The emergent literacy skills of preschool children with autism spectrum disorder

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MW conceived of the study, initiated the grant application, participated in its design and coordination and drafted the manuscript; JP participated in design and statistical analysis of the data and helped draft the manuscript; DT participated in the design and statistical analysis of the data. AW, AH and JR participated in the design; All authors assisted with participant recruitment, participated in the interpretation of the data, provided feedback on the manuscript drafts, and read and approved the final manuscript.

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The Emergent Literacy Skills of Preschool Children with Autism Spectrum Disorder

Abstract

A high percentage of school-age students with autism spectrum disorder (ASD) have reading comprehension difficulties leading to academic disadvantage. These difficulties may be related to differences in children's emergent literacy development in the preschool years. In this study, we examined the relationship between emergent literacy skills, broader cognitive and language ability, autism severity, and home literacy environment factors in 57 preschoolers with ASD. The children showed strengths in code-related emergent literacy skills such as alphabet knowledge, but significant difficulties with meaning-related emergent literacy skills. There was a significant relationship between meaning-related skills, autism severity, general oral language skills, and nonverbal cognition. Identification of these meaning-related precursors will guide the targets for early intervention to help ensure reading success for students with ASD.

In recent years, there has been an increase in attention to the academic achievements of individuals with autism spectrum disorder (ASD) (Keen, Webster, & Ridley, 2015; Wong et al., 2015), due in part to increasing numbers of children diagnosed with ASD in schools. Recent prevalence data suggest ASD affects approximately one in 68 children (Centers for Disease Control and Prevention, 2014). In Australia, the most recent census data indicate that ASD affects approximately 1 in 200 school-age children (Australian Bureau of Statistics, 2014), of whom 95% experience challenges in education due primarily to social, communication, and learning difficulties. That said, academic achievement of students with ASD varies widely and, although cognitive abilities are one influence, discrepancies between cognitive and academic achievement are also observed (Estes, Rivera, Bryan, Cali, & Dawson, 2011).

One critical area of academic achievement is learning to read. Although there is evidence from several studies that school-age children with ASD may perform poorly on tasks measuring reading comprehension (Brown, Oram-Cardy, & Johnson, 2013; Henderson, Clarke, & Snowling, 2014; Jones et al., 2009; Ricketts, 2011), very few studies have investigated how young children with ASD develop their reading foundation skills prior to school-entry (Westerveld, Trembath, Shellshear, & Paynter, 2016). Investigating the early developmental pathways to reading competency, referred to as *emergent literacy development*, in preschool children with ASD will help clarify whether the reasons for reading failure are autism specific or related to these children's often comorbid cognitive and/or oral language difficulties.

The Simple View of Reading

According to the Simple View of Reading (Gough & Tunmer, 1986), reading comprehension is the product of two components: word recognition and oral language comprehension. During the early stages of reading development, the emphasis is on learning to recognize or decode the written words on a page and much of the variance in reading comprehension is explained by children's word recognition ability. As children progress to years three or four of schooling and improve in their ability to accurately and efficiently recognize words, oral language comprehension becomes the main contributor to reading comprehension (Catts, Hogan, & Adlof, 2005). Using this Simple View of Reading as a framework, children with reading comprehension difficulties can be classified as a) those who show weaknesses in word recognition, but have adequate oral language comprehension skills; b) those who show adequate word recognition, but struggle with oral language comprehension; and c) those who show weaknesses in both word recognition and oral language comprehension (Catts, Hogan, & Fey, 2003).

As noted above, research into the reading abilities of individuals with ASD has revealed particular difficulties with reading comprehension but also relative strengths in word recognition or decoding (Henderson et al., 2014; Huemer & Mann, 2010; Nation, Clarke, Wright, & Williams, 2006; Ricketts, Jones, Happé, & Charman, 2013). However, the results of these studies reveal substantial variability in performance for individual participants, both in word recognition and reading comprehension, ranging from severely impaired (more than two standard deviations below the mean) to within normal limits. Furthermore, there is some evidence to suggest that word recognition ability in individuals with ASD explains more of the variance in reading comprehension than would be expected based on typically developing readers (Henderson et al., 2014). When investigating emergent literacy development in children with ASD, we thus need to consider the developmental precursors to both word recognition (i.e., code-related skills) and oral language comprehension (i.e., meaning-related skills). Moreover, considering the heterogeneity of the disorder, several researchers have stressed the importance of investigating behaviors within groups of children with ASD, rather than comparing these children to typically developing peers (Ricketts et al., 2013; Tager-

Flusberg, 2004). An improved understanding of the variation in emergent literacy skills in preschool aged children with ASD may help guide the development and implementation of targeted early intervention practices.

Emergent Literacy Development and Assessment

Using the Simple View of Reading as a framework, emergent literacy may be conceptualized as comprising code-related skills (i.e., letter name and sound knowledge, print concepts, early name writing, and early developing phonological awareness) that are needed for successful word recognition, and meaning-related emergent literacy skills comprising vocabulary, grammatical ability, and narrative retelling and comprehension (NICHD, 2005). Typically developing children who enter school with better developed emergent literacy skills are more likely to become successful readers (Catts, Herrera, Nielsen, & Bridges, 2015; Tunmer, Chapman, & Prochnow, 2006). In fact, Tunmer and colleagues (2006) found that school-entry emergent literacy ability accounted for almost 70% of the variance in reading achievement seven years later. Emergent literacy learning is generally fostered in the home or preschool environment through interactions with parents, caregivers, and early childhood professionals (e.g., Li & Fleer, 2015; Pentimonti et al., 2012; Sénéchal, Pagan, Lever, & Ouellette, 2008). By engaging in literacy-rich activities such as shared book reading and participating in sound games, many emergent literacy milestones, such as the development of print concepts of how to hold books, to read from left to right, and to recognize that letters and words hold meaning, may be achieved before children start school (Justice, 2006). When evaluating children’s emergent literacy performance it is therefore important to assess these children prior to school-entry and to consider how the development of these skills may have been nurtured in the home environment.

Assessment of code-related emergent literacy skills is relatively straightforward and generally includes evaluation of the following predictors of future reading development:

alphabet knowledge, print-concept knowledge, and phonological awareness (National Early Literacy Panel, 2008). Although a range of tasks (both formal and informal) have been published to assess emergent literacy skills in preschool-age children (e.g., Clay, 2000; Dickinson & Chaney, 1997; Dodd, Crosbie, Mcintosh, Teitzel, & Ozanne, 2000; Invernizzi, Sullivan, & Meier, 2001), these assessments do not always include oral language or the meaning-related skills that are needed for adequate reading comprehension (Catts et al., 2015). Based on their recent investigation into predictors of reading comprehension, Catts et al. emphasized the importance of early assessment of oral language skills to identify children who are at risk for later reading comprehension difficulties (see also, Foorman, Herrera, Petscher, Mitchell, & Truckenmiller, 2015). These researchers found that kindergarten oral language and code-related skills were directly associated with reading comprehension three years later.

Researchers also suggest that assessment of preschool oral language skills should go beyond measuring vocabulary to also evaluate children’s comprehension at both the sentence- and discourse- or text-level (Catts et al., 2015; Foorman et al., 2015; Sénéchal & Lefevre, 2002). Although the significant impact of vocabulary knowledge on reading development has been well established (Lucas & Norbury, 2015; Tunmer & Chapman, 2012), the importance of oral narrative comprehension and production should not be underestimated, as preschool oral narrative comprehension has been found to be predictive of future reading comprehension ability (Bishop & Adams, 1990; Lynch et al., 2008). Moreover, children with reading difficulties (but who are otherwise typically developing) often demonstrate significant weaknesses in their ability to comprehend or produce oral narratives, when compared to their peers with typical reading development (Cain, 2003; Westerveld, Gillon, & Moran, 2008). Children with ASD are known to struggle with oral narrative tasks (e.g., Diehl, Bennetto, & Young, 2006; Losh & Capps, 2003; Nuske & Bavin, 2011). Consistent with the central coherence theory (see Happé & Frith, 2006), children with ASD show weaknesses with processing information at a global (or macrostructure) level (e.g., higher-level organization/integration of semantic information), and as a result, their oral narratives may be poorly organized and show limited evidence of causal language (Diehl et al., 2006; Losh & Capps, 2003). Therefore, assessment of meaning-related emergent literacy skills should include an oral narrative task, which will yield important information about children's ability to comprehend and produce language at discourse-level (see also, Justice, Bowles, Pence, & Gosse, 2010).

Importance of the Home Literacy Environment

Children who grow up in a 'rich' home literacy environment are more likely to develop their emergent literacy skills (see Boudreau, 2005; Sénéchal, 2006). For instance, Sénéchal et al (2008) found that the frequency of shared book reading was positively related to expressive vocabulary for 4-year-old participants with typical development. In contrast, a more recent study conducted by Petrill, Logan, Sawyer, and Justice (2014) indicated that for children at risk of language impairment, low frequency of book reading was associated with low levels of print knowledge, but high frequency was not necessarily related to high levels of print knowledge. These findings highlight that the relationship between the home literacy environment and children's emergent literacy skills is not linear, at least not for those children who demonstrate difficulties in learning language. It is important, then, to consider the home literacy environment when investigating emergent literacy skills in children, particularly for those with language impairments, which includes the majority of children with ASD (Lanter, Watson, Erickson, & Freeman, 2012).

Emergent Literacy Skills in children with ASD

A recent systematic review of the literature revealed only three studies that addressed the emergent literacy skills of preschool-age children with ASD (Westerveld et al., 2016).

Three interesting findings emerged. First, although a percentage of preschool children with ASD demonstrated age-appropriate code-related emergent literacy skills, including letter knowledge and early phonological awareness (Davidson & Ellis Weismer, 2014; Dynia, Lawton, Logan, & Justice, 2014; Lanter et al., 2012), individual variation was substantial with some children unable to perform the tasks and others scoring at ceiling levels. Second, some evidence was found for early difficulties in meaning-related skills as measured by definitional vocabulary (Dynia et al., 2014). However, none of the studies included an oral narrative comprehension or retell task. Third, correlations were found between children's performance on both code-related and meaning-related skills and their oral language skills (as measured on the Preschool Language Scale, Fourth Edition (PLS-4; Zimmerman, Steiner, & Pond, 2002) and nonverbal cognition (Davidson & Ellis-Weismer, 2014). Although results from Davidson and Ellis-Weismer's (2014) longitudinal study of children with ASD indicated significant negative, all be they mild, concurrent correlations between autism severity and performance on the Test of Early Reading Ability – Third Edition (TERA-3; Reid, Hresko, & Hammill, 2001) at age 5½, autism severity did not contribute unique variance to (predictive or concurrent) performance on the TERA-3. Taken together, the findings from these studies indicate a clear need for research investigating the emergent literacy skills of young children with ASD prior to school-entry, which includes fine-grained measures of both code-related and meaning-related skills as well as descriptive measures of oral language, nonverbal cognition, and autism severity.

The Current Study

To address the identified gap in the research literature, the current study was designed to answer the following questions: a) How do preschool children with ASD perform on code-related and meaning-related emergent literacy measures?; b) Are parent reported home literacy practices related to preschool children's emergent literacy performance?; and c) Are oral language skills, nonverbal cognition, and autism severity related to code-related and/or meaning-related emergent literacy skills in preschool-age children with ASD? Based on previous research we predicted that the children would show relative strengths in code-related and weaknesses in meaning-related emergent literacy skills (Davidson & Ellis Weismer, 2014). We anticipated that the parent-reported frequency of shared book reading would be associated with children's code-related and meaning-related emergent literacy skills (Dynia et al., 2014; Sénéchal et al., 2008). Finally, we expected oral language, home literacy, nonverbal cognition, and autism severity to account for variance in the children's emergent literacy performance (Davidson & Ellis Weismer, 2014), but we had no specific hypotheses about the strength of these correlations.

Method

The study was approved by the Griffith University ethics committee (AHS/13/14/HREC) and the Sydney Children's Hospitals Network ethics committee (HREC/14/SCHN/270).

Participants

Participants were recruited through early childhood services for children with ASD, private speech pathology clinics, and a children's hospital. In addition, flyers were posted on parent support websites and distributed via professional networks. To be included in the study, and based on parent-report, children needed to: a) have a confirmed diagnosis of ASD, b) be at least 4 years of age and not yet enrolled in formal schooling, c) speak in short sentences, and d) be able to participate in preschool type activities such as pointing at pictures and following simple commands. A total of 60 children were recruited (51 boys, 9 girls). Families resided in the greater Brisbane area (52) and metropolitan Sydney (8), Australia.

To confirm autism diagnosis, parents provided written documentation such as letters from pediatricians or child psychologists. In addition, where available (n = 25), results were obtained regarding children's performance on the Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 2012). For those children (*n* = 35) who had not completed an ADOS, parents completed the Social Communication Questionnaire – Lifetime version (Rutter, Bailey, & Lord, 2003). A cut-off of 11 was used to confirm diagnosis (as recommended by Lee, David, Rusyniak, Landa, & Newschaffer, 2007). Four children scored below 11; two of these were excluded, and two were offered an ADOS. One of these children scored above the clinical cut-off on the ADOS and was included in the present study. Thus, the final sample included 57 children (48 boys and 9 girls) who were aged between 4 years, 0 months, and 5 years, 10 months (mean age 57.63 months; *SD* = 6.12 months). Parent report indicated that 29% of mothers had completed secondary school, whereas 71% of mothers had completed post-secondary studies and obtained a tertiary education. This variable was used as an indicator of socioeconomic status (SES). All primary caregivers spoke English as their first language and reported speaking English with their child at home. Two caregivers reported that their child was also exposed to another language in the home.

Procedure and Tasks

All participants were seen on two occasions by a certified practising speech-language pathologist (SLP) with sessions lasting approximately 90 minutes. Assessments took place at each child's early childhood facility, in their home, or in the university clinic, depending on parent preference. The SLP exercised her clinical judgment regarding the presentation order of tasks to maximize child engagement and battery completion. Some of the instructions were adapted, and verbal instructions were simplified as not all tasks had been validated for use with children with ASD. However, care was taken that the same adaptations were used for all participants (see details below). All sessions were recorded using digital voice recorders. For 31 children who had completed the Social Communication Questionnaire (SCQ; Rutter et al., 2003) or the Vineland Adaptive Behavior Scales -II (VABS-II; Sparrow, Cicchetti, & Balla,

2005) (see below) within six months prior to the study, the results were obtained from the early intervention provider with parental consent. For those participants who had not previously completed these two measures, an interview was conducted with the primary caregiver over the phone or in person by qualified SLPs (who were trained in administering these tasks). Parents were also asked to complete questionnaires about demographics and home literacy practices.

Cognitive ability. To determine the participants' level of nonverbal ability, two subscales from the Mullen Scales of Early Learning (MSEL; Mullen, 1995) were administered: Visual Reception and Fine Motor. As per previous research with young children with ASD (Davidson & Ellis Weismer, 2014; Yang, Paynter, & Gilmore, 2016), a nonverbal ratio IQ score (nonverbal cognition) was calculated by dividing the child's age equivalent average across the two subscales by the child's age in months, before multiplying it by 100.

Autism severity. The Social Communication Questionnaire (Lifetime or Current) form (SCQ; Rutter et al., 2003) was used to verify diagnosis and the total score was used as a measure of autism severity as per previous research (e.g., Paynter, Riley, Beamish, Davies, & Milford, 2013). The SCQ was completed by the primary caregiver and included 40 dichotomous (yes/no) items of autism symptoms that yielded a total score.

Communication skills – Parent report. The Communication domain VABS-II (Sparrow et al., 2005) was used to determine the participants' communication skills. The Communication domain comprises three subdomains: receptive, expressive, and written. The manual reports excellent test-retest reliability for ages 3 – 6 (Communication domain $r = .90$; receptive $r = .84$; expressive $r = .84$; written $r = .89$). Furthermore, the VABS-II was found to be successful in differentiating clinical groups of verbal children with ASD from nonclinical groups using the communication domain ($p < .01$). Age equivalent scores were calculated for spoken communication by averaging the age equivalent scores of the receptive and expressive subdomains. Age equivalent scores were also calculated for the written communication subdomain as reported in the manual. Age equivalent scores were chosen for analysis based on recommendations made for this age group of children with ASD (Yang et al., 2016).

Emergent literacy skills. To the authors' knowledge there are no well-validated norm-referenced tests for measuring emergent literacy skills in young children with ASD. Therefore, the following tests were used.

The Phonological Awareness Literacy Screening for Preschoolers (PALS-PreK; Invernizzi, Sullivan, Meier, & Swank, 2004), which has been used for typically developing young children, was selected. The PALS-PreK is specifically designed to evaluate a child's emerging knowledge in the most important areas of emergent literacy, including name writing, alphabet knowledge, beginning sound awareness, rhyme awareness, and print and word awareness (p. 5). As reported in the PALS-PreK manual, the tasks were designed to be developmentally appropriate for four-year-olds and show acceptable criterion-validity, predictive validity, internal consistency, and construct validity (Invernizzi et al., 2004).

For the current study, the procedures used in the PALS-PreK were adapted. First, we administered all alphabet knowledge tasks and did not impose a discontinuation rule. Furthermore, all verbal instructions were simplified to shorten the sentences, while retaining the key words. The following four subtests of the PALS-PreK were administered: 1) *Alphabet knowledge*. For the letter name knowledge task, children were presented with a white sheet of paper on which all 26 letters of the alphabet were printed in random order, in upper case. The child received a point for each letter correctly named (maximum score 26). For letter sound knowledge, children were shown a different sheet of paper with 26 letters printed in upper case. Children were awarded one point for each letter sound produced correctly. A sheet of white paper was used to cover part of the sheet so that only one line of letters was shown at a time; 2) *Phonological awareness*. Phonological awareness was assessed using the beginning sound awareness subtest of the PALS-PreK. This subtest contains four practice items and eight test items. It requires the child to first repeat the word depicted on a card (with particular emphasis on the first sound in the word), before asking the child to produce the initial sound in the word. The child's first attempt at producing the sound was scored as correct/incorrect. For the current study, rather than matching each card to previously used cards containing the same initial sound, children were asked to put the cards in one of three cups; 3) *Print-concept knowledge* was assessed using the Print and Word Awareness (PWA) subtest. This task uses a small book *Hey Diddle Diddle* and tests the child's knowledge of print concepts, such as identifying words on a page and reading from left to right. There were 10 items for a maximum of 10 points; and 4) *Name writing.* Children were asked to write their name and draw a picture of themselves on the front sheet of the PALS-PreK score form. Name writing (NW) attempts were scored on a 7-point scale. For example 0 points were awarded if the name was just a scribble; 3 points were given if the name consisted of random letters and symbols; 5 points were awarded if the name consisted of many correct letters with no filler letters or symbols; and 7 points were awarded if the name was correct with no backwards letters or mirror image writing (Invernizzi et al., 2004, p. 14).

Rapid automatic naming (RAN) was assessed using a subtest of the Woodcock Reading Mastery Tests – Revised (Woodcock, 1998). This subtest contained two tasks, rapid object naming and rapid color naming. Children were first asked to name five pictures of common objects and to name the colors of five squares to ensure they knew the names of these objects and colors. The children were then presented with a sheet of paper containing a 36-item array of five randomly repeated objects, and asked to name these as rapidly as possible. Next they were asked to name a 36-item array of five randomly repeated colors as rapidly as possible. Standard scores (SS) were computed and for those children who were unable to complete the task or who made too many errors (more than four per task), an SS of 55 (the lowest possible standard score) was coded for analysis.

Receptive vocabulary skills were evaluated using the Peabody Picture Vocabulary Test – Fourth Edition (PPVT-4; Dunn & Dunn, 2007). This task required children to point to a picture from a set of four. Standard scores (SS) were computed and reported, but raw scores were used for analysis.

Oral narrative retelling and comprehension ability. Children were asked to listen twice to a recording of an unfamiliar story (*Ana gets Lost*), while looking at the pictures of the story book on a computer screen. For a full description of the task, including the prompts, the model story and the comprehension questions, see Westerveld and Gillon (2010). Following the first exposure to the story, children were asked eight questions, yielding an Oral Narrative Comprehension score (maximum score of 8). After the second exposure to the story, children were asked to retell the story without the use of the pictures. The stories were transcribed and scored for Oral Narrative Quality, using a quality rubric. Total scores on the Oral Narrative Quality rubric ranged between 0 and 40. This task has been used successfully in the past with four-year-old children and showed adequate criterion and predictive validity (Westerveld, Gillon, & Boyd, 2012).

Home literacy. Parents completed a questionnaire developed by Boudreau (2005). Two questions were analyzed for the purpose of the current study, on a scale from 1 (never) to 5 (very often): 1) Does your child ask you to read to him/her?; and 2) How often do you, or other members of your family, read to your child in a typical week? We decided to focus on the frequency of shared book reading only, based on previous research demonstrating the important predictive nature of this aspect of the home literacy environment and four-year-old children's oral language skills (Sénéchal et al., 2008), as well as on recent research showing that this relationship may be different for children with identified language difficulties (Petrill et al., 2014). Parents' answers to these questions showed adequate internal reliability (Cronbach's alpha = .739). Therefore, parent responses to these two questions were combined (minimum score 2, maximum score 10) and this composite measure was used for the following analyses.

Results

Data Screening and Preliminary Analyses

Descriptive statistics. Table 1 shows the group's performance on the SCQ, nonverbal cognition, the VABS-II communication domain and the PPVT-4. Missing data were detected in 2.5% of the cases; < 1% of the values were missing, thus missing data were deleted list-wise. No significant correlations were found between age in months and performance (in raw scores) on the PPVT-4 (r = .105, p = .439), the VABS-II receptive (r = -.199, p = .142) and expressive (r = -.121, p =.376), the SCQ (r = -.095, p = .484), or any of the PALS-PreK subtests (ranging from r = .259, p = .052 for print concepts to r = .061, p = .650 for letter sound knowledge), except for name writing, r = .302, p = .023. Correlations between age in months and oral narrative comprehension (r = .198, p = .140) or oral narrative quality (r = -.024, p = .862) were also not significant. A small, but significant negative correlation was found between age and nonverbal cognition (r = -.282, p = .034), as would be expected. No significant correlations were found between SES and any of the measures (ranging from r = .014 to r = .250, with all ps < .05). Therefore, the group was analyzed as a whole and age and SES were not entered into analyses.

Spoken vs. written communication skills. Children's performance on the VABS-II communication domain was evaluated, using two paired-samples t-tests to compare age equivalent scores (in months) between written and spoken subdomains and between written subdomain and chronological age. Results showed that the children performed significantly better in the written subdomain (*M* = 54.04, *SD*= 10.84) than in the spoken subdomain (*M* = 35.90, SD = 9.90), $t(55) = 10.955$, $p < .001$, $d = 1.46$. However, children's performance (i.e., age equivalent scores) in the written subdomain was still significantly below their chronological age (*M* = 57.55, SD = 6.15), $t(55) = -2.058$, $p = .028$, $d = .29$.

[Insert Table 1 here]

Emergent Literacy Performance

To answer the first research question, children's performance on the emergent literacy tasks was evaluated and compared against available norms.

Code-related skills. Group performance on the code-related emergent literacy tasks is shown in Table 2. Mean group performance on most of the code-related emergent literacy measures was within the expected range as reported in the manual of the PALS-PreK. However, individual variation was large, with some children unable to complete the task and others scoring at ceiling. Depending on the task, between 40.4% and 75.4% of children scored within the expected range.

Meaning-related skills. We first considered children's receptive vocabulary performance as measured by the PPVT-4. As shown in Table 1, 54.4% of the participants scored within or above the expected range based on the standard scores as reported in the manual (Dunn & Dunn, 2007). Performance on the oral narrative task was compared to the performance of 4-year-old children as reported by Westerveld et al. (2012). As shown in Table 2, only 14 – 15.8% of the children scored within the expected range (i.e., ≥ 25th percentile) on measures of oral narrative comprehension or production.

[Insert Table 2 here]

Home Literacy Environment

To answer the second research question (that is the relationship between the frequency of book reading in the home and children's emergent literacy abilities), we analyzed parents’ responses to the two frequency questions. When asked how often parents read to their child, 70% of parents reported reading to their child often or very often, with 26% indicating they sometimes read to their child. When asked how often their child asked to be read to, 42.1% of parents said this was often or very often; 38.6% said this was sometimes; 14.1% said this was seldom or never. For further analysis, a composite measure was created by combining these two questions (maximum score 10): scores ranged between 3 and 10 (mean 7.44, SD = 1.76).

To explore whether frequency of book reading was related to children’s performance on the emergent literacy tasks (oral narrative comprehension, oral narrative quality, PPVT-4 SS, letter name knowledge, letter sound knowledge, phonological awareness, and Print and Word Awareness), correlation coefficients were calculated. There was a small, but significant positive correlation between frequency of book reading and oral narrative quality (r = .274, p = .045). All other correlations were non-significant, as shown in Table 3.

Predictors of Emergent Literacy Performance

Our final aim of the study was to investigate which factors were associated with emergent literacy performance in preschool children with ASD. Table 3 shows the correlations (Spearman’s rank was used due to the inclusion of ordinal scales) between children’s performance on the SCQ (‘autism severity’), frequency of book reading, the VABS-II spoken communication, nonverbal cognition, and the emergent literacy measures. As shown, there were no significant correlations between SCQ scores and any of the measures, although the correlation between letter name knowledge and autism severity (SCQ score) approached significance (r = .255, p = .055), indicating that higher autism severity as measured on the SCQ was associated with better performance on the letter name knowledge task. Performance on the spoken communication subdomains of the VABS-II showed moderate significant correlations with nonverbal cognition (r = .455, p <.001) and PPVT-4 raw scores (*r* = .407, *p* = .002), and low but significant correlations with oral narrative comprehension (*r* = .394, *p* = .003) and name writing (*r* = .324, *p* = .015). The PPVT-4 showed significant moderate correlations with all emergent literacy measures (*r* = .397 to *r* = .668, *p*s < .002), except letter name knowledge (*r* = .159, *p* = .238).

[Insert Table 3 here]

To investigate concurrent predictors of code- and meaning-related emergent skills, two composite scales were calculated to produce more stable variables for analysis (see, for example Yoder, Watson, & Lambert, 2015) and to reduce family-wise error through multiple analyses. For code-related ability all variables that were hypothesized to be predictive of word recognition ability based on research with typically developing children (National Early Literacy Panel, 2008; Storch & Whitehurst, 2002) and were significantly correlated (*p* <.001) were selected: Letter name knowledge, letter sound knowledge, phonological awareness, Print and Word Awareness, and RAN. For meaning-related ability, we selected oral language abilities that are known to be precursors to reading comprehension proficiency (Storch & Whitehurst, 2002): receptive vocabulary (PPVT-4), oral narrative comprehension, and oral narrative quality which were likewise all significantly correlated (*p* < .001). All scores were converted to z-scores and these were averaged to create the two composite scores. For code-related ability, the component variables showed a high level of internal consistency as determined by a Cronbach's alpha of .832. For meaning-related ability, the level of internal consistency (Cronbach's alpha) was .792.

To answer our research question, concurrent predictors of the code-related ability score were analyzed through multiple regressions with SCQ, nonverbal cognition, VABS-II Spoken Communication raw scores, and PPVT-4 RS entered as predictors. These explained 34.3% of the variance in code-related performance and together significantly predicted code-related ability scores, $F(4,51) = 6.67$, $p < .001$. Only PPVT-4 was a significant individual predictor ($B = .093$, $t = 3.459$, $p = .001$).

Predictors of meaning-related ability score were analyzed through a multiple regression with SCQ, nonverbal cognition, home literacy, and VABS-II spoken communication as predictors. These explained a significant proportion of the variance in meaning-related performance, explaining 38% of the variance. When taking home literacy out of the model, the remaining variables (SCQ, nonverbal cognition, and VABS-II spoken communication) explained 40.7% of the variance. All three variables were significant individual predictors: SCQ ($B = .037$, $t = 2.355$, $p = .022$), nonverbal cognition ($B = .015$, $t = 2.756$, $p = .008$), and VABS-II spoken communication ($B = .016$, $t = 2.692$, $p = .010$).

Group performance based on nonverbal cognition

Given that nonverbal cognition was a significant individual predictor of meaning-related skills but not code-related skills, and considering the exploratory nature of the current study, we further investigated emergent literacy performance patterns by dividing the group into two subgroups based on nonverbal cognition. As per previous research (see Yang et al., 2016), we used 70 as a cut-off , which resulted in 21 participants in the low group (< 70) and 36 in the higher nonverbal cognition group (≥ 70). There were no significant differences in age ($p = .485$) or autism severity ($p = .553$). Group means were compared using multivariate ANOVAs and effect sizes were calculated using eta squared. Because of the exploratory nature of this analysis, we retained a *p* value of .05 (Perneger, 1998). The higher nonverbal cognition group outperformed the lower nonverbal cognition group on all measures, however statistically significant group differences were only found on the code-related measures of name writing ($p = .002$), letter sound knowledge ($p = .021$), and Print and Word Awareness ($p < .001$), but not on phonological awareness ($p = .071$), or letter name knowledge ($p = .192$). There were significant group differences on the meaning-related measures of PPVT (*p*

< .001), oral narrative comprehension ($p < .001$) and oral narrative quality ($p = .028$). Effect sizes were generally small to medium, explaining 3.1% to 21.5% of the variance. Performance on the PPVT explained 25.5% of the variance. Table 4 shows the results.

[Insert Table 4 here]

Discussion

The current study is the first investigation into the emergent literacy performance of young children with ASD prior to school-entry. Results from our study showed that most children were able to complete the assessment battery, although variability was large as reflected in the range of scores (see Table 2) with some children obtaining zero scores and other scoring at ceiling. These results were expected, not only given the heterogeneous nature of the disorder, but also based on the variability in emergent literacy performance observed in typically developing children (Westerveld, Gillon, van Bysterveldt, & Boyd, 2015) and in children with identified language impairment (Cabell et al., 2010). These results not only extend prior findings regarding the emergent literacy abilities of young children with ASD (Davidson & Ellis Weismer, 2014) into the preschool age range, but also provide more detailed results regarding the full range of skills considered predictive of future reading performance in typically developing children, including phonological awareness, alphabet knowledge, print-concept knowledge, and oral language (National Early Literacy Panel, 2008). These results also reiterate that we cannot assume that all preschoolers with ASD will show proficiency in code-related precursors to reading development, even though relative strengths in word recognition are often observed in school-age children with ASD (Henderson et al., 2014; Huemer & Mann, 2010; Nation et al., 2006; Ricketts et al., 2013).

Strengths and Weaknesses in Code-Related and Meaning-Related Emergent Literacy Skills

To answer our first research question, we compared children's emergent literacy performance across the meaning- and code-related measures to existing published norms. As shown in Table 2, the children in our study demonstrated particular difficulties with meaning-related emergent literacy tasks involving oral narrative comprehension and production, two skills that are strongly linked to future reading comprehension in typically developing children (Bishop & Adams, 1990). Children's receptive vocabulary performance was a relative strength, with the group mean score within the normal range, and more than 50% of the children obtaining scores within one standard deviation from the mean. These results are in line with previous research showing a discrepancy between performance on word-level tasks and those involving higher-level organization or integration of semantic information (see Eigsti, De Marchena, Schuh, & Kelley, 2011, for a review). Our findings also expand our existing knowledge base regarding the oral narrative production abilities of school-age children with ASD (Diehl et al., 2006; Losh & Capps, 2003) by demonstrating oral narrative production and comprehension weaknesses in preschoolers (see also Nuske & Bavin, 2011).

In contrast to the challenges found in meaning-related emergent literacy skills, the participants demonstrated a relative strength on code-related tasks, particularly on letter name and letter sound knowledge. Consistent with previous research (Davidson & Ellis Weismer, 2014; Dynia et al., 2014), the group mean on these tasks fell within the normal range, based on existing norms for typically developing children. Considering the participants' oral language weaknesses as measured by the VABS-II, one might expect difficulties in acquiring letter names and sounds similar to that observed in children with Specific Language Impairment (SLI; Justice, Bowles, & Skibbe, 2006; McGinty & Justice, 2009). Instead, our findings are in agreement with the research of Dynia et al. (2014) who found strengths in letter name knowledge in young children with ASD, compared to an age-matched control group without ASD. In addition, our within group analysis suggests a possible association between level of symptoms and skill in this area, which implies that there may be some aspects of ASD symptomology (e.g., repetitive restricted interests and behaviours) that lead some children to excel in this area, but not necessarily in literacy more broadly. Alternatively, as Davidson and Ellis Weismer (2014) hypothesized it may be that this interest in individual letters (or a focus on detail) is consistent with the weak central coherence account of cognitive processing in ASD (Happé & Frith, 2006). Regardless, there is a clear need for identification of ASD characteristics that are relevant diagnostically but also clinically with respect to understanding how children learn to read and ultimately how they may respond differentially to intervention due to presence/absence/amount of these behaviours. Moreover, these findings reiterate the notion that code-related emergent literacy skills of children with ASD should not be measured with a single measure (of letter name knowledge), as this may overestimate children's emergent literacy proficiency (Lanter et al., 2012).

In contrast to the findings by Dynia et al. (2014), the group mean of our participants fell within the normal range for phonological awareness. These differences in findings between the two studies may best be explained by the differences in phonological awareness task complexity. Dynia et al. (2014) used phonological awareness tasks that measured elision and blending abilities, whereas the current study only measured initial phoneme identification, which is mastered much earlier in children with typical development (Lonigan, Burgess, Anthony, & Barker, 1998). Future research should investigate whether the development of phonological awareness in young children with ASD follows this typical trajectory. Furthermore it remains unclear whether phonological awareness proficiency in preschool children with ASD is predictive of future word recognition ability, considering some evidence exists that real-word reading in school-age children with ASD is not always aligned to their nonword reading, suggesting a reliance on different mechanisms for word recognition (Henderson et al., 2014). Longitudinal follow up of the current cohort is needed to help answer this question.

The findings from our study revealed weaknesses in print concepts as measured by the Print and Word Awareness task with the mean group score below the expected developmental range. Again these results are consistent with previous research by Dynia and colleagues (2014) who reported significantly lower print-concept knowledge in their participants with ASD compared to a group of typically developing peers, even after controlling for language ability. To help explain these findings, we considered whether the home literacy environment showed significant associations with children's emergent literacy abilities.

Home Literacy Environment

A surprising finding was the lack of significant links between parents' reported home literacy practices, as measured by the reported frequency of book reading at home, and children's code-related emergent literacy skills. The only significant (but mild) correlation was between frequency of book reading and oral narrative quality, indicating that frequency of book reading is associated with children's ability to tell a better story, although the causal connection is not clear. Based on previous research, we would also have expected positive correlations between the frequency of book reading and alphabet knowledge as well as print concept knowledge (Dynia et al., 2014) and between frequency of book reading and vocabulary development (Sénéchal et al., 2008). One explanation includes the lack of variability in home literacy practices in our current cohort (i.e., 70% of parents reported reading to their child often or very often and 26% indicating they sometimes read to their child) based on a rather crude measure of home literacy environment (i.e., using a questionnaire). Research into the book reading practices with preschoolers with SLI has also highlighted the importance of children's attention difficulties as a possible moderator

(McGinty & Justice, 2009). McGinty and Justice (2009) examined the predictors of print knowledge (including letter name knowledge and print concepts) in children with SLI and revealed that the only significant predictor was the quality of the children's home literacy environment, moderated by children's attentional difficulties. More specifically, they found that children with clinically significant attention difficulties (based on parent report of child behaviors using the Child Behavior Checklist; Achenbach & Rescorla, 2000) demonstrated lower print knowledge scores, but only when the quality of home literacy was low. Given that children with ASD also often demonstrate attention difficulties (e.g., difficulties concentrating, waiting), and considering findings from eye-tracking research indicate atypical monitoring and responsivity to social cues signaling goal-directed actions amongst children with ASD (Vivanti, Trembath, & Dissanayake, 2014), future research into the home literacy environment of children with autism should incorporate behavioral, and if possible objective measures of attention.

Concurrent Predictors of Emergent Literacy Performance

The final research question investigated which variables predicted children's performance on code-related and meaning-related measures of emergent literacy. To better understand the relationships between the emergent literacy variables, we presented bivariate correlations (Table 3). Consistent with findings from a study by Dickinson, Mccabe, Anastasopoulos, Peisner-Feinberg, and Poe (2003), who investigated the emergent literacy skills of 533 preschoolers with typical development, we found significant correlations between most measures, confirming these measures are significantly interrelated in preschool children with ASD, as they are in their typically developing peers. These findings are consistent with the important role oral language plays in emergent literacy development as would be predicted by the simple view of reading for children with ASD (Ricketts et al., 2013).

We then investigated the predictors of code-related emergent literacy performance. Although our overall model (which included SCQ, Nonverbal cognition, PPVT-4 and VABS-II spoken communication) was significant, it only explained 34% of the variance in children's code-related emergent literacy, and performance on the PPVT-4 was the only unique predictor. The links between early receptive vocabulary (PPVT-4) and code-related emergent literacy skills are not surprising and in line with previous research investigating emergent literacy performance in typically developing children (Catts et al., 2015; Dickinson et al., 2003; Dickinson & Snow, 1987) and children at risk of communication impairments (Cabell, Justice, Konold, & McGinty, 2011). The fact that vocabulary growth predicts phonological awareness has been well documented and is consistent with the lexical restructuring hypothesis (Metsala & Walley, 1998, cited in Stoel-Gammon, 2011), which posits that growth in vocabulary requires more fine-grained phonological representations. Furthermore, previous studies have found significant links between receptive vocabulary (PPVT) and print-related knowledge. For example, Dickinson et al. (2003) tested a group of 533 preschoolers with typical development on measures of oral language and print-related emergent literacy and found a correlation of .42 ($p < .001$) between the PPVT and performance on the Emergent Literacy Profile (Dickinson & Chaney, 1997). Similarly, Cabell et al. (2011) assessed 492 preschoolers considered at high risk for communication difficulties and reported bivariate correlations of .52 (PPVT and Print and Word Awareness on the PALS PreK) and .40 (PPVT and Letter Name Knowledge).

When investigating the predictors of meaning-related emergent literacy skills (i.e., oral language comprising vocabulary and oral narrative skills), our overall model containing autism severity (as measured by the SCQ), nonverbal cognition and VABS-II communication was again significant and explained 40.7% of the variance. This time, all three variables were unique significant predictors. It was not surprising to find that nonverbal cognition and spoken communication (as tested by the VABS-II) predicted children's meaning-related emergent literacy skills. These results extend the results from Davidson and Ellis-Weismer (2014) who investigated the early literacy skills of a group of 5-year-old children with ASD, some of whom had already started their formal schooling, to a group of younger preschool-age children with ASD. Our findings also stress the importance of taking both nonverbal cognition and oral language performance into consideration when investigating the early meaning-related emergent literacy skills of children with ASD (Davidson & Ellis Weismer, 2014). Considering the non-significant correlations between SCQ scores and the emergent literacy variables, it was surprising to find that autism severity (using the SCQ) significantly predicted some of the unique variance in the composite meaning-related emergent literacy score. The most likely explanation pertains to the fact that we used standardized scores to form the meaning-related composite. Overall, our tentative results are in line with previous investigations showing the possible influence of autism severity in predicting outcomes in ASD (e.g., Davidson & Ellis Weismer, 2014; Whitehouse, Line, Watt, & Bishop, 2009), including literacy. These findings reinforce the importance of including autism severity in future studies that investigate the reading profiles of children with ASD (Davidson & Ellis Weismer, 2014).

Limitations and Future Directions

As with any study of children with ASD, the eligibility criteria should be considered when interpreting the findings. On this occasion, the fact that children needed to be able to speak in short sentences and participate in preschool type activities to be included reduces the relevance of the findings to children on the autism spectrum with more substantial communication and behavioral needs. It is also possible that sampling may have included a bias towards parents who were more likely to engage in reading and other emergent literacy practices at home. The majority of mothers had undertaken a tertiary education and thus were more likely to have higher literacy skills themselves and were perhaps more likely than other parents to read or help their children with pre-literacy skills. In fact, most of the parents reported they read regularly with their children. This homogeneity of home literacy practices may have accounted for the lack of links between these practices and children's emergent literacy skills and it is possible that a more mixed cohort would demonstrate higher variability in this area. The study comprised parents whose first language was English, implying relative cultural homogeneity within the group, and it is possible that culturally-based differences in child-rearing practices may influence emergent literacy development in the preschool years.

We were only able to explain 34 to 40% of the variance in emergent literacy performance in this group of preschoolers with ASD. We examined behaviours directly linked to the simple view of reading, but it is likely that we will need to go further to examine social cognitive underpinnings of these skills, such as attention (McGinty & Justice, 2009), social factors (Davidson & Ellis Weismer, 2014; Ricketts et al., 2013), and print motivation. Our main focus in this study was on generating a comprehensive profile of emergent literacy skills in preschool children with ASD, given the lack of detailed investigation of these skills in most previous studies. However, in view of the strong association between emergent literacy skills and broader language ability in children with and without ASD (e.g., Catts et al., 2015; Davidson & Ellis Weismer, 2014), the use of a more comprehensive battery of oral language abilities is recommended in future research, including an objective measure of broader language skills. Nevertheless, u the VABS-II has allowed us to investigate the links between the children's emergent literacy skills and their functional spoken communication skills in everyday environments. Finally, there is a need to look not only at absolute ability, but also dynamic assessment of capacity to develop skills, as ability/inability to learn a constituent skill, in the presence of a targeted intervention, may tell us more about where the system works or does not work, rather than looking at attainment at a particular point in time given the complex educational histories and skill profiles of many of these kids.

Conclusion

This study investigated the emergent literacy skills of a sample of children with ASD and the links between these skills and predictive factors such as autism severity, nonverbal cognition, home literacy environment, and oral language skills. Although children demonstrated widely varying levels of skills and performance, the majority had difficulty with oral narrative comprehension and production tasks. In contrast, receptive vocabulary and code-related skills were often areas of strength. Predictive factors of code-related emergent literacy included receptive vocabulary, whereas autism severity, oral language skills, and nonverbal cognition predicted some of the variance in children's meaning-related emergent literacy performance.

Our results provide an increased understanding of the emergent literacy skills of young children with ASD. Considering these children are at increased risk of long-term reading difficulties, an improved understanding of early strengths and weaknesses in code- and meaning-related precursors to future reading achievement should enable us to provide better targeted early intervention with the ultimate aim of ensuring reading success.

Compliance with Ethical Standards

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Ethics approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Conflict of Interest: The authors declare that they have no conflict of interest.

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Table 1

Group Performance on Measures of Autism Severity, Nonverbal Cognition, and Oral Language

n = 57	Mean	SD	Range
Age (in months)	57.6	6.11	48 -70
SCQ	15.790	5.753	5 - 32
Nonverbal cognition	79.11	19.53	44 – 119
VABS-II: communication SS[a]	83.929	11.659	57 - 110
VABS-II: spoken communication AE[a]	35.902	9.893	17 - 69
VABS-II: written communication AE[a,b]	54.036	10.839	29 - 73
PPVT-4 – SS	90.0	16.3	64 - 127

Note. SCQ = Social Communication Questionnaire raw scores; Nonverbal cognition based on MSEL (Mullen Scales of Early Learning); VABS-II: Vineland Adaptive Behavior Scales – Second Edition; SS = standard score; AE = age equivalent; PPVT-4 = Peabody Picture Vocabulary Test – Fourth Edition

[a] *n* = 56. [b] distribution positively skewed.

Table 2

Group Performance on the Emergent Literacy Tasks

n = 57	M	SD	Range	Devt range[a]	% Scoring ≥ expected range
Code-related					
Name writing	3.8	2.4	0 - 7	5 - 7	42.1%
LNK	15.7	10.6	0 - 26	12 - 21	63.2%
LSK	8.6	9.1	0 - 25	4-8	52.6%
PA	6.7	4.0	0 - 10	5-8	75.4%
PWA	5.1	3.2	0 - 10	7-9	40.4%
Meaning related					
PPVT-4 raw scores	64.5	21.9	21 - 115	≥ SS 85	54.4%
ONC	1.5	1.9	0 - 6	≥ 4	15.8%
ONQ	6.9	7.6	0 - 34	≥ 16	14%

Note. LNK = letter name knowledge; LSK = letter sound knowledge; PA = phonological awareness; PWA = print and word awareness; ONC = Oral narrative comprehension; ONQ = Oral narrative quality.

[a] Developmental range as reported in the PALS-PreK manual for code-related skills; see Westerveld, Gillon, & Boyd (2012) for ONC and ONQ statistics.

Table 3

Bivariate Correlations Between Descriptive Variables and Emergent Literacy Measures

Measures	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. SCQ	-													
2. SES	.005	-												
3. Home Literacy	-.167	.186	-											
4. VABS-SPC	-.162	.012	.231	-										
5. IQ	.079	.028	.049	.471**	-									
6. NW[c]	.042	.056	-.002	.456**	.465**	-								
7. LNK	.255†	.214	-.121	-.008	.227	.341**	-							
8. LSK	.177	.231	-.033	.078	.351**	.471**	.762**	-						
9. PA	.027	.156	.110	.221	.371**	.446**	.519**	.755**	-					
10. PWA	.224	-.037	-.080	.342**	.473**	.618**	.353**	.587**	.598**	-				
11. RAN	.025	.152	.024	.182	.361**	.444**	.505**	.600**	.483**	.632**	-			
12. PPVT-4	.131	.022	.059	.501**	.593**	.548**	.159	.419**	.596**	.668**	.397**	-		
13. ONC	.139	-.154	-.033	.443**	.470**	.579**	.058	.253	.362**	.683**	.396**	.693**	-	
14. ONQ	.125	.020	.274*	.367**	.271*	.353**	.128	.304*	.467**	.499**	.244	.447**	.531**	-

Note. VABS-SPC = VABS-II spoken communication raw score; NW = name writing; LNK = letter name knowledge; LSK = letter sound knowledge; PA = phonological awareness; PWA = print and word awareness; RAN = rapid automatic naming (raw score); PPVT-4 = Peabody Picture Vocabulary Test, 4th edition (raw score); ONC = oral narrative comprehension; ONQ = oral narrative quality.

* $p < .05$. ** $p < .001$. † $p = .055$

Table 4

Group Performance by Nonverbal Cognition

	Nonverbal cognition < 70	Nonverbal cognition ≥ 70	Effect size in η^2
n	21	36	
Age in months	58.38 (5.98)	57.19 (6.24)	.009
SCQ	15.19 (5.38)	16.14 (6.01)	.006
Code-related			
Name writing	2.48 (1.83)	4.50 (2.41)	.167*
LNK	13.71 (10.80)	17.50 (10.22)	.031
LSK	5.33 (8.10)	11.03 (9.10)	.093*
PA	5.52 (3.86)	7.50 (3.93)	.058
PWA	3.19 (2.64)	6.22 (2.96)	.215*
Meaning related			
PPVT- raw scores	49.95 (16.58)	73.03 (20.78)	.255*
ONC	0.29 (0.56)	2.06 (1.90)	.239*
ONQ	3.86 (5.88)	8.44 (8.17)	.084*

Note. LNK = letter name knowledge; LSK = letter sound knowledge; PA = phonological awareness; PWA = print and word awareness; PPVT-4 = Peabody Picture Vocabulary Test, 4th edition; ONC = oral narrative comprehension; ONQ = oral narrative quality.

* $p < .05$