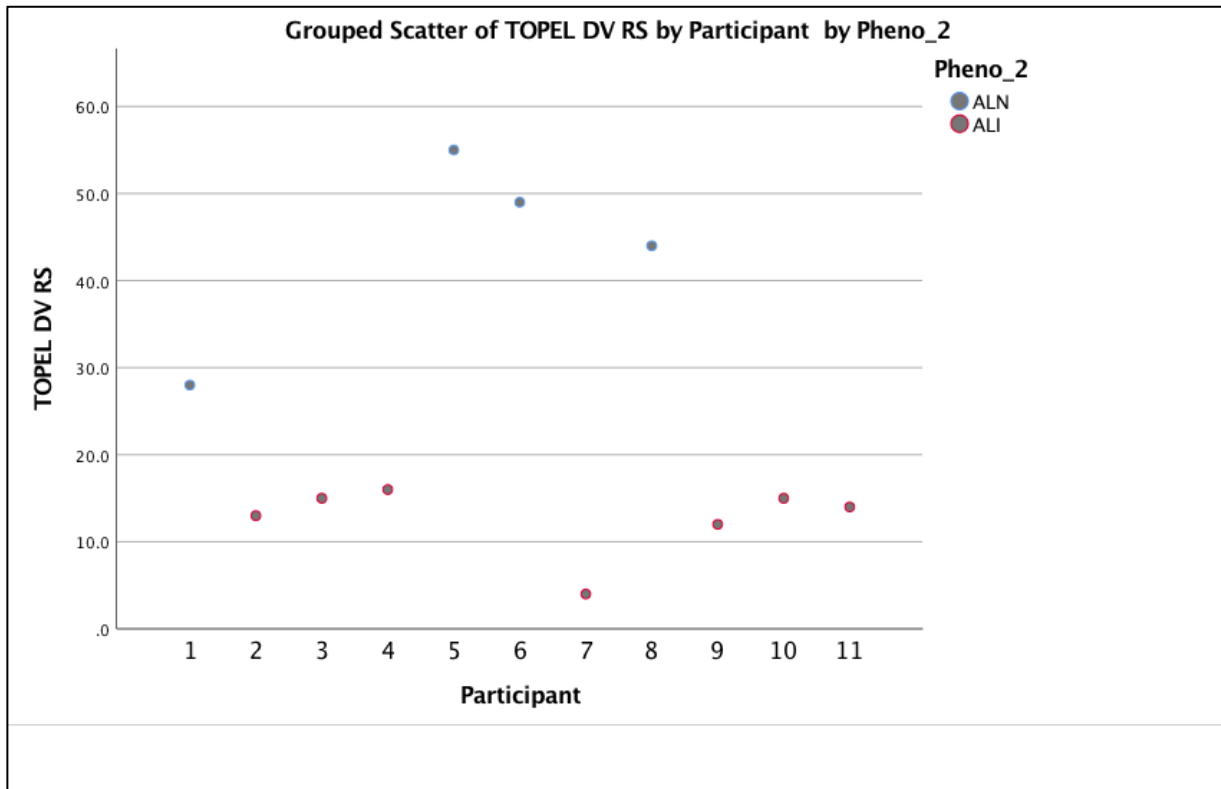


Figure 7

Test of Preschool Early Literacy Print Knowledge Subtest Score as a Function of Phenotype

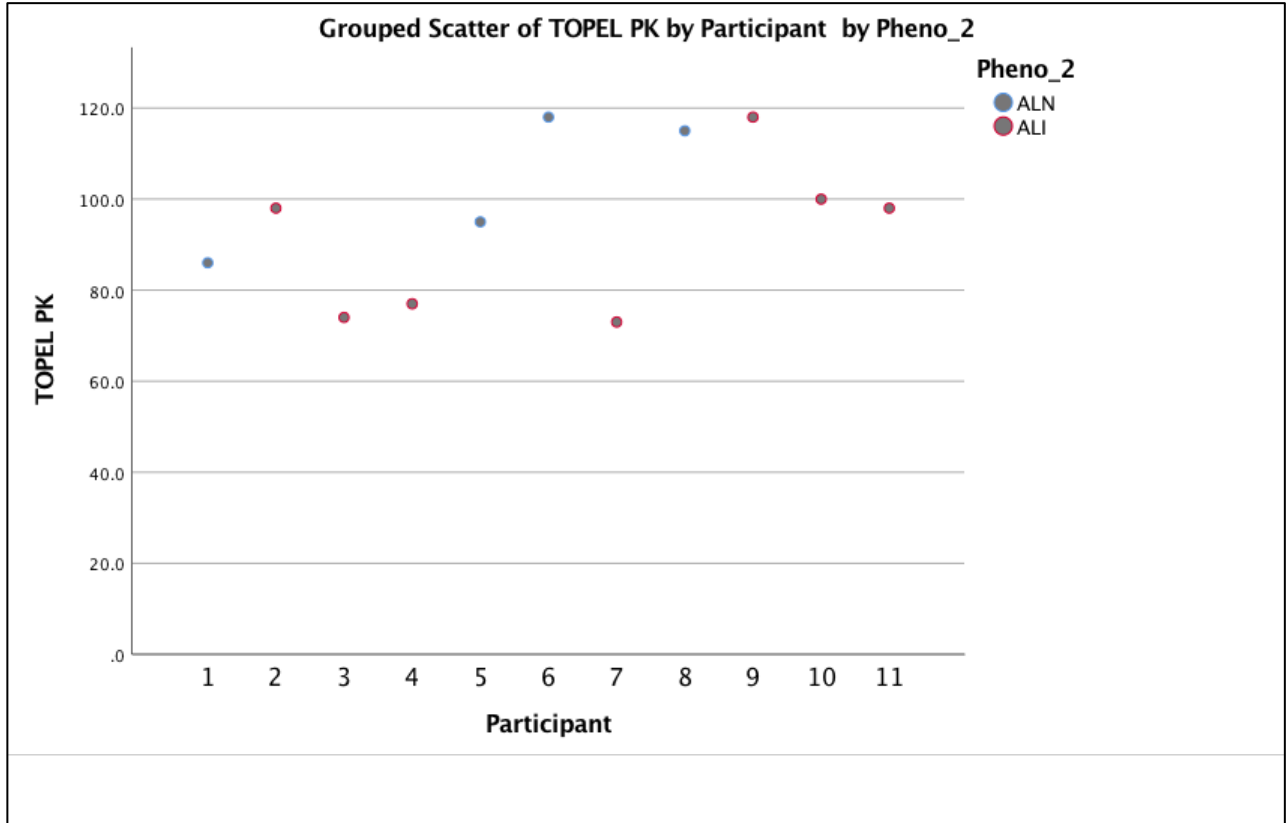


Figure 8

Test of Preschool Early Literacy Phonological Awareness Subtest Raw Scores as a Function of Phenotype

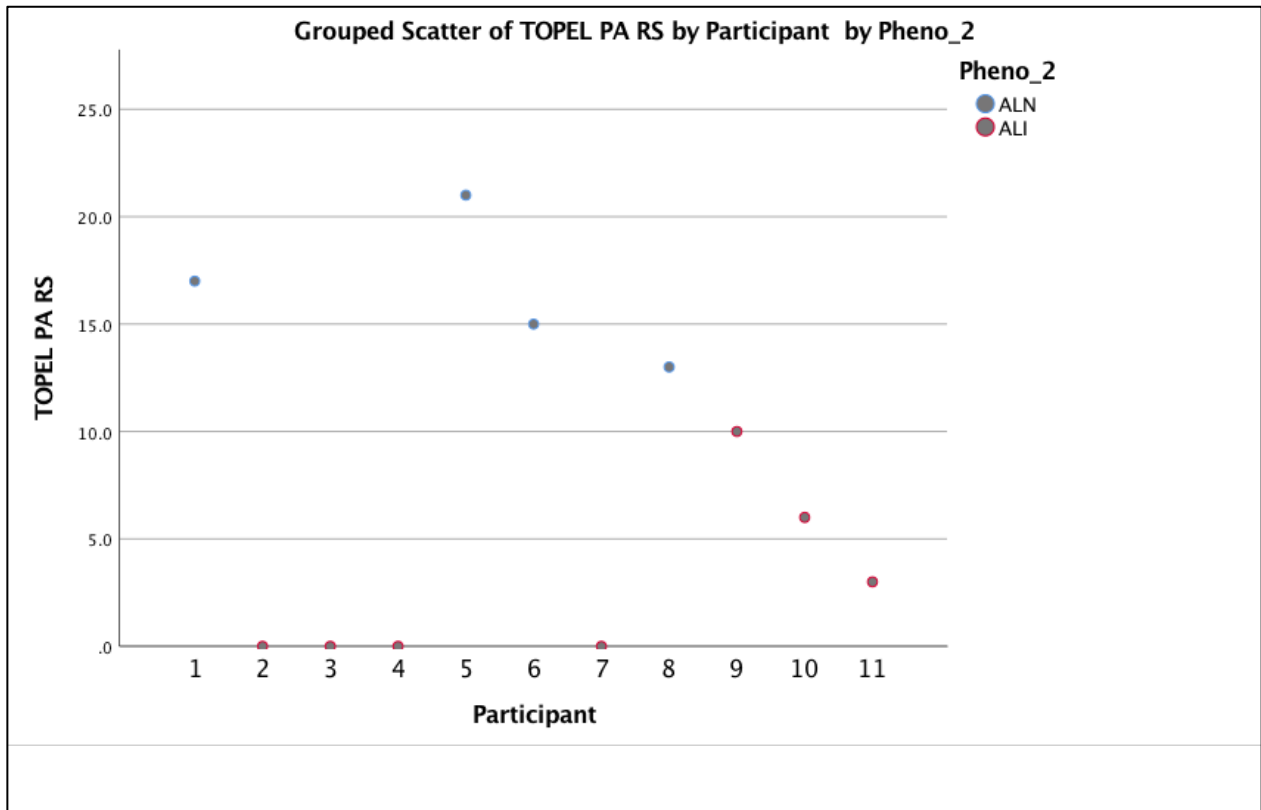
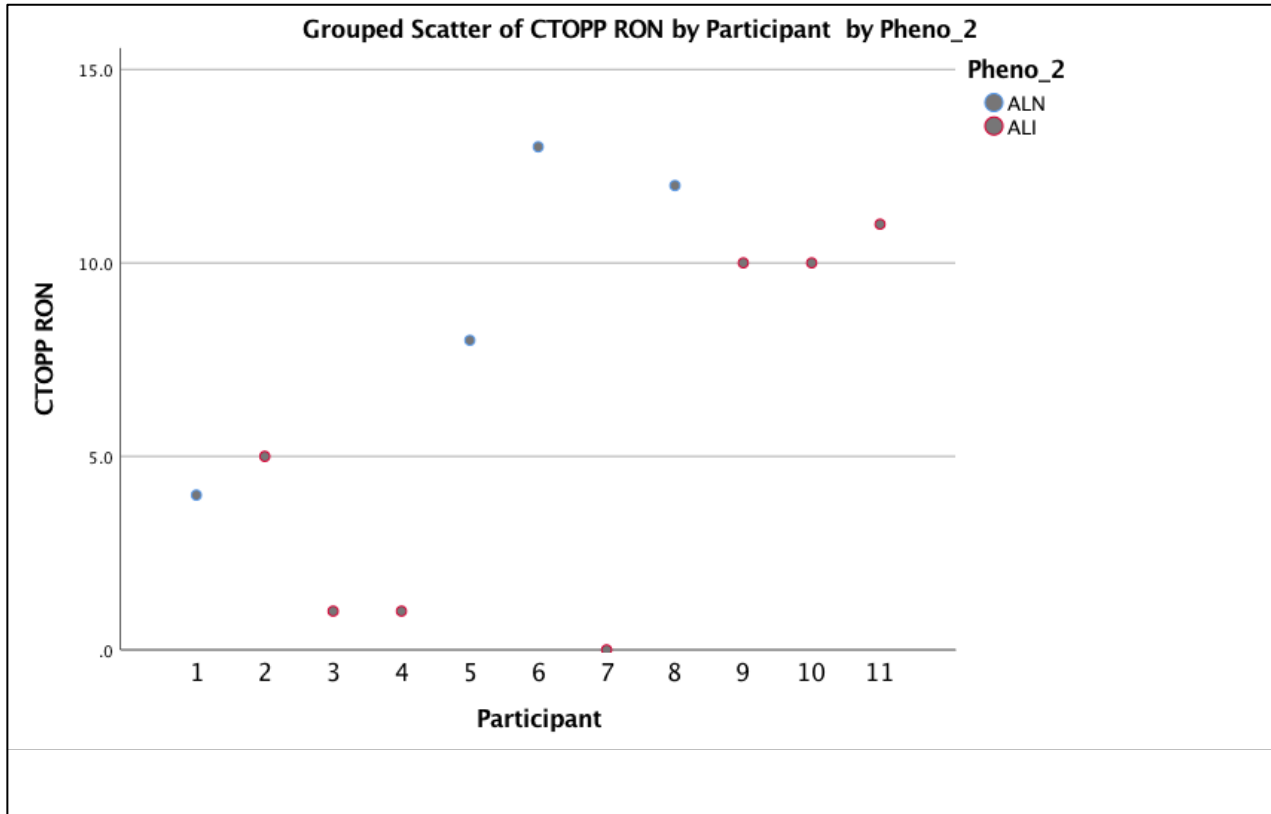


Figure 9

Comprehensive Test of Phonological Processing – Second Edition Rapid Object Naming Subtest

Scores as a Function of Phenotype



The mean and standard deviations for each group on all oral language tests and subtests are presented in Table 1. Mean and standard deviations for each group on all emergent literacy subtests are presented in Table 2. Individual scores for each participant for these assessments are presented in Appendices D and E.

Overall, mean scores in oral language domains, such as pragmatics, vocabulary, lexical retrieval, syntax, and morphology, were higher in the ALN participants than in the ALI participants. Mean scores on the Print Knowledge subtest for both ALN and ALI phenotype groups are considered within average range, while raw scores on the Phonological Awareness subtest show a greater discrepancy in scores between groups. In looking at the mean standard scores on the GARS-3 for both groups, the ALI group had a higher mean score, meaning greater autism severity, than the ALN group, which exhibited lower autism severity.

Research Questions

The first research question in this study was whether children in the ALN and ALI phenotypes performed differently on measures of emergent literacy (phonological awareness and print knowledge). Mann-Whitney U tests were conducted to assess for significant differences in emergent literacy performance between these two groups to answer this first research question.

The second research question in this study was whether predictors of emergent literacy (i.e. vocabulary, lexical retrieval, syntax, morphology, and pragmatics) vary based on language phenotype? While sample size was a limiting factor in analysis of this data, correlational analysis assessed associations between these predictors and emergent literacy measures.

Each dependent variable is outlined below with respective statistical analyses.

Table 1

Mean and Standard Deviations for Oral Language Test Scores as a Function of Group (ALN andALI)

Phenotype		CTOPP Nonword Repetition	TOLD Syntactic Understanding	TOLD Morphological Completion	CASL Pragmatic Judgment	CTOPP Rapid Object Naming	TOPEL Definitional Vocabulary Raw Score
ALN	Mean	10.8	6.8	7.3	88.3	9.3	44.0
	N	4	4	4	4	4	4
	Std. Deviation	3.3	.5	2.9	10.1	4.1	11.6
ALI	Mean	3.6	2.7	3.7	66.0	5.4	12.7
	N	7	7	7	7	7	7
	Std. Deviation	1.9	.9	.8	4.7	4.9	4.1
Total	Mean	6.2	4.2	5.0	74.1	6.8	24.1
	N	11	11	11	11	11	11
	Std. Deviation	4.3	2.2	2.5	13.0	4.8	17.3

Note: CTOPP and TOLD:P-4 results are reported in scaled scores (mean = 10 +/- 3). CASL and TOPEL results are reported in standard score quotients (CASL, mean = 100 +/- 15; TOPEL, mean = 100 +/- 10).

Table 2

Mean and Standard Deviations for Early Literacy Test Scores as a Function of Group (ALN and ALI)

Phenotype		TOPEL Print Knowledge	TOPEL Phonological Awareness Raw Score	TOPEL Early Literacy Index
ALN	Mean	103.5	16.5	94.0
	N	4	4	4
	Std. Deviation	15.5	3.4	10.4
ALI	Mean	91.1	2.7	61.4
	N	7	7	7
	Std. Deviation	16.9	3.9	11.7
Total	Mean	95.6	7.7	73.3
	N	11	11	11
	Std. Deviation	16.8	7.8	19.6

Note: TOPEL results are reported in standard score quotients (TOPEL, mean = 100 +/- 10).

Phonological Awareness scores are presented as raw scores.

ASD Phenotype

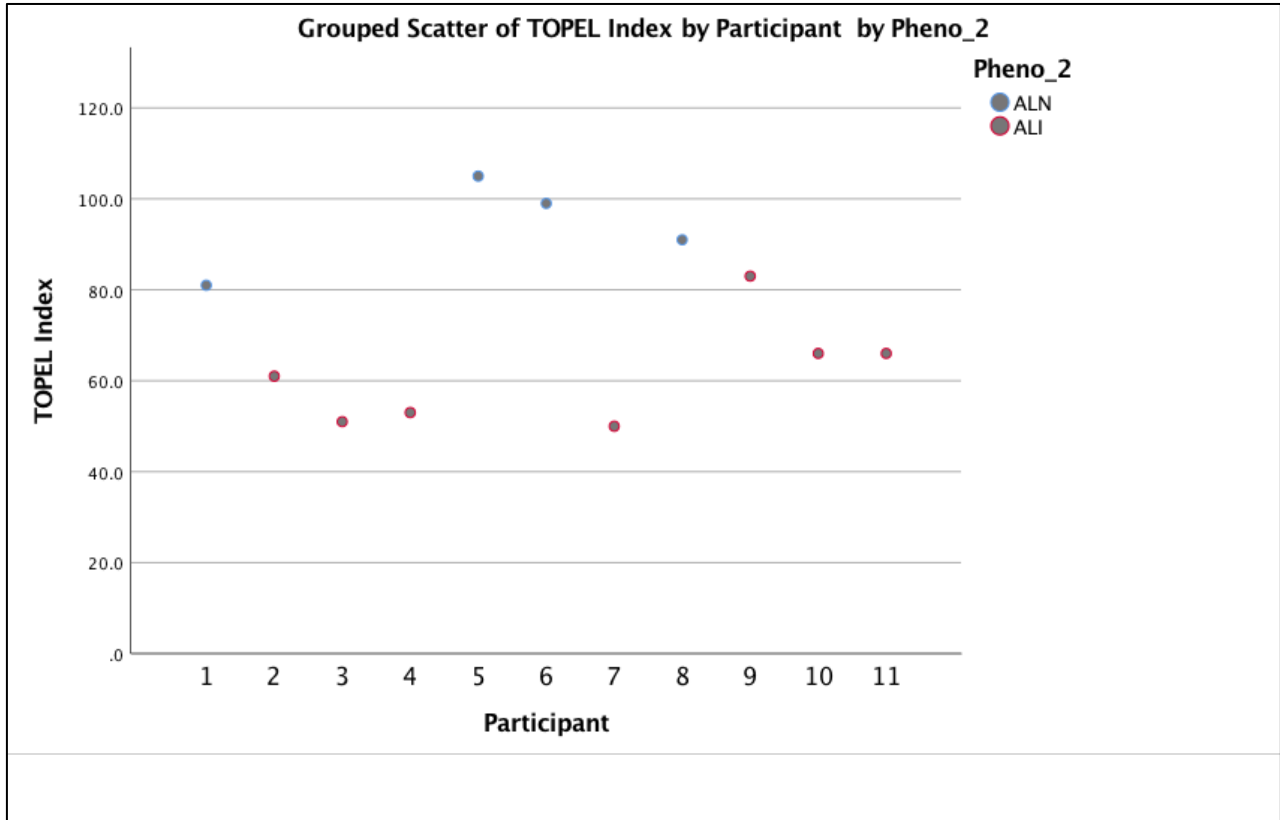
An independent-samples exact Mann-Whitney U test was conducted on phenotype group membership (ALN, ALI) and GARS-3 Index score to test for significance of GARS-3 Index scores between the two phenotypes. There was a significant difference between GARS-3 scores in ALN and ALI phenotypes, $p = .02$, $U = 25.50$, which indicated that autism severity was significantly different between ALI and ALN phenotypes. The mean GARS-3 score for the ALN group was 72.3, while the mean GARS-3 score for the ALI group was 95.1. Higher scores on this subtest indicate greater autism severity.

Relationship of Oral Language to Emergent Literacy Skills

Pearson correlation analyses were conducted on all tests and subtests administered to test for significant correlation between performance on oral language domains and emergent literacy skills. Oral language domains include semantics, which is represented by the CTOPP Rapid Object Naming subtest and the TOPEL Definitional Vocabulary subtest, syntax morphology, which is represented by the TOLD:P-4 Syntactical Understanding and Morphological Completion subtests, and pragmatics, which is represented by the CASL Pragmatic Judgment subtest. Emergent literacy domains include phonological awareness, which is represented by the TOPEL Phonological Awareness subtest, print knowledge, which is represented by the TOPEL Print Knowledge subtest, and overall emergent literacy performance, which is represented by the TOPEL Early Literacy Index. Distribution of TOPEL Early Literacy Index Scores across all participants is presented in Figure 10.

Figure 10

Test of Preschool Early Literacy Early Literacy Index Scores as a Function of Phenotype



Of note, three participants scored below the threshold for standardized score interpretation for the TOPEL Definitional Vocabulary subtest, and four participants scored below the threshold for standardized score interpretation for the TOPEL Phonological Awareness subtest, earning scores of <55 for those subtests. To ensure more accurate analysis and interpretation of these two subtests, standard scores were substituted for raw scores.

The relationships between scores on each oral language and emergent literacy test are represented in Figure 11.

Semantics

Results of the Pearson correlation analysis between semantic domain subtests and measures of emergent literacy is presented in Table 3. A positive significant correlation was found between lexical retrieval (CTOPP Rapid Object Naming) and overall emergent literacy (TOPEL Index), $r(9) = .72, p = .01$. When broken down into emergent literacy skill, lexical retrieval was significantly positively correlated to print knowledge, $r(9) = .92, p < .01$, but not phonological awareness $r(9) = .54, p = .09$. Lexical retrieval was also not found to be significantly correlated to the other subtest measuring semantic ability, TOPEL Definitional Vocabulary, $r(9) = .52, p = .10$. Definitional vocabulary was found to be significantly positively correlated to phonological awareness, $r(9) = .84, p < .01$, but not print knowledge, $r(9) = .46, p = .16$.

An independent-samples exact Mann-Whitney U Test was conducted to test for significance of lexical retrieval performance across phenotype groups, and definitional vocabulary performance across phenotype groups. A significant difference was found for definitional vocabulary as a function of phenotype groups, $U = .00, p = .01$, but no significant

Figure 11

Correlations Among Oral Language and Emergent Literacy Test Scores

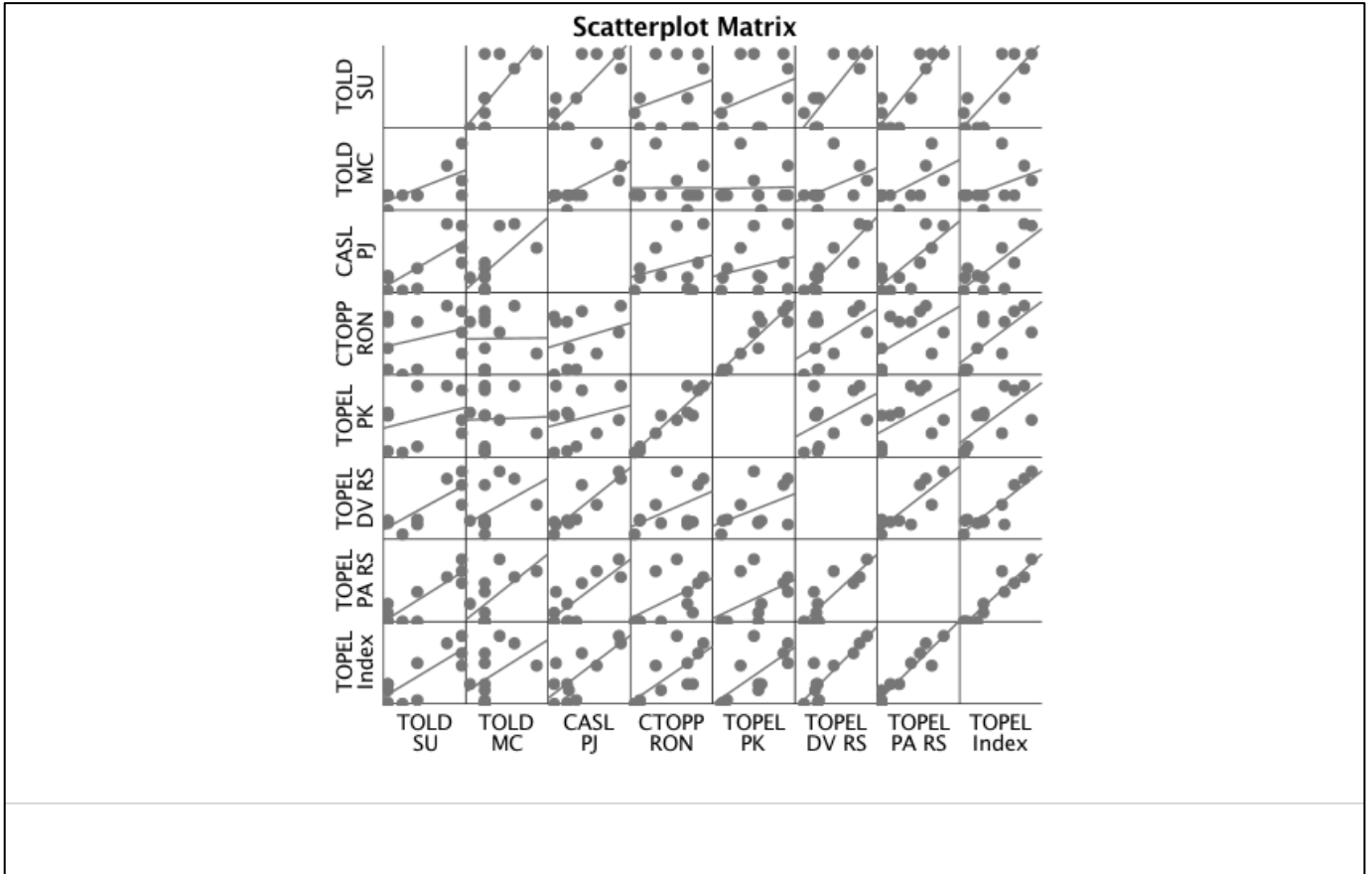


Table 3.

Correlation Between Lexical Retrieval, Definitional Vocabulary, and Emergent Literacy

Measures (Phonological Awareness, Print Knowledge, Early Literacy Index).

		CTOPP Rapid Object Naming	TOPEL Definitional Vocabulary Raw Score	TOPEL Early Literacy Index	TOPEL Phonological Awareness Raw Score	TOPEL Print Knowledge
CTOPP Rapid Object Naming	Pearson Correlation	1	.52	.72*	.54	.92**
	Sig. (2-tailed)		.10	.01	.09	.00
	N	11	11	11	11	11
TOPEL Definitional Vocabulary Raw Score	Pearson Correlation	.52	1	.88**	.84**	.46
	Sig. (2-tailed)	.10		.00	.00	.16
	N	11	11	11	11	11
TOPEL Early Literacy Index	Pearson Correlation	.72*	.88**	1	.94**	.71*
	Sig. (2-tailed)	.01	.00		.00	.01
	N	11	11	11	11	11
TOPEL Phonological Awareness Raw Score	Pearson Correlation	.54	.84**	.94**	1	.51
	Sig. (2-tailed)	.09	.00	.00		.11
	N	11	11	11	11	11
TOPEL Print Knowledge	Pearson Correlation	.92**	.46	.71*	.51	1
	Sig. (2-tailed)	.00	.16	.01	.11	
	N	11	11	11	11	11

*. Correlation is significant at the 0.05 level (2-tailed).

Note: CTOPP results are reported in scaled scores (mean = 10 +/- 3). TOPEL scores are reported in standard score quotients (mean = 100 +/- 10). Raw scores are also reported for Definitional Vocabulary and Phonological Awareness subtests

difference was found for lexical retrieval across phenotype groups, $U = 7.00$, $p = .23$. The mean definitional vocabulary raw score for ALN participants was 44.0, while the mean raw score for ALI participants was 12.7. ALN participants had significantly higher definitional vocabulary scores than their ALI peers.

The mean lexical retrieval scaled score for the ALN group was 9.3 while the mean scaled score for the ALI group was 5.4. Therefore, vocabulary performance was significantly different between ALN and ALI participants; however, lexical retrieval performance cannot be explained as a function of language phenotype.

Syntax/Morphology

Results of the Pearson correlation analyses between syntax/morphology domains and measures of emergent literacy is presented in Table 4. This analysis shows a significant positive correlation between Syntactical Understanding and Morphological Completion subtests, $r(9) = .68$, $p = .02$, showing a significant positive relationship between performance on measures of syntax and morphology among participants. In relation to measures of emergent literacy, performance on the Syntactical Understanding subtest was significantly positively correlated to phonological awareness, $r(9) = .88$, $p < .01$, and overall emergent literacy performance, $r(9) = .81$, $p < .01$. Syntax was not, however, significantly correlated to print knowledge performance, $r(9) = .36$, $p = .33$.

Performance on the Morphological Completion subtest was significantly positively correlated to phonological awareness performance, $r(9) = .64$, $p = .04$, but was not found to be significantly correlated to print knowledge, $r(9) = .03$, $p = .93$, or overall emergent literacy performance, $r(9) = .48$, $p = .13$.

Table 4.

Correlation Between Syntax and Morphology, and Emergent Literacy Measures (Phonological Awareness, Print Knowledge, Early Literacy Index).

		TOPEL Early Literacy Index	TOLD Syntactic Understanding	TOLD Morphological Completion	TOPEL Print Knowledge	TOPEL Phonological Awareness Raw Score
TOPEL Early Literacy Index	Pearson Correlation	1	.81**	.48	.71*	.94**
	Sig. (2-tailed)		.00	.13	.01	.00
	N	11	11	11	11	11
TOLD Syntactic Understanding	Pearson Correlation	.81**	1	.68*	.33	.88**
	Sig. (2-tailed)	.00		.02	.33	.00
	N	11	11	11	11	11
TOLD Morphological Completion	Pearson Correlation	.48	.68*	1	.03	.64*
	Sig. (2-tailed)	.13	.02		.93	.04
	N	11	11	11	11	11
TOPEL Print Knowledge	Pearson Correlation	.71*	.33	.03	1	.51
	Sig. (2-tailed)	.01	.33	.93		.11
	N	11	11	11	11	11
TOPEL Phonological Awareness Raw Score	Pearson Correlation	.94**	.88**	.64*	.51	1
	Sig. (2-tailed)	.00	.00	.04	.11	
	N	11	11	11	11	11

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Note: TOLD:P-4. Results are reported in scaled scores (mean = 10 +/- 3). TOPEL results are reported in standard score quotients (mean = 100 +/- 10). Phonological Awareness subtest scores are reported as raw scores.

An independent-samples exact Mann-Whitney U Test was conducted to test for significance of syntax performance across phenotype groups, and morphology performance across phenotype groups. A significant difference was found for syntax across phenotype groups, $U = .00, p < .01$, and a significant difference was found for morphology across phenotype groups, $U = 3.00, p = .04$. Mean scaled scores on syntactic understanding in ALN and ALI phenotype groups were 6.8 and 2.7, respectively. While there was a significant difference between these scores as a function of language phenotype, both groups had mean scaled scores that were considered below average. Mean scaled scores on morphological completion in ALN and ALI phenotype groups were 7.3 and 3.7, respectively. While ALN mean scores are considered low average, ALI mean scores were below average for morphological completion. Therefore, both syntax and morphology performance were significantly different between ALN and ALI participants.

Pragmatics

Results of the Pearson correlation analyses between the Pragmatic Judgment subtest of the CASL and measures of emergent literacy is presented in Table 5. Performance on the Pragmatic Judgment subtest is significantly positively correlated to the TOPEL Early Literacy Index, or overall emergent literacy performance, $r(9) = .76, p = .01$. Pragmatic performance was also significantly positively correlated to phonological awareness, $r(9) = .79, p < .01$, but not print knowledge performance, $r(9) = .25, p = .46$, demonstrating that pragmatics were significantly related to phonological awareness and overall emergent literacy, but not print knowledge in this group of participants.

Table 5.

Correlation Between Pragmatics and Emergent Literacy Measures (Phonological Awareness, Print Knowledge, Early Literacy Index).

		TOPEL Early Literacy Index	TOPEL Phonological Awareness Raw Score	TOPEL Print Knowledge	CASL Pragmatic Judgment
TOPEL Early Literacy Index	Pearson Correlation	1	.94**	.71*	.76**
	Sig. (2-tailed)		.00	.01	.01
	N	11	11	11	11
TOPEL Phonological Awareness Raw Score	Pearson Correlation	.94**	1	.51	.79**
	Sig. (2-tailed)	.00		.11	.00
	N	11	11	11	11
TOPEL Print Knowledge	Pearson Correlation	.71*	.51	1	.25
	Sig. (2-tailed)	.01	.11		.46
	N	11	11	11	11
CASL Pragmatic Judgment	Pearson Correlation	.76**	.79**	.25	1
	Sig. (2-tailed)	.01	.00	.46	
	N	11	11	11	11

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Note: CASL results are reported in standard score quotient scores (mean = 100 +/- 15). TOPEL results are reported in standard score quotients (mean = 100 +/- 10). Phonological Awareness subtest scores are reported as raw scores.

An independent-samples exact Mann-Whitney U Test was conducted to test for significance of pragmatic performance across phenotype groups. A significant difference was found in the distribution of Pragmatic Judgment scores across phenotype groups, $U = .00$, $p = .01$, demonstrating that pragmatic skills were significantly different in ALN and ALI phenotype groups. The mean pragmatic judgment standard score for the ALN group was 88.3, which is considered average, while the mean standard score for the ALI group was 66.0, which is considered below average.

Emergent Literacy Performance by Phenotype

The relationship between emergent literacy skills and their distribution across phenotype groups was also examined to investigate my first research question, whether emergent literacy performance varies by language phenotype. Pearson correlation analysis between Print Knowledge and Phonological Awareness subtests and the Early Literacy Index are presented in Table 6. Both print knowledge and phonological awareness performance are significantly correlated to overall emergent literacy skill, however, the correlation between overall emergent literacy and phonological awareness, $r(9) = .94$, $p < .01$, is greater than the correlation between emergent literacy and print knowledge, $r(9) = .71$, $p = .01$. Notably, print knowledge and phonological awareness performance were not found to be significantly correlated to each other, $r(9) = .51$, $p = .11$.

An independent-samples exact Mann-Whitney U Test was conducted to test for significance of both print knowledge and phonological awareness performance across phenotype groups. While phonological awareness scores were significantly different across phenotype groups, $U = .00$, $p = .01$, there was no significant difference in print knowledge scores across phenotype groups, $U = 9.50$, $p = .41$. The mean scaled score for print knowledge in the ALN

Table 6

Correlation Between Phonological Awareness, Print Knowledge, and Early Literacy Index.

		TOPEL Print Knowledge	TOPEL Phonological Awareness Raw Score	TOPEL Early Literacy Index
TOPEL Print Knowledge	Pearson Correlation	1	.51	.71*
	Sig. (2-tailed)		.11	.01
	N	11	11	11
TOPEL Phonological Awareness Raw Score	Pearson Correlation	.51	1	.94**
	Sig. (2-tailed)	.11		.00
	N	11	11	11
TOPEL Early Literacy Index	Pearson Correlation	.71*	.94**	1
	Sig. (2-tailed)	.01	.00	
	N	11	11	11

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Note: TOPEL results are reported in standard score quotients (mean = 100 +/- 10). Phonological Awareness subtest scores are reported as raw scores.

group was 103.5, which is considered average, and the mean scaled score in the ALI group was 91.1, which is also considered average. The mean raw score for phonological awareness in the ALN group was 16.5, while the mean raw score for the ALI group was 2.7. According to the Mann-Whitney U test analysis, participants in the ALN group demonstrated significantly better performance on this measure of phonological awareness than their ALI peers.

Chapter 4

Discussion

Clinical research investigating emergent literacy and the effect of its associated oral language skills is necessary to fully understand literacy development, as well as how educators, parents, and speech-language pathologists can promote positive literacy outcomes in children. When considering emergent literacy in children with autism, less is known about the patterns, skills, and outcomes that emerge in this critical period of literacy development.

Several lines of research have focused on literacy development in school aged children with autism, which have identified particular trends in literacy success within this population (Jacobs & Richdale, 2013; Lucas & Frazier Norbury, 2014; and McIntyre et al., 2017). These trends include deficits in reading comprehension in children with ASD in comparison to their typically developing peers; however, there is evidence in the literature that comprehension deficits are associated with oral language ability rather than autism diagnosis (McIntyre et al., 2017; Lucas & Frazier Norbury, 2014). Research into emergent literacy also identifies trends in performance of children with ASD, namely an overall strength in phonological awareness and overall weakness in print knowledge (Westerveld et al., 2017).

When considering clinical application of this research within this population, it is important to note the heterogeneity of the ASD population and the difficulty in building one overarching profile of literacy development in children with autism. The categorization of children with ASD into various phenotypes can be useful in examining literacy development within this population. One line of research by Tager-Flusberg and colleagues investigated the possible overlap in language characteristics of children with autism and Specific Language

Impairment (Kjelgaard and Tager-Flusberg, 2001; Tager-Flusberg and Joseph, 2003; Tager-Flusberg, 2006). The two distinct language phenotypes that these researchers have used, Autism Language Normal (ALN) and Autism Language Impaired (ALI) are being applied in this study, to examine the differences in literacy development within the ASD population. In an effort to create greater specificity in the current understanding of emergent literacy skills in children with ASD, the current study was designed to explore the influence of language phenotype on predictors of emergent literacy skills in children with ASD.

Research Question One

The first research question addressed whether there was a difference in emergent literacy performance between children in the ALN and ALI phenotypes. Analysis of standardized scores on the Test of Preschool Emergent Literacy (TOPEL) as a function of phenotype revealed a significant difference in phonological awareness performance between ALN and ALI participants; however, no significant difference was found in print knowledge between ALN and ALI participants.

This significant difference in phonological awareness performance revealed two distinct profiles in the emergent literacy abilities of preschool aged children with autism of different language phenotypes. While the ALN participants had grossly average phonological awareness (*mean raw score = 16.5*) and print knowledge skills (*mean standard score = 103.5*), the ALI participants exhibited weakness in phonological awareness (*mean raw score = 2.7*) and grossly average print knowledge (*mean standard score = 91.1*). Print knowledge abilities in both phenotypes were considered within average range based on descriptive ranges of the TOPEL, indicating a relative strength in print knowledge in both groups. This finding is contrary to

previous research which cites print knowledge as a relative weakness in the ASD population (Dyonia et al., 2016; Westerveld et al., 2017).

The mean average performance for both ALN and ALI groups in print knowledge could be explained by the inclusion of alphabet knowledge in the Print Knowledge subtest of the TOPEL, since alphabet knowledge has been shown to be a strength in children with ASD, and even comparable to typically developing peers (Dyonia et al., 2016). Other standardized measures of emergent literacy skills which isolate print knowledge and alphabet knowledge into separate subtests or standard scores might provide a more accurate picture of print knowledge skill. Another possible explanation for this finding may be the influence of literacy environment on print knowledge development. All participants enrolled in this study were students at a preschool with a strong focus on literacy development, exposure to literacy artifacts, and explicit instruction in letter-sound correspondence, which may have contributed to relatively high scores in this area.

While print knowledge scores did not significantly differ between groups as a function of phenotype, phonological awareness scores were significantly different, and suggest the possible influence of language phenotype on phonological awareness in this population. Participants in the ALN group had significantly higher phonological awareness scores than their ALI peers. Phonological awareness has previously been considered a strength in children with autism (Westerveld et al., 2017), however, in the ALI participants in this study, phonological awareness was a relative weakness. In four out of the seven ALI participants, standard scores in phonological awareness were at least 3.5 SD below the mean, earning a standard score of <55, while ALN participants were considered average or slightly below average based on TOPEL descriptive scoring (*mean standard score = 95.5*).

These findings are consistent with research by Lanter et al. (2012), which found that total emergent literacy abilities differed between groups of preschool children with autism of differing language abilities, but individual subtest scores from the Emergent Literacy Profile (ELP) were not significantly different among participants separated into groups based on oral language ability. The present study's findings differ from Lanter et al.'s study in that phonological awareness skill was found to be significantly different among children of differing language abilities; however, both studies show that not all emergent literacy skills can be explained by language ability.

One explanation for the significant difference in phonological awareness as a function of language phenotype is the significant positive correlation between phonological memory performance and phonological awareness performance among all participants. Since measures of phonological memory (CTOPP NWR) were used to determine language phenotype, and phonological memory and phonological awareness are highly correlated, it would not be surprising that phonological awareness is statistically significantly different as a function of language phenotype.

However, regardless of the correlation between phonological awareness and phonological memory, this data represents a significant difference in phonological awareness skill within the broader population of children with autism. While ALN participants demonstrated grossly average emergent literacy abilities in both skills, phonological awareness (*mean raw score = 16.5*) and print knowledge (*mean standard score = 103.5*), ALI participants demonstrated a relative strength in print knowledge (*mean standard score = 91.1*) and a relative weakness in phonological awareness (*mean raw score = 2.7*), which impacted overall emergent literacy performance per the TOPEL Early Literacy Index score.

Furthermore, correlational analysis showed that phonological awareness performance and print knowledge performance were not significantly correlated for all participants. These findings indicate that print knowledge and phonological awareness, which both fall under the umbrella of emergent literacy, were two distinct skills, and performance in each skill was relatively independent of the other. Because these skills are not significantly correlated, it is necessary to evaluate both of these skills separately to gain an accurate picture of the nature of their emergent literacy abilities. By taking into account the distinct nature of phonological awareness and print knowledge skills, speech-language pathologists can evaluate and target specific skills that underlie future formal literacy development.

Overall, this research study shows that two distinct profiles of emergent literacy ability exist in children with ASD, and that these profiles correspond to two distinct language phenotypes. The presence of differing profiles underscores the significant contribution of oral language skill to literacy development and indicates a difference in the literacy development of children with autism of different language phenotypes. Clinically these findings are useful for educators and speech-language pathologists to understand the different emergent literacy patterns in children with autism and serves as an example of the importance of the appraisal and differential diagnosis of oral language abilities when assessing children with emergent literacy difficulties.

Research Question Two

The second research question in this study addressed whether predictors of emergent literacy (i.e. oral language domains) vary based on language phenotype. While the sample size was not large enough to analyze the correlation between oral language and emergent literacy as a

function of phenotype, the current study analyzed the correlation between oral language and emergent literacy in all 11 participants, as well as the difference in oral language skills as a function of phenotype. The oral language domains investigated in this study included semantics, specifically vocabulary and lexical retrieval, syntax and morphology, and pragmatics.

Results from the current study suggest a relationship between oral language domains and emergent literacy skills. Previous research by Westerveld et al. (2017) investigated factors that contribute to emergent literacy performance in children with autism, including nonverbal cognition, oral language ability, home literacy environment, receptive vocabulary, and autism severity among other variables. Westerveld et al. (2017) showed that oral language ability was significantly associated with emergent literacy performance, and that when combined with other variables, oral language ability significantly predicted both code related performance (i.e. letter name knowledge, letter sound knowledge, phonological awareness, print and word awareness, and rapid automatic naming) and meaning-related skills (i.e. receptive vocabulary, oral narrative comprehension, and oral narrative quality). The current study sought to break down the variable of overall oral language ability into oral language domains to gather a narrower view into which oral language skills were related to emergent literacy performance in preschool aged children with autism spectrum disorders.

Semantics. Correlational analysis revealed a significant positive correlation between lexical retrieval (rapid object naming) performance and overall emergent literacy performance, however, when emergent literacy performance was broken down into phonological awareness and print knowledge performance, lexical retrieval was significantly correlated to print knowledge performance but not phonological awareness. Definitional vocabulary performance, on the other hand, was significantly correlated phonological awareness but not print knowledge.

These findings show that semantics, as based on definitional vocabulary and lexical retrieval measures, as an oral language domain is associated with emergent literacy skills in this group of participants, although lexical retrieval was associated with print knowledge while definitional vocabulary was associated with phonological awareness in all participants as a whole.

This finding is consistent with previous research, which has found that vocabulary is a significant predictor of emergent literacy performance in children with autism, and further supports the important role of semantic and vocabulary ability in literacy development (Westerveld et al., 2017).

This analysis also showed that definitional vocabulary and lexical retrieval were not significantly related to each other, showing that while these skills both fall under the oral language domain of semantics, they represent distinctly separate skills and processes. The lack of association between these semantic skills could help explain their differing relationships to emergent literacy skills in all participants.

Definitional vocabulary was shown to be significantly different across phenotype groups, however, lexical retrieval was not significantly different across phenotype groups.

Syntax and Morphology. Correlational analysis revealed a significant positive correlation between syntactic and morphological performance, which supported the decision to consider syntax and morphology as one oral language domain for the purposes of this study. Furthermore, both syntax and morphology were found to be significantly different between ALN and ALI participants. The ALN group had higher mean standard scores on syntax and morphology (*mean* = 6.8, 7.3, respectively) than the ALI group (*mean* = 2.7, 3.7, respectively), which shows that participants in the ALN group were statistically significantly stronger in syntax and morphology.

When analyzed in terms of emergent literacy performance, syntax was shown to be associated with overall emergent literacy performance and phonological awareness but not print knowledge. Morphology was associated with phonological awareness but not overall emergent literacy and print knowledge. While syntax was shown to have a stronger relationship with overall emergent literacy ability, both syntax and morphology were significantly associated with phonological awareness skill for all participants as a whole.

Pragmatics. Correlational analysis demonstrated that pragmatic ability was significantly correlated to overall emergent literacy ability and phonological awareness, but not print knowledge in all participants as a whole. These results mirror the relationship between syntax/morphology and emergent literacy skills, with a significant relationship with phonological awareness but not with print knowledge.

Pragmatics was also shown to be significantly different across phenotype groups, which indicates that pragmatic language performance could be at least partially explained by language phenotype membership. The ALN group exhibited higher pragmatic judgment scores ($M = 88.3$) than the ALI group ($M = 66.0$).

The general findings related to this research question show an overall trend in the significant positive relationship between all oral language domains and phonological awareness. Definitional vocabulary, syntax, morphology, and syntax were all associated with phonological awareness overall. These findings are consistent with emergent literacy research in typically developing children by Hipfner-Boucher et al. (2014), which showed that phonological memory, alphabet knowledge, word reading, vocabulary, and narrative structure skills were significantly related to and accounted for 65% of the variance in phonological awareness skills. The findings in this study in conjunction with previous research on emergent literacy in typically developing

children by Hipfner-Boucher et al. (2014) suggests that children with ASD have a relationship between oral language domains and phonological awareness similar to their typically developing peers.

Lexical retrieval was the only oral language skill that did not demonstrate a relationship with phonological awareness, and it was also the only oral language skill that was associated with print knowledge. This trend implies that the underlying mechanism related to lexical retrieval is closely related to how print knowledge is being assessed, while the underlying mechanism of other oral language skills is closely related to phonological awareness.

One explanation for the relationship between lexical retrieval and print knowledge could be related to the nature of the TOPEL Print Knowledge subtest test items. The portion of this subtest related to alphabet knowledge specifically required participants to identify letter names when given printed letters, which relies, in part, on similar retrieval skills to the CTOPP Rapid Object Naming task. However, while the TOPEL Print Knowledge subtest assesses potentially unknown orthographic knowledge, the CTOPP Rapid Object Naming task assesses the speed and accuracy in retrieving known object names only.

These findings also show that definitional vocabulary, syntax, morphology, and pragmatic performance was significantly different across ALN and ALI groups, indicating that oral language performance in these domains could be explained in part by language phenotype membership. Not only do these results confirm the reliability of using the phonological memory as an indicator of language phenotype membership, but they are consistent with the previously discussed findings that phonological awareness, which was significantly correlated to all four of these oral language skills, are significantly different across language phenotype. The relationship between oral language skills and phonological awareness as a function of phenotype suggests

that significant differences may also emerge later in literacy development. As the children in the ALN phenotype begin formal literacy development, their strengths in phonological awareness may promote success in phonological decoding and spelling skills, which have foundations in phonological awareness. The fact that children with autism spectrum disorders differ in their emergent literacy abilities implies that their formal literacy skills will be equally as diverse, suggesting that it is important for speech-language pathologists to engage in continuous evaluation and formulation of treatment goals for each child to target the skills that influence literacy development. While the sample size of this study is not large enough for a multiple regression analysis of the relationship of oral language and emergent literacy skills as a function of phenotype, the current findings are promising for future research in this area.

Limitations

One limitation of this study was low statistical power due to small sample size. A larger group of participants would have allowed for more thorough statistical analysis of test scores and would allow for a broader interpretation of results as it relates to the general ASD population. The number of participants in each phenotype group was both small and unequal; therefore, the test scores of the 4 ALN participants were weighted more heavily than the 7 ALI participants. It is unknown how the ALN and ALI phenotypes are distributed across the general ASD population; therefore, it is impossible to conclude whether the participant spread in this study is representative of the broader population of preschool children with ASD. Regardless, larger and more equally distributed subgroups would provide greater statistical power for future analysis.

Larger sample size would also allow for analysis of the impact of oral language domains on emergent literacy skills as a function of phenotype. Due to the small sample size in this study,

the correlations between oral language and emergent literacy skill were analyzed in terms of all ASD participants rather than by phenotype group. Future research in this area could investigate the impact of language phenotype on these relationships and provide a more comprehensive picture of how emergent literacy ability develops in children with autism of different phenotypes.

Future Research

Findings from this study warrant future research to further investigate the differences in emergent literacy development as a function of language phenotype. As previously mentioned, larger sample sizes of participants would allow for a more comprehensive and thorough analysis of the relationship between oral language, emergent literacy, and language phenotype. By analyzing the relationship between these three variables and better understanding how oral language predicts emergent literacy skills, researchers and clinicians alike can gain further understanding of how literacy develops in preschool aged children with autism and which factors contribute to these patterns of development. This study has begun to show that different patterns of emergent literacy exist within the population of children with ASD, and future research is needed to expand and explore how these patterns develop.

In investigating the variables related to print knowledge as a measure of emergent literacy, no oral language skill evaluated in this study with the exception of lexical retrieval was significantly correlated to print knowledge. Future research can take a closer look at the factors that determine print knowledge success in children with autism and investigate other variables besides oral language ability may contribute to performance on that measure.

Another avenue for future research is to follow this group of participants into elementary school and adolescence, and to study their reading and written language abilities as they age. By

using this data to begin a longitudinal study, researchers could investigate whether these language profiles persist or shift over time, and how formal reading development is shaped by the participants emergent literacy abilities as preschoolers. Studies related to formal reading performance in school aged children with autism have already shown the wide range of literacy abilities in this population, and evidence that reading ability is not necessarily associated with autism symptomatology (Lucas & Frazier Norbury, 2014; McIntyre et al., 2017). Using the language phenotype framework with a comprehensive look at oral language domains, researchers may be able to identify particular profiles or trajectories of literacy development and the factors that correlate to or predict those profiles in children with Autism Spectrum Disorders.

Clinical Implications

Any improvement in our understanding of how children with autism develop language and literacy skills can assist clinicians in providing accurate diagnosis and treatment of language and literacy disorders in this population. Due to the fact that ASD represents a large and heterogeneous population on the speech-language pathologist's caseload, it is imperative that current research exists to assist clinicians in making informed assessment and treatment decisions. By investigating the different language phenotypes of children with ASD in relation to their emergent literacy development, clinicians can apply these patterns and profiles to their own practice.

One important clinical implication from this study is the finding that phonological awareness and print knowledge present significantly differently based on language phenotype. As a result, looking at one measure of emergent literacy in a child with autism may not provide the whole picture of strengths and weaknesses, and that the two distinct skills of phonological

awareness and print knowledge must be assessed separately in order to fully describe the emergent literacy abilities of an individual child on the spectrum. When thinking about these findings in the context of Rohde's Comprehensive Emergent Literacy Model, it proves true that the four components of oral language, phonological awareness, print awareness, and early writing overlap and interact, and only further emphasizes the importance of considering each one of these components when making clinical decisions for both assessment and treatment.

Summary

The purpose of this study was to investigate the influence of language phenotype on predictors of emergent literacy in children with autism spectrum disorders. Analysis of standardized test scores of oral language domains and emergent literacy skills in the context of ALN or ALI language phenotype revealed significant findings that both contribute to the current body of research in this area and suggest clinical application for speech-language pathologists working with young children with autism spectrum disorders.

The first research question, which analyzed whether children in the ALN and ALI phenotypes performed differently on measures of emergent literacy, showed that phonological awareness skills were significantly different based on phenotype, while print knowledge skills were not. This finding suggests a close relationship with phonological awareness and language phenotype and reveals two different emergent literacy patterns based on phenotype group membership. ALN participants showed grossly average performance in both measures of emergent literacy, while ALI participants showed relative weaknesses in phonological awareness and relative strengths in print knowledge that rivaled their ALN peers. Knowing that emergent literacy skills are widely variable in children with autism, and that language phenotypes can

assist clinicians in identifying possible strengths and weaknesses, this study highlights the importance of comprehensive evaluation of children with autism.

The second research question analyzed how oral language domains, which are related to emergent literacy development per the Comprehensive Emergent Literacy Model, vary based on language phenotype (Rohde, 2015). The results show a strong association between all oral language domains (semantics, syntax, morphology, and pragmatics) and phonological awareness, and emphasizes the interrelated development of oral language skills and phonological awareness at this age. Performance on all oral language domains also significantly differed based on language phenotype, suggesting that language phenotype was highly associated with both oral language and emergent literacy performance. In thinking about how these emergent literacy skills may shape later literacy development, it would be expected that those children with strengths in phonological awareness would develop greater phonological decoding skills and spelling abilities than those children who were weaker in phonological awareness. Since the children in the ALN language phenotype displayed significantly greater phonological awareness skills, it could be predicted that those children in the ALN phenotype will have greater phonological decoding and spelling success in the future.

These oral language domains (i.e. definitional vocabulary, syntax, morphology, and pragmatics) were not associated with print knowledge, with the exception of lexical retrieval as a semantic skill. This suggests not only that phonological awareness and print knowledge are distinct skills as previously discussed, but that print knowledge success may be explained by variables other than oral language ability.

The findings presented in this study not only offer opportunity for future research, but also implications for clinicians to integrate into their practice of assessment and treatment of

emergent literacy in children with autism. Emergent literacy is the foundation for formal reading skills, and by working to understand the development of those skills in each individual child, clinicians can provide the best possible treatment to ensure positive literacy outcomes in all children.

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Appendix A

Institutional Review Board Approval Form



EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building · Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284**
www.ecu.edu/ORIC/irb

Notification of Exempt Certification

From: Social/Behavioral IRB
To: [Olivia Boorum](#)
CC: [Marianna Walker](#)
Date: 12/28/2017
Re: [UMCIRB 17-002427](#)
The Influence of Language Phenotype on Predictors of Emergent Literacy in Children with Autism Spectrum Disorders

I am pleased to inform you that your research submission has been certified as exempt on 12/22/2017. This study is eligible for Exempt Certification under category #1.

It is your responsibility to ensure that this research is conducted in the manner reported in your application and/or protocol, as well as being consistent with the ethical principles of the Belmont Report and your profession.

This research study does not require any additional interaction with the UMCIRB unless there are proposed changes to this study. Any change, prior to implementing that change, must be submitted to the UMCIRB for review and approval. The UMCIRB will determine if the change impacts the eligibility of the research for exempt status. If more substantive review is required, you will be notified within five business days.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418

Appendix B

Informed Consent Form



Department of Communication Sciences and Disorders
College of Allied Health Sciences

3310 Health Sciences Building | Mail Stop 668
East Carolina University | Greenville, NC 27834-4354
252-744-6100 office | www.ecu.edu/csd

Dear Parent/Guardian,

I am presently working on my Master's of Science in Communication Sciences and Disorders at East Carolina University. As part of my degree requirements I am planning an educational research project, under the supervision of my faculty advisor Dr. Marianna Walker, to take place in the classroom that will help me to learn more about early literacy in preschool aged children with Autism Spectrum Disorders. The fundamental goal of this research study is to determine which factors predict literacy skills in children with ASD who have different language profiles.

As part of this research project in the classroom, your child will participate in various standardized language testing activities over the next six to eight weeks that will allow me to gather information about their strengths and weaknesses in language and literacy. As this study is for educational research purposes only, the results of your child's participation **will not** affect your child's grade.

I am requesting permission from you to use your child's data in my research study. Please know that participation is entirely voluntary.

If you have any questions or concerns, please feel free to contact me at my office at (252)-744-6121 or by emailing me at booromo16@students.ecu.edu. If you have questions about your child's rights as someone taking part in research, you may call the Office of Research Integrity & Compliance (ORIC) at phone number 252-744-2914 (days, 8:00am-5:00pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971.

If you permit your child's data to be used in my study, please return the attached form by **February 16th, 2018**. Thank you for your interest in my educational research study.

Your Partner in Education,
Olivia Boorum

As the parent or guardian of _____,
(write your student's name)

- I grant my permission for Ms. Boorum to use my child's data in her educational research project regarding literacy in children with Autism Spectrum Disorders. I fully understand that my child's data will be kept completely confidential and will be used only for the purposes of Ms. Boorum's research study. I also understand that I or my child may at any time decide to withdraw my/our permission and that my child's grade will not be affected by withdrawing from the study
- I do NOT grant permission for Ms. Boorum to use my child's data in her educational research project regarding literacy in children with Autism Spectrum Disorders.

Signature of Parent/Guardian: _____ Date: _____

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Appendix C

GARS-3 Test Scores

Participant	Age (months)	Phenotype	Gender	GARS Index
1	58	ALN	M	61
2	57	ALI	M	111
3	63	ALI	M	109
4	59	ALI	M	87
5	54	ALN	M	69
6	61	ALN	M	87
7	57	ALI	M	105
8	65	ALN	M	72
9	52	ALI	M	81
10	60	ALI	M	74
11	55	ALI	M	99

Appendix D

Oral Language Experimental Test Scores

Participant	Age (months)	Phenotype	Gender	CTOPP NWR	TOLD SU	TOLD MC	CASL PJ	CTOPP RON	TOPEL DV Raw Score
1	58	ALN	M	9	7	11	84	4	28
2	57	ALI	M	2	2	4	69	5	13
3	63	ALI	M	2	2	4	68	1	15
4	59	ALI	M	5	4	4	73	1	16
5	54	ALN	M	14	7	6	96	8	55
6	61	ALN	M	13	6	8	97	13	49
7	57	ALI	M	2	3	4	61	0	4
8	65	ALN	M	7	7	4	76	12	44
9	52	ALI	M	6	4	4	62	10	12
10	60	ALI	M	6	2	2	68	10	15
11	55	ALI	M	2	2	4	61	11	14

Appendix E

Emergent Literacy Experimental Test Scores

Participant	Age (months)	Phenotype	Gender	TOPEL PK	TOPEL PA Raw Score	TOPEL Index
1	58	ALN	M	86	17	81
2	57	ALI	M	98	0	61
3	63	ALI	M	74	0	51
4	59	ALI	M	77	0	53
5	54	ALN	M	95	21	105
6	61	ALN	M	118	15	99
7	57	ALI	M	73	0	50
8	65	ALN	M	115	13	91
9	52	ALI	M	118	10	83
10	60	ALI	M	100	6	66
11	55	ALI	M	98	3	66

