AutismCRC

Predicting Optimal Literacy Outcomes in Children on the Autism Spectrum in their First Year of Schooling

Final report

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Copies of this report can be downloaded from the Autism CRC website **autismcrc.com.au.**

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About the Cooperative Research Centre for Living with Autism (Autism CRC)

The Cooperative Research Centre for Living with Autism (Autism CRC) is the world's first national, cooperative research effort focused on autism. Taking a whole of life approach to autism focusing on diagnosis, education and adult life, Autism CRC researchers are working with end-users to provide evidence-based outcomes which can be translated into practical solutions for governments, service providers, education and health professionals, families and people on the autism spectrum.

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Table of contents

1. Literature review

1.1 Introduction

Learning to read is a pivotal skill in an increasingly literate world for all children, including children on the autism spectrum (Brown, Oram-Cardy, & Johnson, 2013; Catts, Fey, Zhang, & Tomblin, 2001). Early literacy learning, known as emergent literacy, forms the foundation for later reading and writing success and involves knowledge of both print-related skills (including letter-sound knowledge, phonological awareness, and print awareness) and meaning-related skills (such as vocabulary, grammatical ability, and story comprehension and retell) (Westerveld, Gillon, van Bysterveldt, & Boyd, 2015; Whitehurst & Lonigan, 1998). There is now ample empirical evidence with children who are developing typically confirming the importance of these emergent literacy skills for future reading success (Catts, Fey, Zhang, & Tomblin, 1999; Tunmer, Chapman, & Prochnow, 2006). Although reading is not considered a core impairment associated with autism spectrum disorders, previous research into the reading performance of this population has shown significant difficulties with reading, particularly in reading comprehension, that cannot be explained by a diagnosis of autism, low intelligence, or spoken language weaknesses alone (Arciuli, Stevens, Trembath, & Simpson, 2013; Brown et al., 2013; Huemer & Mann, 2010).

Children develop their emergent literacy skills from birth though interactions with literacy-related materials, both in the home and in early childhood education facilities (Pullen & Justice, 2003). Despite many children on the spectrum showing considerable reading difficulties, surprisingly little research has been conducted into how young children on the spectrum develop their emergent literacy skills across meaning-related and print-related skills (Westerveld, Trembath, Shellshear, & Paynter, 2016). To better understand the early literacy pathways of children on the spectrum, we initially recruited a cohort of 57 verbal preschool-age children on the spectrum, who had not yet started school (Westerveld et al., 2016; Westerveld et al., 2017). Our results indicated early strengths in print-related skills, such as letter knowledge and phonological awareness, and weaknesses in meaning-related skills, particularly in story comprehension (Westerveld et al., 2017; Westerveld & Roberts, 2017). The current study followed these children as they transitioned into their first year of formal schooling to identify which emergent literacy skills would predict their reading accuracy and comprehension performance approximately one year later. This longitudinal study is the first of its kind to investigate factors that may predict and maintain reading advantage and disadvantage in young children on the spectrum (Dynia, Brock, Justice, & Kaderavek, 2017).

1.2. Simple view of reading

The ultimate aim of learning to read is no doubt to read accurately and fluently and to understand what the written material means. Using the Simple View of Reading as a theoretical framework, reading comprehension is considered the product of two components: word recognition (i.e. the ability to decode words) and listening comprehension (i.e. the ability to understand language at word, sentence, and text level) (Gough & Tunmer, 1986). In fact, the combination of these two components explains approximately 80% of the total variance in reading comprehension (Catts, Hogan, & Adlof, 2005). However, the unique contributions change over time. During the early stages of learning to read, the focus is on learning to decode and approximately 27% of the unique variance in reading comprehension is explained by word recognition ability. By year 3 or 4 of schooling, children move beyond the early stages of learning to read and have generally learned to read accurately and fluently. At that stage, the emphasis shifts to 'learning through reading'. By year 8, word recognition only accounts for 1% of the variance, whereas listening comprehension has increased to 36% (Catts et al., 2005). When investigating reading comprehension performance of school-age children, it is thus important to include assessment of word recognition as well as listening comprehension, to better understand these children's reading profiles and initiate targeted intervention if required.

1.3 Foundation year of schooling

During the first formal year of schooling, also known as the foundation year of schooling (Australian Curriculum Assessment and Reporting Authority [ACARA], 2012), the English curriculum, which is built around the three strands of Language, Literature and Literacy, focuses on developing students' "knowledge, understanding and skills in listening, reading, viewing, speaking, writing and creating" (p 18). With respect to word recognition, by the end of foundation year, students are expected to read predictable texts, "attempting to work out unknown words by combining contextual, semantic, grammatical, and phonic knowledge" (p. 23). During the year, learning outcomes include understanding concepts about print (left to right, spaces between words and so on), knowing letter sounds, reading and writing sight words, and increasing awareness of phonemes in words (ACARA. 2012). In reading comprehension, students are expected to "use comprehension strategies to understand and discuss texts listened to, viewed or read independently" (p. 24), including talking about the meanings in texts, providing a simple retelling of narratives texts, and finding a key word in a text to answer a literal question.

2. Research Design

2.1 Research questions

The children who participated in our current study were all in their foundation (first or “prep”) year of schooling and had attended for at least 6 months. To better understand these children’s early literacy performance we administered a range of oral language and reading-related tasks.

The following three questions were asked:

1. How does our cohort of children on the autism spectrum perform on reading-related measures in their first year of formal schooling?
    - Reading accuracy: word recognition at word- and sentence-level.
    - Reading comprehension.
2. What are the correlations between children’s oral language performance and their reading performance in their first year of schooling?
3. Which emergent literacy skills prior to school entry predict reading accuracy and comprehension performance following the children’s transition to school?

2.2 Method

The present study employed a prospective cohort design in which the children were seen at two time points, prior to and following their transition into formal schooling.

Ethical approval was granted by the Griffith University Human Ethics Committee (AHS/13/14/HREC) and by the Human Research Ethics Committee – The Sydney Children’s Hospital Network (HREC/14/SCHN/270).

2.3 Recruitment

Of the original cohort of 57 children, a total of 41 children (35 boys, 6 girls) and their families were available and agreed to participate in the follow-up study. Families resided in the greater Brisbane area (*n*=35) and metropolitan Sydney (*n*=6). Families were approached via email or phone and invited to participate in the follow up study. Assessment sessions were scheduled so that the children had completed between 6 – 12 months (2 – 4 school terms) of their foundation year of schooling (Prep year in Queensland), with one child seen after only 4 months due to scheduling issues.

2.3.1 Autism Diagnosis

A diagnosis of an autism spectrum disorder was verified prior to participation in our original study. At the time, copies of written documentation related to the child's diagnosis were obtained and, where available (*n*=21), results were acquired regarding children's performance on the Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 2012). For the 20 children that did not have ADOS results, parents were asked to complete the Social Communication Questionnaire (Rutter, Bailey, & Lord, 2003). As recommended by Eaves, Wingert, Ho and Mickelson (2006), a cut-off score of 11 or above was used to confirm diagnosis.

2.3.2 Participants

Participants included 41 of the 57 families who participated in the original study (Westerveld et al., 2017) whose families agreed to be seen for a follow-up. Reasons for declining participation included: moving out of state (*n*=3), being unavailable during the assessment dates (*n*=3), or difficult child behaviours (*n*=2). Two families did not provide reasons for declining participation, while six families were unable to be contacted by either phone or email.

There were no significant group differences between the children who did and did not agree to participate on baseline measures of:

- Receptive vocabulary: Peabody Picture Vocabulary Test (PPVT-4; Dunn & Dunn, 2007) standard scores (SS) (*p*=0.568)
- Autism characteristics: the Social Communication Questionnaire (SCQ; Rutter et al., 2003) Total Score (*p*=0.934),
- Communication: the Vineland Adaptive Behaviour Scales- Version 2 (VABS-II) (Sparrow, Cicchetti, & Balla, 2005) Communication SS (*p*=0.686)
- Cognitive functioning, based on the Developmental Quotient (DQ) (Mullen, 1995) (*p*=0.415).

Table1 provides an overview of participant characteristics including age, gender, autism characteristics, and developmental quotient at Time 1. Mothers' level of education was used as an indicator of socioeconomic status (SES). Parent report indicated that 32% of mothers had completed year 12 (highest level of secondary school education in Australia), whilst 63% of mothers had gone beyond year 12 to complete tertiary studies. Data were unavailable for two mothers. All of the parents who participated in the research spoke English as their primary language.

Table 1: Participant characteristics

	n	Mean	Range	SD
Gender (M/F)	35/6			
Age (months)	41	73.4	66-81	4.5
Months of schooling	41	9.2	4-12	2.0
Developmental Quotient	41	78.1	44-119	20.6
SCQ	41	15.8	5-32	6.0

Note. Developmental Quotient based on the fine motor and visual perception subtest of the Mullen Scales of Early Learning (Mullen, 1995). SCQ = Social Communication Questionnaire, scores ≥11 strongly suggest the presence of autism characteristics; those who scored <11 had Autism Diagnostic Observation Schedule-2 assessments completed to verify diagnosis.

2.4 Procedure and assessment tasks

Children were seen for a single assessment session by one of four research assistants who were qualified speech-language pathologists and a psychology PhD candidate. Assessment session duration was approximately two hours and took place at AEIOU centres, the Griffith University Campus clinic, or in the children's homes, depending on parent preference. The sessions comprised a set number of tasks assessing oral language and early literacy skills, with the order of the tasks varied to suit individual children's behavior and attention in an attempt to obtain the most valid estimate of their abilities. Verbal instructions of the tasks that were not validated for use with children on the spectrum were adapted and simplified; the most salient information was highlighted in the manual and care was taken that these adaptations were the same for all participants. All sessions were voice-recorded and referred to when needed for scoring. Finally, parents completed an informal interview to examine their views of literacy development, including barriers and enablers they have encountered.

2.4.1 Early Literacy Tasks

Letter Sound Knowledge

To evaluate the children's alphabet knowledge the York Assessment of Reading for Comprehension (YARC) (Psychological Assessments Australia, 2012) Letter Sound Knowledge subtest was completed. The child was presented with 26 letters and six digraphs and asked to label the sound that the letters make. Each correct item was given a score of 1, resulting in a maximum raw score of 32. Raw scores were then converted into Ability Scores and Standard Scores using the assessment manual.

Single Word Reading

The children's ability to read a) regular, b) irregular, and c) non-words was assessed using the online Castles and Coltheart test 2 (CC2) (Castles & Coltheart, 2004). For this assessment, the child was presented with a single word on the computer screen, or paper (when internet access was not available), and asked to read it out loud. Words were randomly presented in terms of word class, however were arranged in order of increasing length and complexity. Correct responses were provided with a score of 1. Standardised Z scores were then computed using the Macquarie Online Test Interface (MOTIf). These Z scores allow for the recognition of patterns across word types to determine the child's strengths and weaknesses in reading pathways.

Passage Reading

To evaluate the children's ability to read and comprehend short passages we used the YARC Passage Reading subtest (Psychological Assessments Australia, 2012). During this task the child was presented with a reading passage and asked to read each word as clearly and carefully as they could. Children were encouraged to sound out unfamiliar words and were provided with the correct response for any words that they were unable to read. At the end of the passage the child was asked a series of comprehension questions to determine their understanding of the story content. Scores were provided based on the child's reading accuracy (number of words correct), rate of reading (time taken to complete the passage), and passage comprehension. Children who reached the maximum number of allowed decoding errors on either the first or second passage were scored on the beginner passage only. The following scores were obtained: beginner passage accuracy ability score; beginner passage comprehension raw score (max 8); overall reading accuracy standard score (typical range 85 – 115); overall reading comprehension standard score (typical range 85 – 115). With regards to the beginner passage ability scores, a score of 22 equates to 17 word errors, while an ability score of 40 equates to zero errors. The beginner passage contains 26 words for the child to read, with a recommended ceiling of 15 errors.

Phonological Awareness

The children's phonological awareness skills were assessed using the Sutherland Phonological Awareness Test – Revised (SPAT-R; Neilson, 2003). This assessment is a norm-referenced instrument which provides a comprehensive overview of the phonological awareness skills required for literacy development in the early school years. Tasks include syllable counting, rhyming, first and last sound awareness, sound blending and segmentation, consonant deletion, non-word reading, and non-word spelling. Correct items were given a score of 1, resulting in a

maximum raw score of 60. Results were then converted into percentiles based on the child's year of schooling.

Pre-Literacy Rating Scale

Parents were asked to complete the Clinical Evaluation of Language Fundamentals, Preschool – 2nd Edition Pre-literacy Rating Scale (CELF-P2; Wiig, Secord & Semel, 2004). The Pre-Literacy Rating Scale evaluates the child's emergent reading and writing skills. The items included reflect milestones observed in the typical development of literacy in the pre-school years. This is a criterion-referenced checklist consisting of 26 early literacy skills. Parents were asked to rate their child's abilities on a four point Likert scale (1= never to 4 = always) leading to a maximum score of 104. The child's score was then compared to a criterion score based on their age to determine whether they were meeting their developmental literacy expectations.

2.4.2 Oral Language Tasks

Expressive and Receptive Language skills:

To assess the children's oral language skills, the CELF-P2 Core Language components were administered. The CELF-P2 is a norm-referenced instrument of comprehensive language ability suitable for children entering an academic setting. Administration of the Core Language subtests provides a reliable measure of the child's overall language performance. Standard scores are computed (typical range 85 – 115). The core language subtests include:

- Sentence Structure: Assesses the child's ability to interpret spoken sentences of increasing length and complexity. This subtest is comprised of 20 questions and requires the child to listen to a spoken sentence and point to the picture, from a choice of four, which best represents the sentence.
- Word Structure: Evaluates the child's understanding of morphological rules in a sentence-completion task. The child is required to complete a sentence pertaining to pictured representation of the target word.
- Expressive Vocabulary: This task assesses the child's naming and word retrieval abilities. The child is shown an illustration and asked to label the object, vocation, or action pictured.

Descriptive Pragmatics Profile

All parents completed the CELF-P2 Descriptive Pragmatics Profile (Wiig et al., 2004). This questionnaire is a criterion-referenced checklist consisting of 26 items. The Descriptive Pragmatics Profile assesses the child's overall pragmatic development across the areas of non-verbal communication skills, conversational routines and skills, and asking for, giving and responding to information. Parents were required to rate their child's abilities on a Likert scale of one to four (1= never to 4 = always), therefore, a maximum score of 104 could be achieved. This score was then compared to a criterion score for the child's age to determine whether they were meeting their developmental expectations in the area of pragmatics.

Story Comprehension

To assess the children's ability to comprehend a story, we used the Profile of Oral Narrative Ability (Westerveld, Gillon, & Boyd, 2012). In this task the children were asked to listen twice to a recording of an unfamiliar story, while viewing the pictures of the story book on a computer screen. The story was an English translation of Ko au Na Galo (Ana Gets Lost; Swan, 1992), which describes the adventures of a Pasifika girl, Ana, who gets lost while looking for her parents. Following the initial exposure to the story the children are asked eight questions to determine their story comprehension skills. This task was used with a representative sample of students attending foundation year in Queensland (Westerveld & Vidler, 2016). Raw scores were used for analysis; a score of 4 or lower on this task was considered below expectations (Westerveld & Vidler, 2016).

2.4.3 Speech Sound Production

To determine the children's speech sound development (for descriptive purposes), we used the Diagnostic Evaluation of Articulation and Phonology Screener (Dodd, Hua, Crosbie, & Holm, 2002). Ten illustrations were presented one-by-one, and the children asked to label them. If the child was unable to identify the correct name for the word a forced choice question was used (is it a pig or a shoe?), whilst further incorrect responses led to a direct request for imitation (it's a pig, say pig). The presence of a speech sound error on any word required a repetition of the stimulus item to determine the child's consistency in word production. If the sound continued to be produced incorrectly the child was asked to imitate the target sound in isolation to determine stimulability. An overall percentage of phonemes correct was calculated, and the type of sound error (articulatory, delayed/deviant) identified.

2.4.4 Home Book Reading Video

All parents were asked to video themselves reading two books with their child. The books were Pip and Posy: the Big Balloon (Scheffler, 2012) and a home-reader from school or a favourite book. Pip and Posy is a fictional narrative which contains 25 pages with illustrations and simple text. The home reader or favourite book was selected by the family based on those available and/or the child's preferences. Parents were provided with the simple instruction of reading with their child as they typically would, including allowing the child to read if this was their normal practice. Parents were also asked to complete a short form indicating the time the books were read, book titles and authors, whether their child had seen the book before, and whether the reading session was considered typical of their child's usual behaviour.

2.4.5 Parent Interviews

Parent Interviews

Parents were asked a series of questions pertaining to their understanding of literacy learning and barriers their child has faced when developing their early literacy skills. Interviews were completed at the time of the child's assessment and generally lasted between 5-10 minutes. Interviews were audio- recorded and later transcribed for analysis of recurring themes.

3. Findings

3.1 The reading skills of children on the autism spectrum in their first year of schooling

Our first research question asked how the cohort of children on the autism spectrum perform on reading related measures in their first year of formal schooling. As participants in this study ranged in age from 66 to 81 months, and the time the children had spent in formal schooling from 4 to 12 months, correlational analyses were performed between age in months, months of schooling, and performance on reading related measures. No significant correlations (p <0.05) were found, suggesting that reading ability was not correlated with increased exposure to formal schooling or age. As a result, further analyses were completed on the group as a whole. Table 2 outlines group performance on measures of reading-related tasks in addition to the percentage of children who scored within or above the typical range for each task (based on norms reported in the task manuals, or previous research).

Table 2: Group performance on reading-related tasks

Assessment	*n*	Mean	Range	SD	% Scoring ≥ age expectations (% of group)
York Assessment of Reading for Comprehension (YARC):					
Letter Sound Knowledge*	41	98.4	70 - 130	19.8	70.7
Reading Accuracy SS*	21	103	74 - 130	17.3	85.7 (43.9)
Reading Comprehension SS*	21	88.9	70 - 123	20.0	38.1(19.5)
First passage accuracy ability score	39	29.2	22 - 40	7.4	33.3 (31.7)
First passage comprehension raw score	36	2.4	0 - 8	2.5	NA
CC2 Single Word Reading					
Regular words^ **Raw scores**	39	-0.45 9.5	-1.58 - 2.05 0 - 35	1.1 11.6	55.3 (51.2)
Irregular words^ **Raw scores**	39	-0.28 25.6	-1.58 - 2.53 0 - 23	1.4 6.8	42.9 (36.5)
Nonsense words^ **Raw scores**	39	-0.27 6.0	-1.21 - 2.48 0 - 35	1.0 9.0	68.4 (63.4)

CC2 Total (raw score)	39	21.1	0 - 86	26.3	
SPAT-R~	36	44.4	2 - 99	35.9	61 (53.7)
CELF P2 Pre-literacy rating scale $	40	84.7	55 - 142	16.8	62.5 (61)

NOTE: *Denotes standard scores (scores between 85-115 are WNL). ^Denotes Z scores (scores between -1.0 – 1.0 are WNL). First passage accuracy ability score refers to the Ability Score achieved on the first passage of the YARC (range= 22-40; 22 = 17 word errors, 40 = 0 word errors). First Passage comprehension raw score, max = 8, achieved on the comprehension questions for the first reading passage of the YARC. CC2: Castles and Coltheart 2 raw score, max score= 120. SPAT-R: Sutherland Phonological Awareness Test- Revised (Neilson, 2003). ~Denotes a percentile rank (scores between 16 and 84 are WNL). $Criterion scores for children over 5;6 is ≥72.

3.1.1 Group Performance

At group-level, mean group performance was within typical limits on the following print-related tasks: letter-sound knowledge, single word reading, and phonological awareness (SPAT-R). Moreover, at group level, parents rated their child's pre-literacy skills as meeting criterion. Only 21 children were able to complete the first two passages of the YARC. Standardised data for these passages is available based on the performance of children who are developing typically in their first year of schooling. At group-level those 21 children scored within typical limits on reading accuracy and reading comprehension.

3.1.2 Individual Performance

As shown in Table 2, there was a wide range in performance on all tasks, with scores ranging from minimum to maximum on most tasks. Overall, relative strengths were observed in word recognition. Interestingly, parents of 60% of the children rated their child's pre-literacy skills as satisfactory. It is of concern that only 44% of the children in this cohort scored within typical limits on reading accuracy. Furthermore, 19.5% of our cohort performed within typical limits on reading comprehension.

3.2 Participant performance on oral language tasks

Table 3 provides an overview of the participants' performance on the oral language tasks.

Table 3: Group performance on oral language tasks

Assessment	*n*	Mean	Range	SD	% Scoring ≥ age expectations (% of group)
CELF-P2 Core Lang^	38	75.6	45-122	20.5	31.6 (29.2)
CELF-P2 Pragmatics*	40	72.3	47-90	10.8	55 (53.6)
Story comprehension#	40	2.8	0 – 7	2.2	25 (24.4)
DEAP PPC$	38	92.1	59-100	8.9	84.2 (78)

CELF-P2 = Comprehensive Evaluation of Language Fundamentals - Preschool 2 (Wiig et al., 2004), ^standard scores (scores between 85-115 are WNL). CELF-P2 Pragmatics = The CELF-P2 Descriptive Pragmatics Profile. *Criterion scores for 5;6 -5;11 years ≥70, for 6;0 – 6;5 years ≥86, and 6;6-6;11 ≥91. Story comprehension, max score 8 (Westerveld & Vidler, 2016). DEAP = Diagnostic Evaluation of Articulation and Phonology (Dodd et al., 2002). PPC = percent phonemes correct. $ PPC of ≥ 85 was considered within age expectations.

At group-level, mean group performance was below typical limits on all oral language tasks. Children showed relative strengths in speech production skills with almost 80% of children producing at least 85% phonemes correct on the DEAP.

3.3 Correlations between oral language and reading tasks in year 1 of schooling

We first investigated if there were any significant correlations between autism severity (SCQ) and any of the oral language and reading tasks. All correlations were small ($r < .197$) and non-significant ($p > 0.05$). Therefore SCQ was not included in subsequent analyses.

As shown in Appendix 1, children's developmental quotient (DQ) was significantly correlated with all oral language and reading measures. Furthermore there were significant and strong correlations between children's ability to decode the first passage of the YARC and their oral language performance on the CELF ($r = .522$, $p < .001$), their letter sound knowledge ($r = .772$, $p < .001$), and their ability to decode single words ($r = .910$, $p < .001$). Similarly, significant and strong correlations were found between children's ability to answer questions based on the first passage and their core language skills ($r = .755$, $p < .001$), and between first passage comprehension and story comprehension ($r = .834$, $p < .001$). As expected children's reading comprehension also

correlated with their decoding skills, including letter sound knowledge (r = .409, p < .05), single word reading (r = .514, p = .002), and first passage reading ability (r = .425, p = .01).

For the group of children who managed to read beyond the first passage and for whom a standard score could be obtained (n = 21), reading accuracy performance showed moderate and significant correlations with DQ (r = .449) and letter sound knowledge (r = .519) and strong correlations with single word reading ability (r = .907, p < .001). For reading comprehension, there were moderate and significant correlations with DQ (r = .595) and significant strong correlations with core language scores (r = .773) and story comprehension (r = .826).

3.4 Correlations between performance prior to school entry and reading accuracy following transition to school

Next, we investigated whether any correlations existed between child performance on emergent literacy tasks prior to school entry and reading-related skills once formal schooling had commenced. Appendix 2 outlines correlations between letter-sound knowledge, phonological awareness/first sound awareness, and print and word awareness in the preschool years and measures of reading accuracy following transition to school. Three of these correlations are explained in more detail below.

3.4.1 Letter-Sound Knowledge

As shown in Appendix 2, there were significant correlations (p < .05) between letter-sound knowledge in the preschool years and all measures of reading accuracy following transition to school. This included reading accuracy of passages (r = .527), and reading of regular words (r = .718), irregular words (r = .757) and nonsense words (r = .622) at the single word level.

3.4.2 Phonological awareness

Initial sound awareness in the preschool years (using the PALS-PreK) was found to significantly correlate (p < .05) with reading accuracy of passages (r = .466), reading accuracy of the beginner passage of the YARC (r = .494), and reading of regular (r = .543), irregular (r = .522) and nonsense words (r = .531) following transition to school.

3.4.3 Print and Word Awareness

As shown in Appendix 2, early print and word awareness abilities, as measured using the Print and Word Awareness Task of the PALS-PreK (Invernizzi, Sullivan, Meier, & Swank, 2004) significantly correlated ($p < .05$) with all reported measures of reading accuracy described above.

3.5 Correlations between performance prior to school entry and reading comprehension following transition to school

Next, we investigated correlations between receptive language abilities (based on PPVT scores), Print and Word Awareness, and story comprehension prior to school entry and reading comprehension skills following transition to formal schooling. Appendix 3 shows the correlations between these potential predictors and the children's reading comprehension skills. As expected there was a significant correlation between reading accuracy and reading comprehension as measured on the YARC ($r = .436$).

3.5.1 Receptive Language Ability (PPVT)

Significant correlations ($p < .05$) were found between preschool receptive language (vocabulary) performance on the PPVT and later reading comprehension ($r = .708$) and reading accuracy of passages ($r = .482$).

3.5.2 Story comprehension

As shown in Appendix 3, there were significant correlations ($p < .05$) between early story comprehension and later comprehension scores on the beginner passage of the YARC ($r = .647$) and the overall YARC comprehension standard scores ($r = .692$).

3.5.3 Print and Word Awareness

Early print and word awareness was significantly correlated ($p < .05$) with later comprehension scores on the beginner passage of the YARC ($r = .670$), and the overall YARC comprehension standard score ($r = .470$).

3.6 Predicting year 1 reading accuracy performance

As mentioned previously, children's ability to read single words was assessed using the CC2 (Castles & Coltheart, 2004) and comprised three subtests: a) regular, b) irregular, and c) non-

words. Because floor effects were found for nonword reading, and because regular and irregular word reading were highly correlated (r = .93, p < .001), we selected regular word reading as the outcome for single word reading accuracy. Moreover, single word reading was highly correlated with beginner passage ability score (r = .92, p < .001). As such we decided to focus on single regular word reading only to investigate preschool predictors of year 1 word reading ability in our group of participants.

To answer our question, we conducted hierarchical multiple regression analyses. At Step 1, vocabulary (PPVT SS) and non-verbal intelligence (DQ) were entered. These accounted for 23.2% of the variance in single word reading, F (2, 36) = 5.43, p = .009. Neither variable added a significant independent contribution to this variance. At Step 2, we entered the following preschool emergent literacy variables: LSK (letter sound knowledge), PA (phonological awareness), and PWA. These accounted for an additional 37.7% of the variance in single word reading, F (3, 33) = 5.59, p < .001. At Step 2, letter-sound knowledge was the only significant independent predictor, accounting for 12.6% of the variance in single word reading.

3.7 Predicting year 1 reading comprehension performance

Only 21 children were able to attain a YARC comprehension standard score as 20 participants were unable to complete the first two passages, needed to obtain a standard score on this test. However, 39 children completed the beginner passage, and 36 of these children attempted to answer the questions, yielding a first passage comprehension score max 8. As these beginner passage comprehension scores were highly correlated with the YARC comprehension standard score (n = 21, r = .79, see Appendix 3), we subsequently used this beginner passage comprehension score as our outcome measure when investigating preschool predictors of year 1 reading comprehension ability in our group of participants.

To answer our question, we conducted hierarchical multiple regression analyses. At Step 1, non-verbal intelligence (DQ) and reading accuracy beginner passage ability score were entered. These accounted for 39.8% of the variance in single word reading, F (2, 33) = 10.90, p < .001. DQ added unique independent contribution to, accounting for 21.7% of the variance. At Step 2, we entered the following preschool emergent literacy variables: PPVT, story comprehension, and PWA. These accounted for an additional 21.8% of the variance in reading comprehension F (3, 30) = 5.675, p = .003. At Step 2, none of the variables added unique independent contribution to this variance.

3.8 Summary of findings

A total of 41 children with a diagnosis of autism participated in the current longitudinal study. These children were originally assessed on a range of oral language and emergent literacy skills prior to school entry. At the time of re-assessment all children had commenced formal schooling (foundation or prep year) and all but one child had attended for at least six months.

Research question one investigated how the children performed on a standardised test of reading ability. It was found that 43.9% of children scored within typical range on reading accuracy (i.e., the ability to read short passages); 19.5% of the children scored within the typical range on reading comprehension i.e., the ability to answer questions after reading short passages. When asked to read single words, just over 50% of the children demonstrated age-appropriate skills for decoding regular words (such as pet and hot).

Research question two considered the relationship between children's oral language skills and their reading ability. As expected, children's performance on a standardised test of oral language was significantly related to their reading accuracy and comprehension skills, indicating the important links between spoken and written language.

When investigating children's pre-school performance on emergent literacy skills and their reading accuracy performance approximately one year later, significant correlations were found between pre-school performance on letter sound knowledge, phonological awareness, and print awareness and single word reading when children were in their first year of schooling. Similarly, significant correlations were found between pre-school performance in receptive vocabulary and story comprehension and reading comprehension approximately one year later.

The third research question investigated pre-school predictors of year-one (foundation year) reading accuracy and reading comprehension performance. After accounting for vocabulary and nonverbal intelligence, pre-school skills of letter sound knowledge, phonological awareness, and print and word awareness accounted for a significant amount of the variance in year-one single word reading. For year-one reading comprehension, preschool vocabulary knowledge, story comprehension, and print and word awareness were significant predictors.

4. Limitations

This study investigated the early literacy and oral language skills of 41 children on the spectrum in their first year of formal schooling. However, the ability to generalise findings may be limited by several factors. First, given the heterogeneity of this population the ability to predict outcomes for all children on the spectrum based on the findings of this study may be limited.

Secondly, there is a risk of recruitment bias. It could be hypothesised that families who chose to participate in the study held a pre-existing interest in literacy and may therefore create relatively rich literacy environments. This may be reflected in the parent interviews in which most parents were able to identify barriers and enablers to their child's literacy learning, and could list strategies they have implemented to assist them with early literacy development.

Finally, the assessment sessions comprised a set number of tasks assessing oral language and early literacy skills and took approximately 240 minutes to complete. Not all children were able to concentrate for this length of time which, at times, impacted on the number of tasks completed. Follow-up assessment sessions were completed where possible, but did not always fit in with the family's schedule and therefore some children had data missing. Although breaks were offered during the assessment session, the child's ability to concentrate throughout may have influenced the quality of their performance, particularly for tasks completed at the end of the session.

5. Future Research

The first research question sought to describe the early literacy skills of a cohort of children on the spectrum in their first year of schooling. Consistent with previous research, our results suggest relative strengths in print-related literacy development, including phonological awareness, letter-sound knowledge, and single word reading. In contrast, this cohort demonstrated particular difficulties in reading comprehension, with concurrent challenges in story comprehension. Despite relative strengths in single word reading, however, it is of concern that only 43.9% of the students showed adequate decoding skills at paragraph level as measured using a standardised test of reading ability.

Research questions two and three investigated preschool predictors of foundation year literacy achievement. Our findings revealed that pre-school emergent literacy skills that are known to be predictive of later literacy achievement in typically developing children (National Early Literacy Panel, 2008), are important literacy predictors for children on the spectrum. These are letter sound knowledge, phonological awareness, story comprehension, vocabulary, and print concepts.

Based on our findings, it is essential to raise awareness of the significant difficulties in reading many children on the spectrum are likely to experience. We are currently pursuing several avenues for disseminating our findings. We have created a video clip for educators illustrating our findings and providing suggestions for assessment and intervention of emergent and early literacy skills (**https://www.youtube.com/watch?v=4qcDksXtfVE&t=90s**) and are running workshops and webinars on request. Second, with support from the Autism CRC we are conducting research in collaboration with the First Five Forever team (Brisbane City Council Libraries) aimed at upskilling librarians to provide accessible, affordable (free) autism-friendly story time sessions in the community (Autism CRC project 2.052RI).

Having established the literacy needs of children on the spectrum, and potential pathways for supporting their development, a key focus of future research should be on developing and evaluating interventions. Although recent research suggests preschoolers on the spectrum show improvements in emergent literacy in response to intervention (Hudson et al., 2017), the effect sizes are small and it is not clear if these interventions result in better reading outcomes once children start school. We recommend future research to investigate the effectiveness of individualised intervention strategies targeting print-related and/or meaning related emergent literacy skills based on individual children's early reading profiles. Further, we recommend children in these future studies are followed up longitudinally to confirm the causal connections between

emergent literacy skills and future reading accuracy and reading comprehension for children on the spectrum.

Future research into literacy pathways of children on the spectrum should include minimally verbal children. Considering approximately 25% of children on the spectrum commence schooling with fewer than five functional words (Rose, Trembath, Keen, & Paynter, 2016), this group may be at particular risk of persistent literacy challenges.

6. References

Arciuli, J., Stevens, K., Trembath, D., & Simpson, I. C. (2013). The relationship between parent report of adaptive behavior and direct assessment of reading ability in children with Autism Spectrum Disorder. *Journal of Speech, Language, and Hearing Research, 56*(6), 1837-1844. doi: 10.1044/1092-4388(2013/12-0034)