

A systematic review of the literature on emergent literacy skills of preschool children with Autism Spectrum Disorder

Author

Westerveld, Marleen F, Trembath, David, Shellshear, Leanne, Paynter, Jessica

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**The Emergent Literacy Skills of Preschool Children with Autism Spectrum Disorder: A
Systematic Review of the Literature**

Marleen F. Westerveld, David Trembath, Leanne Shellshear, and Jessica Paynter

Marleen F. Westerveld, PhD

Griffith Institute for Educational Research

School of Allied Health Sciences

Griffith University, Gold Coast, Queensland 4222, Australia

M.westerveld@griffith.edu.au

David Trembath, PhD

Menzies Health Institute, Queensland

Griffith University, Gold Coast, Queensland 4222, Australia

d.trembath@griffith.edu.au

Leanne Shellshear, BSP-hons

Griffith University, Gold Coast, Queensland 4222, Australia

leanne.shellshear@uqconnect.edu.au

Jessica Paynter, PhD

AIEOU Foundation, 66 Hamilton Road, Moorooka, Queensland, Australia

Jessica.paynter@aeiou.org.au

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The Emergent Literacy Skills of Preschool Children with Autism Spectrum Disorder: A Systematic Review of the Literature

Abstract

A wealth of research has been conducted into emergent literacy (i.e., precursors to formal reading) skills and development in typically developing children. However, despite research suggesting children with Autism Spectrum Disorder (ASD) are at risk of reading challenges, limited research exists on their emergent literacy. Thus, we aimed to systematically review emergent literacy research with this population. Database searches from 1995-2015 yielded three papers that met inclusion criteria. Results suggested both strengths and challenges in emergent literacy skills in children with ASD. Significant links between emergent literacy skills and both oral language and nonverbal cognition were also found. The findings highlight the need for further research; future directions and implications are discussed.

Learning to read for meaning is no doubt one of the most important skills learned at school. Children who show strong emergent literacy skills at school entry are more likely to become successful readers (Tunmer, Chapman, & Prochnow, 2006). *Emergent literacy* can be described as, “...*the skills, knowledge, and attitudes that are developmental precursors to reading and writing*” (Whitehurst & Lonigan, 1998, p. 848). These emergent literacy skills serve as the foundation for accurate and fluent reading with comprehension and include *code*-related skills (such as letter knowledge, print concepts, early name writing, and early developing phonological awareness), as well as *meaning*-related skills including vocabulary, grammatical ability, and story retelling and comprehension (NICHD, 2005; Pullen & Justice, 2003). Children with Autism Spectrum Disorder (ASD) are known to be at risk of reading difficulties (Jones et al., 2009; Nation, Clarke, Wright, & Williams, 2006), with a majority of children with ASD showing difficulties in reading comprehension, rather than in word recognition (or decoding) abilities. To better understand the developmental pathways and underlying causes for this failure in reading comprehension, the current review of the literature aims to systematically investigate empirical evidence related to the development of emergent literacy skills in children with ASD, prior to school-entry. These findings will potentially guide intervention practices and inform future research into early reading development of children with ASD.

A Component Model of Literacy Development

Using the *simple view of reading* as a theoretical framework, reading comprehension is the *product* of two components: word recognition and oral language comprehension (Gough & Tunmer, 1986). For reading comprehension to occur, the reader needs to recognize the words on a page (decoding) and understand what the written word / text means. Previous research supports the simple view of reading by demonstrating the relatively independent but significant contributions of word recognition and oral language comprehension to reading

comprehension (e.g., Catts, Hogan, & Fey, 2003; Hoover & Gough, 1990), with the combination of these two components explaining about 80% of the total variance in reading comprehension (Catts, Hogan, & Adlof, 2005). It is important to note that these unique contributions change over time. In the initial stage of reading acquisition, word recognition alone accounts for approximately 27% of the variance in reading comprehension, whereas oral language comprehension contributes only 9%. By 8th grade, children's reading skills have become fluent and automatic, at which stage word recognition only accounts for 1% of the variance and oral language comprehension has increased to 36% (Catts et al., 2005). Using this component model, three subgroups of poor readers may be identified: 1) those who struggle with word recognition only, 2) those who show oral language comprehension difficulties only, and 3) those who demonstrate both word recognition and language comprehension difficulties (Catts & Hogan, 2003). When investigating emergent literacy development, it is thus not only important to consider which early abilities are predictive of later reading achievement (Shanahan & Lonigan, 2013), but also whether these skills relate to word recognition (i.e., code-related) or oral language comprehension (meaning-related). Amongst the strongest predictors of future reading development are alphabet knowledge, print concept knowledge, phonological awareness, and oral language (National Early Literacy Panel, 2008).

The code-related skills of alphabet knowledge, print concepts, and phonological awareness are relatively straightforward constructs that have received much attention in the research literature. Print concept knowledge includes the child's awareness of left-to-right directionality and the fact that letters make up words. Phonological awareness is defined as the conscious awareness of sounds in words (see Gillon, 2004) and typically develops from larger to smaller linguistic units (i.e., syllables, onset-rime, phonemes). Some level of phonological awareness can be seen in typically developing children as young as three years

of age (Lonigan, Burgess, Anthony, & Barker, 1998). Phonological awareness and alphabet knowledge not only show consistent concurrent and longitudinal links with reading achievement, the efficacy of phonological awareness intervention for improving word recognition performance in children has been well established (National Early Literacy Panel, 2008).

The construct of oral language is much more complex and consists of vocabulary and grammar (morphology and syntax), as well as text-level language abilities, such as oral narratives or stories (Catts & Hogan, 2003; Lynch et al., 2008). Difficulties in oral language may impact word recognition, for example, when a child does not know the word on a page, or does not recognise the syntactic structure of the sentence. However, the major impact of oral language difficulties is likely to be on reading comprehension ability. Evidence for the link between early oral language comprehension and later reading comprehension comes from longitudinal studies of typically developing children and children with language impairment (Bishop & Edmundson, 1987; Catts, Bridges, Little, & Tomblin, 2008) and shows that children who show weaknesses in oral language prior to school entry are at increased risk of persistent reading comprehension difficulties.

Autism Spectrum Disorder and Oral Language Skills

ASD affects approximately 1 in 68 children (Centers for Disease Control and Prevention, 2014) and is characterized by impairments in social-communication skills combined with repetitive and restricted behaviours and interests (American Psychiatric Association, 2013). Severity of symptoms varies in each of these domains and ASD is considered a 'spectrum disorder' due to heterogeneity. Challenges with oral language skills as well as intellectual disability commonly co-occur (Williams, Botting, & Boucher, 2008) and children with ASD show large variability in oral language ability, cognitive ability, and learning prognosis (Howlin, Savage, Moss, Tempier, & Rutter, 2014). In terms of oral

language ability, some children with ASD are non-verbal and do not develop oral language skills (i.e., functional expressive language), while others may show skills on par with their typically-developing peers (Boucher, 2012; Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg, 2005). Likewise, intellectual ability can range from meeting criteria for intellectual disability (approximately 30%) through to average or above average intelligence (Centers for Disease Control and Prevention, 2014). Not surprisingly, there is an important relationship between intellectual quotient (IQ) and overall language abilities. To illustrate, children with higher nonverbal cognitive ability perform significantly better on standardized language tests than children with lower ability (Kjelgaard & Tager-Flusberg, 2001), and non-verbal IQ has been shown to be a strong predictor of oral language outcomes in children with ASD (Wodka, Mathy, & Kalb, 2013). However, oral language impairments can co-occur with ASD independently of intellectual disability as measured by both full-scale and non-verbal IQ (e.g., Kjelgaard & Tager-Flusberg, 2001; Williams et al., 2008).

In general, children with ASD have substantial difficulties developing oral language comprehension and production across the domains of semantics (vocabulary, word meanings), and syntax and morphology (grammar), with most pronounced difficulties in pragmatics, i.e., the social use of language (see Eigsti, De Marchena, Schuh, & Kelley, 2011, for a review). In the area of semantics, Eigsti et al. (2011) concluded that children with ASD often show adequate receptive vocabulary (as measured by standardized tests), but difficulties arise when tasks involve higher-level organisation of semantic information or relate to mental states. Moreover, during the preschool period, children with ASD show oral language difficulties at sentence- and text-levels. For example, Eigsti, Bennetto, and Dadlani (2007) observed that 4- to 6-year-old children with ASD used less complex syntax than their peers with developmental delays; Nuske and Bavin (2011) reported specific difficulties with narrative comprehension involving the integration of contextual clues in the text with

knowledge of typical scripts, such as birthdays and family routines. Furthermore, pragmatic or social interaction difficulties of children with ASD have been well documented and include difficulties taking turns in conversation, interpreting listener behaviour or taking the listener's needs into consideration, and/or using appropriate levels of formality in conversation (e.g., Lord & Pickles, 1996). Pragmatic difficulties have also been observed when asking children with ASD to re/tell stories (Capps, Losh, & Thurber, 2000), especially with respect to using narrative as a social activity and trying to maintain the listener's attention through the use of linguistic devices, such as evaluative comments. Taken together, these early and often persistent difficulties in oral language clearly put children with ASD at risk of later reading comprehension problems.

When considering the area of phonology (the systematic organisation of sounds in words), weaknesses have been observed in the area of phonological *processing*, including phonological awareness and retrieval of phonological information as measured by nonword repetition tasks (Bishop et al., 2004; Kjelgaard & Tager-Flusberg, 2001). Smith Gabig (2010) investigated phonological awareness and word recognition in 14 young school-age children with ASD and found significantly poorer performance in phonological awareness compared to their typically developing peers, despite demonstrating age appropriate word recognition skills. A strong correlation was found between children's receptive vocabulary score (but not their nonverbal IQ) and their phonological awareness ability (identifying initial sounds in words), indicating that reduced vocabulary may hamper phonological awareness development. Furthermore, there was no significant correlation between phonological awareness and word recognition skills in the group of children with ASD only, indicating a possible reliance on sight word reading over phonological decoding.

Reading Ability in Children with ASD

Given that oral language comprehension is foundational to reading comprehension (Hoover & Gough, 1990), it is not surprising that research into reading performance of children with ASD has shown reading difficulties in this population (Arciuli, Stevens, Trembath, & Simpson, 2013; Brown, Oram-Cardy, & Johnson, 2013; Nation et al., 2006; Ricketts, Jones, Happé, & Charman, 2013). Generally speaking, children with ASD demonstrate strengths in word recognition (decoding) and limitations in comprehending written materials (Frith & Snowling, 1983). Closer inspection of the reading performance of school-age children with ASD has, however, shown wide variability (Arciuli et al., 2013; Nation et al., 2006). For example, Nation et al. (2006) investigated the reading accuracy and reading comprehension performance of 41 school-aged children (ages 6 to 15 years). Children were invited to participate in the study if they had been diagnosed with ASD by experienced clinicians, were at least 6 years of age, and showed sufficient language skills to participate. Three key findings emerged. First, more than 20% of the children ($n = 9$, mean age 10.8) were unable to read single words out of context, indicating that oral language abilities of children with ASD do not necessarily predict reading skill acquisition. Second, of the remaining 32 children who were able to decode single words, only 20 children demonstrated age appropriate decoding skills (i.e., standard scores within one standard deviation of the mean) on the reading accuracy subtest of the Neale Analysis of Reading Ability (Neale, 1999). The remaining 12 children showed below average performance, indicating that reading difficulties in children with ASD were not confined to reading comprehension alone. Third, 'only' 10 of the 32 participants showed reading comprehension deficits that could not be explained by poor word recognition ability. In summary, these results suggest that a high proportion of children with ASD struggle with reading and that their reading abilities cannot be predicted by their oral language skills alone.

Results from Nation et al.'s (2006) study also provide some insight into the contribution of code- and/or meaning-related skills to word recognition and/or reading comprehension performance in children with ASD. When comparing the contribution of nonword decoding (which relies on applying letter-sound correspondence rules to decode words) to word recognition, based on expectations of typically developing children, a pattern of dissociation appeared. As a group, the children with ASD showed low levels of nonword reading, and 42% of the children scored at least one standard deviation below the population mean on a standardized test. Although Nation et al. did not assess the participants' code-related skills such as phonological awareness and alphabet knowledge, these results suggest specific difficulty in applying letter-sound correspondence rules to decode nonsense words. When considering the participants' meaning-related oral language skills, it appeared that all children who demonstrated reading comprehension difficulties in the absence of word recognition problems, performed poorly on tasks of receptive vocabulary or more general language comprehension (using the WISC-III; Wechsler, 1992). These results are consistent with the simple view of reading, which would have predicted for this group of poor readers to demonstrate difficulties in oral language comprehension (Hoover & Gough, 1990). Taken together, the results from Nation et al.'s study (2006) highlight the need for a better understanding of how children with ASD develop their early or emergent literacy skills across the areas of oral language, phonological awareness, and alphabet knowledge.

A more recent study by Jacobs and Richdale (2013) attempted to address this need. A total of 26 participants with ASD (ages 6 to 8 years) attending mainstream classrooms participated. All children demonstrated average to above average nonverbal IQ, but performance on specific standardized oral language tests was not reported. Rather, composite scores of oral language performance were used to calculate concurrent predictors of oral language skills (semantics, syntax, pragmatics) and phonological processing (phonological

awareness, phonological memory) on reading comprehension and word recognition/decoding. A comparison group of 40 children with typical development, matched for age and nonverbal IQ was also included. The results showed no significant group differences on measures of phonological processing, syntax, decoding, or reading comprehension; in contrast, the children with typical development outperformed their peers with ASD on measures of semantics and pragmatics. Concurrent predictors of decoding were similar for both groups of children, with IQ, phonological processing, and syntax the biggest predictors. Reading comprehension was predicted by children's decoding ability as well as their syntactic skills, which is not surprising considering these children were still in their early stage of reading development when reading comprehension is heavily reliant on word recognition. Although these results indicate similar patterns of early reading ability in children with ASD compared to their typically developing peers, the use of composite scores makes it difficult to draw conclusions about individual variability in performance across specific code-related (e.g., phonological awareness) or meaning-related skills (narrative retell, receptive vocabulary).

In summary, a heterogeneous pattern of reading skills in children with ASD has been found. What is not clear is whether this variability in reading performance reflects children's oral language ability and/or word recognition skills, or whether a dissociation between these reading component skills exists that is specific to this group of children. Investigation into children with ASD's emergent literacy development prior to formal reading tuition at school is needed. A better understanding of the early developmental pathways to literacy in children with ASD may reveal predictors of reading success and provide guidance for early intervention and remediation programs in this population.

Study Aim

The current review of the literature aimed to investigate the emergent literacy development of young children with ASD by systematically searching the research evidence

for patterns of development in children with ASD across meaning- and code-related skills.

The following research question was posed: What emergent literacy skills can we expect of children with ASD prior to formal reading tuition?

Method

A search was conducted in January 2014, including online databases: Web of Science, ERIC, Scopus, and Psycinfo. The search terms included ‘child*’ AND (‘autis*’ OR ‘ASD’) in combination with (‘literacy’ OR ‘phon* awareness’ OR ‘narr*’ OR ‘letter knowledge’ OR ‘phonic*’ OR ‘vocab*’). In addition, Medical Subject Headings (MeSH) or database specific subject headings were explored for databases with this feature and relevant subject terms were selected to capture terminology related to emergent literacy that may have been specific to a database (e.g., ‘beginning reading’, ‘invented spelling’, ‘phoneme grapheme correspondence’). Searches were restricted to peer-reviewed articles written in English and published from 1995 onwards. The following inclusion criteria were used: (a) the study involved English-speaking children aged between 3 and 8 years inclusive; (b) participants had a diagnosis of ASD; (c) participants were in the emerging or early literacy stage and had not commenced formal schooling; (d) the study’s focus was on emergent or early literacy ability or development; (e) participants completed at least one emergent literacy task (e.g., letter name/sound knowledge, phonological awareness, narrative production).

The following exclusion criteria were identified:

- (a) Participants had other diagnosed disabilities (e.g., autism and Fragile X Syndrome), except a dual diagnosis of intellectual disability due to common comorbidity;
- (b) Studies which only used qualitative measures (e.g., teacher interviews);
- (c) Intervention studies presenting literacy progress;
- (d) Participants using an AAC device;
- (e) Study focus on handwriting/motor literacy development;

(f) Case study descriptions of literacy skills without correlation analysis.

Initial searches identified 1914 articles. All article titles and abstracts were read, and if needed, the full text was reviewed. A total of 18 articles were short-listed for further evaluation and were subsequently reviewed by the first author; Two peer-reviewed journal articles met the final inclusion criteria. Following this electronic search, the reference lists of review articles as well as the two shortlisted articles were reviewed to identify further publications relevant to the review. Citations for the shortlisted two articles were also reviewed via online databases. No additional articles meeting the criteria were found. A follow-up search was conducted in January 2015, using the same search terms and procedures as those used in 2014. In addition, citations to the two shortlisted articles were reviewed. One additional study met the inclusion criteria. Figure 1 provides an overview of the complete search process.

[Insert Figure 1 here]

Data Extraction

Information extracted from the studies included: (a) research design, (b) participant characteristics and inclusion criteria (e.g., diagnosis, number, gender, age range), (c) emergent literacy skills across code-related and meaning-related measures, and (d) main results.

Results

Three studies met the inclusion criteria for the current review. Table 1 lists the studies and reports the descriptive data. Two studies (Dydia et al., 2014; Lanter, Watson, Erickson, & Freeman, 2012) utilized a descriptive group design; The remaining study (Davidson & Ellis Weismer, 2014) used a prospective longitudinal design. The three studies were coded using a shortened version of the Critical Review Form for Quantitative Studies (Law et al., 1998). As shown in Table 2, the three studies were not of equal quality.

[Insert Table 1 here]

[Insert Table 2 here]

Participant Characteristics and Inclusion Criteria

A total of 170 children with ASD participated across the three studies, with participant numbers ranging between 26 and 82. As shown in Table 1, there were noteworthy differences between the studies regarding their diagnostic criteria for ASD and the inclusion criteria regarding nonverbal cognitive ability and verbal ability. A brief summary follows.

ASD diagnosis. Lanter et al. (2012) used a parent-provided written report of ASD diagnosis, and did not seek to confirm this diagnosis, whereas Dynia and colleagues (2014) based their ASD diagnosis on teacher-report only. Davidson and Ellis Weismer (2014) are the only authors who confirmed the participants' ASD diagnosis using either the *Autism Diagnostic Observation Scale – 2nd Edition* (Lord et al., 2012) or the *Autism Diagnostic Interview – Revised* (Rutter, Le Couteur, & Lord, 2003).

Nonverbal cognition. As shown in Table 1, none of the studies excluded children based on their nonverbal cognitive ability; Lanter et al. (2012) only provided results for 29 of the 41 children (range 48-121); Dynia et al. (2014) did not report any measure of the participants' nonverbal cognitive abilities; Davidson and Ellis Weismer (2014) reported standard scores between 38 and 115.

Verbal ability. None of the three studies set inclusion criteria for oral language ability and reported standardized language scores between 39 and 117 (Davidson & Ellis Weismer, 2014; Dynia et al., 2014; Lanter et al., 2012).

Summary of the Emergent Literacy Studies

Lanter et al. (2012) assessed 41 children with ASD, aged between 4.0 and 7.11. Children demonstrated a range of oral language abilities as measured using the TELD-3 (Hresko, Reid, & Hammill, 1999), and were divided into three language ability groups:

severe language impairment (LI) = standard score (SS) < 55; mild-moderate LI = SS between 55 and 77, and typical language = SS > 77. However, because IQ scores were not available for all children, it is not clear if their oral language impairment reflected a more general cognitive impairment. Children were assessed on code-related measures of letter name knowledge (9 letters), letter sound knowledge (9 letters), environmental print (5 images of logos, such as McDonalds), print concepts (i.e., a 4-item multiple choice task assessing the child's ability to point to the right word [not picture] when asked, "Which one says?"), and emergent name writing skills. As shown in Table 3, results revealed significant ($p < .05$) correlations between children's oral language ability and their code-related emergent literacy skills. Closer inspection of the results shows large variability in performance across the emergent literacy tasks, regardless of the children's language status as measured on the TELD-3; in each language ability group, some children obtained full scores (i.e., 100% correct).

Dynia et al. (2014) analyzed the emergent literacy performance of 35 children with ASD attending early childhood special education classrooms and included a control group of 35 children with typical language skills, matched to the participants on age and gender. The children with ASD demonstrated language abilities that ranged from severely impaired (SS = 45) to typical (SS = 106) using the core subtests of the *Clinical Evaluations of Language Fundamentals –Preschool 2nd Edition* (Wiig, Secord, & Semel, 2004). Children's nonverbal cognitive abilities were not reported, so it is not clear if the children's oral language skills reflected their overall cognitive ability. Code-related emergent literacy tasks included alphabet knowledge (upper and lower case, max 52), print-concept knowledge (i.e., print conventions), and phonological awareness requiring deletion of a sound in a word, known as 'elision' (e.g., "Say *dog*, now say *dog* without the /d/ sound") and blending (e.g., "What word do you hear /m/ /o/ /p/?" = mop).

Results showed that the children with ASD showed equivalent levels of alphabet knowledge compared to their typically developing peers. However, they performed significantly below their peers on print-concept knowledge, definitional vocabulary, and phonological awareness ($p < .01$). As shown in Table 3, oral language ability was a significant predictor for all emergent literacy variables. When controlling for oral language ability, however, there were no significant group differences in definitional vocabulary and phonological awareness. In contrast, significant group differences existed for measures of print-concept knowledge and alphabet knowledge with the typically developing children outperforming their peers with ASD on print-concept knowledge. In contrast, the children with ASD performed significantly better than their TD peers on alphabet knowledge once language ability was controlled for. Similar to the results from Lanter et al.'s (2012) study, there was large variability in performance, with standard deviations close to the mean scores in phonological awareness and print concept knowledge.

Davidson and Ellis Weismer (2014) reported the only longitudinal study of a cohort of 89 children with a confirmed diagnosis of ASD. Children were first seen at a mean age of 2.6 and again at age 5.6 (4.11 – 6.7). At that stage, 24 children were reportedly still at 'kindergarten'. The participants demonstrated receptive language skills ranging from severely impaired ($SS = 50$) to above average ($SS = 129$) as measured by the *Preschool Language Scale – Fourth Edition*, auditory comprehension subtest (PLS-4; Zimmerman, Steiner, & Pond, 2002). The *Test of Early Reading Ability – Third Edition* (TERA-3; Reid, Hresko, & Hammill, 2001) was used to measure code-related (Alphabet subtest: letter name and sound knowledge, phonological awareness; Conventions subtest: print conventions) emergent literacy skills as well as early reading comprehension skills (Meaning subtest: at word, sentence, and paragraph levels). An overall TERA-3 reading quotient was also provided.

Overall, performance of the children with ASD fell within normal limits on the TERA-3; however, weakness in performance was observed on the Conventions and Meaning subtests. Children with ASD showed relative strengths on the Alphabet subtest compared to their performance on both the Conventions and the Meaning subtests. There was no statistically significant difference between the Convention and Meaning subtest scores. As shown in Table 3, the strongest individual concurrent predictors of overall early reading performance were nonverbal cognition (IQ), social ability, and expressive language skills. Longitudinal predictors included IQ and expressive language skills. Consistent with the results from the two previous studies, there was large variability in performance on all of the subtests of the Test of Early Reading, with standard scores ranging from 1 – 19.

[Insert Table 3 here]

Discussion

The aim of this systematic review was to investigate the emergent literacy skills of pre-school children with ASD in terms of meaning- and code-related skills to better understand emergent literacy skill development in this population. The search yielded only three studies that met inclusion criteria (Davidson & Ellis Weismer, 2014; Dynia et al., 2014; Lanter et al., 2012), highlighting the current lack of research regarding emergent literacy development in children with ASD. Nevertheless, the findings from these three papers provide important preliminary insights into the emergent literacy skills of preschool children with ASD that have both research and practical implications.

Our research question focused on what emergent literacy skills we can expect of children with ASD prior to formal reading tuition. The results clearly show that at least some children with ASD demonstrate age-equivalent skills in code-related emergent literacy skills, such as alphabet knowledge and early phonological awareness (Davidson & Ellis Weismer, 2014; Dynia et al., 2014; Lanter et al., 2012). However, the large standard deviations and

ranges reported in all studies point to marked individual differences amongst children on the spectrum.

Across the three studies, the children with ASD were found to have challenges with aspects of code-related emergent literacy skills. Davidson & Ellis Weismer (2014) reported that print-concept knowledge (e.g., reading from left to right, knowing about the title and the author of the book etc.) was an area of particular difficulty for participants in their study. Although Dynia et al., (2014) found some evidence regarding difficulties in meaning-related skills as measured by definitional vocabulary, none of the studies included other meaning-related emergent literacy skills such as receptive vocabulary, grammar, or oral narrative ability (Catts & Hogan, 2003; Lynch et al., 2008; Westerveld, Gillon, Van Bysterveldt, & Boyd, 2015). Thus, the limited research to date suggests relative strengths in alphabet knowledge, but evidence of difficulties in both meaning-related as well as other code-related emergent literacy skills (i.e., print-concepts and phonological awareness) in the preschool years.

In considering the results and implications of the three studies, it is essential to take into account the possible relationship between the children's oral language skills and cognitive abilities and their performance on the emergent literacy tasks. Results suggest important associations between children's oral language skills and nonverbal IQ and their code-related (Dynia et al., 2014) as well as meaning-related emergent literacy skills (Lanter et al., 2014). However, when Dynia et al. (2014) controlled for the children's language ability, the group of children with ASD still performed below expectations on print concept knowledge. Taken together, these results tentatively suggest that children with ASD may have difficulty acquiring print-concept knowledge that cannot be explained by their oral language ability alone.

Only one study investigated which emergent literacy skills are predictive of very early reading acquisition (Davidson & Ellis Weismer, 2014). Davidson and Ellis Weismer reported early reading comprehension results at a mean age of 5.5, as well as concurrent code-related emergent literacy skills and print concept knowledge. Not surprisingly, group-level results seemed to indicate early weakness in reading comprehension as measured by the Meaning subtest of the TERA-3. However, few specific results pertaining to children's emergent literacy skills were reported, such as initial phoneme identification (phonological awareness), making it difficult to determine what skill levels to expect prior to school entry. Furthermore, as mentioned previously, some important meaning-related emergent literacy skills, such as receptive vocabulary and narrative comprehension and production, were not tested (see Catts & Hogan, 2003). Finally, as there was no sub-group analysis for level of schooling in this study, it is not clear whether there was an effect of formal reading tuition on children's emergent literacy performance.

Addressing Current Limitations in Future Research

At the outset of this article we outlined the clinical and research imperative for research examining emergent literacy development in children with ASD. The results of this review highlight not only the need for further research, but also the need for substantial improvements in the design of such studies (see Table 2). The fact that two of the three studies in this review relied on informant reports of diagnosis points to the need for consistent and thorough participant characterization across studies. This should include standardized measures of ASD symptomology (e.g., ADOS, ADI-R) in order to elucidate the specific effects of autism symptomology on early literacy development and allow for comparison of findings across studies. This approach would not only inform our understanding of the processes by which children with ASD acquire literacy skills, but also reveal whether this development is by similar or different routes to typical development. Such findings would

have important clinical implications for both early detection and intervention for reading difficulties.

Future research into the emergent and early literacy development of children with ASD should also include both nonverbal IQ and oral language measures. Given nonverbal IQ was an independent predictor of early reading comprehension, both concurrently and longitudinally (Davidson & Ellis Weismer, 2014), and is linked to language ability on standardized tests (e.g., Kjelgaard & Tager-Flusberg, 2001), it is important for further research to investigate both oral language and non-verbal IQ to untangle the relative contributions of each. In the present review, this was only completed in one study (Davidson & Ellis Weismer, 2014), whereas the remaining two included only a measure of oral language ability which may have been a proxy for more general cognitive impairment or ability.

In addition to more accurate, consistent, and comprehensive characterization of children's ASD symptomology and non-verbal cognition, there is a clear need for future research to use fine-grained measures of emergent literacy skills and oral language skills. For example, more research is needed to clarify if the development of phonological awareness in preschool children with ASD is important for acquisition of accurate and fluent decoding, as it is for typically developing children (National Early Literacy Panel, 2008). Likewise, further investigation of the links between oral language skills, including those that extend beyond word- and sentence-level (i.e., narrative skills), and acquisition and development of reading comprehension is urgently needed.

Longitudinal studies that extend beyond year two of schooling would be of value in this research area to more clearly identify early predictors as well as developmental trajectories in this population. Distinguishing the impact of formal schooling on such development is also important, and was not reported in the previous longitudinal research (Davidson & Ellis Weismer, 2014).

Summary and Conclusions

In summary, there is a critical gap in the research literature concerning emergent literacy development in children with ASD. Nevertheless, there is preliminary evidence to suggest that learning to read is difficult for many children with ASD, and that difficulties with emergent literacy development, predominantly in meaning-related areas involving oral language, are implicated. Existing research shows by school-age, children with ASD face challenges with reading, particularly in terms of meaning-related skills (Ricketts, 2011) and further longitudinal research may elucidate the pathways to these challenges.

Learning to read is just one of many challenges faced by children with ASD, given the pervasive and multifaceted nature of the disorder. Yet, given that learning to read commences in the early developmental period and is inextricably linked to educational outcomes, there is a strong case for it being given greater priority in early intervention programs for children with ASD. Research into emergent literacy is therefore vital to provide an empirical basis to formulate early detection and intervention strategies to improve literacy in children with ASD to support their participation in education, and ultimately facilitate improved long-term outcomes.

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Table 1. Overview of studies included in the review

Study	Participants			Design	Descriptive information		
	N M/F	Age Mean years.months (SD) range	Dx + diagnostic tests used		Cognition Mean (SD) range	Oral language	(Emergent) Literacy Measures
(Lanter et al., 2012)	41 33/8	5.9 (1.3) 4.1 – 7.10	ASD (Written diagnosis only)	Descriptive group design	No exclusions Test: KBIT-2 (Kaufman & Kaufman, 2004). Standard Scores N= 29 79 (24.5) 48 – 121	No exclusion criteria TELD-3: composite quotient: 64.6 (23.1) 39 - 111	ELP - Emergent Literacy Profile.
(Dydia et al., 2014)	35 30/5	ASD: 4.5 (0.6) 3.2 – 5.1 Typical (TD) N = 35 4.6 (0.6) 3.0 – 5.7	ASD (teacher report only)	Descriptive group design with a control group matched for gender and age.	No exclusions Not reported	No specific criteria CELF:P2 composite 68.3 (19.6) 45 – 106 Typical (TD) CELF-P2: 93.9 (5.8) 86 - 106	PALS: LNK and LSK. PWPA: print concepts TOPEL: definitional vocabulary TOPEL: Phonological awareness (elision and blending)
(Davidson & Ellis Weismer,	94 82/12	2.7 (0.3) 1.11 – 3.3 (Initial)	89 x ASD 5 x PDD- NOS	Longitudinal cohort study	No exclusions Test:	No specific criteria PLS-4 Auditory	TERA-3: Reading Quotient, Alphabet, Conventions, Meaning

2014)	5.6 (0.4) 4.9 – 6.7 (Final)	Tests: (ADI-R or ADOS or ADOS-T) ADOS severity: 7.34 (1.79) 4 - 10	Mullen Early Scales of Learning: Nonverbal Ratio IQ Scores: 76.98 (14.88) 38 – 115	Comprehension: 60.83 (13.09) 50 – 117 PLS-4 Expressive Communication: 72.73 (10.97) 50 – 103	subtests and overall performance
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Note: KBIT-2: Kaufman Brief Intelligence Test – 2nd Edition (Kaufman & Kaufman, 2004); TELD-3: Test of Early Language Development – 3rd Edition (Hresko et al., 1999); ELP: Emergent Literacy Profile (Dickinson & Chaney, 1997); CELF-P2: Clinical Evaluation of Language Fundamentals – Preschool 2nd Edition (Wiig et al., 2004) standard scores; PALS: Phonological Awareness Literacy Screening (Invernizzi, Sullivan, Meier, & Swank, 2004); PWPA: Preschool Word and Print Awareness assessment (Justice, Bowles, & Skibbe, 2006); LNK: Letter Name Knowledge; LSK: Letter Sound Knowledge; TOPEL: Test of Preschool Early Literacy (Lonigan, Wagner, Torgesen, & Rashotte, 2007). ADOS: Autism Diagnostic Observation Schedule (Lord et al., 2012). ADI-R: Autism Diagnostic Interview-Revised (Rutter et al., 2003). Mullen Early Scales of Learning (Mullen, 1995); PLS-4: Preschool Language Scales – 4th Edition (Zimmerman et al., 2002); TERA-3: Test of Early Reading Achievement – 3rd Edition (Reid et al., 2001);

Table 2. Quality appraisal of the short-listed studies

No	Criteria	Lanter et al. (2012)	Dynia et al. (2014)	Davidson & Ellis Weismer (2014)
1	Is the study design relevant to address the study aim?	Yes	Yes	Yes
2	Is the sample described in detail?	No	No	Yes
3	Is the sample size justified?	No	No	No
4	Is there no identified potential sample / subject selection bias?	Yes	No	Yes
5	Are the outcome measures valid and reliable?	Yes	Yes	Yes
6	Are the results reported in terms of statistical significance (including effect sizes)?	No	Yes	Yes
	Total	3/6	3/6	5/6

Note: Tool adapted from Law et al., (1998).

Table 3. Overview of emergent literacy measures administered in the studies and main results

Study	Code-related emergent literacy skills		Meaning – related (emergent) literacy or language skills	Results
	Print concepts (PC)	Other measures		Correlations
(Lanter et al., 2012) ASD only: N = 41	Print concepts Wide variability observed	Letter name and sound Environmental print Name writing Wide variability – some children 100%, regardless of language ability Phonological awareness not measured.	Only TELD-3 composite scores reported	TELD-3 composite and: Letter name identification: $\rho = .34, p = .02$ Letter sound correspondence: $\rho = .42, p < .01$ Environmental print: $\rho = .40, p = .01$ Print concepts: $\rho = .35, p = .01$ Emergent writing: $\rho = .47, p < .01$ Total Emergent Literacy: $\rho = .56, p < .01$
(Dydia et al., 2014) ASD: N = 35 TD: N = 35	Print concept knowledge Large SD in print concepts reported	Alphabet knowledge Phonological awareness Large SD in phonological awareness reported	Definitional vocabulary CELF-P2 composite scores reported	ASD = TD on alphabet knowledge ($p = .45$) ASD < TD on PA, PC, and Vocabulary ($p = .01$) When controlling for language ability: ASD < TD on PC ($p < .05$) ASD > TD on alphabet knowledge ($p < .01$) Predictors: Language ability: Alphabet knowledge ($\beta = 0.50, p < .01$), print concepts ($\beta = 0.10, p < .01$), definitional vocabulary ($\beta = 0.88, p < .01$), and phonological awareness ($\beta = 0.39, p < .01$).

				Autism severity when controlling for language ability: Alphabet knowledge ($\beta = 16.45, p < .01$), print concepts ($\beta = -2.17, p < .05$).
(Davidson & Ellis Weismer, 2014) ASD only N = 94 (Visit 1 – age 2.5) Visit 4 – age 5.5 – reported here	TERA-3 Conventions subtest: Book handling, print conventions, punctuation, capitalisation, spelling Performance (SS): M 6.80 (SD 3.37); range 2 – 18	TERA-3 Alphabet subtest: Letter-sound correspondence, letter names Phonological awareness: phoneme / syllable counting, initial and final sounds Performance (SS): M 11.00 (SD 4.66); range 3 - 19	PLS-4 scores reported (auditory comprehension: AC and expressive communication, EC) TERA-3 Meaning subtest: Reading comprehension outcome measure: 1. Comprehension of printed words 2. sentences 3. and paragraphs Performance (SS): M 6.91 (SD 3.94); range 1 – 19	Overall performance on the TERA-3: M 88.64 (SD 22.81); range 51 – 149 No difference between performance on Conventions and Meaning subtest scores ($p = .676$). Concurrent predictors (at age 5.5) *: TERA-3 (64%): IQ, SES, social ability, PLS-4 EC. Conventions (46%): IQ, SES, social ability, PLS-4 EC. Alphabet (57%): IQ, SES, social ability, PLS-4 AC. Meaning (53%): IQ, ASD, social ability, PLS-4 EC Longitudinal predictors, visit 1 to visit 4: TERA-3 (46%): IQ, ASD, SES, PLS-4 EC. Conventions (29%): IQ, ASD, SES, PLS-4 EC. Alphabet (37%): IQ, ASD, SES, PLS-4 AC Meaning (46%): IQ, ASD, social ability, PLS-4 EC

Note: PLS-4 (Zimmerman et al., 2002); TERA-3 (Reid et al., 2001); TELD-3 (Hresko et al., 1999); ELP (Dickinson & Chaney, 1997); CELF-P2 (Wiig et al., 2004); PALS (Invernizzi et al., 2004). TD = Typically developing; PA = Phonological awareness; SS = Standard score. * measures in **bold** were significant individual predictors ($p < .01$)