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Development of Reading, Language, and Social Skills in Young Children With ASD

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Dedication

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ABSTRACT OF THE DISSERTATION

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by

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Children with autism spectrum disorder (ASD) display a number of associated deficits that may impact reading comprehension development. The simple view of reading suggests that reading comprehension is the product of decoding skills and oral language, which is a deficit area for students with ASD. Some literature has also suggested that social skills impact reading comprehension development. The present study examines the simple view of reading with added emphasis on social skills in two samples of students with ASD, kindergarteners (N = 128) and second graders (N = 73), using latent variable path analyses. The study also examines the relationship between social skills and reading skill growth across pre-kindergarten to second grade, the impact of oral language on this growth, and the impact of this growth on reading comprehension in a larger sample of students with ASD (N = 182) using longitudinal growth analyses. Results indicate that

the simple view of reading, including social skills, was an appropriate model for both kindergarteners and second graders, with some differences between the models. Additionally, reading growth impacted later reading comprehension, although social skills growth did not.

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Children with autism spectrum disorders (ASD) display a number of deficits, many of which are associated with the diagnosis. These core deficits of ASD include impairment in social communication, and the presentation of restricted and repetitive behaviors (5th ed.; *DSM-5;* American Psychological Association, 2013). However, associated deficits in areas such as attention (Mayes, Calhoun, Mayes, & Molitoris, 2012), internalizing behaviors (Kim, Szatmari, Bryson, Streiner, & Wilson, 2000), externalizing behaviors (Baker & Blacher, in press; Tonge, Brereton, Gray, & Einfeld, 1999), and oral language (Kjelgaard & Tager-Flusberg, 2001), often arise in children and adolescents with ASD. These noted deficits can impact children in many ways, including in the area of academic functioning. For instance, children with ASD have documented difficulties with reading comprehension (Nation, Clarke, Wright, & Williams, 2006; CNorbury & Nation, 2011) such that they perform below the level expected of typically developing peers, even on early indicators of reading comprehension given in pre-kindergarten and kindergarten (Davidson & Weismer, 2014). These noted deficits have led to an interest in determining how they develop, and determining whether children with ASD are differentially impacted due to existing deficits associated with the disorder.

The Research Problem: Deficits in Reading Comprehension in ASD

Although research on the reading development of young children with ASD is limited, the literature has been concentrated on documenting the poor reading comprehension skills in this population (Davidson & Weismer, 2014; Nation et al., 2006;

Norbury & Nation, 2011; Ricketts, Jones, Happe, & Charman, 2013). Research has heavily focused on reading comprehension skills in the adolescent years (Jones et al., 2009; Newman et al., 2007; Ricketts et al., 2013), and later childhood (Lindgren, Folstein, Tomblin, & Tager-Flusberg, 2009; Nation et al., 2006), with very few studies examining the early development of reading comprehension skills in young children with ASD (Davidson & Weismer, 2014). However, preliminary results have suggested that even in pre-school and kindergarten, children with ASD display clear deficits in reading comprehension. One of the few studies documenting early reading skills in children with ASD suggested that the mean performance on a measure of constructing meaning from print was already one full standard deviation below the average level in a population with a mean age of 5.5 years (Davidson & Weismer, 2014).

However, developmental reading skills change as the child ages (Vellutino, Scanlon, & Tanzman, 1994; Vellutino, Tunmer, Jaccard, & Chen, 2007), and measurement of reading comprehension in pre-school and kindergarten is quite different from measurement of reading comprehension in students who have shifted from learning to read to reading to learn (Chall, 1983). Still, these clear deficits in reading comprehension have been demonstrated in studies of older children with ASD, as well (Nation et al., 2006; Ricketts et al., 2013). In a sample of children and adolescents between the ages of 6 and 15 years old (M = 10.3 years), 38% of the sample scored two standard deviations below average on an inference-based measure of reading comprehension; further, 65% of the total sample scored at least one standard deviation below average (Nation et al., 2006). These figures were mimicked in an older sample of

adolescents (i.e., ages 14 to 16), where 32% performed two standard deviations below average, and 60% performed at least one standard deviation below average (Ricketts et al., 2013). Thus, poor performance on reading comprehension measures has been demonstrated across many age groups of children and adolescents with ASD, highlighting a clear problem with regard to literacy development in this population.

Along these lines, a meta-analysis of studies examining reading comprehension in ASD showed that while overall, children with ASD have demonstrated poor reading comprehension skills, there is variability in these skills (Brown, Oram-Cardy, & Johnson, 2013). Children with ASD tend to demonstrate reading comprehension skills that range from far below average, to somewhere within the average range (Brown et al., 2013). Brown and colleagues (2013) also pointed out that while having ASD is associated with an increased likelihood of reading comprehension difficulties, these difficulties do not arise from the ASD diagnosis on its own. This variance in performance, which skews toward the less proficient side of the spectrum, may be accounted for by deficits associated with the diagnosis, rather than the diagnosis itself. For instance, Brown and colleagues (2013) found that students with ASD did markedly worse on reading comprehension tasks for highly social texts and better on less social texts, suggesting that level of social functioning may have an impact on reading development. Another area of interest in the literature is oral language.

Given the research documenting the frequent deficits in reading comprehension exhibited by an abnormally large percentage of children with ASD throughout development, there is a clear need for research examining how reading comprehension

deficits develop longitudinally, and in response to variables that may affect reading growth. This leads to the question of why some students with ASD successfully develop reading comprehension skills, while a large percentage of these children flounder. This study will examine relationships among key variables noted in research on typically developing children that have more recently been extended to children with ASD. Specifically, relationships among important variables proposed to impact reading comprehension will be examined across multiple age groups. Further, data will be examined longitudinally, as this has not been done in students with ASD.

Thus, the present review of literature will first focus on variables that likely impact the development of reading comprehension in children with ASD. An understanding of typical reading development is necessary to propose research directions for children with ASD, as has been shown in previous literature in ASD that reflects upon theories first posited for typically developing children, such as the simple view of reading. Accordingly, the simple view of reading and its implications and use in ASD research (Davidson & Weismer, 2014; Ricketts et al., 2013) will be examined. Some research in typical development has also highlighted the importance of social competence in relation to reading development (Miles & Stipek, 2006; Welsh, Parke, Widaman, & O'Neil, 2001; Wentzel, 1991), which has transferred over into research in children with ASD, as social competence is a clear area of deficit in this population. However, only ASD research has combined features of the simple view of reading with aspects of social competence within one model. Further, while longitudinal research examining growth in reading and social skills exists for typically developing children, these models have not

transferred to the ASD literature. Modeling the growth of social and reading skills over time in this population will allow for an examination of how these skills impact each other longitudinally. This proposal aims to address these gaps, and extend the research to a sample of young children with ASD.

Simple View of Reading

Examining theoretical frameworks helps to illuminate what features associated with ASD may lead to the development of these noted reading comprehension deficits. The simple view of reading, first introduced by Gough and Tunmer (1986), asserts that reading comprehension is the product of linguistic comprehension and decoding skills. Therefore, this theory posits that reading comprehension is directly affected by a child's ability to decode (the ability to sound out words) written text and comprehend spoken words. Further, reading comprehension is improved when lower level skills, such as decoding, are improved and no longer require mental resources (Perfetti, 1985), and the child depends more on their oral language skills. In general, research has supported that oral language development is foundational for developing adequate reading comprehension skills.

The simple view of reading, and thus the relationship between oral language and reading comprehension, is supported both by research examining the predictive ability of oral language, as well as research on the characteristics of children with deficits in reading comprehension. The latter area of research, namely how deficits in oral language are related to deficits in reading comprehension, began with an examination of features of "poor readers" (Stothard & Hulme, 1992) and dates back to the 1970s (Berger, 1978;

Smiley, Oakley, Worthen, Campione, & Brown, 1977), even before the simple view of reading was proposed. More recently, research in these areas has been extended to children with ASD to determine if this relationship perhaps impacts this group so significantly because of their characteristic difficulties with oral language.

In an attempt to determine whether decoding, oral language, and reading comprehension skills were "independent" and unrelated, or "interdependent," studies conducted by Berger (1978), Smiley and colleagues (1977), and Stothard and Hulme (1992) examined samples of poor readers and assessed their language skills. Unsurprisingly, Berger (1978) found that participants with poor reading comprehension demonstrated poorer listening comprehension skills than children with average reading comprehension skills. Similarly, Stothard and Hulme (1992) discovered that poor comprehenders performed more poorly than same-age controls on measures of both receptive and expressive language.

Child age and decoding ability. Since these studies that were published before the simple view of reading, more recent research has focused on how the model changes with regard to different variables. For instance, research has suggested that the importance of linguistic comprehension, a facet of oral language, in the simple view model changes as a child grows older and develops more decoding skills. Vellutino, Tunmer, Jaccard, and Chen's (2007) investigation of their convergent skills model found that while oral language components predicted reading comprehension for both younger (grades 2 and 3) and older (grades 6 and 7) children, oral language was more predictive for older children. Further, decoding skills were only predictive of reading

comprehension for the younger children, suggesting that as decoding skills become more fluent, other variables become more important in their relationship to reading comprehension outcomes (Vellutino et al., 2007). Decoding skills are the best predictors of reading comprehension in young children, unless they are poor decoders, or have fully developed decoding skills (Vellutino et al., 1994). However, Vellutino and colleagues (2007) did not study children at the earliest stages of decoding development, in kindergarten or first grade.

These findings suggest that it is important to examine the simple view of reading model at different ages. While certain skills (i.e., decoding skills) may be indicative of later reading comprehension skills at one age, other skills (i.e., oral language skills) may be more important as the child ages (Vellutino et al., 2007). This is a critical point in the TD literature that has not been examined in the ASD literature. While the simple view of reading has been explicitly examined in children with ASD above the age of six (Nation et al., 2006; Ricketts et al., 2013), it has not been supported in younger children with ASD who do not yet have adequate decoding skills (i.e., students in kindergarten).

Various forms of oral language. Another way that research has examined the intricacies of the simple view of reading has been through the study of different forms of oral language. Although the simple view of reading specifies linguistic comprehension, which is a receptive oral language skill, research implying the potential importance of expressive oral language in both typically developing (Stothard & Hulme, 1992) and ASD populations (Davidson & Weismer, 2014; Nation et al., 2006) has resulted in an interest in examining multiple areas of oral language as they relate to predicting reading

comprehension (Berninger & Abbott, 2010; Roth, Speece, & Cooper, 2002). Across grade levels (i.e., 2nd to 7th), aspects of oral language have been found to correlate with and predict reading comprehension (Berninger & Abbott, 2010; Vellutino et al., 2007). Berninger and Abbott (2010) recruited two cohorts, differing in age: one group that was studied in grades 1, 3 and 5 (younger cohort); and one group that was studied in grades 3, 5 and 7 (older cohort). The authors found that oral expression (expressive language) and listening comprehension (receptive language) both contributed unique variance to reading comprehension in grades 1 and 3 (Berninger & Abbott, 2010). However, oral expression did not consistently predict variance in reading comprehension across cohorts in grade 5, and was not a significant predictor of reading comprehension at all in grade 7, indicating that receptive oral language was more critical in these groups. None of these analyses included decoding skills in their regressions, and thus the importance of oral language may be exaggerated, particularly for the participants in grade 1, who may have still been developing decoding skills.

On the other hand, Vellutino and colleagues (2007) ran analyses on a convergent skills model, which not only included measures of both expressive oral language (i.e., the vocabulary and similarities subtests on the Wechsler Intellectual Scale for Children, deemed measures of "semantic knowledge") and receptive oral language (a listening comprehension test, deemed a measure of "language comprehension"), but also measures of decoding (a single word reading test, or "context-free word identification," and phonological awareness assessments). In addition to their finding that oral language was an important predictor of reading comprehension for both age groups (the younger,

grades 2 and 3, and the older, grades 6 and 7), Vellutino and colleagues (2007) found that both receptive and expressive language were important in their model. Specifically, while decoding skills, or context-free word identification skills, were found to be related to reading comprehension only in the younger cohort, both language comprehension (receptive oral language) and semantic knowledge (expressive oral language) were related to reading comprehension in the younger and older groups. Thus, multiple aspects of oral language appeared to be important to developing adequate reading comprehension skills, even when decoding skills were accounted for, although Berninger and Abbott's (2010) results diminished the importance of expressive language.

The simple view and ASD. The simple view of reading has been applied to multiple populations of children, including those with ASD. The applicability of the simple view of reading to children with ASD is supported by the findings that children with ASD display poorer oral language skills than typically developing children (Gabig, 2010) and than those with dyslexia (Huemer & Mann, 2010); this may indicate that this model is even more relevant for studying reading within this population, as oral language skills may impact reading comprehension even more than in other groups of children. Nation and colleagues (2006) examined relationships among decoding, oral language, and reading comprehension in children and adolescents with ASD and found that the simple view was upheld in this population. Ricketts and colleagues (2013) supported this finding with a slightly older sample of adolescents. Davidson and Weismer (2014) also cited the simple view of reading in their study of reading comprehension development in a young sample of children with ASD, but did not consider early decoding skills as

predictors. Regardless, the simple view of reading is a relevant model for examining the development of reading comprehension in children with ASD.

Similarities in the study of oral language and reading. Literature on reading in typically developing children often influences research in ASD. Thus, the finding that poor comprehenders performed poorly on measures of both receptive and expressive language (Stothard & Hulme, 1992) is particularly pertinent to the discussion of poor reading comprehension in children with ASD, given that children with ASD display a wide range of deficits in different aspects of oral language (Kjelgaard & Tager-Flusberg, 2001). In support of the importance of this finding, it was mimicked in a sample of children with ASD (Nation et al., 2006). Nation and colleagues (2006) found that "less-skilled" comprehenders performed significantly poorer on measures of both vocabulary and listening comprehension than did children classified as "skilled comprehenders." Identifying deficits in children who already display deficits in reading comprehension highlights the interdependent nature of early literacy and language skill development.

Further, the question of the differential predictive ability of receptive versus expressive language exists in literature on the reading development of children with ASD, as well. Davidson and Weismer (2014) first posed the question explicitly in their examination of the simple view of reading with a sample of young children with ASD (mean ages from time point 1 to time point 2 of 2 ½ to 5 ½, $N = 94$). The authors included separate measures of expressive and receptive language as predictors of reading comprehension on the Tests of Early Reading Ability, third edition (TERA-3; Reid et al., 2001). While receptive language at time point 1 was related to phonics skills at time point

1, expressive language at time point 1 was uniquely predictive of reading comprehension at time point 2 (Davidson & Weismer, 2014). This indicates that while phonics skills may draw on receptive language more so than expressive language in this young sample of children with ASD, expressive language may be more important in developing later reading comprehension skills. This is an interesting finding, given the focus on receptive language in both the simple view of reading, as well as research in typically developing children.

Similarly, Ricketts and colleagues (2013) measured both receptive and expressive language separately, but in their sample of adolescents with ASD (ages 14 to 16 years, *N* = 100). However, unlike Davidson and Weismer (2014), Ricketts and colleagues (2013) found that receptive oral language uniquely predicted reading comprehension, while expressive oral language was not entered into the final regression. These differences in findings could be due to a number of dissimilarities between the studies, including large age differences, differences in measurement of oral language and reading comprehension, and differences in the time difference between time point 1 and time point 2. Regardless of why these differences emerged, it is clear that examining the differences between types of oral language is important in developing an understanding of how reading comprehension develops in ASD, in order to develop effective interventions targeting specific skills early in children's academic careers. At the least, multiple measures of oral language should be considered when measuring oral language skills.

Although the distinction between receptive versus expressive oral language is important, oral language is more than a black and white construct. There are multiple

types of oral language skills (Rathvon, 2004), and many have been specifically implicated in affecting the development of reading comprehension in children with ASD. Such skills include vocabulary (Davidson & Weismer, 2014; Nation et al., 2006), pragmatic language (Norbury & Bishop, 2002), syntax (Lucas & Norbury, 2014; Ricketts et al., 2013), and receptive vocabulary (Nation et al., 2006). Thus, there are numerous features of oral language that are worth examining in their relationship to reading comprehension.

Although research in typically developing children has influenced research in children with ASD, there are some areas that remain to be examined in ASD. For instance, while the simple view of reading may be an applicable model and perspective from which to study reading in ASD, the relationships among the variables involved (decoding, linguistic comprehension, and reading comprehension) have been shown to vary dependent on child age or decoding ability, although this has not been examined in children with ASD. Further, although reading comprehension has been examined in young children (M = 5.5 years old) as predicted by oral language (Davidson & Weismer, 2014), the full simple view of reading including decoding skills and oral language skills was not examined. While early elementary aged children have been examined within a larger sample of children with a wider age range (i.e., 6-14 years old) (Nation et al., 2006), a group of same-aged children with ASD in the early elementary years has not been explicitly examined.

The potential differences in the model with regard to age have not been examined in the ASD literature, but may provide unique information regarding intervention. Thus,

one aspect of this proposal will focus on the relationships among the variables involved in the simple view of reading and how they may be different in two separate age groups. However, social skills will also be added to the model due to its support in the literature, and the importance of including all relevant variables within one model of development. These models will provide support for the importance of building skills where deficits typically exist in children with ASD in order to impact separate areas of functioning, such as reading comprehension, specifically in school settings.

Social Skills: Deficits and Their Relationship to Reading

While the importance of oral language and decoding skills in determining later reading success has been clearly supported in the typically developing (Vellutino et al., 1994; Vellutino et al., 2007) and ASD literature (Davidson & Weismer, 2014; Nation et al., 2006; Ricketts et al., 2013), other skills have been implicated to a lesser extent. Some research has suggested that social competence may be related to academic performance, and there is evidence to support this in the literature (Malecki & Elliott, 2002; Miles & Stipek, 2006; Welsh et al., 2001; Wentzel, 1991).

Social competence is specifically defined as pro-social behaviors, peer relations, and appropriate classroom behavior (McClelland, Morrison, & Holmes, 2000). Various aspects of social competence have been associated with academic outcomes, including socially responsible behavior (Wentzel, 1991), general social skills (Malecki & Elliott, 2002), interpersonal problem solving skills (Wentzel, 1991), social communication (Ricketts et al., 2013), cooperation (Caprara, Barbaranelli, Pastorelli, Bandura, & Zimbardo, 2000; Konold, Jamison, Stanton-Chapman, & Rimm-Kaufman, 2010;

Normandeau & Guay, 1998; Welsh et al., 2001), empathy (Miles & Stipek, 2006; Normandeau & Guay, 1998), and assertion (Konold et al., 2010). These various social competence variables have been found to impact multiple areas of academics in typically developing children, including performance on statewide achievement test scores (Malecki & Elliott, 2002), standardized achievement tests (Miles & Stipek, 2006), and grade point average or grades (Welsh et al., 2001; Wentzel, 1991).

Related to social skills and social functioning are social-emotional skills, which can be considered another aspect of social functioning commonly studied in the research in relation to reading outcomes. The interest in this area originates in the study of school readiness, and how early transitional social emotional skills and academic achievement are intertwined and thus provide the foundation for successful classroom interactions and later achievement (Duncan et al., 2007). While some research has shown that social-emotional skills upon school entry rarely impact reading outcomes (Duncan et al., 2007), other research has suggested these and related skills are quite important longitudinally (Caprara et al., 2000). In a longitudinal study of children in Italy, Caprara and colleagues demonstrated that pro-social behavior measured in third grade predicted academic achievement in eighth grade, even better than aggressive behavior, which has extensive research to support it (Caprara et al., 2000).

In children with ASD. Heightened social deficits in ASD have led to interest in examining how these deficits may influence reading comprehension in similar, but perhaps more pronounced, ways to their influence on reading comprehension development in typically developing children. Further, these studies have supported the

proposed impact of social skills on reading comprehension, both in younger children (Davidson & Weismer, 2014; Estes, Rivera, Bryan, Cali, & Dawson, 2011) and adolescents (Ricketts et al., 2013) with ASD. Although the research in this area is quite limited, it offers an interesting perspective on development of complex reading comprehension skills in children with ASD. It is important to emphasize that both Ricketts and colleagues (2013) and Davidson and Weismer (2014) approached their analyses from the perspective of the simple view of reading, meaning that they were also interested in the impact of oral language on reading development, but also included social competence as a potential variable of interest. This methodology is unique to literature in ASD, as literature in typically developing children has never combined these elements.

Davidson and Weismer (2014) recently found that reading skills, including alphabet knowledge (phonics), print conventions, and constructing meaning from text (reading comprehension), were concurrently related to social competence in young children (between the ages of 23 to 29 months at their first visit and 57 to 79 months at their last visit) with ASD. The authors defined social competence as socialization, as measured by the Vineland Adaptive Behavior Scales, Second Edition (Sparrow, Cicchetti, & Balla, 2005), a semi-structured interview and parent report of child behaviors. The Socialization domain score was used, which measures coping skills, play and leisure, and interpersonal relationships. Subtests of the TERA-3 (Reid, Hresko, & Hammill, 2001) were used as measures of reading ability, including the Alphabet subtest (a measure of phonics), the Conventions subtest (a measure of print conventions), and the Meaning subtest (an early measure of reading comprehension). When longitudinal

predictors (at mean age of 2 ½) of various reading domains (at mean age of 5 ½) were examined, social competence was only a significant predictor of the reading comprehension subtest, indicating that while social competence may not be important in the development of early literacy skills, it may be important early on in the development of reading comprehension skills (Davidson & Weismer, 2014). Perhaps even more important, social competence predicted unique variance in reading comprehension above and beyond oral language, a well-accepted predictor of reading comprehension in TD children and those with ASD (Davidson & Weismer, 2014).

Estes and colleagues (2011) similarly examined the predictive relationship between social competence and reading achievement, but with a slightly older sample of children with ASD (from mean age of 6 at the first time point, and 9 at the last), and a slightly different definition of social competence. In this study, social competence was measured with the Social Skills Rating System (Gresham & Elliot, 1990). Rather than using parent report, the authors examined teacher rating of social competence, in order to get an estimate of child social behaviors in the classroom and at school, rather than at home. Additionally, rather than using a measure of reading comprehension, as Davidson and Weismer (2014) did, Estes and colleagues (2011) used the Differential Ability Scales (Elliott, 1990) subtest measuring word reading. Despite these differences, Estes and colleagues (2011) similarly found that better social skills were associated with better reading skills, specifically in the area of word reading. Further, social skills predicted word reading above and beyond the child's IQ.

This relationship has also been examined by Ricketts and colleagues (2013), who studied predictors of reading comprehension in adolescents with ASD. Similar to other studies in the field, these authors included a measure of early literacy (word recognition) and oral language, but also included measures of social communication behavior and social cognition, determined to be two separate facets of social skills, as defined by Ricketts and colleagues (2013). Social communication behavior was measured using the Autism Diagnostic Observation Schedule-Generic (Lord, Rutter, DiLavore, & Risi, 2008), which is an observation of child behavior conducted by a trained examiner. Social cognition, however, was measured using cognitive tasks, including the Strange Stories task (Happe, 1994), in which the child reads a text and is asked questions about the intentions of nonliteral utterances. Ricketts and colleagues (2013) found through separate hierarchical regressions that both social communication and social cognition predicted reading comprehension above and beyond word recognition and oral language skills.

While there are clear differences in the definitions of social skills and reading achievement, as well as in the samples of children and adolescents with ASD who were examined, a common theme emerged in this research. All of the above studies suggested that social skills at an earlier time point were predictive of reading achievement at a later time point (Davidson & Weismer, 2014; Estes et al., 2011; Ricketts et al., 2013). Therefore, social skills, as measured by various tools, may be important in the development of reading skills, especially reading comprehension. Further, children with ASD perform more poorly in terms of reading comprehension on highly social passages than they do on less social passages (Brown et al., 2013). Social skills predicted unique

variance in reading achievement, above and beyond IQ (Estes et al., 2011), word recognition (Ricketts et al., 2013), and oral language (Davidson & Weismer, 2014; Ricketts et al., 2013), and should therefore be examined more thoroughly throughout early development of literacy skills in children with ASD. Thus, this proposal will examine the relationships among oral language skills, social skills, decoding skills, and reading comprehension using multiple indicators of skills, and within two separate age groups. This analysis will address the major gaps in the literature applying the simple view of reading to children with ASD, and may provide valuable information with regard to how to better intervene before reading comprehension deficits emerge in children with ASD.

Reading and Social Development Longitudinally

While analyses examining one model within two separate age groups is useful, the study of growth over time may prove even more beneficial in determining what skills predict inter-individual differences in growth and development, and what outcomes result from this growth. The development of early literacy skills over time in ASD is not a commonly studied area of research, although a handful of studies have begun to delve into the topic (Davidson & Weismer, 2014; Gabig, 2010; Lanter, Watson, Erickson, & Freeman, 2012) by examining skills at different time points. Often, decoding skills are assessed in children or adolescents with ASD with an average age within the range of the later elementary school years, or even secondary school (Huemer & Mann, 2010; Jones et al., 2009; Lucas & Norbury, 2014; Nation et al., 2006; Newman et al., 2007; Norbury & Nation, 2011; Ricketts et al., 2013). Regardless, various aspects of decoding development

have been addressed in the literature. First, due in part to its heavy association with hyperlexia, some efforts have focused on exploring this relationship (Grigorenko et al., 2002; Newman et al., 2007) and examining the purported above average decoding skills in children with ASD. In contrast, decoding skills in this population have been found to vary quite a bit (Nation et al., 2006), perhaps even more than the variation noted in typically developing children, a trend that has surfaced across the literature (Brown et al., 2013).

Decoding skills: A developmental process. Decoding skills, or the ability to break down and read words, can be conceptualized and measured in a number of ways, and can be composed of a variety of literacy skills. The National Reading Panel (2000) highlighted the "big five" areas of reading, namely phonemic awareness, phonics, fluency, vocabulary, and reading comprehension, a collection of literacy skills that display the developmental nature of reading well. While fluency, vocabulary, and reading comprehension are skills that develop later in reading development, and involve more advanced processes, phonemic awareness (knowledge that words are composed of sounds) and phonics (knowledge that letters correspond with sounds) contribute to a child's overall ability to decode words, and are conceptualized as emergent literacy skills (Whitehurst & Lonigan, 1998). Whitehurst and Lonigan (1998) identified numerous skills that comprise emergent literacy skills, including language, conventions of print, letter-name knowledge, rapid naming, and print motivation. Further, these emergent literacy, or pre-literacy, skills that children enter school with have been found to impact later reading development (Foster & Miller, 2007; Whitehurst & Lonigan, 1998).

During this stage of reading development, when children first enter school, emphasis is placed on learning letters and understanding letter-sound correspondence, a skill that children with ASD tend to excel at (Lanter et al., 2012). Lanter and colleagues (2012) collected direct assessments of emergent literacy skills, as well as parent reports of these skills, for a sample of children with ASD between the ages of 4 years and 7 years, 11 months. Although the direct assessments were not norm-referenced, and therefore somewhat difficult to interpret, 97% of parents suggested that their children could identify letters (while the other 3% reported that they "maybe" could). This indicated that letter identification was an area of relative strength for these children, possibly due to a restricted interest in letters.

Phonological awareness and phonics are fundamental literacy skills that are of focus in the early elementary years. These skills are very good predictors of later reading success (de Jong & van der Leij, 2002; Foster & Miller, 2007; Hulme et al., 2002). While letter name knowledge tends to be a relative strength for children on the autism spectrum, phonological awareness is often an area of deficit (Gabig, 2010). This is possibly due to the oral nature of phonological awareness, which is sometimes considered an oral language skill. As noted previously, children with ASD often demonstrate deficits in oral language (Kjelgaard & Tager-Flusberg, 2001). These deficits are extended into phonics skills, as well, since children with ASD have been found to do more poorly reading nonsense words (words that have typical English structure, but are not real words) than real words (Gabig, 2010). Single word identification (of real words), like letter

identification, appears to be an area of strength for children with ASD (Lucas & Norbury, 2014).

Eventually, this decoding becomes automatic, thus freeing up cognitive resources for comprehending text (LaBerge & Samuels, 1974; Perfetti, 1985). Lucas and Norbury (2014) teased apart word reading abilities in children with ASD and examined the single word reading and sentence reading of a sample of children ages 7 to 14. While their sample of children with ASD also demonstrated language impairment, the majority of the sample successfully read single words, but only 50% of those sampled read full sentences fluently and accurately (Lucas & Norbury, 2014). Interestingly, semantic coherence was related to fluent reading, while syntactic coherence was not (Lucas & Norbury, 2014), which indicated the critical nature of understanding meaning, and underemphasized the role of correctly formulating sentences.

In summary, reading skills in children with ASD tend to vary quite a bit (Brown et al., 2013). While automatic processes, such as letter or word identification, seem to be easy tasks for the majority of children with ASD (Lanter et al., 2012), tasks involving decoding of nonsense words, or fluently reading sentences, appear to be areas where more deficits are seen (Gabig, 2010; Lucas & Norbury, 2014). Although ASD has been consistently associated with hyperlexia (Silberberg & Silberberg, 1967), more recent research has noted these intricacies in the development of deficits. This research highlights the variability in decoding skills demonstrated by children with ASD, rather than over-emphasizing the prevalence of hyperlexia. While these findings are informative separately, a developmental, longitudinal study of early reading skills would be beneficial

in order to examine the development of skills over time. This research informed the second research question in this study, which focuses on examining the reading (and social) development and growth across six grades in young children with ASD.

Longitudinal modeling of reading skills. Although reading skills have not been examined longitudinally in a sample of young children with ASD, similar studies have been conducted with typically developing children (Kendeou, van den Broek, White, & Lynch, 2009; Storch & Whitehurst, 2002; Vellutino et al., 2007), and children with language impairment (Catts, Sittner Bridges, Little, & Tomblin, 2008). The results of these studies can offer valuable information toward an understanding of this process in children with ASD. This can be done through structural equation modeling, a technique that allows researchers to quantitatively test theoretical models against data (Lomax, 2013). Further, latent growth curve modeling, a type of SEM, is useful for examining trends and changes over time (Preacher, Wichman, MacCallum, & Briggs, 2008). In latent growth curve modeling, one can examine the intercept, or starting point, of a group on a specific variable, and then assess the growth and trajectory of that variable across a span of time, making these models useful for the examination of growth and changes in reading and social development. For example, Catts and colleagues (2008) found that a quadratic model of reading growth in children with language impairment fit the data best, suggesting that reading skills tend to show a steeper slope in the early years of reading, and then tend to level off.

Longitudinal modeling of social skills. While there is a dearth in the literature regarding the longitudinal study of literacy skills for children with ASD, this deficiency is

surprisingly present in the study of longitudinal change in social skills or social functioning over time, especially in its relationship to reading development. The literature in typically developing children and adolescents has examined growth in social skills over time as a result of setting, e.g., home versus school (Chan, Ramey, Ramey, & Schmitt, 2000). Additional research suggests significant relationships between social skills and literacy skills over time, utilizing SEM techniques including cross-lagged panels (Miles & Stipek, 2006; Welsh et al., 2001), and longitudinal growth curve analysis (Konold et al., 2010). While their findings suggested the importance of social skills in the development of reading skills over time for boys and girls (Miles & Stipek, 2006), children coming from low-income families (Konold et al., 2010), and typically developing children in general (Welsh et al., 2001), these results have not been extended to children with ASD, a group that is notorious for their social skills deficits. One of the only studies to examine social growth in children with ASD was conducted by Szatmari and colleagues (2009), who found using hierarchical linear modeling (HLM) of growth that the shape of growth in social skills fit to a quadratic model best.

More research examining the longitudinal development of both reading and social skills is necessary, especially in children with ASD. Since the impact of social skills on the development of reading skills has been clearly shown, modeling both of these skills over time would be beneficial to determine how growth in one domain may impact growth in the other domain. Further, examining potential predictors of this growth, as well as possible outcomes in reading comprehension skills that are a result of growth, would provide critical information for developing more effective interventions to address

deficits in ASD. This is why this is a focus in the second research question in the present proposal.

Impact of Oral Language and Social Skills on Development

Predictors of this growth are also critical to study, as they provide some valuable information about where to direct early intervention efforts. Studies using SEM models have continually shown the impact of oral language skills, in as early as pre-kindergarten, and decoding skills on reading comprehension (Kendeou et al., 2009; Storch & Whitehurst, 2002), in support of the simple view of reading. Additional research has shown how oral language skills affect social skill development, as well (Szatmari et al., 2009). Further, research in social competence has shown on receipt of social skills interventions potentially impacts reading development (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Jones, Brown, & Aber, 2011). While the focus of this proposal is on the development of reading and social skills and the effect this development and growth has on reading comprehension skills, receipt of social skill intervention and oral language skills are of interest toward understanding the extent to which they affect the starting point (intercept) and growth (slope) of social skills and reading skills over time in this sample of young children with ASD.

Longitudinal impact of oral language. Models in typically developing children that included decoding skills, oral language, and reading comprehension have shown that decoding skills and oral language as early as pre-kindergarten (Storch & Whitehurst, 2002) and kindergarten (Kendeou et al., 2009) are related to various reading outcomes, including word identification in second grade, which then is related to reading

comprehension in third and fourth grade (Storch & Whitehurst, 2002). Although they did not use a growth model, Kendeou and colleagues (2009) examined the effect of early decoding and oral language skills on later reading skills in two age groups: one composed of children ages 4 to 6, and one of children ages 6 to 8. As previously mentioned, the authors found that these variables in kindergarten were related to reading comprehension in second grade. Further, although they did not examine the growth and change in these skills, their results suggested a developmental process such that skills in pre-kindergarten impact skills in kindergarten, which then influence reading comprehension in second grade. Vellutino and colleagues (2007) found similar findings in their two age groups, although oral language became more important in its relationship with reading comprehension in their older group of children in grades 6 and 7 (i.e., ages 11 to 12).

While theses studies examined the effects of oral language on reading comprehension in typically developing students, Catts and colleagues (2008) longitudinally examined the differential growth of children with and without language impairment. Their aim was to compare reading growth across the school years between typically developing children and children with language impairment, as a longitudinal study of this nature had not yet been conducted (Catts et al., 2008). The authors found that the two groups began at different levels for both word recognition and reading comprehension, indicating that children with language impairment began their reading development at a lower point. The growth analyses, however, indicated that their slopes were comparable, showing that they demonstrated similar growth patterns (Catts et al., 2008). These analyses suggested that language impairment may have an impact on where

a child begins in their reading development, but it does not appear to affect how their reading skills develop over time. This is worth examining in children with ASD who demonstrate some similar profiles to children with language impairments (Kjelgaard & Tager-Flusberg, 2001), but who also have concomitant deficits in social skills, as it may provide implications for intervention research and practice.

Although few longitudinal growth models of children with ASD exist, these relationships have been studied in children with ASD by predicting reading comprehension at a later time point from oral language skills at an earlier time point (Davidson & Weismer, 2014). For instance, Davidson and Weismer (2014) showed that oral language skills at an early time point (M = 2.5 years old) predicted an estimate of later reading skills (M = 5.5 years old). However, the majority of research in this area features concurrent measurement. Thus, this study aims to address this gap in the literature by examining the impact of oral language skills on growth in reading and social skills.

Research is limited in regards to the impact of oral language on growth in social functioning, but some available literature has examined the impact of structural language impairment on this growth (Szatmari et al., 2009) in children with ASD. In one study that examined the longitudinal development of social functioning (i.e., socialization as measured by an adaptive behavior scale), it was shown that the growth curve model was improved when presence or absence of structural language impairment was included as a covariate (Szatmari et al., 2009). More explicitly, children with ASD and concomitant structural language impairment displayed a different socialization trajectory than those

without this impairment. Thus, previous research in ASD has demonstrated that oral language skills impact the development of social skills to some extent. However, they should be examined alongside literacy development.

Social competence interventions. The research in typically developing children, which has established links between early social functioning and later or concurrent reading achievement, becomes more important when considering how best we can apply it. A number of studies have examined the impact on academic achievement attained as a result of interventions in social competence and social-emotional skills (Durlak et al., 2011; Jones et al., 2011). Jones and colleagues (2011) demonstrated that for those children identified before the intervention to be at most risk behaviorally, academic achievement was increased after a social-emotional and literacy intervention was implemented school-wide.

Amplifying these findings, Durlak and colleagues (2011) discovered through meta-analysis that social-emotional programming improved academic performance of students in a variety of settings. Thus, this intervention research utilized existing data to suggest that social competence is important in developing adequate reading skills, and has applied it to intervention frameworks. This kind of integrative research would be critical for children with ASD, as it could provide evidence for the influence that social skills interventions may have on reading development, and thus provide a greater impetus for provision of social skills services in school settings for this group of children. However, the research for children with ASD in this area is hugely lacking. While it is implicitly clear that social skills interventions impact social skills, this has been

minimally supported in the literature for children with ASD (Bellini, Peters, Benner, & Hopf, 2007; White, Keonig, & Scahill, 2007), where inconsistencies have been identified.

Rationale for the Current Study

While the discussed studies provide useful information regarding reading and social skill development across the early elementary years for typically developing children, and more specific information about children with language impairment, no study to date has examined the relationships amongst oral language, social skills, decoding and reading comprehension comparatively across age groups in ASD. There is limited evidence to suggest that early predictors of reading comprehension that have been examined in the ASD literature, such as oral language (Davidson & Weismer, 2014; Nation et al., 2006; Norbury & Nation, 2011; Ricketts et al., 2013) and social skills (Davidson & Weismer, 2014; Ricketts et al., 2013), have an observable impact on the development of reading skills, and thus reading comprehension. Further, although some studies have examined the relationships between these variables in early childhood (Davidson & Weismer, 2014) and middle childhood (Nation et al., 2006), no study has compared these models within one sample of high-functioning children with ASD across two different age groups, particularly at points in time when reading skills begin to change (e.g., around second or third grade). Further, few studies in children with ASD have examined these and related issues from a structural equation modeling perspective. Similarly, while social skills have been shown to be related to reading comprehension in very young children with ASD (Davidson & Weismer, 2014) and adolescents with ASD (Ricketts et al., 2013) this relationship has not been examined comparatively across age

groups. Structural equation modeling allows for multiple indicators of latent variables, so issues arising from the use of single indicators and reliability, or those arising from whether measures of expressive or receptive language were included, will be ameliorated using this kind of modeling.

Despite the fact that social skills are a core deficit in ASD, and have a noted impact on reading comprehension, a model of their development across the early years in children with ASD has rarely been examined, nor has the impact of this growth on reading comprehension been examined. Similarly, growth in reading skills and the impact of this development on reading comprehension in children with ASD has not been examined. While these analyses may present important implications for the inclusion of both early social skills interventions in schools for children with ASD, as well as the possibility of incorporating social skills training within reading comprehension interventions for this population, it has not been an area of focus in the literature. Further, Duncan and colleagues (2007) suggested that before intervention research can be validated, we must test and then establish that interventions in these areas not only affect early skills, but impact adjustment in the long term, thus affecting later skills. Additionally, no studies have examined the simultaneous development of social skills and reading skills in children with ASD, although some studies have attempted this in typically developing children (Konold et al., 2010; Miles & Stipek, 2006; Welsh et al., 2001).

Support for the proposed models. The simple view of reading has been proven true for both typically developing children and those with ASD. Oral language clearly

impacts both decoding skills and word recognition (Davidson & Weismer, 2014; Kendeou et al., 2009; Nation & Snowling, 2004; Storch & Whitehurst, 2002), as well as reading comprehension skills (Berninger & Abbott, 2010; Hugh W. Catts et al., 2008; Nation et al., 2006; Nation & Snowling, 2004; Norbury & Nation, 2011; Stothard & Hulme, 1992; Vellutino et al., 2007); further, decoding skills are related to reading comprehension outcomes (Storch & Whitehurst, 2002). However, social skills have never been considered alongside oral language skills and decoding skills within this model, which is particularly relevant for children with ASD, whose reading outcomes may be largely impacted by their difficulties with social understanding. Because oral language has a demonstrated impact on the development of social skills (Szatmari et al., 2009), and social skills have a demonstrated impact on reading development (Miles & Stipek, 2006; Welsh et al., 2001), it is logical that these skills would interact within a model of reading.

It is logical that this model may be different for children dependent on grade. Vellutino and colleagues (2007) demonstrated that while oral language was related to reading comprehension for both their younger (i.e., grades 2 and 3) and older (i.e., grades 6 and 7) cohorts, they were more highly related in the older group. However, they did not include a group of children upon entry in formal schooling (e.g., kindergarten or first grade), and their sample included only typically developing children; it is reasonable to expect that oral language skill may be even more critical for children with ASD, given the literature. Further, Miles and Stipek (2006) found that while social skills were related to reading skills in kindergarten and first grade, this impact on reading disappeared in

third grade; it is unclear what happened within this relationship in second grade, as it was not examined.

Research Questions and Hypotheses

The current study aims to address gaps in the literature regarding reading development in young children with ASD, and how it develops alongside oral language and social development. Of particular interest in this study is how reading skills are related to social and oral language skills upon school entry (e.g., kindergarten) and when children begin to develop more decoding skills (e.g., second grade). These interests inform the first section of the proposed study, in which the following questions are posed:

1. To what extent does the simple view of reading, with added emphasis on social skills, explain the reading comprehension performance of a sample of young children with ASD?
    a. Specifically, to what extent do oral language skills impact social skills, early reading skills, and reading comprehension?
    b. Then, recursively, to what extent do social skills and early reading skills then impact reading comprehension skills?
    c. Are these relationships different between a sample of kindergarteners and a sample of second graders?

Further, the proposed study will address gaps in the literature by examining the longitudinal development of social skills and reading skills in ASD throughout the early years of schooling (e.g., pre-kindergarten through third grade), and how they are affected by oral language skills and whether or not the child received social skills intervention.

Additionally, the impact of their growth on reading comprehension is of interest. As such, the following questions will be addressed:

2. To what extent does the average level of social skills and early reading skills among young children with ASD change from pre-kindergarten to third grade?
    a. To what extent is initial status in social skills and early reading skills related to these growth trajectories?
3. Longitudinally, to what extent do oral language skills and whether the child received social skills intervention predict change in child social skills and early reading skills?
    a. Does initial status (intercept) and change (slope) in these variables then predict reading comprehension outcomes?

Methods

Participants

A portion of the data for the proposed study was drawn from the Smooth Sailing Study, a longitudinal study of the early transition to school for children on the autism spectrum. Additional data was collected during a follow-up visit from a select group of participants from the Smooth Sailing Study specifically for use in the proposed analyses. This study was conducted at sites in southern California (primarily from Riverside and Los Angeles Counties) and Boston, Massachusetts. Children were recruited primarily from public schools, programs for children with ASD, and service providers in southern California and the greater Boston area. Participants were recruited in three waves, one

beginning in summer 2011, the second beginning in summer 2012, and the third beginning in summer 2013. The children recruited were between pre-kindergarten and second grade age at the time of enrollment. Consistent with the ASD population, 83.1% of the sample recruited was male. The majority of the participants were white (71.1%), followed by Hispanic (14.8%), Asian (7.4%) and African-American (5.9%). All participants were English-speaking.

Eligibility. Eligibility for the study was determined prior to the assessment visits, at which point children had to meet four inclusion criteria in order to be included in the study. First, participants had to be between the chronological age of 4 years and 7 years, 3 months at the time of enrollment (i.e., the eligibility visit). This age range captures an important time span for reading skill development for any child, including those with high-functioning autism spectrum disorder (ASD). Second, an outside diagnosis of (or suspicion of) ASD was required, including Pervasive Developmental Disorder not otherwise specified (PDD-NOS), Asperger's syndrome, high-functioning autism, and autism, now collectively referred to as autism spectrum disorder (ASD) by the DSM-5 (5^{th} ed.; *DSM-5;* American Psychological Association, 2013). All diagnoses were confirmed through the use of gold standard assessments (i.e., Autism Diagnostic Observation Schedule) and children without an outside diagnosis were further assessed to verify the classification (i.e., using the Autism Diagnostic Interview – Revised). Third, an IQ above 50 was required to ensure that the child would be able to participate in the activities involved in the study. Similarly, children in the study were required to have a level of language that would allow them to participate in the study activities (e.g., at least

single words). Recruitment was ongoing during the study, and participants continued to enroll after the study began. The means of the group retained for the study and the group that dropped out of the study were compared to ensure there were no differences based on attrition. The missing data were such that there was planned missingness, and thus missing data was considered missing completely at random.

Dataset. As mentioned, this study incorporated the use of an existing dataset from the Smooth Sailing Study for a portion of the analyses. However, a visit for additional data collection was conducted for the purposes of this study. Using an existing, longitudinal dataset allowed for advanced statistical analyses across the span of reading development for children with ASD, which would not be possible if I had collected the entirety of the data on my own. Further, I was heavily involved since the beginning of the first wave of data collection, and have been a critical member of the team when making decisions about the study and its protocol.

Using and expanding on an existing dataset also maximized my sample size. Recruitment of the eligible participants for the Smooth Sailing Study took three years to complete, and thus recruiting a sample on my own within the span of one year would have considerably limited my sample size. Further, due to the rather extensive measures administered and proposed within my study, it would be difficult to recruit specifically from school districts. Clearly, use and expansion of the Smooth Sailing dataset provided me with opportunities to conduct this research that would not be possible if I had recruited my own sample. I was in charge of every aspect of the follow-up visit,

including contacting families, creating the protocol for the visit, providing consultation during the visit, and collecting and interpreting data.

Procedures

Participants were recruited primarily from public schools, although a small handful (9.9%) came from private schools. Recruitment was completed by distributing a flyer for the study at various sites, with their approval. Participants and their parents were invited to one of three assessment centers (two in southern California, one in an urban area of Massachusetts) where they were assessed for eligibility for the study. Participants were eligible for the study if they were enrolled in pre-kindergarten, kindergarten, first grade, or second grade at the time of enrollment.

After eligibility was determined, participants were brought in for three visits throughout the study. The first visit (Time 1) took place at the beginning of the school year. The second visit (Time 2) was conducted toward the end of this same school year. The third visit within the Smooth Sailing Study (Time 3) was conducted toward the end of the succeeding year (i.e., spring). At each of these three visits, data were collected on participants' oral language, social skills, early reading skills, and reading comprehension skills. Participants received an honorarium at each visit in thanks for their participation. The procedures for this portion of the study were reviewed and approved by the Institutional Review Board (IRB).

Additional procedures. As part of my study, I collected an additional time point of data (Time 4), in order to expand my sample of older students, and gain additional measures of reading comprehension and social outcomes. This visit took place at the end

of the school year, similar to data collected during Times 2 and 3. Thus, participants from the original Smooth Sailing Study who consented to being contacted for future studies were contacted and invited to participate in this follow-up visit. As an incentive for this visit, participants were offered a free consultation regarding their child's education from an advanced graduate student in school psychology. The main procedures of this additional visit, as well as the new measures, were approved by IRB, and additional adjustments can be made to the existing protocol. Out of a possible 109 participants, 47 participants consented to the additional visit and came in to our centers in southern California and Massachusetts. This 43% retention rate for this additional visit that had not been part of the original study was high, as many families had not been in contact with the center for a couple of years.

For the analyses related to the first research question, the data were structured as follows: data from children who were in kindergarten at Time 2, Time 3, or Time 4 (i.e., at the end of the year) were considered one group, and were analyzed together. The same is true for participants who were in second grade at Time 2, Time 3, or Time 4. Thus, data collected on these participants' social skills, early reading skills, and reading comprehension at the corresponding visit were used. Information regarding these participants' prior oral language skills were gathered from the preceding assessment.

For the analyses pertaining to growth in social functioning and early reading skills (i.e., those corresponding with research questions 2 and 3), the entire sample (all children eligible for enrollment who participated in Time 1 visits, regardless of grade at entry) was analyzed together, and data were structured somewhat differently. For these analyses, the

whole sample was included, and each participant's data collected during their Time 2, Time 3, and Time 4 visits (i.e., data collected at the end of the year) was used. Each participant was in a different grade at each of these time points, and thus provided three time points of data for modeling growth. Because data was collected from participants who ranged in grade from Time 2 (grades pre-kindergarten to second grade) to Time 4 (grades first grade to fourth grade) the model addressed growth in reading and social skills across grades pre-kindergarten through third grade, since most children were within this range. Due to high levels of missingness at third grade (i.e., 78.9%, as the majority of children in the study started at a much younger age), the data was modeled from pre-kindergarten to second grade so as not to extrapolate too much on the missing data. Table 1 presents the breakdown of data collected for each "group" of students. A student's group was determined by the wave of entry (1, 2 or 3) and grade at entry. Strategies for addressing missing data will be discussed.

Measures

Survey. Parents of participants were asked to fill out a basic demographic survey at their eligibility visit, which included information about their household and their child's educational history. Parents were asked specifically whether their child had received any early intervention services (i.e., "has your child ever received any early intervention services?"), or services within the school setting through individualized education plans (i.e., "does your child currently receive any special education services?"). For both of these variables, parents were asked to specify what kind of intervention or special education services, and provided answers to these questions in a free response

format. Answers to these variables were coded such that information could be gathered regarding whether or not the child had been receiving some form of school-based or outside social skills intervention up until Time 1 in the study. For families who came in for the additional Time 4 visit, they were asked briefly about the intervention their child had received (e.g., was it in school, how many children were in the group, how often did it occur) to ensure that the variable was correctly coded. This variable was dummy coded where 0 indicates no social skills intervention, and 1 indicates receipt of some kind of social skills intervention.

Comprehensive Assessment of Spoken Language (CASL). Oral language was estimated using child performance on the Comprehensive Assessment of Spoken Language (Carrow-Woolfolk, 2008). The Syntax Construction and Pragmatic Judgment subtests were used from the CASL. These subtests have adequate internal consistency, with coefficients ranging from .73 to .88 for Syntax Construction across age groups and .77 to .92 for Pragmatic Judgment. Test-retest reliability was adequate for these subtests (.79 for Syntax Construction and .73 for Pragmatic Judgment). Content validity was supported through research on disordered language. The criterion validity is high, as demonstrated by correlations with other measures of oral language, including the Peabody Picture Vocabulary Test – Third Edition (PPVT-III) with coefficients for the three subtests ranging from .45 to .66, and the Expressive Vocabulary Test (EVT), with coefficients for the three subtests all at .64. For the purposes of these analyses, the standard scores of the subtests were used as separate indicators of language skills in research question 1, and were initially combined as a single covariate with another

measure of language (WJ-III Picture Vocabulary, discussed below) for the latent growth curve model.

Social Skills Improvement System (SSIS). Social skills were estimated by parent report on the Social Skills Improvement System (Gresham & Elliott, 2008). The SSIS is a measure of social skills that provides overall estimates of major scales, including social skills, problem behaviors, and academic competence (Gresham & Elliott, 2008). The social skills total scale was used in this study for the latent growth curve model, and individual subscales were used for the latent variable path analyses. The subscale estimates of social behaviors include communication, cooperation, assertion, responsibility, empathy, engagement, and self-control. Parents were asked to rate specific behaviors exhibited by the child or adolescent on a 4-point scale based on frequency ratings from "never" (or "0") to "almost always" (or "4").

Median alpha levels for the major scales range from the mid to upper .90s. The test-retest reliability coefficient for the social skills scale is .84. The internal consistency reliability is high for the social skills subscales, with coefficients ranging from .74 to .96 across age groups. Reports of the validity of the measure include high correlations with other measures of social skills, including the Behavior Assessment System for Children (BASC-2), with a coefficient of .67 for the BASC-2 Social Skills scale.

Woodcock Johnson Tests of Achievement – Third Edition (WJ-III). Separate subtests from the WJ-III (Woodcock, McGrew, & Mather, 2001; 2007) were used as measures of decoding, oral language and reading comprehension analyses related to the latent variable path analysis. Subtests were also used as the repeated measure of

decoding, or early reading, skills for the latent growth curve model, as well as an indicator of reading comprehension in these analyses. For decoding, the Word Attack and Letter-Word Identification subtests, which are measures of phonics skills and single word reading, respectively, were administered, and were given again at the Time 4 visit. Letter-Word Identification requires the child to identify letters and read single words. The Word Attack subtest requires children to sound out non-words. Reading Fluency was given as a general measure of reading, and was included as an indicator of decoding or general reading ability. In this timed, three minute fluency subtest, children are asked to read complete sentences and decide if they are true or false. The Picture Vocabulary subtest was used as a measure of expressive oral language. This subtest requires students to orally produce the name of objects presented as pictures.

One of the outcome measures in this study was the Passage Comprehension subtest, which was administered to participants at multiple times throughout the original study. This subtest requires the child to perform multiple tasks: first, he or she is asked to match picture representations of objects with an actual picture of those objects (e.g., "chair"). In the next set, he or she is asked to perform similar tasks, but with phrases (e.g., "yellow bird"). The last set of tasks is cloze reading tasks, where the child reads a short passage and fills in a blank with a word.

The WJ-III is a reliable and valid measure of reading achievement. The five subtests that will be used in this study (Letter-Word Identification, Word Attack, Reading Fluency, Picture Vocabulary, and Passage Comprehension) have high test-retest and split-half reliability coefficients: .94, .87, .81 and .88, respectively. Test-retest reliability

has been assessed for the timed speed tests, of which one (Reading Fluency, .94) was used in this study. The WJ-III also has high criterion validity and is highly correlated with other measures of reading skills, including the reading composite of the Wechsler Individual Achievement Test (WIAT; .82). The reading comprehension sections of the WJ-III are highly correlated with the reading comprehension sections in the WIAT (r = .79).

Gray Oral Reading Tests – Fifth Edition (GORT-5). The GORT-5 (Wiederholt & Bryant, 2012) was originally added to be used as an outcome measure of reading comprehension for latent growth curve analyses and was given at the Time 4 visit. However, not enough GORT-5 data was collected for students who were in second and third grade (N = 27, 78.9% missingness), so the GORT-5 data was addressed separately through descriptive analyses and independent t-tests. The GORT-5 assessment consists of 16 short passages that the child is instructed to read. The examiner then presents the child with five short questions after each passage that require the child to make inferences about the passage. The child is allowed to look through the passage when answering the questions, and responds to questions by circling the correct answer. Internal consistency reliability coefficients are above .90 for the reading comprehension portion of the assessment. The GORT-5 is also correlated with other measures of reading comprehension, indicating adequate validity.

The comprehension questions were coded regarding whether they were literal (e.g., could be answered using only material from the text) or if they involved inference-making (e.g., drawing conclusions using knowledge from outside the text). Follow-up

analyses were conducted to determine the average percentage of literal vs. inference-based questions answered correctly, as well as the extent to which the percentage of correct literal or inference-based questions were related to a child's oral language and social skills functioning.

Proposed Analyses: Research Question 1

The research questions were addressed primarily using structural equation modeling (SEM). For the first research question, one model was fit to the data for two separate age groups (kindergarteners and second graders; Figure 1). The purpose of these analyses was twofold: first, these analyses allowed for an examination of whether the simple view of reading held in a sample of children with ASD in both kindergarten and second grade. These analyses mimicked those conducted by Vellutino and colleagues (2007) who examined the convergent skills model in two different age groups. Second, these analyses brought social skills into the model, an additional feature not considered in the original simple view of reading, but one which may be especially relevant for children with ASD. It was hypothesized that while the model will fit to the data for both grades, oral language and social skills would produce larger effects on reading comprehension in second grade, while the effect of reading skills would fade.

Latent variable path analyses were fit to the raw data. Latent variable analyses include the estimation of two models: the measurement model, and the path, or structural, model (Kline, 2011; McDonald & Ho, 2002). As such, the fit of both models to the data was estimated for each group (kindergarten and second grade). As explained by Kline (2011), the steps that were taken in these analyses included: 1) model specification, 2)

model identification, 3) model estimation, and 4) model re-specification. Structurally, the internal validity of a construct, or the structural model, is defined using latent factors (of which there are four in this model), where f_n is the factor score on the latent variable:

$$y_{1n} = \lambda_1 f_n + \mu_1$$

$$y_{2n} = \lambda_2 f_n + \mu_2$$

$$y_{3n} = \lambda_3 f_n + \mu_3$$

$$y_{4n} = \lambda_4 f_n + \mu_4$$

The external validity, or the measurement model (i.e., the factor analysis), is defined using regressions that predict latent variables, where m is the number of measurements and *d* is the disturbance of the latent variable (i.e., measurement error and additional variance):

$$f_n = \beta_1 x_{1n} + \beta_2 x_{2n} + \beta_3 x_{3n} + \beta_4 x_{4n} + d_n$$

Model specification. At this step, model hypotheses are presented in the form of equations and graphical representations (Figure 1). The metric of the factors was also set at this step (Anderson & Gerbing, 1988). Latent variable path analyses are appropriate for answering questions regarding theoretical frameworks, and the relationships among variables. Because research question 1 proposed an expansion of the simple view of reading, latent variable path models were an ideal technique for modeling these relationships. Further, latent variable path models allow for more reliable estimates of the variables being measured, as they allow incorporate multiple predictors of latent constructs in one model, and allow single indicators to be corrected using their reliability estimates (Kline, 2011), creating a more reliable model overall. In contrast, path analyses

incorrectly assume that exogenous variables are completely reliable. In specifying a model, it is important to consider all variables that may affect the relationships presented (Kline, 2011); thus, the basic model of the simple view of reading was presented with the additional social skills factor, as this has clearly been shown to impact reading comprehension development, particularly in children with ASD.

The directionality of the paths is an important consideration of model specification. The model presented is recursive, meaning that all of the paths move in one direction toward an endogenous variable (Kline, 2011), which in this case is reading comprehension. Directionality of paths within these two models was of interest, as the measures of social skills, reading skills and reading comprehension were collected concurrently. The measure of oral language skills was collected at a prior assessment, so the direction of paths from this estimate is clear. In support of the direction of other paths, research clearly indicates that decoding or reading skills (Juel, 1988; Perfetti, 1985; Shankweiler et al., 1999; Vellutino et al., 2007), social skills (Malecki & Elliott, 2002; Miles & Stipek, 2006; Ricketts et al., 2013; Welsh et al., 2001), and oral language (Nation et al., 2006; C. Norbury & Nation, 2011; Roth et al., 2002; Speece, Ritchey, Cooper, Roth, & Schatschneider, 2004; Frank R. Vellutino et al., 2007), have a direct impact on the development of reading comprehension skills. Further, it was hypothesized that oral language had a direct impact on reading comprehension, but that it also influenced social skills (Fujiki, Brinton, & Todd, 1996; Szatmari et al., 2009) and reading skills (Kendeou et al., 2009), which in turn would predict reading comprehension.

Thus, the following paths were assessed in the latent variable path analyses for each grade, kindergarten and second grade:

1. Oral language skills predicting social skills (i.e., H_0: $\beta_{f1 \rightarrow f2}=0$; H_1: $\beta_{f1 \rightarrow f2} \neq 0$)
2. Oral language skills predicting decoding skills (i.e., H_0: $\beta_{f1 \rightarrow f3}=0$; H_1: $\beta_{f1 \rightarrow f3} \neq 0$)
3. Oral language skills predicting reading comprehension skills (i.e., H_0: $\beta_{f1 \rightarrow f4}=0$; H_1: $\beta_{f1 \rightarrow f4} \neq 0$)
4. Social skills predicting reading comprehension skills (i.e., H_0: $\beta_{f2 \rightarrow f4}=0$; H_1: $\beta_{f2 \rightarrow f4} \neq 0$)
5. Decoding skills predicting reading comprehension skills (i.e., H_0: $\beta_{f3 \rightarrow f4}=0$; H_1: $\beta_{f3 \rightarrow f4} \neq 0$)

Multiple indicators were used for each factor, with the exception of reading comprehension skills. Thus, the proposed model was considered a partially latent structural regression model (Kline, 2011). Indicators, or manifest variables, were indicated in the models with rectangles, whereas latent variables were indicated with circles. Single indicators are not recommended, as the score inevitably includes error variance unrelated to the child's skill in that area (Anderson & Gerbing, 1988; Kline, 2011). Consequently, the error variance can be corrected for by using an estimate of the reliability of the specific measure (i.e., WJ-III Passage Comprehension) gathered from the technical manual (Anderson & Gerbing, 1988).

Two CASL subtests, Pragmatic Judgment and Syntax Construction, were used as indicators of oral language. These subtests measure pragmatic language and syntax, both important oral language skills in reading comprehension development (Cutting, Materek, Cole, Levine, & Mahone, 2009; Roth et al., 2002). WJ-III Picture Vocabulary was also used as an indicator of oral language, rather than reading skills, because expressive vocabulary is often conceptualized as an oral language skill, and is frequently used as a proxy for expressive oral language in the literature, particularly in studies of Spanish speaking children who similarly have oral language deficits (H.W. Catts, Compton, Tomblin, & Bridges, 2012; Lesaux, Crosson, Kieffer, & Pierce, 2010; Nakamoto, Lindsey, & Manis, 2008; Proctor, Carlo, August, & Snow, 2005; Roth et al., 2002).

Three WJ-III subtests were used as indicators of reading, or decoding, skills: Word Attack, which measures phonics; Letter-Word Identification, which measures letter and single word recognition; and Reading Fluency, which measures general reading skills. These skills are indicative of overall reading capabilities, as is emphasized by both the emphasis on the big five areas of reading (NRP, 2000), as well as research on reading development (Shankweiler et al., 1999).

Subtests of the SSIS were used as indicators of social skills. Social communication (Ricketts et al., 2013), cooperation (Caprara et al., 2000; Konold et al., 2010; Normandeau & Guay, 1998; Welsh et al., 2001), responsibility (Wentzel, 1991), and assertion (Konold et al., 2010) have been most often examined in the literature in regards to social behaviors and their relation to academic outcomes, which is why the SSIS subscale scores of social communication, cooperation, responsibility, and assertion

will be used. Reading comprehension was estimated using a single indicator, WJ-III Passage Comprehension.

Part of model specification requires determining which paths were restricted in the model. This is included in the graphical representation (Figure 1). This relates to the concept of parameter status (Kline, 2011). Some parameters in the model were considered free parameters, and were estimated with the data. Others were considered fixed parameters, which are fixed at a certain, pre-determined value. Still others were considered constrained parameters, which are estimated with the data but are constrained to be equal to another parameter in the model (Kline, 2011). The variances of each indicator were constrained to be equal to other indicators of the same factor, and one indicator path for each factor will be fixed to equal 1. The remaining parameters were free to vary (indicated by symbols).

Another consideration is the model complexity, which will affect the number of estimates that can be made before the model becomes non-rejectable. The following calculation can be used to determine the number of observations using the number of observed variables (v):

$$v(v + 1)/2$$

In these two models, there are 11 observed variables, so the number of observations is equal to: $11(11 + 1)/2$, which equals 66. Thus, the model would be best specified if fewer than 66 parameters are estimated.

Alternative models were considered in order to be able to address model re-specification (Kline, 2011). In SEM analyses, if the proposed model shows poor fit to the

data, alternative models are considered and the model is re-specified, and the following steps would be repeated. Alternative models to the one presented are provided in Figure 2. Alternative models that were considered included a model in which the proposed model is nested (Figure 2a), as well as models that are nested within the proposed model (Figure 2b, 2c). The first alternative model includes a covariance estimate between social skills to reading skills; this relationship has not been supported in the literature explicitly, although social skills are related to general "reading" composites that typically include some measure of reading comprehension or overall academic competence (Miles & Stipek, 2006; Welsh et al., 2001). The second alternative model omits the direct path from oral language to reading comprehension, and oral language to decoding skills. The third alternative model omits the social skills latent variable altogether.

Model identification. Two requirements must be met in order for a model to be identified: first, the model degrees of freedom must be at least 0, and above 0 in order to be rejectable. The model degrees of freedom is equal to the number of values in the covariance matrix (e.g., the number of observations, calculated above) minus the number of parameters being estimated. The proposed model has 66 observations, and 27 parameter estimations. Thus, the proposed models each had 39 degrees of freedom to start, making the model identifiable.

Second, every latent variable should be assigned a scale or metric (Kline, 2011). For each factor, one indicator will be set as a reference variable whose path will be fixed to a scale of 1.0. This technique was chosen because it is preferable when analyzing a

structural equation model across independent samples, so that important information about the variability of latent factors across samples is not lost (Kline, 2011).

Model estimation. The model fit to the data was estimated by Mplus® statistical software, version 7.2 (Muthen & Muthen, 2011) using maximum likelihood estimation. The convergence of the model was examined first. Additionally, there are three assumptions for maximum likelihood estimation that will be tested, which include: 1) independence of scores, 2) multivariate normality of endogenous variables, and 3) independence of error terms and exogenous variables (Kline, 2011).

To run latent variable path analyses, two models were fit: 1) the measurement model, and 2) the structural model (McDonald & Ho, 2002). First, the measurement model was examined, and fit was assessed. Second, the structural model was estimated. This two-step approach is taken to avoid the ambiguity of poor fit results if the whole model were run all at once (Anderson & Gerbing, 1988). In other words, it would be difficult to determine whether the poor fit is due to the measurement model, or the structural model, if this approach was not taken. The measurement model is first specified as a confirmatory factor analysis to assess whether the indicators are explained by the latent variable. If the model had shown poor fit to the data, it would be re-specified until there was adequate fit. Then, the path or structural model would be estimated.

The goodness of fit of each model was examined using multiple indices, including the χ^2 statistic. A significant χ^2 statistic indicates that the model did not fit well to the data. However, because χ^2 is dependent on sample size and subject to high correlations in the model, additional fit indices were examined, as well. These indices include the root

mean square error of the approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis Index (TLI), and the Bayesian Information Criterion (BIC).

RMSEA, like χ^2, is an index of absolute fit (McArdle & Ho, 2002). These fit indices compare how the model fits the data as compared to no model at all. An RMSEA value of .08 or lower indicates good fit. Careful interpretation of the RMSEA is encouraged, as it can be misleading when the sample size is not large. Thus, the 90% confidence interval of the RMSEA was examined; if the lower value approaches 0, this indicates good fit. The TLI is an incremental fit index, as is the CFI. Good fit is indicated through values of .95 or greater, and adequate fit is indicated through values of .90 or greater. Both values were considered in examining the fit of the model to the data. The BIC is a comparative fit index, and a lower value indicates better fit, whereas larger values indicate strong evidence against the fit of the model to the data (Singer & Willet, 2003). While χ^2 is a measure of perfect fit, other indices will provide indications of good model fit to the data. The TLI takes degrees of freedom into account, as does the CFI; further, the CFI penalizes for every parameter estimated. For instance, if parameters are added to the model, the CFI would decrease, thus indicating poorer fit to the data. In addition to whole model fit, parameter estimates were examined to determine the strength of the relationships among latent variables. This helped determine whether the paths in the specified model were significant, or if the model should be re-specified.

Proposed Analyses: Research Questions 2 and 3

Latent growth curve analyses were run using structural equation modeling to examine the longitudinal relationships among oral language, receipt of social skills

intervention, change in social skills and reading skills over time, and reading comprehension outcomes. This analysis answered research questions two and three. The purpose of this analysis was also twofold: first, this model examined the possibility that receipt of social skills interventions, as well as prior oral language skills, were related to growth in social skills and reading skills. Further, this analysis allowed for an examination of how this growth in social skills and reading skills affected student outcomes, namely in the area of reading comprehension. These analyses are similar to the longitudinal analyses conducted by Miles and Stipek (2006) and Catts and colleagues (2008), in that they will examine the impact of social skills and decoding, or reading, skills on reading comprehension over time. However, latent growth curve models were used in these analyses for the following reasons: 1) their ability to examine both inter- and intra-individual change in skills over time in response to covariates, 2) their ability to simultaneously examine growth on two dependent variables (i.e., social skills and reading skills), and 3) their ability to examine the effect of growth of a repeated variable on endogenous outcome variables (i.e., reading comprehension).

To answer these research questions, a conditional latent growth curve analysis was run using oral language as a time-varying covariate (i.e., predictor), a dichotomous variable of whether the child was receiving social skills intervention as a time-invariant covariate, social skills and reading skills as dependent variables, and reading comprehension as an endogenous outcome variable, specifically as a sequelae of change (T. E. Duncan, Duncan, & Strycker, 2006). Oral language skills was measured as a latent variable using CASL Syntax Construction and Pragmatic Judgment and WJ-III Picture

Vocabulary. Social skills were estimated using the SSIS total social skills score. Reading skills were estimated using Letter-Word Identification on the WJ-III, which more students completed fully. Reading comprehension was measured using the child's score on the WJ-III Passage Comprehension subtest; originally, it was proposed that the child's reading comprehension score on the GORT-5 would be included, but not enough older children completed this measure for it to be included in these analyses.

The unique nature of the Smooth Sailing data, namely that this data was collected over four time points for children in a wide variety of grades (pre-kindergarten to third grade), provides an interesting opportunity to examine growth over the early years of schooling. To take advantage of this wide variety in grades, social skills and reading skills were modeled across a range of grades, from pre-kindergarten to second grade, meaning that there were one year lags in between repeated measure estimates. Data was included from participants who had between two and three data points throughout the study, as data from the first time point will not be included as it was collected at the beginning of the school year, while the other time points of data were collected toward the end (Times 2, 3, and 4).

Model assumptions. To serve the purpose of answering these research questions, a conditional latent growth curve model with parallel processes was examined. Conditional models included covariates, which are variables of interest in that they are hypothesized to affect the individual's trajectory on the exogenous variable (i.e., social skills or reading skills).

In order to be run, latent growth curve models require: 1) a continuous dependent variable; 2) scores with the same units across time; and 3) time structured data, such that all individuals are tested at the same intervals, although they do not need to be equal intervals (Kline, 2011). One dependent variable, social skills, was estimated using a performance score and was thus considered a continuous variable. The other dependent variable, reading skills, was estimated using a continuous variable. The scores within each variable had the same units across time, as they were measured with the same measure across time. Further, due to the restructuring of the data, there was one-year intervals between each data point (i.e., pre-kindergarten, kindergarten, 1st, and 2nd grade).

Model specification. Latent growth curve analyses conducted through SEM have multiple benefits. Most importantly in regards to these research questions, these analyses allowed for the simultaneous analysis of growth curves of different variables, in addition to providing estimates of whole model fit (Kline, 2011). The simultaneous estimation of growth curves for two variables that are measured at the same time points (social skills and early reading skills, in the present study) is called a parallel growth process. This kind of longitudinal modeling is only available through latent growth curve modeling via SEM, as latent growth modeling through SEM uniquely allows variables to act both as independent and dependent variables within the same model (T. E. Duncan et al., 2006).

The model equations, which include two covariates and six repeated measures on two dependent variables, are as follows (Bollen & Curran, 2006):

Trajectory: $y_{it} = \alpha_{iy} + \lambda_t\beta_{iy} + \varepsilon_{yit}$

$w_{it} = \alpha_{iw} + \lambda_t\beta_{iw} + \varepsilon_{wit}$ $\sum_{q=2}^{Q}$ $\sum_{q=2}^{Q}$

Intercept: $\alpha_{iy} = \mu_{\alpha y} + \gamma_{qay1}x_{1iq} + \gamma_{qay2}x_{2iq} + \zeta_{\alpha yi}$

$$\alpha_{iw} = \mu_{\alpha w} + \sum_{q=2}^{Q} \gamma_{qaw1}x_{1iq} + \sum_{q=2}^{Q} \gamma_{qaw2}x_{2iq} + \zeta_{\alpha wi}$$

Slope: $\beta_{iy} = \mu_{\beta y} + \sum_{q=2}^{Q} \gamma_{q\beta y1}x_{1iq} + \sum_{q=2}^{Q} \gamma_{q\beta y2}x_{2iq} + \zeta_{\beta yi}$

$$\beta_{iw} = \mu_{\beta w} + \sum_{q=2}^{Q} \gamma_{q\beta w1}x_{1iq} + \sum_{q=2}^{Q} \gamma_{q\beta w2}x_{2iq} + \zeta_{\beta wi}$$

- y_{it} is the trajectory variable for case i at time t (grade) for DV y,
- α_{iy} and α_{iw} are the intercept of trajectory for case i (for DVs y and w),
- β_{iy} and β_{iw} are the slopes of trajectory for case i,
- λ_t is the value of the trend variable for time t (grade),
- ε_{yit} is the disturbance on y_{it},
- $\mu_{\alpha y}$ is the mean of the intercepts,
- $\mu_{\beta y}$ is the mean of the slopes,
- x_{1yi} and x_{2yi} are the two covariates or predictors of intercepts and slopes (i.e., oral language skills and receipt of social skills),
- $\gamma_{\alpha y1}$ and $\gamma_{\alpha y1}$ are the covariate coefficients in the random slope equation,
- $\zeta_{\alpha yi}$ and ζ_{byi} are the disturbance terms.

The latent growth curve model was analyzed in multiple steps (Kline, 2011), similar to the latent variable path analyses. First, an intercept only model was examined, where only the intercept was entered into the model for each dependent variable. This model assumes that there is no change over time in the repeated, dependent variable. If the model fit is poor, the next step is to estimate a change model, or simply the repeated

measurements (i.e., social skills and reading skills), which were modeled for each variable. Thus, two models were examined at first: one for growth in reading skills, and one for growth in social skills. This serves the purpose of examining the trajectory of each of these variables. Within this step, slope paths were first fixed so that the growth was linear; in other words, the slope for pre-kindergarten was set to equal 0, kindergarten was set to equal 1, first grade was fixed at 2, and second grade was fixed at 3 (to represent that one year, or one unit of time, has passed in between each repeated measure). A latent basis model was estimated separately for each dependent variable if model fit was poor for the linear model. In a latent basis model, only the first and last slope paths are fixed, while the slope paths for the remaining values are free to vary. The first path at pre-kindergarten would be fixed at 0, and the last path at second grade would be fixed at 1. This allows for the model to estimate a non-linear trajectory, which may be more appropriate for the data.

When the model fit is acceptable for each of these models (whether through the linear or the latent basis model), the next step is to combine the two latent growth curve models to form the parallel growth process model, and hypothesized relationships among the covariates (social skills intervention and oral language skills) would be modeled. It was hypothesized that growth trajectories in social skills would be greater for students exhibiting higher oral language skills, and for students who have received social skills interventions. Similarly, it was hypothesized that growth trajectories in reading skills would be greater for students exhibiting higher oral language skills, and for students who have received social skills intervention. These hypothesized relationships are supported

in the literature (Miles & Stipek, 2006). However, the model can be re-specified (e.g., modeling social skills and reading skills separately) when model fit was poor, and alternative models were then considered.

Model identification. Latent growth curve models are always identified if the change model is identified, and if all exogenous variables are manifest (Bollen & Curran, 2006). The proposed model meets the second requirement, and the first requirement was tested before proceeding with analyses (as indicated above). Latent growth curve models have two latent growth factors: the initial status (intercept), and the slope. The model being estimated is presented in Figure 3. Each predictor, oral language skills and whether the child received social skills intervention, was hypothesized to have direct effects on both of the latent growth factors, and the growth factors are hypothesized to have a direct effect on reading comprehension. The latent factors and each of the predictors have associated error variances. The model presented in Figure 3 has a total of 11 observed variables (two observed covariates, 8 observed repeated measurements across two variables, and one observed sequelae of change variable), and thus 88 (i.e., (11*16)/2)) observations to estimate the 29 parameters in the prediction model (13 variances, six direct effects on latent growth factors, four direct effects of latent growth factors on the endogenous sequelae of change variable, and four direct effects of the slope on the repeated measures).

Model estimation. The model fit to the data was estimated by Mplus® statistical software, version 7.2 (Muthen & Muthen, 2011) using maximum likelihood estimation. Latent growth curve analyses were estimated using a mean structure (Kline, 2011). This

model includes data from children with ASD from pre-kindergarten through second grade; data being used includes any data collected during assessments at the end of the year for each of the grades in the model. Table 1 provides information regarding which participants provided data at which grades. Although each participant did not provide data at each grade, participants typically provided data for two consecutive years, providing estimations of correlations that could be modeled across the remaining years. Whole model fit and the parameter estimates were examined in the same way as the prior research question. More specifically, parameter estimates were also examined to determine the effect of the covariates on the intercepts and slopes of the growth curves, as well as the effect of the growth curves on reading comprehension outcomes.

Missing values were addressed through multiple imputation and full information maximum likelihood. However, data must be shown to be at least missing at random (MAR), meaning that observed scores available for participants who continued in the study versus those who did not are variable only by chance (Bollen & Curran, 2006; Kline, 2011). The data were considered missing completely at random (MCAR) if in addition to this specification, missing data on a variable are unrelated to other variables in the dataset, making it a stricter assumption of the patterns of missing data than MAR (Bollen & Curran, 2006; Kline, 2011). It is highly plausible that the data are MCAR because those instances of missing data were never intended to be collected (Schafer & Graham, 2002). Non-traditional methods of dealing with missing data (e.g., multiple imputation and full information maximum likelihood) are far preferable to traditional methods (e.g., listwise deletion) as they provide more optimal estimations of missing

data, even when data are not MCAR (Bollen & Curran, 2006). Both multiple imputation and full information maximum likelihood methods were used to address missing data so that the estimations resulting from each technique could be compared. Similar results between the two techniques would lead to stronger evidence for the resulting estimations.

Multiple imputation. Multiple imputation is a model-based imputation method for dealing with missing data conceptualized by Rubin (Rubin, 1987), and will be used to estimate the missing data in this sample. Multiple imputation was conducted using SAS® software (version 9.4) multiple imputation procedure ("Proc MI Analyze") ("SAS Institute Inc.," 2013). This method is preferable for imputing data because it takes the existing structure of the data into consideration, and can generate more than one score for every missing observation (Kline, 2011). In multiple imputation, missing values are replaced by lists of $m > 1$ values that are simulated, where m is the number of imputations (Schafer & Graham, 2002). There are then m potential versions of the complete data, which are each analyzed as complete data, and the results are then combined to create overall estimates. Rubin (1987) demonstrated that m number of imputations were nearly as efficient as infinite numbers of imputations, such that calculations based on data with 50% missingness were 95% efficient. Schafer and Graham (2002) noted that $m = 20$ imputations is typically quite effective, although larger numbers of estimations have recently been suggested.

In multiple imputation, missing values are predicted using observed values, and random error is added to ensure the same variability in both observed data and imputed data (Schafer & Graham, 2002). Algorithms are used to generate values, and these are

estimated from any available data in the sample. For example, if one group of students had data for Y_1 and Y_2 but not Y_3, the relationship between Y_1 and Y_2 would be considered when imputing multiple values for Y_3. Thus, the fact that each participant has multiple data points in this sample would aid in the generation of values for missing data.

Full information maximum likelihood. Full information maximum likelihood is another method of dealing with missing data that will be implemented in Mplus. Maximum likelihood estimation draws inferences about missing data from the likelihood function, generated from estimating the population from the set of statistics (Schafer & Graham, 2002). Thus, missing items are estimated using the expected values generated from the non-missing data, and the model is then re-estimated using the complete data. This method assumes that the estimates are unbiased and normally distributed (Schafer & Graham, 2002). Raykov (2005) laid out the steps for the full information maximum likelihood method. In summary, the contributions of each individual and their data to the log-likelihood are summed, and thus the data log-likelihood is obtained, and this is maximized to estimate the unknown parameters of the model. The use of this technique, as well as the multiple imputation technique, will allow for the optimal estimates of missing data to be obtained. Output generated from both of these estimates will be reported, and outcomes will be compared to ensure that the missing data was handled appropriately. M-plus software automatically uses full information maximum likelihood techniques to address missing data.

Expected Results

Research question 1. First, it was hypothesized that the model fit would differ between kindergarteners and second graders. For both groups, it was expected that the factor analysis for indicators on each factor would show good fit to the data. For kindergarteners, it was expected given previous research, that paths from reading skills to reading comprehension would be the strongest path (Vellutino et al., 2007), but that the direct paths from oral language skills and social skills to reading comprehension would also be significant. Further, it was expected that there would be significant path coefficients from oral language to social skills and reading skills. For second graders, it was expected again that all paths would be significant, but that the paths from social skills to reading comprehension, and from oral language skills to reading comprehension would be the strongest, given the research suggesting the importance of social skills in reading comprehension development for this population (Davidson & Weismer, 2014; Ricketts et al., 2013).

Research questions 2 and 3. It was expected that there would be curvilinear growth in social skills and reading skills (Hugh W. Catts et al., 2008; Chan et al., 2000; Szatmari et al., 2009). Further, it was anticipated that greater oral language skills would be associated with a larger intercept and steeper slope in both social skills and reading skills growth (Szatmari et al., 2009). This was also expected of children whose parents reported they had received any social skills intervention prior to the study beginning (Durlak et al., 2011; Jones et al., 2011). It was also expected that reading comprehension

outcomes would be greater for children whose reading and social skills trajectories were steeper.

Potential Implications

As discussed, children with ASD have noted deficits in social competence (5th ed.; *DSM-5*; American Psychological Association, 2013), and some children have co-occurring language impairment. Research findings indicate that children with ASD often demonstrate oral language difficulties (Kjelgaard & Tager-Flusberg, 2001). These clinically noted deficits are also included in the Individuals with Disabilities Education Act (IDEA, 2004), which includes a development delay that affects verbal and nonverbal communication, as well as poor social interactions. Despite these definitions, children with ASD often do not receive evidence-based services that they need in school settings (Hess, Morrier, Heflin, & Ivey, 2008), although IDEA requires the use of evidence-based educational programs (IDEA, 2004). Hess and colleagues (2008) used a review of research on evidence-based interventions for children with ASD to conduct a survey to determine how frequently evidence-based interventions were being used in schools. Results indicated that interventions with strong (e.g., discrete trial training) or promising (e.g., social decision-making) empirical evidence were not often used in schools (Hess et al., 2008).

Given the educational climate, reading proficiency is possibly the most desired outcome for all students in schools. However, there is little evidence to suggest what reading interventions are effective with children with ASD, given their associated deficits that can affect successful reading development (Flores et al., 2013; O'Connor & Klein,

2004). Most interventions do not address other skill deficits that impact the development of reading comprehension skills. While reading is an area of need for children with ASD (Davidson & Weismer, 2014; Nation et al., 2006; C. Norbury & Nation, 2011; Ricketts et al., 2013), as noted, there are additional areas of functioning that require attention, and if addressed, may subsequently improve a child's reading development. Already, an association has been found between reading comprehension skills and the social loading of the reading passages, such that children with ASD perform more poorly on reading comprehension in highly social passages than they do on less social passages (Brown et al., 2013). Establishing that these deficits (i.e., reading, social skills, and oral language) are interrelated may inspire interventions that jointly address them, and thus have a wider impact than reading interventions alone.

Results

The descriptive statistics, including means, standard deviations, and correlations, for study variables related to research question 1 are provided in Tables 2 through 4. As can be seen, correlations existed between variables measuring similar skills, such as reading (Letter Word ID, Word Attack, Reading Fluency, and Passage Comprehension), oral language (Pragmatic Judgment, Syntax Construction, and Picture Vocabulary), and social skills (Communication, Cooperation, Responsibility, and Assertion). Further, the WJ-III Passage Comprehension measure was correlated with many measures outside of reading skills, including social skills. Descriptive statistics (means, standard deviations, and ranges) are also provided for the variables in the latent growth curve models in Table 5, while their correlations are provided in Table 6.

ASD and the Simple View of Reading

The first research question examined the extent to which the simple view of reading, with an added emphasis on social skills, explained reading comprehension performance in the sample. A latent variable path analysis using structural equation modeling was used to fit a model to the data for two separate age groups: kindergarteners and second graders (Figure 1). Significant paths were hypothesized from oral language to social skills, decoding, and reading comprehension, as well as from both social skills and decoding skills to reading comprehension. Model specification, identification, and estimation were previously discussed.

For model fit, a non-significant chi-square is desired, as the null hypothesis that there is no discrepancy between the suggested model and the covariance matrices suggests a favorable model fit. Further, root mean square error of approximation (RMSEA) values below .08 are desired, while a Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) above .90 suggests adequate fit to the data, and a value above .95 suggests good fit to the data.

Kindergarten. As mentioned, the latent variable path analyses were run in two steps: first, a measurement model was specified, and pending good fit, a structural model was then specified. The measurement model was examined through confirmatory factor analyses run in Mplus. The model for kindergarteners converged (N = 128), and model fit was variable (Table 7). The chi-square was significant, $\chi^2(39) = 88.37$, $p < .001$, and the RMSEA value was above .08 with a value of .10 and a confidence interval (CI) of .07 to .13. Further, the CFI (.94) and TLI (.91) indicated adequate fit. Model modification

indices indicated that the model would be improved by removing WJ-III Word Attack as an indicator of decoding skills in part due to relationships with other variables, and also suggested specifying covariance between some of the social skills indicators due to their high correlations. Once these changes were made, model fit significantly improved. Although the chi-square was still significant, $\chi^2(28) = 47.60$, $p < .05$ ($p = .01$), the RMSEA decreased below .08 with a value of .07 (CI = .04-.11). Further, the CFI and TLI were both above .95 with values of .97 and .95, respectively. The model was retained due to good fit indices with the exception of the chi-square; model modification indices did not indicate any further changes that would improve the model. The chi-square fit statistic is highly vulnerable to large sample size and high correlations between indicators, which is why the practical fit indices were created. A significant chi-square is not typically desired, but it does indicate a basis for rejecting the model should the other indices not suggest good fit, although they did in this circumstance.

Due to a good fit in the measurement model, the next step was taken and the structural model was specified. Again, the chi-square was significant $\chi^2(31) = 48.91$, $p < .05$ ($p = .02$), but the RMSEA estimate was below .08 at a value of .07 with a confidence interval of .03 to .10 (Table 7). Further, the CFI (.97) and TLI (.96) values indicated good fit with values at or above .95. Significant paths are indicated with single-headed arrows, and non-significant paths are dashed (Figure 4). Again, although the chi-square was significant, the model modification indices did not indicate any changes that would improve the model, and all other fit indices indicated good fit. According to parameter estimates, prior oral language skills were predictive of reading comprehension on WJ-III

Passage Comprehension (β = .18, $p < .05$), decoding skills (β = .52, $p < .001$), and social skills (β = .03, $p < .001$). Further, WJ-III Passage Comprehension was predicted by social skills (β = 3.25, $p < .05$) and decoding skills (β = .78, $p < .001$). All paths were significant. The retained model is shown in Figure 4. The hypothesized structural model fit to the kindergarten data: oral language was predictive of social skills, decoding skills, and reading comprehension, and social skills and decoding skills were both predictive of reading comprehension.

Second Grade. The second grade measurement model produced poor results (N = 73) when specified the same way as the initial kindergarten model (Table 8). The chi-square was significant, $\chi^2(39) = 113.56$, $p < .001$, and the RMSEA estimate was high with a value of .16 (CI=.13-.20). The CFI value (.86) and TLI (.81) values also both indicated poor fit to the data. After examining matrices and model modification indices, the model was re-specified such that WJ-III Reading Fluency was taken out as an indicator of decoding and WJ-III Picture Vocabulary was taken out as a measure of oral language, and covariances between certain indicators of social skills were again specified. This model produced significantly improved results: the chi-square was no longer significant, $\chi^2(21) = 28.17$, $p = .14$, and the RMSEA estimate was much lower with a value of .07 (CI=.00-.13). Furthermore, the CFI and TLI values indicated good fit, with values of .98 and .97, respectively. This model was retained and used in the next steps of model building.

The differences between the kindergarten and second grade models continued in the structural models, as well. The chi-square was not significant $\chi^2(22) = 30.02$, $p = .12$

(Table 5). The RMSEA value was below .08 with a value of .07 (CI = .00-.13), and both the CFI and TLI demonstrated good fit with values above .95 (.98 and .97, respectively). According to path estimates, prior oral language skills significantly predicted decoding skills ($\beta = .34$, $p < .01$), but not social skills. Further, oral language skills predicted WJ-III Passage Comprehension ($\beta = .37$, $p < .001$), as did decoding skills ($\beta = .53$, $p < .001$), and social skills ($\beta = 1.22$, $p < .01$). Thus, the relationship between oral language skills and social skills was not observed in the second grade sample, although all other paths were significant. The retained model is displayed in Figure 5. Oral language skills were predictive of decoding skills and reading comprehension in this model, but not of social skills; further, social skills and decoding skills were predictive of reading comprehension. Thus, prior oral language skills appeared not to impact social skills in second grade.

Model comparison. In summary, the models looked somewhat different for kindergarteners and second graders, both in terms of the measurement and structural models. In the kindergarten measurement model, WJ-III Word Attack was removed as an indicator, leaving only Letter Word Identification and Reading Fluency. WJ-III Picture Vocabulary was retained as an indicator of oral language. However, for the second grade sample, WJ-III Picture Vocabulary did not load onto the oral language latent variable; further, WJ-III Reading Fluency was removed as an indicator of decoding skills, while WJ-III Word Attack was retained. With regard to the structural models, all hypothesized paths were significant for the kindergarten sample, including all paths from oral language (to social skills, decoding skills, and reading comprehension), as well as from decoding skills to reading comprehension, and from social skills to reading comprehension.

Conversely, for second graders, prior oral language skills predicted decoding and reading comprehension, but not social skills. However, reading comprehension was again predicted by social skills and decoding skills.

While oral language, social skills, and decoding skills all significantly predicted reading comprehension in both the kindergarten and second grade model, the beta weight from oral language to reading comprehension was smaller for the kindergarten sample ($\beta = .18$, $p < .05$) than for the second grade sample ($\beta = .37$, $p < .001$), indicating that oral language skills become more important in relation to reading comprehension as the child ages. Conversely, the beta weight from decoding skills to reading comprehension was larger for the kindergarten sample ($\beta = .78$, $p < .001$) than the second grade sample ($\beta = .53$, $p < .001$), indicating the decreased importance of decoding skills as a predictor of reading comprehension as the child ages. The beta weight from social skills to reading comprehension was greater for kindergarteners ($\beta = 3.25$, $p < .05$) than for second graders ($\beta = 1.22$, $p < .01$).

Longitudinal Predictors of Change

The second and third research questions, which involved the change in social and reading skills over time, and the extent to which oral language skills and the receipt of social skills intervention predicted change in child social skills and early reading skills, were examined through conditional latent growth curve analyses using structural equation modeling. A general examination of means in social skills and reading skills from kindergarten to 2nd grade indicates an upward trend (Table 5).

This model was evaluated in multiple steps (Kline, 2011). First, the intercept model was run, which assumes that there is no change in the repeated measures variables (social skills and reading skills). Second, change models were separately examined on just the repeated measures variables to explain the covariances and means of these variables across time. Lastly, the predictors (oral language skills and receipt of social skills intervention) were added to the model to predict change, and the outcome (reading comprehension) was added. Measures of fit were considered at each step, and are presented in Tables 9 through 12, and 14.

Missing data were addressed through non-traditional methods, including multiple imputation (Acock, 2012) and full information maximum likelihood (FIML). Results were examined using both methods, and results were compared. This was deemed acceptable in the literature, because in a Monte Carlo study, m number of imputations was almost as efficient as an infinite number of imputations, so calculations based on data with missingness of 50% was 95% efficient (Rubin, 1987). The model fit statistics for the series of models fitted to the reading skills variables are provided in Table 9, and the results for the social skills variables are provided in Table 10. The building of the growth models for reading skills and social skills are discussed separately, and then together when models are merged.

Reading skills. The first model was a no growth, intercept-only model, which is the most restrictive model, and assumes that there was no change over time in reading skills. Results of the analyses using multiple imputation will be discussed first, and the results using FIML will be compared to these results after. When using multiple

imputation, the no growth model for reading skills showed poor fit to the data, as indicated by a significant chi-square, χ^2 (8) = 80.36, p < .001, and extremely low CFI (.00) and TLI (-.48) values. Furthermore, the RMSEA estimate (.22) was high. Due to poor fit to the data, the model building proceeded to the next step.

The next model examined change across time in reading skills. Within this step, slope paths were first fixed so that the growth was linear; in other words, the slope for pre-kindergarten was set to equal 0, kindergarten was set to equal 1, first grade was fixed at 2, and second grade was fixed at 3 (to represent that one year, or one unit of time, had passed in between each repeated measure). Residual variances for each of the slope estimates were specified to be equal due to negative residual variance. The model demonstrated improved fit to the data over the no growth model, but not across indices. The chi-square was now non-significant, χ^2 (8) = 11.75, p = .16. Further, the RMSEA estimate approached 0 at .05 (CI = .00-.11); however, the CFI and TLI values indicated limited fit to the data, with values of .90 and .92, respectively. Thus, the model building process proceeded to specification of a latent basis model for reading growth. This model demonstrated improved fit to the data across indices. The chi-square was non-significant, χ^2 (6) = 6.08, p = .41, and the RMSEA estimate approached 0 at .01 (CI = .00-.10). Further, the CFI and TLI values indicated good fit to the data, with values of .99 and .99, respectively. The estimates at each of the time points were as follows: pre-kindergarten at 0, kindergarten at .29 (p< .001), first grade at .76 (p< .001), and second grade at 1. The intercept was negatively correlated with the slope (β = -34.58, p< .05), indicating that lower skills initially led to greater slopes.

The model using FIML produced similar results, but only to an extent. The intercept-only model showed similarly poor fit to the data. The chi-square was significant, the RMSEA was high above .08, and the CFI and TLI values were far below .95. The linear model also showed poor fit to the data. Still, when re-specified as a latent basis and quadratic model, these also showed poor fit to the data. Thus, the latent basis model was retained for reading skills, although results were somewhat poorer using FIML to address missing data (Table 9). This model indicated that reading growth was limited from pre-kindergarten to kindergarten, and had a steeper increase after kindergarten, which is typically considered formal school entry. Further, lower skills in reading in pre-kindergarten were related to steeper slopes in reading skills; in other words, students who had more room to grow tended to make this growth.

Social skills. Similar procedures were used to build a model for social skills. Again, the first step was a no growth, intercept only model, assuming no growth in social skills over time. This model produced adequate results regarding fit to the data using multiple imputation, with a non-significant chi-square, χ^2 (8) = 9.10, p = .33 and a RMSEA estimate near 0 at .03 (CI = .00-.09). The TLI estimate also indicated adequate fit at .95, but the CFI was lower at .93. A linear growth model was fit to the data to determine if the model could be improved. This model had more consistent indices of good fit, with a non-significant chi-square, χ^2 (5) = .96, p = .97, and an RMSEA of 0 (CI = .00-.00). Additionally, the CFI and TLI produced estimates that suggested good fit with the data, with values of 1.00 and 1.32, respectively. The standardized estimates at each of

the time points were as follows: pre-kindergarten at 0 ($p < .001$), kindergarten at .37 ($p < .001$), first grade at .65 ($p < .001$), and second grade at .86 ($p < .001$).

These results were consistent when using FIML, and were perhaps even more indicative of poor model fit for the intercept-only model, which produced a significant chi-square, an RMSEA value above .08 and CFI and TLI values below .95 (Table 7). In this model, SSIS measured at Time 1 had a negative residual variance, although insignificant; thus, the variance for all SSIS estimates was specified to be equivalent. The linear model had improved fit to the data. Addressing missing data through FIML also indicated that the linear model fit best to the data, as the latent basis model did not converge (Table 10). Thus, multiple imputation and FIML strategies produced the same results regarding model fit to the social skills growth model. The linear model was thus retained.

Further, the intercept was negatively correlated with the slope in both models, the model using multiple imputation ($\beta = -90.10$, $p < .05$) and the model using FIML ($\beta = -23.23$, $p = .42$), although the relationship was not significant in the FIML model. Thus, lower initial status in social skills (intercept) led to greater growth in social skills over time (slope). In summary, social skills growth tended to demonstrate a linear trend; there was equal growth in skills across each of the years. Further, students who started out with fewer social skills tended to demonstrate steeper slopes over time.

Parallel process model. Reading skills and social skills were joined in a parallel process model using their appropriate specifications (i.e., latent basis for reading skills, and linear for social skills). This model allows for estimations of the impact of each

skill's initial status and slope on the other's initial status and slope. The variance for each of the WJ-III Letter Word Identification estimates was set to be equal due to negative residual variances. When both models were included, and reading skills initial status and slope were regressed onto social skills initial status and slope, the model produced good fit to the data as indicated by the non-significant chi-square test, χ^2 (22) = 10.36, p = .98, as well as the RMSEA estimate of 0 (CI = .00-.00), and high CFI (1.00) and TLI (1.34) estimates (Table 11). However, the paths from initial status in social skills to initial status and slope in reading, and from slope in social skills to initial status and slope in reading, were not significant. Further, the results were culled over only 8 of the 10 multiply imputed data sets, indicating some concerns with the model.

These results indicated that a parallel process growth model was not an appropriate fit to the data. Due to this poor fit to the data, the analyses proceeded by adding the proposed covariates (receipt of social skills intervention and oral language skills) and sequelae of change (reading comprehension) to the model in two separate models: one for reading skills and one for social skills. Due to results of the first research question suggesting that CASL Pragmatic Judgment, CASL Syntax Construction, and WJ-III Picture Vocabulary loaded onto the oral language factor, this same factor was used as a covariate in further analyses.

Reading skills with covariates and outcome. The two covariates, oral language skills and receipt of social skills intervention, and the sequelae of change, reading comprehension (measured by WJ-III Passage Comprehension), were added to the latent basis growth model for reading skills. All three indicators of oral language were initially

included in the model (CASL Pragmatic Judgment and Syntax Construction, and WJ-III Picture Vocabulary), but this model produced poor fit to the data; only WJ-III Picture Vocabulary was retained, due to greater use in the literature of similar measures. The final model indicated that when WJ-III Passage Comprehension was included as the reading comprehension outcome, oral language skills were no longer predictive of initial status or slope of reading skills, although they approached significance on impact on the intercept. The model produced good fit to the data (Table 12). The model results suggested that the trajectory or slope of reading skills was predictive of reading comprehension (β =.62, $p < .01$), and that the initial status or intercept of reading skills in pre-kindergarten was negatively related to the slope or trajectory of reading skills over time (β = -33.16, $p < .05$) (Table 13). Thus, a student's reading skills in pre-kindergarten predicted their later reading comprehension skills. Further, as was found in the initial reading growth model without covariates or sequelae of change, lower initial reading skills in pre-kindergarten led to steeper slopes (i.e., more growth) in reading skills over time.

Social skills with covariates and outcome. The two covariates, oral language skills and receipt of social skills intervention, and the sequelae of change, reading comprehension, were added to the linear growth model for social skills, and the final model produced good fit to the data (Table 14). The results indicated that neither initial status nor slope in social skills predicted the reading comprehension outcome. Further, oral language was not related to the slope nor the initial status of social skills, although its relationship with initial status of social skills approached significance (β = .39, p = .08)

(Table 15). Thus, initial status and growth in social skills did not appear to impact reading comprehension. Further, while the relationship between oral language skills in pre-kindergarten and social skills in pre-kindergarten nearly achieved significance, these skills were not related within the greater context of the growth model.

GORT-5 Analyses

Because there were too few older students who had taken the GORT-5 to use it in the longitudinal analyses, additional analyses were conducted with the GORT-5 comprehension questions specifically. First, basic relationships were examined through correlations between GORT-5 comprehension standard score and WJ-III subtests (Passage Comprehension, Picture Vocabulary, Reading Fluency, Word Attack, and Letter Word Identification), CASL subtests (Pragmatic Judgment and Syntax Construction) and the SSIS Total Score. All correlations with the GORT-5 were significant (Table 16), suggesting that this measure of reading comprehension that depends more on the student's language and inference-making skills (Keenan, Betjemann, & Olson, 2008) is related to a reading comprehension measure that relies more upon decoding skills (Keenan et al., 2008), as well as to measures of decoding, oral language, and social skills.

Next, questions were coded as "inference-based" if they required knowledge not explicitly provided in the text, and "literal" if they required knowledge directly from the text. Examples of each type of question are provided in Table 17. A total of 45 students in 1st through 5th grade completed some portion of the GORT-5 and attempted to answer comprehension questions. The percent correct of attempted questions was calculated for inference-based questions and literal questions separately, and then for all comprehension

questions together. Of the 45 students, 33 answered a higher percentage of literal questions correctly than inference-based questions, 10 answered a higher percentage of inference-based questions correctly than literal questions, and 2 answered no questions correctly. The average percentage correct was 35% for inference-based questions, 44% for literal questions, and 41% for questions overall.

Independent samples t-tests were conducted to determine differences in the percentage correct for total questions, inference-based questions, and literal questions for two groups: students who were in the below average range on the SSIS total score (i.e., standard score below 85, N = 31) and those who were in the average range on the SSIS total score (i.e., standard score between 85 and 115, N = 14). Due to the nature of the sample, there were no students who were in the above average range on the SSIS total score. The average social skills group, as per the SSIS, answered a higher percentage (48%) of inference-based questions correctly than the below average social skills group (32%), and the difference was statistically significant, $t(43) = -2.24$, $p < .05$. The average social group also answered a higher percentage (54%) of literal questions correctly than the below average social skills group (42%), but this difference was not statistically significant, $t(43) = -1.75$, $p = .09$. The average social skills group also answered a higher percentage (53%) of overall questions correctly than the below average social group (39%), and this difference was statistically significant, $t(43) = -2.04$, $p < .05$. Thus, students on the spectrum with higher social skills performed significantly better than those with lower social skills on reading comprehension questions overall, and on reading

comprehension questions that required inference-making, but not on literal reading comprehension questions.

Discussion

The purpose of the present study was first to establish a model of emergent literacy development in children with ASD that incorporated social skills, oral language, and decoding skills. Then, a similar model would be examined over time to determine the impact of oral language and social skills on reading development. While the impact of social skills was apparent in the latent variable path analyses within one grade level (kindergarten or second grade), the same results were not seen across time in the latent growth curve analyses. Oral language skills in pre-kindergarten did not predict reading or social skills growth, although growth in reading skills did predict later reading comprehension skills.

Simple View of Reading in Kindergarten and Second Grade

The proposed model incorporating social skills into the simple view of reading was supported with the kindergarteners and second graders in the present sample of students with autism spectrum disorder (ASD). However, there were some slight, but noteworthy, discrepancies between the kindergarteners and second graders in terms of both the measurement and structural latent variable path analysis models. The measurement model fit well for kindergarteners (Table 7) and second graders (Table 8), although there were differences in the loadings for the oral language and decoding skills factors. Also, the structural model fit well for both groups, but oral language skills in second grade did not predict social skills in second grade.

Measurement models. Regarding the results of the confirmatory factor analyses and how the chosen measures loaded onto the specified factors (oral language, social skills, decoding skills, and reading comprehension), there were some differences between the kindergarten and second grade samples, particularly for the oral language and decoding skills factors. For oral language, all three of the chosen indicators, or measures (CASL Pragmatic Judgment and Syntax Construction, WJ-III Picture Vocabulary), were retained in the model; however, WJ-III Picture Vocabulary was not retained in the second grade model. Measures similar to WJ-III Picture Vocabulary (i.e., measures requiring the student to name objects in pictures) have been used in similar analyses and are far more frequently used in the literature than measures of pragmatic judgment and syntax construction. For instance, Davidson and Weismer (2014) used the Preschool Language Scale, Fourth Edition (PLS-4; Zimmerman, Steiner & Pond, 2002) Expressive Communication score to predict reading comprehension in their sample of young children on the spectrum. Storch and Whitehurst (2002) also used a similar measure, the Expressive One-Word Picture Vocabulary Test, Fourth Edition (EOWPVT; Gardner, 1990).

The results of the present study suggested that measures such as Picture Vocabulary correlate with other measures of oral language, such as the CASL Syntax Construction and Pragmatic Judgment subtests, which have been used less in other studies. However, this was only true for younger students, who were in kindergarten. It is likely that Picture Vocabulary was too highly correlated with more "reading" based measures in second grade, such as WJ-III Letter Word Identification, Word Attack, and

Reading Fluency, which were all decoding measures, and WJ-III Passage Comprehension, which was an indicator of reading comprehension. In contrast, the relationship between vocabulary and the other oral language measures was stronger than the relationship between vocabulary and the decoding skill measures in kindergarten, which seems age appropriate. This is typical in the literature, which tends to conceptualize and analyze vocabulary measures alongside oral language measures (Roth, Speece, & Cooper, 2002).

Another difference in measurement between the kindergarten and second grade models was the inclusion of indicators that measured the decoding skills factor. While WJ-III Reading Fluency and Letter Word Identification significantly loaded onto one decoding skills factor for kindergarteners, WJ-III Letter Word Identification and WJ-III Word Attack were retained in the second grade model. WJ-III Word Attack and WJ-III Letter Word Identification were highly correlated, which may explain why WJ-III Word Attack was not retained in the kindergarten model. Non-word reading on Word Attack and single word reading on Letter Word Identification appeared to be highly related skills in kindergarten age students in the present sample, similar to previous findings with young children on the spectrum (Gabig, 2010). In contrast, WJ-III Reading Fluency was not highly correlated with decoding measures in the second grade sample, perhaps due to the fact that reading fluency becomes more indicative of reading comprehension between grades 2 and 5, and represented more advanced literacy skills (Wayman, Wallace, Wiley, Ticha, & Espin, 2007). This is a key finding, because many of the kindergarteners were able to read, but without evidence of them necessarily understanding what they read.

One constant across the kindergarten and second grade measurement models was the inclusion of the four indicators of social skills. The measures of social skills used, including communication (Ricketts et al., 2013), cooperation (Caprara, Barbaranelli, Pastorelli, Bandura, & Zimbardo, 2000; Konold et al., 2010; Normandeau & Guay, 1998; Welsh et al., 2001), responsibility (Wentzel, 1991), and assertion (Konold et al., 2010) all proved to be good indicators of the social skills construct for both grade groups. Previous studies with typically developing children were conducted with students across age groups, including kindergarten (Normandeau & Guay, 1998), from kindergarten to fifth grade (Miles & Stipek, 2006), and from third through eighth grade (Caprara et al., 2000); thus, these indicators have proven to be indicative of skills across age groups. Similar to the present study, Konold and colleagues (2010) used an earlier version of the SSIS, the Social Skills Rating Scale (SSRS), but included both teacher and parent ratings. Except for Konold and colleagues, many previous studies had included these features of social behaviors all together under the category of "prosocial behaviors," (Miles & Stipek, 2006; Welsh et al., 2001) while the present study broke them apart separately into the four scales measured by the SSIS, a comprehensive social skills measure.

Structural models. With regard to the structural models, there were some additional differences between the sample of kindergarteners and the sample of second graders. The model for kindergarteners suggested that oral language predicted social skills and decoding skills, which then predicted reading comprehension; further, oral language skills were directly related to reading comprehension. There is a strong research base for these relationships. For instance, research has suggested that oral language skill

development precedes decoding skill development (Davidson & Weismer, 2014; Kendeou et al., 2009), as supported by the present model. Kendeou and colleagues (2009) found that skills in pre-kindergarten impact skills in kindergarten, which is similar to what this study found; oral language skills at the very beginning of kindergarten ("prior" oral language skills) impacted decoding skills toward the end of kindergarten. Davidson and Weismer (2014) also found in their sample of similarly high-functioning young children on the spectrum that oral language skills measured before formal school entry predicted reading skills in kindergarten. Thus, as could be expected, a child's exposure to language prior to kindergarten is important for the development of their reading skills upon school entry, for both typically developing students and for those on the autism spectrum.

The relationship between oral language skills and social skills is less often examined in the literature, and thus it is interesting that these skills were related in the kindergarten sample, but not the second grade sample. Szatmari and colleagues (2009) found that children on the autism spectrum with language impairments had poorer skill trajectories (i.e., lower slopes) in social communication. Thus, a loose connection between oral language and social skills was established. The present study suggests that oral language skills prior to, or at the beginning of, formal school entry are related to social skills at the end of kindergarten. This makes good substantive sense; the more capable students are of using expressive language, which is what was measured in the present study, the more capable they are of developing social skills in relation to peers,

which requires expressive language. However, oral language skills at the beginning of second grade were not related to social skills at the end of second grade.

Part of this may be explained by the fact that the second grade model did not include Picture Vocabulary as an indicator of oral language; it is possible that a student's vocabulary drives the relationship between oral language skills and social skills, particularly as children advance beyond kindergarten, although there is no literature that discusses the intricacies of the relationship between oral language and social skills. Future research should address models of kindergarten and second grade in conjunction to better compare these relationships. Another possible explanation is that as children on the spectrum begin to move through elementary school, their expressive oral language and knowledge of pragmatic language may not mirror their actual use of language with social partners (as rated by their parents on the SSIS). Third, the development of their pragmatic understanding of language just may not keep up with that of their peers, and children on the spectrum may develop unusual compensatory strategies in social interactions. However, the two skills did demonstrate nearly significant covariance.

Further, social and decoding skills were predictive of reading comprehension. Of course, there is a strong research base suggesting that decoding skills such as phonological awareness and phonics are highly related to reading comprehension, particularly in young children who are first beginning to develop their reading skills (Scanlon & Vellutino, 1996; Wagner et al., 1997). Coming to school with some reading skills positively impacts later reading development (Foster & Miller, 2007; Whitehurst & Lonigan, 1998). The significant path from social skills to reading comprehension is also

supported in the literature by other studies examining these variables, particularly in students on the autism spectrum of various ages (Davidson & Weismer, 2014) and levels of cognitive functioning (Ricketts et al., 2013). The present study supported this finding both for kindergarteners and second graders. Konold and colleagues (2010) reported that the impact of social skills on reading was most profound in the earlier years, as social skills accounted for more variation at preschool than it did in the later years (i.e., grades one, three and five), which was similarly found in the present study, where the impact of social skills on reading comprehension decreased from kindergarten to second grade. These findings are important due to their implications on how reading comprehension may be affected by social functioning in the early school years.

Oral language skills have been directly related to reading comprehension across grades, from first to third grade (Berninger & Abbott, 2010), and also found in a young sample of children on the autism spectrum (Davidson & Weismer, 2014). More specifically, expressive oral language has been found to be directly related to reading comprehension in typically developing students and those on the spectrum (Davidson & Weismer, 2014; Nation et al., 2006; Stothard & Hulme, 1992). Vellutino and colleagues (2007) reported in their Convergent Skills Model that oral language skills such as semantic and syntactic knowledge influenced word identification, which was then related to reading comprehension; there was also a direct path from the oral language variable to language comprehension. One difference between these studies and the present study is that Davidson and Weismer (2014) did not include decoding skills in their model, and Vellutino and colleagues (2007) did not include measures of social skills. Thus, the

present study suggests that all of these variables fit well in a model of reading, where oral language skills, social skills, and decoding skills all influence reading comprehension.

Changing relationships. Initial hypotheses suggested that decoding skills would be less important in the second grade model as opposed to the kindergarten model, due to the decreasing importance of decoding skills as children age and build automaticity in word reading (LaBerge & Samuels, 1974; Perfetti, 1985; Torgesen, Wagner & Rashotte, 1997). There is also a diminishing amount of variance in these skills across students (Vellutino et al., 2007). This was found to be true in the present study; the relationship between oral language and reading comprehension strengthened from kindergarten to second grade, while the relationship between decoding skills and reading comprehension decreased from kindergarten to second grade. The relationship between social skills and reading comprehension decreased over time, suggesting that while social skills may continue to play a role in the development of reading comprehension, it is most influential in the early years of schooling. This is aligned with the multitude of research that suggests that early intervention is key, and leaves the door open to the possibility that early intervention in one domain (i.e., social skills) may impact other domains (i.e., reading skills). Again, it would be important to examine these separate models (kindergarten and second grade) as a combined model to examine relationships, as well.

Longitudinal Models

The second purpose of the present study was to examine this model over time in students with ASD with regard to their social and reading skills, and to determine if this growth was related to prior oral language and receipt of social skills instruction.

Additionally, reading comprehension was examined as an outcome of the growth models. Models for reading and social skills were built separately before being examined together in a parallel process growth model including covariates and sequelae of change variables.

Growth models for reading and social skills. The intercept-only, no growth model, which was the first step of the model building process, had poor fit to the data for reading skills. As previous literature has demonstrated (Catts et al., 2008), reading growth is typically not a stagnant process in the early years, and children tend to make some gains in reading rather early in schooling. This fact can be extended to children on the autism spectrum, given the results of this analysis. The latent basis model of growth fit well to the data for reading skills, as indicated by model fit indices, meaning that reading growth was less steep early (between pre-kindergarten and kindergarten) and then increased much more upon formal school entry, i.e., after kindergarten (Table 13). Further, the initial status was negatively correlated with the slope, indicating that students with lower initial reading scores in pre-kindergarten tended to grow more. A similar finding was reported by Konold and colleagues (2010) in their sample of typically developing children; the authors reported a negative correlation between intercept and slope of -.48, which indicated that children with lower initial Letter Word Identification scores grew faster than those with higher initial scores. This finding makes even more sense with the present sample of students on the autism spectrum, as many students started out with very high reading skills, thus leaving less room for growth.

Previous literature has suggested that a quadratic model of reading growth fit the data of a group of typically developing second through eighth graders best (Catts et al.,

2008). In that sample, reading skills showed a steeper slope in the early years of reading, and then leveled off. In the present sample, growth also fit a curvilinear function, but demonstrated less growth early on, and more growth after kindergarten. The present sample represented a younger group, from pre-kindergarten to second grade, and was modeled for a more restricted period of time. This data suggests that children on the spectrum tend to demonstrate skills early on, and continue to develop skills with some consistency throughout the early years of schooling. It is possible that students on the autism spectrum, i.e., students who do not have co-morbid intellectual disability, look very similar to their typically developing peers in terms of reading growth past early elementary school and into middle school.

Social skills development data, on the other hand, fit a linear model best. While the intercept-only model fit well to the data, according to some but not all indices, the linear model demonstrated improved fit across missing data techniques. Further, there was not a steep increase over time in social skills. A previous study conducted by Szatmari and colleagues (2009) examined growth in social communication as measured by the Vineland Adaptive Behavior Scale and found that social skills growth in their sample tended to demonstrate a steep increase, followed by a period of leveling off. However, their study examined children of various ages within one time point, which skewed their results so they cannot be examined as a developmental process. For instance, their first time point included children ages 4 to 6; social skills prior to school entry (at age 4) and after school entry (at age 6) likely look very different, and thus growth models in which the initial status combines children from all of these ages

naturally would look different from a growth model that begins only with students in pre-kindergarten, such as the present model. Further, Szatmari and colleagues (2009) modeled socialization as measured by a broad adaptive behavior scale, while the present study modeled social skills as measured by a specific social skills scale; in both cases, data were reported by the child's parent. These differences in the structure of the model, as well as the measurement of the construct, may explain differences.

Parallel process model. The two linear models retained for reading skills and social skills were then combined in a parallel process model, in which the paths from initial status and slope in social skills on the initial status and slope of reading skills were examined. Contradictory to hypotheses, while the overall model fit to the data was good, the beta weights of the social skills intercept and slope on the reading skills intercept and slope were not significant. These results indicated that initial status in pre-kindergarten in social skills did not impact the initial status or the trajectory across time of reading skills, and vice versa.

Given prior research in which social skills and reading skills were modeled across time (Konold et al., 2010; Miles & Stipek, 2006; Welsh et al., 2001), albeit using different methods of longitudinal modeling, this result was somewhat surprising. One explanation for this difference in findings is the analysis and what it examined. Konold and colleagues (2010) found that social skills demonstrated statistically significant relationships with achievement, including Letter-Word Identification on the WJ-III. Konold and colleagues used social skills as a time-varying predictor of achievement, rather than modeling social skills development as an outcome variable alongside reading

skills, which allowed for the possibility that social skills and their relationships with reading varied over time; the present model did not. Miles and Stipek (2006) and Welsh and colleagues (2001) also found varying relationships between social skills and reading skills over time.

Another possibility is related to measurement; although Konold and colleagues (2010) used an earlier version of the SSIS, which was used in the present study, social functioning in prior research (e.g., Welsh et al., 2001) has included social behaviors (e.g., pro-social behaviors such as sharing, taking turns, begin likable, etc.) as rated by classroom teachers and peers, rather than social skills reported by parents, as measured in the present study. Further, Konold and colleagues (2010) found that teacher-rated social skills were more highly related to academic outcomes than parent-rated social skills. This makes substantive sense, as teachers come into contact with social behaviors in relation to the classroom, which are then more related to academics. The present study examined primarily parent-rated social skills. These differences in measurement could certainly impact relationships, although the use of a psychometrically sound measure such as the SSIS does produce reliable and valid results.

It should also be noted that there was limited growth in social skills in this sample, inherent to the nature of autism spectrum disorder, which may also affect the relationship between social skills growth and reading skills growth. Previous relationships longitudinally have been found primarily in typically developing students (Konold et al., 2010; Miles & Stipek, 2006; Welsh et al., 2001). This brings rise to the question of how this relationship might be different should more effective social skills

intervention be provided early on in schooling, thus potentially changing the trajectory of social skills, and, theoretically, their impact on reading.

These results of the longitudinal model should also be considered alongside the results from the latent variable path analyses, which examined similar relationships but within one grade (i.e., kindergarten and second grade). It is possible that these skills may have a more reciprocal relationship that changes across time, as suggested by Welsh and colleagues (2001) and Miles and Stipek (2006). This would allow for the relationships seen cross-sectionally, but may also explain why the longitudinal model did not highlight these relationships. Additionally, Welsh and colleagues' sample was a typically developing and thus higher-functioning group in terms of social skills; it is possible these relationships are more apparent in populations where there is more social growth across time. The growth in social skills of the present sample was significant, but limited, and may have impacted the ability to predict other skill development.

Growth models with covariates and sequelae of change. The two separate models run for reading skills and social skills that included covariates (oral language and receipt of social skills intervention) and the sequelae of change (reading comprehension) produced different results. In the reading skills model, oral language skills in pre-kindergarten were not related to initial status or slope in reading skills. However, the slope, or trajectory, of reading skills was significantly and positively related to the reading comprehension outcome. Thus, the greater the slope (i.e., the steeper the growth in reading), the larger the reading comprehension outcome was for the student. More growth in reading skills ultimately led to higher reading comprehension scores. This

suggests the impact of increased reading and decoding skills on the development of reading comprehension.

On the other hand, neither initial status nor trajectory of social skills development predicted the reading comprehension outcome. Further, while the beta weight for oral language on intercept of social skills approached significance, it was not significant, nor was the beta weight for oral language on the trajectory of social skills. Thus, while the results of the first research question indicated that oral language impacted social skills, which then impacted reading comprehension in kindergarten, this model was not reproduced over time from kindergarten through second grade. This reiterates the possibility that these relationships are stronger earlier in elementary school, as suggested by Konold and colleagues (2010), and may change over time (Miles & Stipek, 2006). This may also be a product of general cognitive shifts that might occur in children with ASD during the early years of schooling (e.g., ages 5 to 7).

Further, parent-reported receipt of social skills intervention did not predict the initial status or slope of either reading skills or social skills. This finding does not necessarily suggest that social skills intervention does not impact these trajectories, but points to a potential error in the measurement of this construct. While parents were asked to report the kind of social skills intervention their child received, as well as the duration and frequency of the intervention, their report may have been flawed by memory or time passed. Further, there was no guarantee that these interventions were evidence-based or implemented with integrity, which would impact their ability to effect change in reading or social skills (Lane, Beebe-Frankenberger, Lambros, & Pierson, 2001; Lane, Bocian,

MacMillan, & Gresham, 2004). Due to previous research suggesting the impact of social skills interventions on growth in reading skills (Durlak et al., 2011; Jones et al., 2011), and contradictory research pointing to the ineffectiveness of social skills interventions in schools (Bellini et al., 2007), more research is needed to determine the extent of the relationships in these domains, and how social skills intervention in school settings can be made more effective.

Inference-based versus Literal Comprehension Questions

It has been hypothesized that students on the autism spectrum may do more poorly on certain types of comprehension tasks than others; for instance, children with ASD were found to do more poorly on comprehension questions after reading highly social passages than less social passages (Brown et al., 2013). The present study examined this question from the perspective of performance on different types of reading comprehension questions, which has been studied somewhat in the typically developing literature (Johnston, 1983; Pearson, Hansen, & Gordon, 1979). Specifically, Johnston (1983) found that prior knowledge affected the extent to which students answered different types of reading comprehension questions.

The present study found that students with ASD who had higher rated social skills performed better on inference-based questions than those who had lower rated social skills. The higher-rated social group also performed better on comprehension questions overall. However, this effect was not found for literal questions. These findings support the hypothesis that children with higher social functioning demonstrate higher reading comprehension skills; further, when reading comprehension is broken down with regard

to the types of questions being asked, social skills tend to be more important in answering inference-based questions than in answering literal questions from the text. This is promising, as it provides preliminary support for the idea that while poor social skills may impact inference-based reading comprehension skills, they may have less impact on the student's ability to answer literal reading comprehension questions.

Future research may consider additional types of questions, as outlined in Pearson and colleagues (1979), including textually explicit items (with both the question and answer information stated in one sentence in the passage), textually implicit items (with the question and answer information stated in different sentences in the text), scriptally implicit items (where the reader must reflect on background knowledge to answer the question). Additionally, other skills beyond social skills may be examined to determine the differential effects on performance on different types of reading comprehension questions. Finally, it is notable that the measure used to derive these findings (GORT-5) was only administered to a subsample of participants.

Summary. The results of the present study suggest that social skills, oral language, and decoding skills do impact reading comprehension, particularly when measured cross-sectionally. Students with higher oral language skills, greater social skills, and better decoding skills have better reading comprehension skills when measured at one time point. However, this model is not clearly demonstrated across time, from pre-kindergarten to second and third grade, in that initial status and growth in social skills did not impact initial status or growth in reading skills. While some prior research has suggested that this may be due to greater relationships in the earlier school years that vary

across time (Konold et al., 2010; Miles & Stipek, 2006), other research suggests that there may be a reciprocal relationship between the two skills emerging as early as second grade (Welsh et al., 2001). It would appear that in the present sample, there appears to be much greater growth in reading skills than in social skills across time.

Further, while social skills may not impact growth in reading skills (e.g., word reading skills as measured by WJ-III Letter Word Identification), the cross-sectional relationship between social skills and reading comprehension, more specifically, is clear, as evidenced by the results of the latent variable path analyses. Although this relationship was not demonstrated across time in the longitudinal growth curve models, the relationships between these variables at single time points has strong support in the literature (Konold et al., 2010), especially with students on the autism spectrum (Davidson & Weismer, 2014; Ricketts et al., 2013). Thus, although social skills in pre-kindergarten may not directly impact reading comprehension in second and third grade, as per the results of this study, it is still possible that changes made in social skills in the early years of schooling may impact reading skills concurrently, thus improving the reading trajectory of the student indirectly. The findings of the present study suggest that there are intricacies within these relationships to be further examined.

Limitations

There are limitations to be considered in the present study. One is the inherent difficulties associated with longitudinal studies; namely missing data, which necessitated the use of multiple procedures for correction, including multiple imputation and full information maximum likelihood. One strength of the data is that the missingness was in

large part planned missingness, or missing by design, meaning that the structure of visits meant that not all participants would have data collected at each age, i.e., the data could be considered as missing completely at random. In this study, the use of multiple imputation alongside full information maximum likelihood simply bolstered the results, and suggests that regardless of the procedure used, the results are comparable and therefore robust. This was particularly true for the models involving social skills, and was relatively true for models involving reading skills.

Another limitation of the present study is the report of receipt of social skills intervention. Parents were asked to retrospectively report on whether their child had received some kind of social skills intervention prior to enrolling in the study, which can be problematic for a couple of reasons. First, retrospective report can be unreliable. Additionally, the type of social skills intervention, the integrity of its implementation, its effectiveness, how often it was implemented, where it was implemented, and by whom were all variables that were not considered, and thus the variable indicating receipt of social skills intervention may differ for each participant. However, this variable was used simply as an indicator (scored dichotomously) of whether the child had received some kind of social skills intervention at all. It was viewed as providing a stepping stone for future researchers who may want to consider specific aspects of social skills intervention that may drive the types of relationships discovered in the present study.

The measure of reading comprehension used in analyses for the first research question can be considered a limitation of the study. The WJ-III Passage Comprehension test is a cloze reading test of reading comprehension, a type of reading comprehension

task that is more heavily influenced by decoding skills (Keenan et al., 2008). This concern was noted, and additional information was collected on a smaller sample (N = 45) of students' reading comprehension skills using the Gray Oral Reading Tests, Fifth Edition (GORT-5, Wiederholt & Bryant, 2012) for the research questions on longitudinal growth in skills. Due to limited use of the measure with students in second and third grade, additional analyses were run to examine relationships between these various reading comprehension measures. However, had it been possible to use the GORT-5 with a greater number of students, it would likely have produced even more robust results for the longitudinal analyses, given the results of the additional analyses.

Implications and Future Directions

Despite deficits in reading comprehension, oral language, and social competence, children with ASD often do not receive evidence-based services in school settings (Hess et al., 2008). Occasionally, this may be because evidence-based services that address these needs do not exist. For instance, we recognize the importance of validating interventions with different populations of students (e.g., children with autism spectrum disorder, or children whose first language is Spanish), but there is limited literature to guide reading comprehension interventions for students with ASD. In fact, there is little evidence for the use of reading comprehension interventions for children with ASD (O'Connor & Klein, 2004) that also take into account their specific deficits. Beyond reading interventions, even school-based social skills interventions have limited demonstrable effect on improving outcomes for students with ASD. Specifically, meta-analyses of social skills interventions in school settings actually show a minimal effect on

social skills outcomes (Bellini et al., 2007), despite the fact that this is a core area of deficit in this population.

This research examined potential relationships between the developmental domains of reading and social skills, in an attempt to inform next steps in school intervention research for ASD. It considered the fact that "children do not develop in particular domains independently of other domains" and that "social development and academic development are inextricably connected" (Miles & Stipek, 2006, p. 114). Further, as Miles and Stipek (2006) suggest, the improvement of "development in one domain will be more successful if attention is given to development of the other" (p. 114). The results indicating significant relationships among oral language, decoding skills, and social skills in kindergarten and second grade support these assertions. However, these results were not replicated over time in the longitudinal latent growth curve models. In the future, special attention should be paid to the type of measure being used; it is possible that an inference-based measure of reading comprehension might produce different results, as suggested by the results of the subsequent GORT-5 analyses.

Reading proficiency is possibly the most desired outcome for all students in schools, including those with ASD who are relatively high functioning. The present study supports a model of reading development that will help guide reading interventions that are more responsive to the social and oral language needs of students with ASD. Improving social skills by incorporating social skills instruction into reading instruction may prove to be a more viable model for intervention, particularly in the earliest years of schooling.

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Table 1

Timeline of Data Collection from Groups of Students Identified by Wave and Grade of Entry

	Group	Pre-K	K	1st	2nd	3rd
Wave 1	A	X	X		X	
	B		X	X		X
	C			X	X	
	D				X	X
Wave 2	E	X	X	X		
	F		X	X	X	
	G			X	X	X
	H				X	X
Wave 3	I	X	X			
	J		X	X		
	K			X	X	
	L				X	X

Table 2
Descriptive Data for Study Variables: Latent Variable Path Analyses

	Mean	SD	Range
Kindergarten: WJ-III			
Letter Word ID	111.98	17.55	57-156
Reading Fluency	113.09	10.71	78-131
Word Attack	112.76	15.96	63-140
Passage Comprehension	101.46	18.46	48-146
Picture Vocabulary	94.48	17.81	11-125
Kindergarten: CASL			
Pragmatic Judgment	82.65	16.90	55-121
Syntax Construction	83.47	17.56	46-138
Kindergarten: SSIS			
Communication	80.81	14.31	48-121
Cooperation	89.24	14.43	51-123
Responsibility	86.89	14.71	51-115
Assertion	82.73	16.67	47-113
Second Grade: WJ-III			
Letter Word ID	104.91	16.07	51-146
Reading Fluency	98.15	16.98	67-136
Word Attack	104.67	12.42	59-130
Passage Comprehension	89.97	14.95	42-119
Picture Vocabulary	96.24	14.95	53-137
Second Grade: CASL			
Pragmatic Judgment	77.77	19.35	43-120
Syntax Construction	82.11	20.55	41-127
Second Grade: SSIS			
Communication	75.00	16.93	30-110
Cooperation	82.41	15.11	42-114
Responsibility	80.61	16.99	36-114
Assertion	80.66	18.55	36-127

Note. SD = standard deviation; WJ-III = Woodcock Johnson, Third Edition; CASL = Comprehensive Assessment of Spoken Language; SSIS = Social Skills Improvement System; Letter Word ID = Letter Word Identification.

Table 3
Correlations among Variables: Kindergarten Latent Variable Path Analysis

	1	2	3	4	5	6	7	8	9	10	11
1. Letter Word ID	1										
2. Reading Fluency	.79**	1									
3. Word Attack	.81**	.53**	1								
4. Passage Comp.	.82**	.63**	.75**	1							
5. Picture Vocabulary	.38**	.30	.49**	.45**	1						
6. Pragmatic Judgment	.34**	.32	.47**	.44**	.46**	1					
7. Syntax Construction	.40**	.30	.48**	.47**	.54**	.79**	1				
8. Communication	.07	.14	.06	.19*	.19*	.31**	.26**	1			
9. Cooperation	.18	.06	.16	.23*	.26**	.21*	.20*	.61**	1		
10. Responsibility	.20*	.11	.24*	.32**	.37**	.35**	.35**	.68**	.74**	1	
11. Assertion	.08	.00	.13	.26**	.24*	.42**	.36**	.70**	.50**	.66**	1

* $p < .05$, ** $p < .01$.

Table 4
Correlations among Variables: Second Grade Latent Variable Path Analysis

	1	2	3	4	5	6	7	8	9	10	11
1. Letter Word ID	1										
2. Reading Fluency	.73**	1									
3. Word Attack	.84**	.59**	1								
4. Passage Comp	.75**	.81**	.62**	1							
5. Picture Vocabulary	.61**	.71**	.52**	.64	1						
6. Pragmatic Judgment	.35**	.62**	.29*	.69**	.49**	1					
7. Syntax Construction	.42**	.64**	.39**	.67**	.58**	.79**	1				
8. Communication	-.09	.11	-.06	.19	.10	.11	.15	1			
9. Cooperation	-.06	.10	.00	.17	.17	.11	.29*	.63**	1		
10. Responsibility	-.02	.12	.05	.24	.07	.15	.30*	.72**	.78**	1	
11. Assertion	.03	.36**	.03	.36**	.33**	.35**	.28*	.51**	.51**	.42**	1

* $p < .05$, ** $p < .01$.

Table 5
Descriptive Data for Study Variables: Latent Growth Curve Models

	Mean	SD	Range
SSIS Pre-K	62.27	19.96	17-107
SSIS Kindergarten	65.77	20.65	16-114
SSIS 1st Grade	67.67	21.14	0-146
SSIS 2nd Grade	67.89	19.79	19-112
WJ LWID Pre-K	17.45	8.63	1-42
WJ LWID Kindergarten	24.07	10.55	2-59
WJ LWID 1st Grade	34.38	12.60	6-63
WJ LWID 2nd Grade	41.09	11.69	9-73
WJ Picture Vocabulary	99.26	15.12	28-133
CASL Pragmatic Judgment	83.95	16.46	55-121
CASL Syntax Construction	84.78	17.99	46-138
GORT Reading Comprehension	8.31	4.15	1-16
WJ Passage Comprehension	88.35	16.31	39-119

Note. SD = standard deviation; SSIS = Social Skills Improvement System; WJ = Woodcock Johnson, Third Edition; LWID = WJ-III Letter Word Identification; CASL = Comprehensive Assessment of Spoken Language; GORT = Gray Oral Reading Test, Fifth Edition.

Table 6
Correlations between Variables: Latent Growth Curve Models

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. SSIS Pre-K	1												
2. SSIS Kinder	.69**	1											
3. SSIS 1st Grade	.47**	.59**	1										
4. SSIS 2nd Grade	.17*	.20**	.26**	1									
5. WJ LWID Pre-K	.17*	-.02	-.18*	-.08	1								
6. WJ LWID Kinder	.26**	.04	.07	-.04	.86**	1							
7. WJ LWID 1st Grade	.31**	.12	.09	.02	.57**	.69**	1						
8. WJ LWID 2nd Grade	.18*	.14	.07	-.34**	.58**	.49**	.63**	1					
9. WJ Picture Vocabulary	.26**	.16*	.18*	.54**	.33**	.34**	.13	.03	1				
10. CASL Pragmatic Judgment	.17*	.22**	.22**	.41**	.08	.13	.11	.08	.17*	1			
11. CASL Syntax Construction	.18*	.31**	.23**	.40**	-.02	.00	.14	.02	.40**	.50**	1		
12. GORT Reading Comprehension	-.16*	-.05	-.06	-.11	-.12	-.17*	-.24*	.06	-.16*	-.15*	-.08	1	
13. WJ Passage Comprehension	.42*	.33**	.17*	.19*	.35**	.19*	.33**	.53**	.25**	.47**	.39**	.06	1

Note. SSIS = Social Skills Improvement System; WJ = Woodcock Johnson, Third Edition; LWID = WJ-III Letter Word Identification; CASL = Comprehensive Assessment of Spoken Language; GORT = Gray Oral Reading Test, Fifth Edition.
*$p < .05$, **$p < .01$.

Table 7
Results of Measurement and Structural Models for Kindergarteners

Goodness of Fit Index	Measurement Model	Re-specified Model	Structural Model
χ^2 (df)	88.37 (39)	48.28 (29)	48.91 (31)
RMSEA (90% CI)	.10 (.07-.13)	.07 (.03-.11)	.07 (.03-.10)
CFI	.94	.97	.97
TLI	.91	.95	.96

Note. Df = degrees of freedom, RMSEA = root mean square error of approximation, CI = confidence interval, CFI = Comparative Fit Index, TLI = Tucker Lewis Index.

Table 8
Results of Measurement and Structural Models for Second Graders

Goodness of Fit Index	Measurement Model	Re-Specified Model	Structural Model
χ^2 (df)	113.56 (39)	28.17 (21)	30.02 (22)
RMSEA (90% CI)	.16 (.13-.20)	.07 (.00-.13)	.07 (.00-.13)
CFI	.86	.98	.98
TLI	.81	.97	.97

Note. Df = degrees of freedom, RMSEA = root mean square error of approximation, CI = confidence interval, CFI = Comparative Fit Index, TLI = Tucker Lewis Index.

Table 9
Model Results for Reading Skills

	Reading Skills: Multiple Imputation			Reading Skills: FIML		
	Intercept Only	Linear	Latent Basis	Intercept Only	Linear	Latent Basis
χ^2 (df)	67.38 (13)	11.75 (8)	6.08 (6)	121.75 (8)	17.88 (6)	14.96 (4)
p value	.00	.16	.41	.00	.01	.00
$\Delta\chi^2$	-	55.63	61.03	-	103.87	106.79
Δdf	-	5	7	-	2	4
CFI	.00	.90	.99	.00	.89	.90
TLI	-1.14	.92	.99	.19	.89	.84
BIC	6694.70	5169.90	5136.15	1498.44	1403.98	1410.45
RMSEA	.16 (.12-.20)	.05 (.00-.11)	.01 (.00-.10)	.36 (.31-.42)	.13 (.07-.21)	.16 (.08-.25)

Note. Df = degrees of freedom, CFI = Comparative Fit Index, TLI = Tucker Lewis Index, BIC = Bayesian Information Criterion, RMSEA = root mean square error of approximation.

Table 10
Model Results for Social Skills

	Social Skills: Multiple Imputation		Social Skills: FIML	
	Intercept Only	Linear	Intercept Only	Linear
χ^2 (df)	7.74 (13)	2.67 (10)	21.12 (9)	13.85 (8)
p value	.33	.97	.01	.09
$\Delta\chi^2$	-	5.14	-	7.27
Δdf	-	3	-	1
CFI	1.00	1.00	.86	.93
TLI	1.53	1.97	.91	.95
BIC	7350.04	7289.10	3022.47	2997.35
RMSEA	.00 (.00-.04)	.00 (.00-.00)	.09 (.04-.14)	.06 (.00-.12)

Note. Df = degrees of freedom, CFI = Comparative Fit Index, TLI = Tucker Lewis Index, BIC = Bayesian Information Criterion, RMSEA = root mean square error of approximation.

Table 11
Results of Parallel Process Model

Goodness of Fit Index	**Final Model**
χ^2 (df)	6.91
RMSEA (90% CI)	.00 (.00-.00)
CFI	1.00
TLI	1.42

Note. Df = degrees of freedom, CI = confidence interval, RMSEA = root mean square error of approximation. CFI = Comparative Fit Index, TLI = Tucker Lewis Index.

Table 12
Results of Final Model for Reading Skills

Goodness of Fit Index	Final Model
χ^2 (df)	7.60 (12)
RMSEA (90% CI)	.00 (.00-.05)
CFI	1.00
TLI	1.15

Note. Df = degrees of freedom, CI = confidence interval, RMSEA = root mean square error of approximation. CFI = Comparative Fit Index, TLI = Tucker Lewis Index.

Table 13
Final Model Parameter Estimates for WJ Reading

		Estimate	S.E.	Est./S.E.	*p* Value
Intercept	WJ LWID 1	1.00	.00	-	-
	WJ LWID 2	1.00	.00	-	-
	WJ LWID 3	1.00	.00	-	-
	WJ LWID 4	1.00	.00	-	-
Slope by	WJ LWID 1	.00	.00	-	-
	WJ LWID 2	.28	.04	7.85	.00
	WJ LWID 3	.76	.04	25.61	.00
	WJ LWID 4	1.00	.00	-	-
Intercept on Oral Language		.17	.10	1.72	.09
Reading Comprehension on Slope		.62	.24	2.59	.01
Intercept w/Slope		-33.16	16.69	-1.99	.04

Note. S.E. = standard error, Est. = estimate, WJ LWID = Woodcock Johnson, Third Edition – Letter Word Identification.

Table 14
Results of Final Model for Social Skills

Goodness of Fit Index	Final Model
χ^2 (df)	1.22 (7)
RMSEA (90% CI)	.00 (.00-.00)
CFI	1.00
TLI	1.51

Note. Df = degrees of freedom, CI = confidence interval, RMSEA = root mean square error of approximation. CFI = Comparative Fit Index, TLI = Tucker Lewis Index.

Table 15
Final Model Parameter Estimates for SSIS

		Estimate	S.E.	Est./S.E.	*p* Value
Intercept by	SSIS 1	1.00	.00	-	-
	SSIS 2	1.00	.00	-	-
	SSIS 3	1.00	.00	-	-
	SSIS 4	1.00	.00	-	-
Slope by	SSIS 1	.00	.00	-	-
	SSIS 2	1.00	.00	-	-
	SSIS 3	2.00	.00	-	-
	SSIS 4	3.00	.00	-	-
Intercept on Oral Language		.39	.22	1.75	.08
Slope on Oral Language		-.04	.10	-.36	.72
Intercept w/Slope		-90.38	42.78	-2.11	.04

Note. S.E. = standard error, Est. = estimate, SSIS = Social Skills Improvement System.

Table 16

Correlations Among Time 4 Variables: Relationships with GORT-5 Reading Comprehension

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. GORT-5 Reading Comp.	1								
2. WJ-III Passage Comp.	.78**	1							
3. WJ-III Picture Vocabulary	.68**	.76**	1						
4. WJ-III Reading Fluency	.74**	.78**	.66**	1					
5. WJ-III Word Attack	.56**	.62**	.55**	.61**	1				
6. WJ-III Letter Word ID	.70**	.78**	.63**	.70**	.87**	1			
7. CASL Pragmatic Judgment	.72**	.69**	.64**	.66**	.32*	.43**	1		
8. CASL Syntax Construction	.79**	.76**	.77**	.67**	.55**	.59**	.83**	1	
9. SSIS Total Score	.35*	.40**	.22	.33**	.17	.27	.33*	.34*	1

Note. GORT-5 = Gray Oral Reading Test, Fifth Edition; Comp. = Comprehension; WJ-III = Woodcock Johnson Tests of Achievement, Third Edition; ID – Identification; CASL = Comprehensive Assessment of Spoken Language; SSIS = Social Skills Improvement System.

*$p < .05$, ** $p < .01$.

Table 17
Inference-based and Literal Questions on the GORT-5

Inference-based Questions	Literal Questions
• Where do you think "here" is in this story? • What did the man plan to do with the box? • What one word would you use to describe how the jay felt throughout most of the story? • Why is the lady worried? • What one word would you use to describe the queen's actions in this story?	• Who has just come home? • What one word in the story was used to describe the box? • Why couldn't the jay drink the water? • What is the name of the lady in this story? • What does the story say about how the queen dealt with opposition to her wishes?

From the *Gray Oral Reading Test, Fifth Edition.*

Figure 1

Proposed Latent Variable Path Analysis Model for Kindergarteners and Second Graders

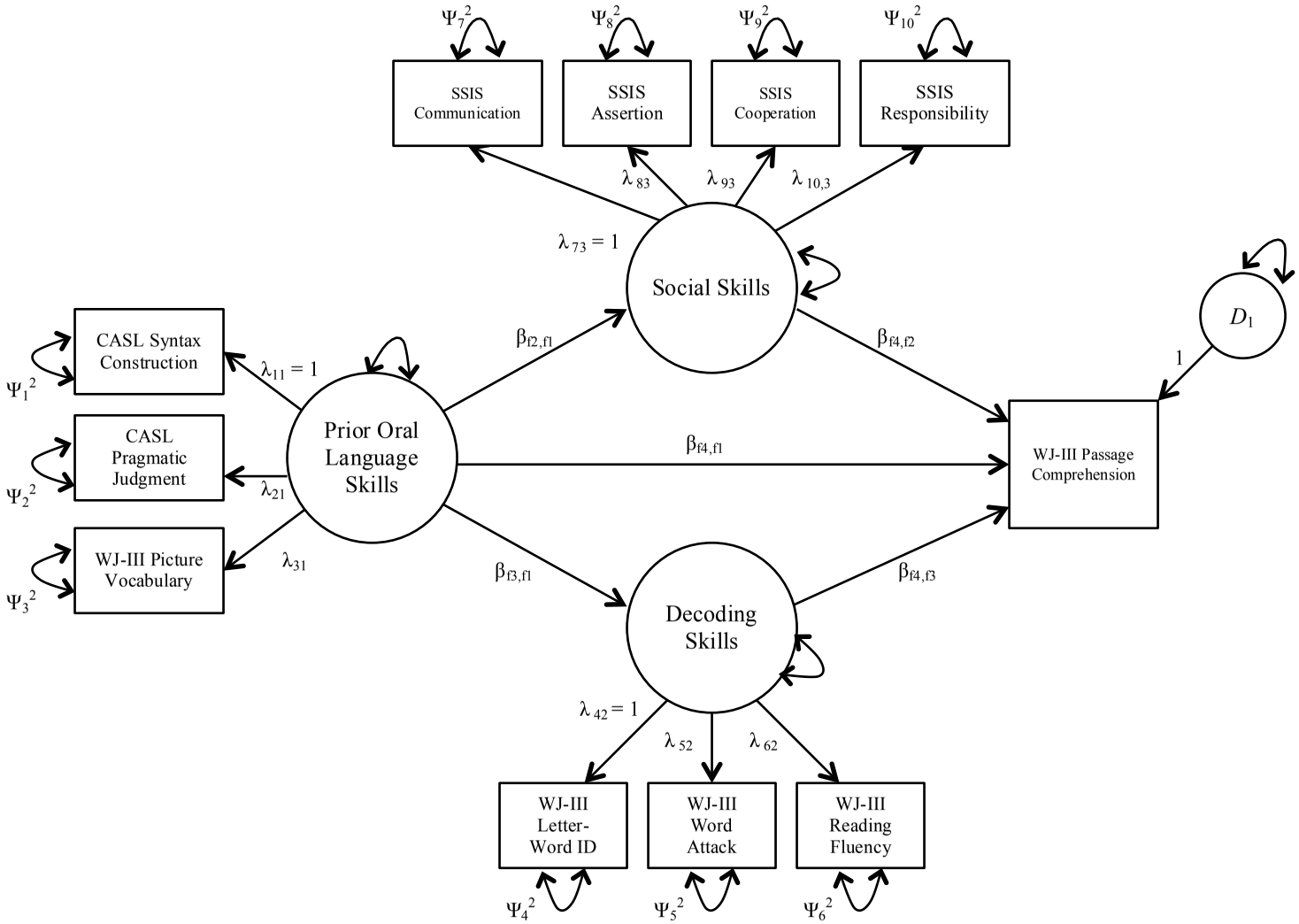
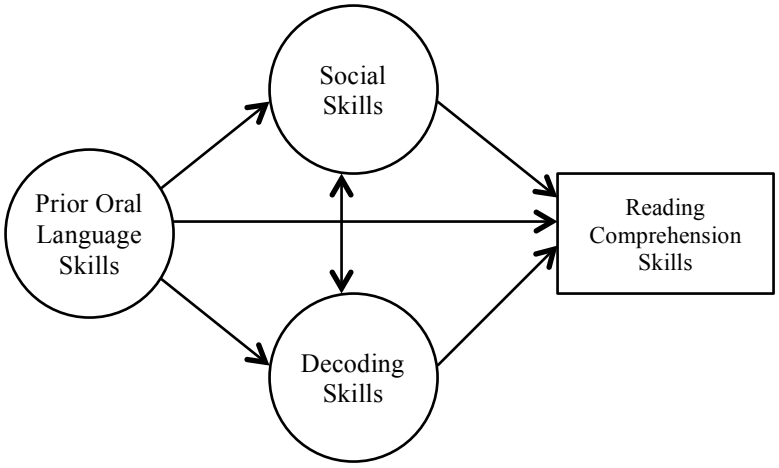
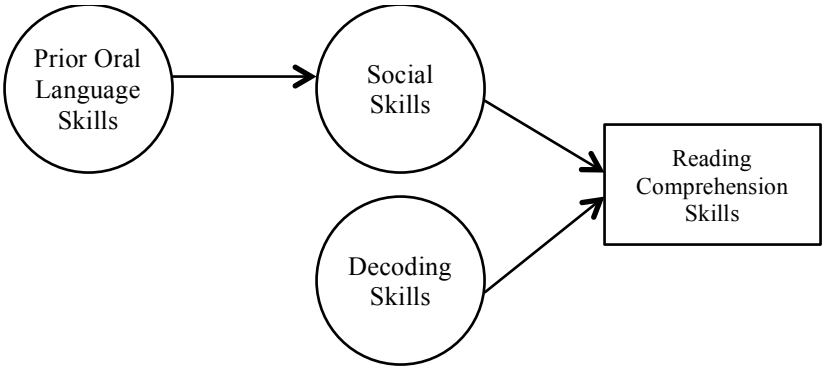


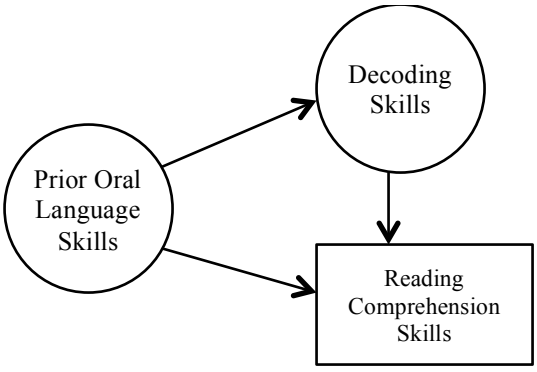
Figure 2
Alternative Latent Variable Path Models



(a) Full model



(b) Nested alternative model 1



(c) Nested alternative model 2

Figure 3

Proposed Latent Growth Curve Model

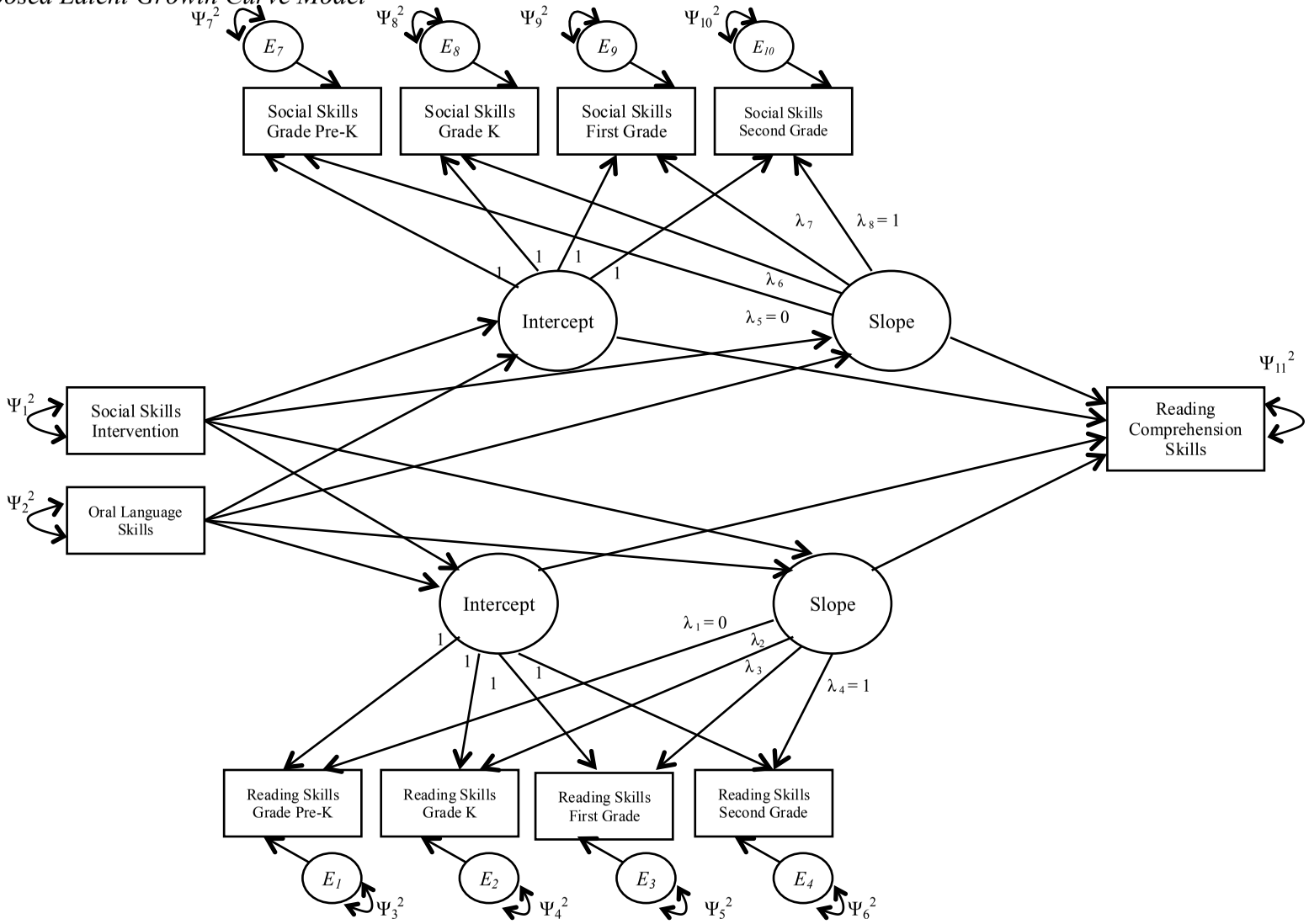


Figure 4
Final Model for Kindergarteners

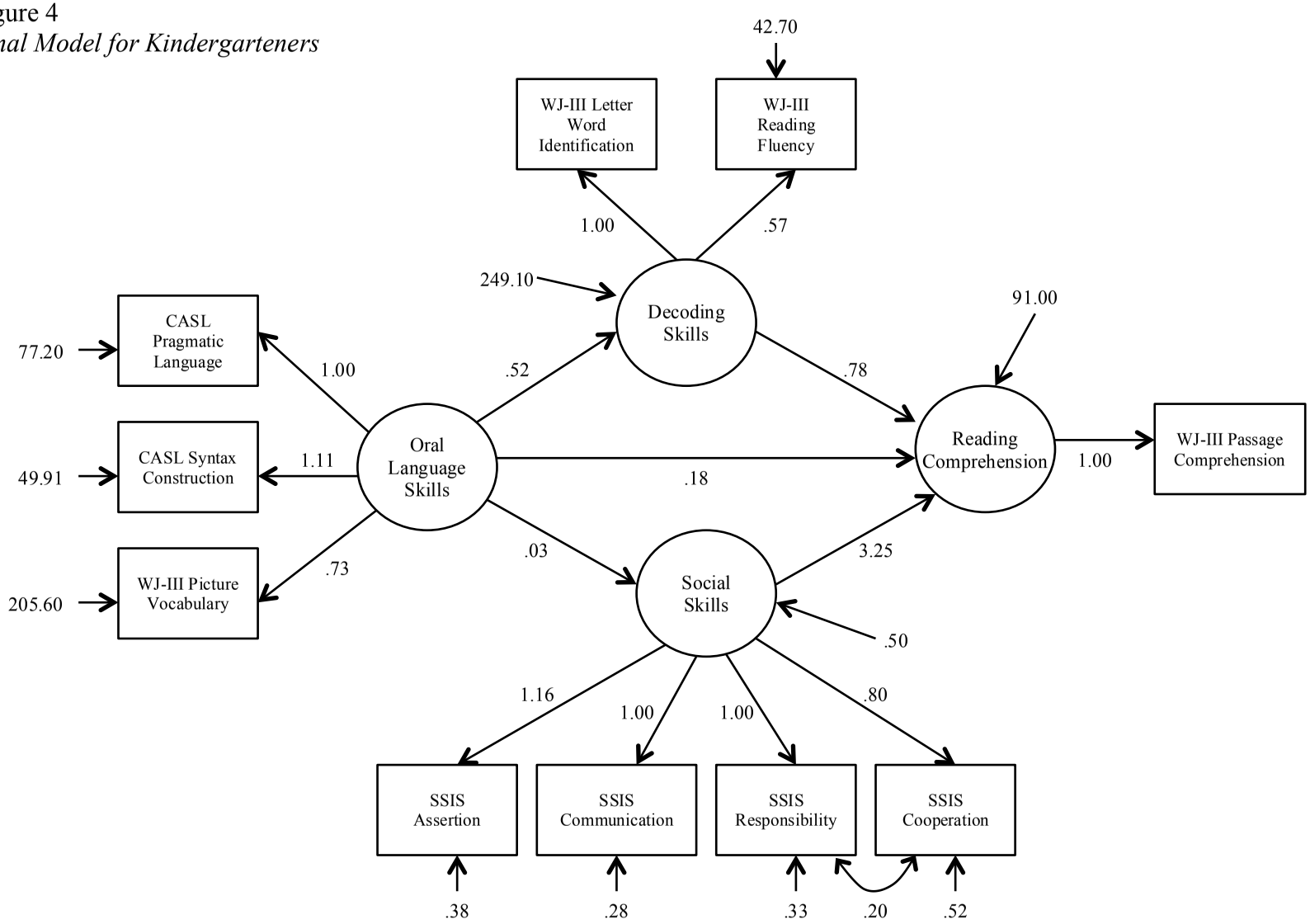


Figure 5
Final Model for Second Graders

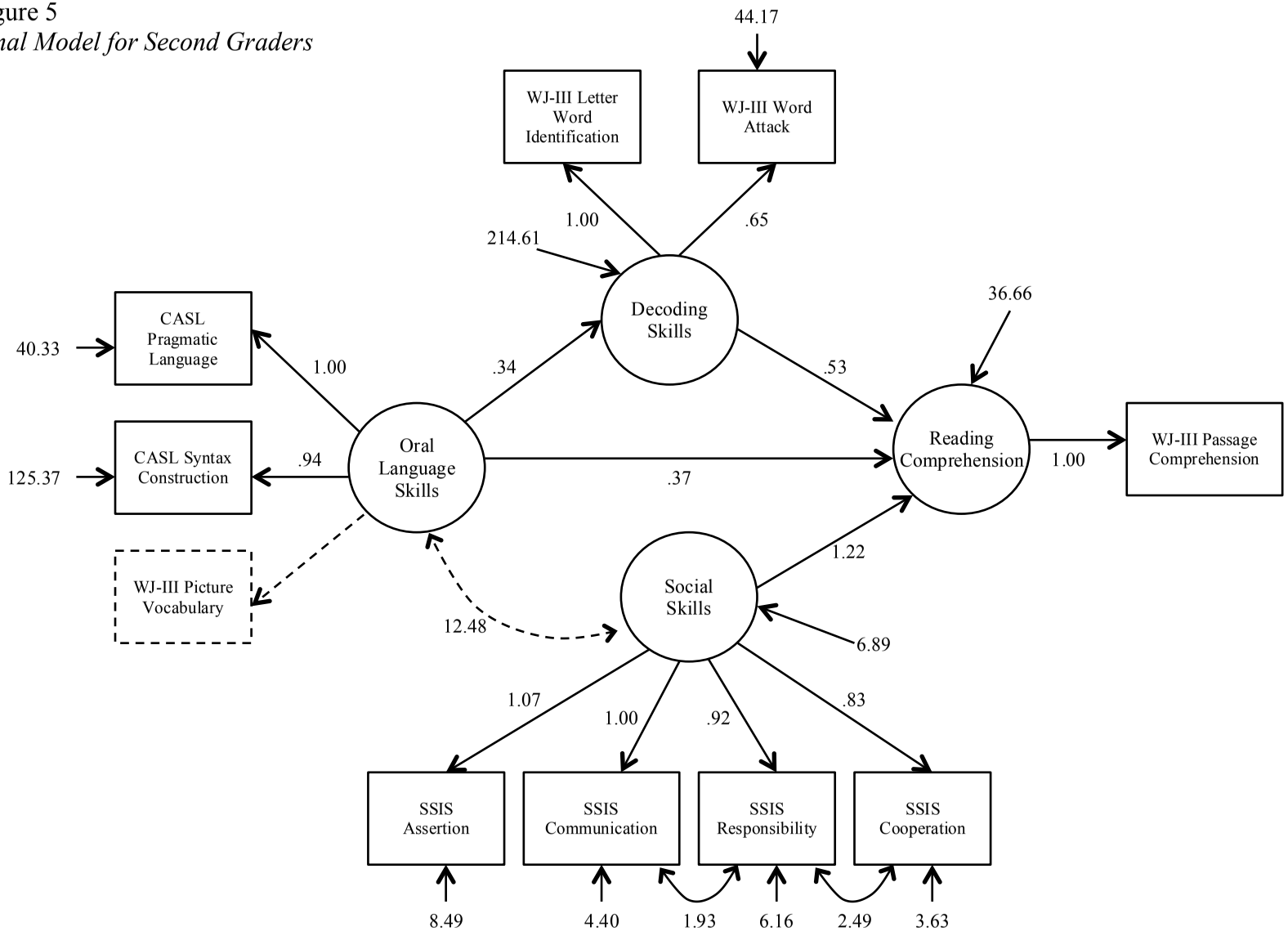


Figure 6
Final Longitudinal Model: Reading Skills

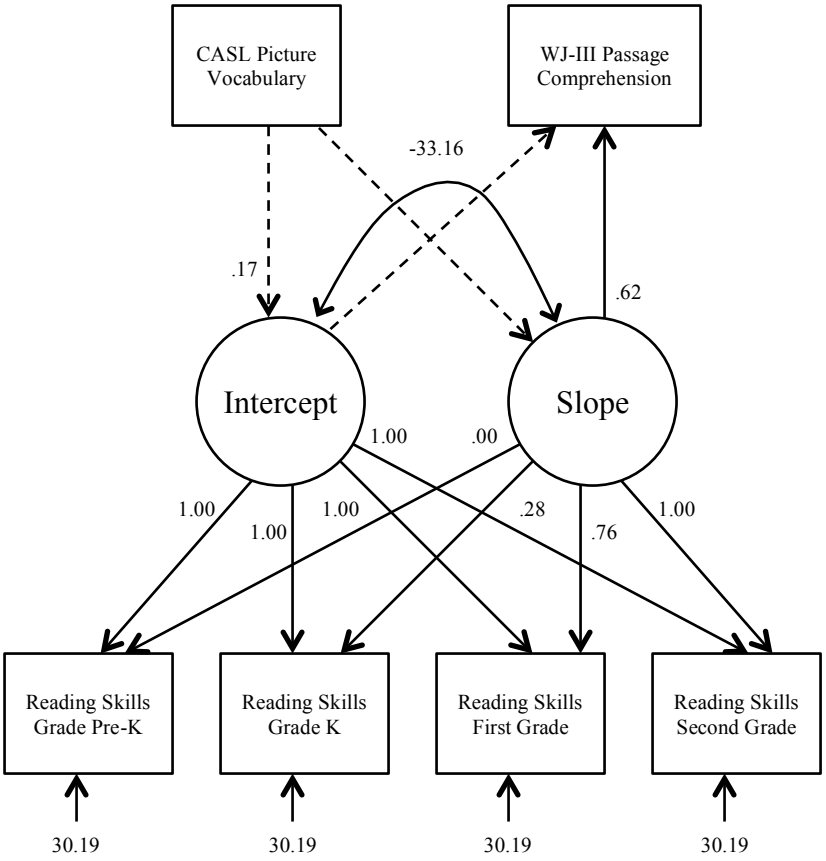


Figure 7
Final Longitudinal Model: Social Skills