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ORIGINAL ARTICLE

Effects of Reading Mastery as a Small Group Intervention for Young Children with ASD

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Abstract The purpose of this study was to compare direct instruction using the *Reading Mastery* curriculum in small groups with peers and typical reading instruction on the beginning literacy skills of moderate to high functioning young children with Autism Spectrum Disorders (ASD). Thirty-two children were in the *Reading Mastery* intervention group and 30 were in a comparison condition. All participants met criteria as beginning readers, based on assessments at the beginning and middle of Kindergarten. Results indicated that school-based implementers were able to use the curriculum

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with fidelity and that there were significant group differences in growth on curriculum-based content, letter sound fluency, and word recognition favoring the *Reading Mastery* intervention.

Keywords Autism · Literacy · *Reading Mastery*

Literacy Skills of Children with ASD

Sound instructional practices to promote learning in early grades provide the foundation for future school success for children with ASD. Effective early literacy instruction in particular is pivotal to learning across all content areas in educational settings, and impacts access to the general curriculum (Ashburner et al. 2010; Whalon et al. 2009).

Many studies have provided descriptive reports on reading abilities for school-age children with ASD, showing a range from nonreaders to students who learn to read single words precociously and often independently (Nation et al. 2006). In their study of 41 children with ASD from 6 to 15 years old, Nation et al. reported that some children read accurately but with poor understanding, some children were poor at reading words and non-words, and some were unable to decode non-words despite reasonable word reading skills. The authors reported that approximately half of the children with ASD in their sample had oral reading skills below their same-age peers and nearly 75 % had below average comprehension. Wei et al. (2015) reported that overall the group of children with ASD performed one standard deviation in reading achievement below the norm in a national sample. However higher functioning children with ASD performed in the normal range. Nation and Norbury (2005), in a report of reading comprehension difficulties, stated that nearly half of the ASD population has shown language impairments or limited speech.

Davidson and Ellis (2014) conducted a study with 94 four to five-year-old children with ASD and noted that 62 % of their sample had a discrepant profile of reading proficiency with higher decoding and lower comprehension. They reported that reading proficiency was associated with higher nonverbal cognition and expressive language. In addition, children with poorer social skills were still able to acquire alphabet knowledge, perhaps showing memorization in spite of poorer communication ability. Poor social skills may also be related to hyperlexia (superior word recognition but limited comprehension), found in some individuals with ASD; and comprehension may be worse with highly social text (Brown et al. 2013). Findings from research have found language deficits in children with ASD including impairments in phonological processing, often relate to other reading and learning problems (Tager-Flusberg and Joseph 2003; Westerveld et al. 2016). Phonological awareness recognition may be poorer for children with autism compared to typically developing peers even though age appropriate word recognition is demonstrated (Smith Gabig 2010).

There is no doubt that substantial learning differences between students on the spectrum exist. Students considered as having high-functioning autism can acquire reading skills commensurate with, or beyond chronological age norms (Goldstein et al. 1994; Griswold et al. 2002). However, many display difficulties with abstract concepts and comprehension (O'Connor and Klein 2004). These disparities tend to increase with age (Goldstein et al. 1994), stressing the need for *early* literacy instruction. Existing research with students with more moderate disabilities including ASD suggests that

functional literacy acquisition for this group is possible (Browder et al. 2006; Kliewer and Biklen 2001).

Reading Intervention Studies and ASD

Very few intervention studies have focused on beginning literacy skills for young children with ASD (Browder et al. 2006; Davidson and Ellis 2014; El Zein et al. 2014; Mirenda 2003). Possible explanations are that practitioners often view their students as too cognitively impaired or having serious language deficits and thus "not ready" for rigorous, academic instruction (Mirenda 2003; Plavnick et al. 2016). Another explanation is that teachers are not adequately prepared to teach reading to children with severe learning or behavioral challenges (Spector and Cavanaugh 2015). Beginning literacy instruction for young children with ASD is thus neglected both in academic settings as well as in educational research.

The small but growing literature on reading intervention studies specifically for children with ASD, however, have shown promising findings. In a recent review of 128 research studies on reading instruction, Browder et al. (2006) reported that the use of storybook reading, social conversation related to literacy, and small group instruction with peers has led to increased exposure to literacy instruction and improved skills for children with more severe disabilities including autism (Kliewer and Biklen 2001; Koppenhaver et al. 2001; Ryndak et al. 1999). The researchers concluded that the use of direct instruction and generalization is necessary to give meaning to literacy. Minshew et al. (1995); cited in Griggs Stringfield et al. 2011) reported on the ability of high functioning children with autism to participate in academic instruction to learn phonetic abilities, lexical knowledge and understanding of the rules of grammar; as well as comprehension of single words (O'Connor and Klein 2004. Several strategies were reported to improve sight word and functional word recognition for students with ASD including picture-to-text matching (Fossett and Mirenda 2005); direct massed trial instruction and embedded distributed trials (Collins et al. 2007); and combined word identification (word wall, making words with letters, and making words with icons) and the use of Augmentative Alternative Communication Hanser and Erickson (2007).

Whalon et al. (2009) in a review of evidence-based reading instruction for children with ASD, reported computer-assisted instruction (formulating sentences with animated pictures) as effective for improving phonological scores and reading. They also recommended multimethod strategy instruction to teach reading including simplifying tasks, providing scaffolding through modeling and think aloud, and procedural prompts such as self-monitoring and visual cues (Bellon and Harn 2008; Koppenhaver et al. 2001). Other promising intervention strategies for children with ASD include strategy instruction (question generation, graphic organizers, and predictions); explicit instruction; and student grouping practices to improve reading performance (see reviews by El Zein et al. 2014; Whalon et al. 2009).

Typical peers have also played an important role in learning for children with ASD. For example, social and academic peer networks have resulted in increased interaction, engagement, and beginning academic skills (Kamps et al. 1997, 2002; Ledford and Wehby 2015). Peers trained to use discrete trials, as another example, increased correct responding for object and picture matching and receptive identification for participants

with autism (Radley et al. 2015). Additionally, peer tutors, and peer-inclusive academic groups have promoted increased oral reading fluency and comprehension for children with ASD (Kamps et al. 1994, 1995; Whalon and Hanline 2008).

Direct Instruction Intervention

Direct Instruction is one proven methodology to address reading problems for children with disabilities. Plavnick and colleagues (Plavnick et al. 2014) provided a definition of direct instruction as a systematic approach to teaching including carefully designed curriculum with detailed sequences of instruction that students must master before advancing to the next level. Students are taught in small groups and instructors follow a script with frequent opportunities for student responding, feedback and positive reinforcement (http://www.asatonline.org/treatment/procedures/Direct). A small body of evidence exists to support the efficacy of teaching beginning literacy skills using direct instruction for students with severe learning disabilities and children with ASD who have academic deficits. Recommended procedures include using (1) small group direct instruction models (Flores and Ganz 2009; Kame'enui and Simmons 2001; El Zein et al. 2014; Engelmann 1997; Kamps and Greenwood 2005; Kamps et al. 2008); (2) computer-assisted instruction with contingent reinforcement and scaffolding (Grindle et al. 2013; Plavnick et al. 2016); and (3) tertiary level intervention (Torgesen et al. 2001; Wanzek and Vaughn 2007; Vellutino et al. 2008).

In a recent review of explicit and systematic scripted (ESS) curricula (including Direct Instruction) for children with ASD, Plavnick et al. (2014) reported promising findings. Two studies showed improved comprehension and behaviors when using the *Corrective Reading* DI curriculum with 11 to 14-year-old students with ASD and DD (Flores and Ganz 2009; Flores et al. 2013). The MimioSprout® Early Reading program, based on principles of applied behavior analysis and direct instruction was shown to be feasible for use with four young children with ASD to improve word recognition (Grindle et al. 2013). Grindle and colleagues reported, however, that additional discrete-trial activities (understanding negation, vocabulary comprehension using pictures, and recall) were needed to supplement children's progress and correct performance. Whitcomb et al. (2011) reported on an earlier version, Headsprout® Early Reading computerized instruction, finding that the program successfully taught word reading skills to a 9-year-old child with autism. Plavnick and colleagues (Plavnick et al. 2016) also showed positive findings for Headsprout® instruction with children with autism. Participants received contingent reinforcement and match-to-sample training which improved their correct interactions per minute with the program and transfer of skills to reading companion books.

The *Reading Mastery* curriculum in particular has a powerful evidence base for its effectiveness with disadvantaged children, English Language Learners, and children with disabilities (Engelmann 1997; Gersten et al.1987; Kamps and Greenwood 2005; Kamps et al. 2008), but limited studies specifically targeting children with ASD.

Plavnick et al. (2014) concluded there is broad applicability for ESS programs for participants with variable language and cognitive abilities including ASD; however, the research is inconclusive suggesting a need for further study including clear

descriptions of the independent variable, procedural modifications, component analysis, and evaluation of educator implementation to confirm feasibility of delivery by school personnel.

Summary

The literature suggests that some children with ASD can learn reading skills in small groups with peers, with potential social and academic benefits (Flores et al. 2013; Kamps et al. 1995). The research also suggests that teacher and peer interactions may be challenging in group settings and thus accommodations may be necessary to address attention problems when using group instruction (Plavnick et al. 2014). Additionally, a limited body of research supports the efficacy of beginning literacy instruction for children with both ASD and cognitive disabilities (Browder et al. 2006). Research further supports the use of explicit and systematic instruction for children with academic risks in early grades (Plavnick et al. 2014), but the number of studies is small with few addressing Direct Instruction for reading with children with ASD. This brief review suggests the need for more research to better understand the effects of treatment on reading abilities for children with ASD including the use of peer networks (small groups with peers with similar reading levels, but no ASD) and direct instruction as a combined approach (Browder et al. 2006; El Zein et al. 2014; Flores et al. 2013; O'Connor and Klein 2004; Plavnick et al. 2014).

Purpose

The purpose of this study was to compare Direct Instruction using the *Reading Mastery* curriculum in small groups with peers, and typical reading instruction for Kindergarten and first grade children with ASD. Sessions were implemented by trained school personnel. Effects on literacy skills including decoding, word recognition, oral reading, and comprehension using curriculum-based measures and standardized assessments were examined.

Methods

Participants

Sixty-two students with ASD, 53 males and 9 females, ranging in age from 62 to 82 months, participated in the reading study. The sample was selected from a larger study of students enrolled in social and literacy peer networks, with a total of 58 schools and 13 districts in Kansas and Washington states participating (Kamps et al. 2014). Students were recruited in three cohorts at the start of their Kindergarten year over the first three years of the project. This staggered recruitment was necessary to complete assessments, training, and ongoing monitoring of groups.

Inclusion Criteria

Inclusion criteria were (1) an educational diagnosis of autism; (2) functional verbal communication such as the ability to make 2–3 word requests and comments, and the ability to follow simple directions (based on teacher report and researcher observation during assessments); (3) Peabody Picture Vocabulary Test-4 score above 50; and (4) beginning reader status defined as scoring less than 50 on the *Dynamic Indicators of Basic Early Literacy Skills-DIBELS* (Kaminski and Good 1998) nonsense word fluency assessment and/or reading less than 50 of the 120 words on the *Reading Mastery* word list at the mid-point in Kindergarten.

Thirty-two participants were enrolled in the *Reading Mastery* small group intervention group; 30 participants were enrolled in the 'business as usual' comparison group (see Experimental Design section). Table 1 shows demographic characteristics for the participants in each group.

Measurement and Data Collection

Table 2 presents a list of the study measures with a description of each and the reliability and validity scores if available. Descriptive and dependent variable measures were included and described as follows.

Descriptive Measures

At the entry point of the study (fall), Kindergarten children were given a battery of assessments for descriptive purposes and to determine if they met inclusion criteria. These included the PPVT-4 (standard scores; Dunn and Dunn 2007), SRS – Social Responsiveness Scale (t scores; Constantino and Gruber 2005), and VABS – Vineland Adaptive Behavior Scale-communication subscale (standard scores; Sparrow et al. 1984). Parents were interviewed and researchers completed the CARS – Childhood Autism Rating Scale (Schopler et al. 1988).

Table 1 Participant characteristics

Reading Mastery N = 32[a]	Age	CARS	PPVT-4	SRS	VABS
Mean	67.9	33	81.1	63.6	80.91
Range	62–80	25–42	54–106	49–81	60–99
Stan. dev.	4.7	4.6	14.5	7.9	8.8
Comparison $N = 30$[b]	Age	CARS	PPVT-4	SRS	VABS
Mean	68.9	33	79.9	66.9	78.9
Range	62–82	21–43	45–123	49–86	51–112
Stan. dev.	5.0	6.0	17.4	9.4	12.6

CARS Childhood Autism Rating Scale (Schopler et al. 1988); *PPVT*-4 Peabody Picture Vocabulary Test-4 (standard scores; Dunn and Dunn 2007); *SRS* Social Responsiveness Scale (t scores; Constantino and Gruber 2005); *VABS* Vineland Adaptive Behavior Scale-communication subscale (standard scores; Sparrow et al. 1984)

[a] Gender, ethnicity: 29 males, 3 females; 20 White, 6 African-American, 2 Hispanic, 4 Asian

[b] Gender, ethnicity: 24 males, 6 females; 20 White, 5 African-Amer., 2 Hisp., 2 Asian, 1 other

Table 2 Measurement and timeline

Measure	Description	Assessment Period
Descriptive Measures		
Peabody Picture Vocabulary Test-4-PPVT (Dunn and Dunn 2007)	Receptive language, identifying labels, actions by pointing to pictures from 4 choices	Fall K Reliability test-retest, .92; validity, .23–.70
Social Responsiveness Scale-SRS (Constantino and Gruber 2005)	Presence or absence of autistic impairment across social and communication and degree of severity, teacher report	Fall K reliability, .80; validity, .80–.94
Vineland Adaptive Behavior Scale-VABS, communication subtest (Sparrow et al. 1984)	Personal, social and communication abilities based on typical performance, teacher report	Fall K reliability, 62–.78; validity, .68
Childhood Autism Rating Scale-CARS (Schopler et al. 1988)	Autistic characteristics (severity levels), parent report	Fall K reliability, .71; validity, .80
Dependent Variables Measures		
DIBELS[a] (Kaminski and Good 1998) Nonsense Word Fluency	Letter-sound correspondence and blending skills; nonsense words using consonant-vowel-consonant and vowel-consonant combinations; students read for 1-min timings	Fall, winter, spring K and 1st reliability, .60–.93; validity, .43–.90
DIBELS Oral Reading Fluency	Oral reading of grade level passages; students read three 1-min timings	Fall, winter, spring 1st reliability, .68–.72; validity, .73–.81
Reading Mastery word list	Word reading skills, decodable words from *Reading Mastery* curriculum; students read words until 10 errors	Fall, winter, spring K and 1st (na)
Woodcock Reading Mastery Test-WRMT Word Identification Word Attack Passage Comprehension (Woodcock et al. 2001).	Word reading, decoding, comprehension	Fall K and Fall, spring 1st reliability, .80–.90; validity, .75–.96

[a] Dynamic Indicators of Basic Early Literacy Skills-DIBELS

Dependent Variable Measures

Letter sound correspondence was assessed with the *DIBELS* nonsense word fluency subtest, administered fall, winter, and spring in Kindergarten and First grade. Oral Reading was assessed with the *DIBELS* oral reading fluency subtest administered fall, winter, and spring First grade. The *DIBELS* website provides a complete description of grade level assessments, and benchmarks for grade level performance and scores indicating students at risk of falling behind and in need of targeted instruction (see https://dibels.uoregon.edu/). A curriculum-based measure using a sample of decodable words from the *Reading Mastery* curriculum was also administered fall, winter and spring of Kindergarten and First grade. The *Reading Mastery* word list included a sample of 112 words representing instructional content for Level I (list available from

authors). To provide a standardized, norm-referenced measure of general reading skills, the *Woodcock Reading Mastery Test-WRMT* (Word Identification, Word Attack and Passage Comprehension subtests) was conducted (Woodcock et al. 2001). All of the WRMT tests were administered in the fall of Kindergarten and the fall and spring of First grade.

Procedural Fidelity

Fidelity of the *Reading Mastery* intervention was monitored using a 25-item checklist. Sample items included: "Uses correct attending cues", "Models correct sound pronunciation", "Uses auditory signals correctly", "Uses hand signals/visual signals correctly", "Uses scripted lesson with 80% accuracy", "Provides scripted error correction", "Uses appropriate pacing/speed of delivery/think time", "Provides immediate, specific feedback for student responses." Researchers completed the fidelity ratings weekly during observations of groups. A total of 322 checklists were completed (approximately 20 % of the sessions), with fidelity ranging from 47 to 100 % with an overall mean of 93.9 %. For those instances where fidelity was less than 80 % (n = 23 sessions), research staff provided corrective feedback to the implementers and coaching until 85 % fidelity or higher was achieved. Fidelity checks less than 80 % were observed in only 8.7 % of all observations.

Experimental Design

A quasi-experimental study was conducted to determine effects of the intervention by comparing the intervention to a business as usual group. A nonequivalent groups design was used for analysis. This design was appropriate in that efforts to randomize were problematic. Assignment to group conditions (a) the intervention, or (b) the comparison group was conducted at the beginning of Kindergarten for the larger study (Kamps et al. 2014). A block randomization procedure (by class) was used for the study with stratification for two levels of severity of ASD (e.g., moderate versus high functioning levels based on the teacher report and observed functional language). In the case that more than one eligible child had the same teacher, both were assigned to the same condition. New children in subsequent cohorts enrolled with teachers previously assigned to a condition were automatically included in that same condition. The block randomization procedure resulted in closely balanced groups across ASD severity, and descriptive characteristics (see Table 1 for a description of the characteristics across groups based on final group assignment), but nonequivalent groups at baseline based on pretest scores on the reading measures.

Initial randomization for qualifying students, and the beginning reader criteria, yielded 32 students assigned to *Reading Mastery* intervention and 30 students assigned to the comparison group. However, due to school concerns, five of the students from each group were re-assigned. Teachers for five of the *Reading Mastery* group students were unable to provide the *Reading Mastery* intervention due to limited resources, so the students were re-assigned to the comparison group. Five of the comparison group students were assigned to receive the *Reading Mastery*

curriculum as part of their special education programming, and so were re-assigned to the experimental group (see Table 1).

Reading Peer Networks Procedures

Reading Mastery curriculum

The *Reading Mastery* (Engelmann and Bruner 2003) Direct Instruction curriculum was selected for the intervention. The *Reading Mastery* curriculum provides carefully sequenced instruction teaching phonemic awareness, letter-sound correspondence, decoding, and beginning comprehension skills. Teacher presentation books provide scripted lessons, cues, signals to teach content, effective instructional tactics i.e., frequent practice (choral responding with peers and individual turns), continuous feedback and standard error corrections, and a focus on accuracy and fluency to mastery. Children learn letter sounds, rather than letter names, and to orally blend sounds together by "saying words slowly and saying words fast." *Reading Mastery* level I includes 160 lessons, with new sounds introduced about every 4 lessons, and blending sounds to read words introduced by lesson 40. Sounds are introduced in a sequence based on common use and for easy blending (am, man, cat, it, tin); and lessons progress to the students reading sentences that include irregular words (non-decodable sight words), blends, and plural word forms (e.g., "he ate a fig and he is sick." "the old goat had an old coat." "al had fun with the pigs."). Close to 500 words are introduced by the completion of level one. Assessments are conducted every 20 lessons to ensure individual mastery before proceeding. Storybooks are introduced in Lesson 90 and match to teacher led lessons. Workbooks provide writing and comprehension activities that match to lessons and the stories.

Small Group Peer Networks

Thirty-two of the participants received *Reading Mastery* in peer networks during their Kindergarten year, and 24 continued to receive *Reading Mastery* in First grade. The decision to continue into First grade was made based on teacher judgement. Teachers determined for five students that they no longer needed supplemental instruction in reading, thus time was no longer allocated for the *Reading Mastery*. Teachers switched two students to *Read Well*, and one to *Language for Thinking* as alternative curricula.

Children received an average of 60 *Reading Mastery* sessions in Kindergarten and 69 in First grade, with groups typically beginning in October or November of each year. These sessions were in small groups (peer network) and supplemental to reading instruction in the general education class. Seven of the children were in groups with other children with ASD, and 27 of the groups included 1 to 3 typical peers. The majority of implementers were special education teachers, with the second largest group of implementers being paraprofessionals. *Reading Mastery* small group lessons with peers were 30 min in length and taught by school staff at least 3 times per week. The groups occurred during the reading/language arts time period for 26 of the 32

students, however the majority of the groups were conducted outside of the general education classrooms to provide quieter instruction (special education classrooms, small therapy rooms, isolated hallways).

Teacher Training

Training in use of the *Reading Mastery* curriculum was conducted in a one-day workshop by a certified Direct Instruction (DI) trainer. During the first two years the DI trainer conducted follow-up coaching at school sites, serving as a model for the project staff to provide appropriate feedback to teachers. Research staff completed the procedural fidelity checklists to monitor accuracy of implementation and to provide weekly feedback to teachers, based on scores and particular items on the fidelity checklists (see procedural fidelity in the measures section).

Comparison Group Reading

Those children not receiving *Reading Mastery* received "business as usual" reading instruction used in their school setting (SPED and general education classrooms), with most classrooms using a Guided Reading model and leveled readers. Twenty-two received small group instruction as part of the general education curriculum, 5 received one-to-one reading in targeted skills, and 1 received instruction only in large group in the classroom setting. Group size was not reported for two participants. The amount of time spent in small groups averaged approximately 110 min per week for the comparison group students. Four used *Read Well* in the small groups and two used basal readers. All others used leveled readers and word study materials.

Data Analysis

SAS PROC MIXED was utilized to run a Multi-Level Model. Each score was predicted by (1) baseline score, (2) time, (3) intervention (*Reading Mastery* or other reading program) and (3) the interaction time and intervention. The 2- way interaction of intervention and time assesses whether the amount of change in score differs across intervention groups. A significant, positive effect for this interaction indicates that those in the intervention group show greater gains than those in the comparison group, even after accounting for differences at baseline, and is the interaction of interest. All 62 students (32 intervention and 30 comparison) were included in the analysis.

Results

Results indicated that there were significant group differences in growth on three of the measures favoring the *Reading Mastery* intervention. Each reading outcome of interest was analyzed separately. Scores were modeled using time, baseline score, intervention condition, and the interaction of those variables as predictors. As expected, student scores improved over time on all reading measures. Thus time was highly significant regardless of which outcome was examined. Baseline scores were also highly predictive of subsequent scores,

indicating that those who had higher scores at the start of intervention, also tended to have higher scores on the same measure throughout the intervention. Of greatest interest was the interaction of time by intervention status. To answer the question of whether the *Reading Mastery* curriculum was more effective than an alternate curriculum we tested the time by intervention interaction in the subgroup. Results for the analysis across measures are shown in Tables 3 and 4.

For the curriculum based *Reading Mastery* word list measure, all effects were significant. After taking into account the number of words read correctly at baseline,

Table 3 Reading outcomes for beginning readers

Reading Outcome	Effect	F	sig	Cohen's d
Reading Mastery Words				
	Baseline Score	23.67	$p < .0001$	$d = 1.24$
	Time	62.43	$p < .0001$	$d = 2.01$
	Intervention	9.88	$p = .0027$	$d = 0.80$
	Time by Intervention	2.97	$p = .0127$	$d = 0.44$
DIBELS nonsense word fluency				
	Baseline Score	60.15	$p < .0001$	$d = 1.97$
	Time	53.93	$p < .0001$	$d = 1.87$
	Intervention	6.38	$p = .0141$	$d = 0.64$
	Time by Intervention	2.80	$p = .0175$	$d = 0.43$
Oral Reading Fluency				
	Baseline Score	311.85	$p < .0001$	$d = 4.49$
	Time	44.64	$p < .0001$	$d = 1.70$
	Intervention	2.05	*ns*	
	Time by Intervention	0.89	*ns*	
WRMT[a] Word Identification				
	Baseline Score	139.25	$p < .0001$	$d = 3.00$
	Time	200.69	$p < .0001$	$d = 3.60$
	Intervention	5.63	$p = .0208$	$d = 0.60$
	Time by Intervention	3.63	$p = .0294$	$d = 0.48$
WRMT Word Attack				
	Baseline Score	97.11	$p < .0001$	$d = 2.50$
	Time	79.79	$p < .0001$	$d = 2.27$
	Intervention	2.44	*ns*	
	Time by Intervention	1.40	*ns*	
WRMT Passage Comprehension				
	Baseline Score	69.51	$p < .0001$	$d = 2.12$
	Time	68.87	$p < .0001$	$d = 2.11$
	Intervention	2.27	*ns*	
	Time by Intervention	1.42	*ns*	

[a] WRMT Woodcock Reading Mastery Test

Table 4 Group means and standard deviations by group

Measure	Reading Mastery Group		Comparison group	
Time	Mean	SD	Mean	SD
Reading Mastery Words				
Fall Kinder	1.38	1.9	5.79	9.2
Winter Kinder	20.50	23.6	17.18	34.2
Spring Kinder	41.81	38.7	49.43	51.5
Fall 1st grade	42.24	43.2	45.00	50.5
Winter 1st grade	75.20	43.2	68.67	52.3
Spring 1st grade	83.37	43.7	78.00	51.6
DIBELS				
Nonsense Word Fluency				
Fall Kinder	7.66	8.7	16.57	15.0
Winter Kinder	17.74	12.7	20.33	18.5
Spring Kinder	20.44	12.7	30.23	24.3
Fall 1st grade	21.57	17.3	26.36	23.0
Winter 1st grade	37.30	26. 7	46.66	36.6
Spring 1st grade	47.97	33.4	51.79	36.4
Oral Reading Fluency				
Fall 1st grade	13.33	16.2	19.00	22.3
Winter 1st grade	25.07	25.9	32.48	28.2
Spring 1st grade	32.17	26.9	36.59	30.0
Woodcock Reading Mastery Test				
Word Identification				
Fall Kinder	6.66	9.4	8.83	11.6
Fall 1st grade	19.27	14.4	21.86	17.4
Spring 1st grade	34.67	15.3	36.25	18.8
Word Attack				
Fall Kinder	1.59	2.9	2.52	4.2
Fall 1st grade	5.50	6.7	8.45	8.6
Spring 1st grade	12.43	9.4	14.07	11.5
Passage Comprehension				
Fall Kinder	1.91	2.5	2.86	4.6
Fall 1st grade	4.73	6.4	5.59	6.3
Spring 1st grade	11.10	8.2	11.38	9.3

those in the *Reading Mastery* group had higher scores than those in the comparison group ($F = 9.88$, $p = .0027$), scores were higher at later time points showing significant growth in number of words read ($F = 62.43$, $p < .0001$), and the amount of growth was greater for those in the intervention group ($F = 2.97$, $p = .0127$) (see Tables 3 and 4 and Fig. 1).

For the measure of letter sound correspondence as assessed by the *DIBELS* nonsense word fluency/Correct letter sounds measure, time ($F = 53.93$, $p < .0001$), intervention

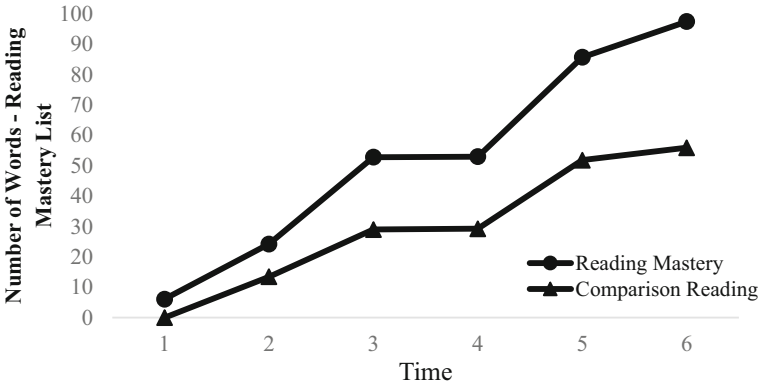

Fig. 1 Reading Mastery Words Results

condition (F = 6.38, p = .0141), and the interaction of time by intervention were significant (F = 2.80, p = .0175), once baseline scores were taken into account (See Tables 2 and 3). Scores improved over time regardless of intervention group, but those in the *Reading Mastery* intervention saw greater improvements. No group by time difference was noted for the measure of oral reading fluency measure (*DIBELS* ORF). Only scores at pre-test (F = 311.85, p < .0001) and time were significant (F = 44.64, p < .0001) (see Tables 3 and 4 and Fig. 2).

The Woodcock Reading Mastery Test provided a norm-referenced comparison of student performance. For the Woodcock Word Identification measure, there was a significant effect for intervention (F = 61.6, p = .0208), time (F = 200.69, p < .0001), and the interaction of intervention by time (F = 3.63, p = .0294) after taking into account the effect of baseline score (see Tables 3 and 4 and Fig. 3). In other words, reading scores increased over time, and the increase was larger for those in the *Reading Mastery* intervention, then for those in the comparison group.

No group differences were noted on the Woodcock Word Attack or Passage Comprehension (see Tables 2 and 3). Only the effects of time (F = 79.79, p < .0001) and pretest (F = 97.11, p < .0001) were significant for Word Attack; or for Passage

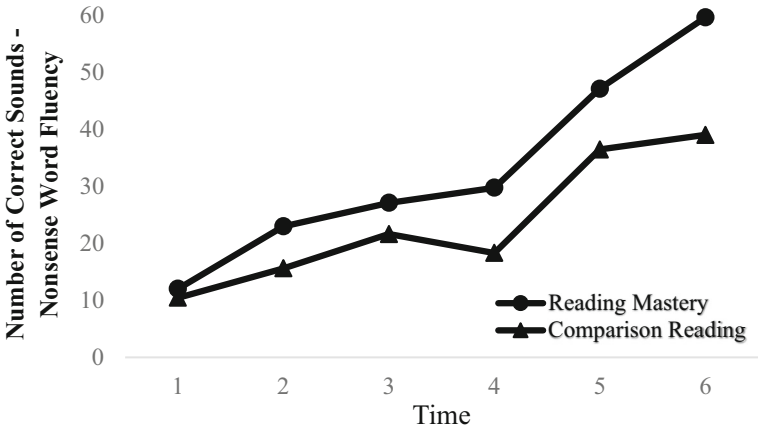

Fig. 2 DIBELS Nonsense Word Fluency/Correct Letter Sounds Results

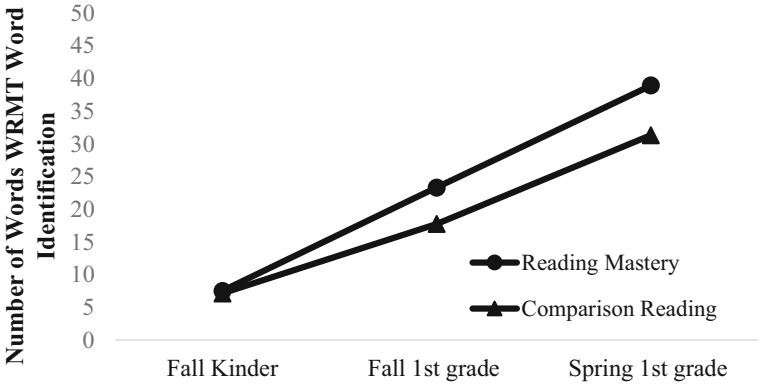

Fig. 3 WRMT Word Identification Raw Score Results

Comprehension: ($F = 68.87$, $p < .0001$, for time), ($F = 69.51$, $p < .0001$). All students, regardless of intervention group, improved significantly over time in their scores on these measures.

Discussion

The primary purpose of this study was to test the effects of the *Reading Mastery* curriculum on early literacy skills for students with ASD in Kindergarten and First grade. The curriculum was delivered in small groups with peers and compared to "business-as-usual" reading instruction. Analysis showed that children in the treatment group showed significantly more growth on the *Reading Mastery* curriculum-based word list, letter sound knowledge (*DIBELS* nonsense word fluency), and on the Word Identification test on the Woodcock Reading Mastery Test. Findings support the use of explicit and Direct Instruction curricula for high risk children who are struggling academically (Kame'enui and Simmons 2001; Kamps et al. 2008); and more specifically children with ASD at risk for learning problems (El Zein et al. 2014; Flores and Ganz 2009; Ganz and Flores 2009; Plavnick et al. 2014, 2016). Findings also support the use of the *Reading Mastery* curriculum to teach children with ASD basic phonemic awareness, decoding skills and word reading (Plavnick et al. 2016; Spector and Cavanaugh 2015).

No significant effects were noted between groups for higher order skills of oral reading fluency or comprehension. This might be related to the fact that most of the participants were just beginning to learn to read. Oral reading and comprehension skills tend to develop as beginning skills such as decoding and word reading become more fluent. The majority of the participants were still in the *Reading Mastery* level I series, and comprehension activities are taught more systematically in levels 2 and higher in the curriculum. Additionally, oral reading practice is limited within the Reading Mastery level I activities and the curriculum in general. Fluency practice may need additional time scheduled for oral reading including practice with a variety of readers and children's literature.

In addition to demonstrating the usefulness of Direct Instruction for reading intervention children in the treatment group were taught in small groups including typical peers

who also showed some reading difficulties. Given the limited resources in school settings, it is critical to continue to show that children with ASD can learn in small groups (El Zein et al. 2014; Flores and Ganz 2009) and do not necessarily need one-to-one instruction or the isolation that imposes. Cooperative learning, peer tutoring, and teacher led instruction in small peer-inclusive groups as seen in this and earlier studies can be an effective instructional model for children with ASD and provide increased access to the general curriculum and potentially more opportunities to communicate with typical peers (Browder et al. 2006; Kamps et al. 1994, 1995; Ledford and Wehby 2015). Another strength of the study was that school staff delivered the majority of the intervention in classroom settings with high fidelity, averaging 93 % overall for implementers. The high levels of fidelity were consistently found with teachers and paraprofessionals and across multiple schools and districts.

An important finding from this study, similar to prior descriptive studies (Nation et al. 2006; Whalon et al. 2009), was that children with ASD enrolled in the peer networks study demonstrated a wide range of reading ability and performance. For this reason, baseline skills were included in each analytical model as a covariate and we were able to experimentally control for the initial group differences and show treatment effects for the *Reading Mastery* curriculum. Given the heterogeneity of the population of children with ASD in language, cognitive ability, social communication skills, and behavioral challenges, quasi-experimental designs may enable more studies using group designs to test interventions for the population in educational settings.

Limitations

Several limitations should be considered when interpreting the findings of this study. First, randomization was only partially fulfilled, thus full experimental control was not attained as is sometimes the case in school settings. For five children assigned to the intervention group, staff was unavailable to deliver the intervention. Five children assigned to the comparison group received *Reading Mastery* instruction. Since the research question was specific to effects of receiving *Reading Mastery* curriculum, analyses were conducted according to the instruction that was actually received. An additional limitation is that eight children didn't receive the *Reading Mastery* intervention in first grade. In five cases, teachers determined that the students had made enough improvement that they could no longer allocate the staff to continue the intervention. Three students were placed in small groups using other curricula. Though not compliant with the original research agreement, the reality of school-based research efforts are such that teachers in subsequent school years sometimes disagree with the commitment of the initial teacher/team particularly when staff resources are limited.

An additional limitation is that the actual time in reading instruction overall was not measured for either group. Instruction time varied both within and across classrooms and treatment conditions. One concern is that additional time spent in the experimental intervention might be responsible for group differences, and not necessarily the use of *Reading Mastery* curriculum. However, anecdotal reports indicated that 29 of the 30 children in the comparison group also received small group or one-to-one instruction as part of their "business as usual" reading instruction. The amount of time for small group reading was reported to be similar to the amount of time per week for the *Reading Mastery* group i.e., approximately 110 min compared to 90 min. This would imply that the structured, explicit

nature of *Reading Mastery* was responsible for the differential effects, rather than access to small group time. This is an area that warrants further study. Also, measures of grade level word lists (Zumeta et al. 2012) and curriculum-related comprehension might be considered in future studies. The dosage of the intervention is also a limitation in that the average number of sessions was less than optimal (we recommended 3–4 times per week). However, the implementation levels may suggest what is realistic given use as a supplemental curriculum. A further concern is that not all staff was positive about using the *Reading Mastery* curriculum. Anecdotally, we learned that some teachers found the highly structured nature of the curriculum to be unappealing (i.e., limiting in the types of interactions or discussions they might have with students, too repetitious, and different from core curriculum). Many staff however reported positive comments in that the curriculum encouraged active participation by all students, and agreed that the curriculum was effective for students with ASD.

A final limitation is that the sample size was relatively small, with data nested within schools, districts and states. The smaller sample size may have impacted our ability to detect small treatment effects. Future research could look at replicating with a larger, randomized sample.

Implications for Future Research and Practice

It is important that educators have access to effective interventions to address reading difficulties for all students including those with ASD (El Zein et al. 2014). This study provides evidence for one such intervention: the *Reading Mastery* curriculum used with small peer network groups. Students in the intervention groups showed more growth on the curriculum based measure (*Reading Mastery* word list), the measure of letter sound correspondence (*DIBELS* nonsense word fluency), and on norm-referenced performance (Woodcock Word Identification subtest) assessments. Teachers were satisfied overall with the intervention, but reported difficulty scheduling groups. Considerations for future research include investigation of specific enhancements under controlled experimental conditions. Possible topics include: effects of the additional practice sessions beyond the standard curriculum; instructional modifications such as enlarged visual stimuli and reduction of distracting stimuli; and strategies for improving group performance and attending behaviors.

Additional questions for study would include the effects of intervention more in line with a recommended dosage of at least one lesson per day, comparison of peer group size, and the efficacy and impact of specific strategies to increase interactions between peers and children with ASD within the instructional groups. In addition, the intervention showed no differences between treatment and comparison group students for high order constructs (comprehension, fluency), thus further research is needed to address intervention in these areas (El Zein et al. 2014; Nation and Norbury 2005; Whalon et al. 2009). The current study focused on beginning literacy skills (letter sound correspondence, word identification) rather than comprehension. Future studies using explicit curriculum for students who have mastered beginning reading skills and for older students with ASD, in combination with strategies to improve oral reading rates and reading comprehension including generalization of reading to other texts (expository and literature), are needed (Brown et al. 2013; Nation et al. 2006;

Nation and Norbury 2005). Difficulty with comprehension of reading material in particular is uniquely related to ASD characteristics including difficulty with abstract concepts. Intervention addressing improvement in understanding text and the relationship to natural contexts (e.g., generalization of understanding to social settings), might dramatically improve functioning and participation of children with ASD beyond the academic groups. As with other treatments for children with ASD, the question of differential effects for the range of ASD functioning levels and autistic characteristics needs to be addressed (Kasari and Lawton 2010) for academic interventions in school settings. Studies with larger sample sizes using Direct Instruction and follow-up assessment are also needed. An additional area of study is the need to maximize interactions with peers as part of the small group instruction. While the study confirmed learning in groups with peers and choral responding in groups, children in the comparison group also received instruction in peer groups. Future studies are needed to determine beneficial components of structuring interactions and communications with peers within instructional formats for children with autism to demonstrate social as well as academic effects.

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Compliance with Ethical Standards

Funding The research was funded by the Institute of Education Sciences, Department of Education (R324A090091). Opinions expressed herein are those of the authors and do not necessarily reflect the position of the funding agency.

Ethical Approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional review board of the University of Kansas and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed parental consent was secured for all participants. Informed teacher consent was secured for all participating school staff.

Conflict of Interest Author A declares that she has no conflict of interest. Author B declares that she has no conflict of interest. Author C declares that she has no conflict of interest. Author D declares that she has no conflict of interest. Author E declares that she has no conflict of interest. Author F declares that she has no conflict of interest.

References

Ashburner, L., Ziviani, J., & Rodger, S. (2010). Surviving in the mainstream: capacity of children with autism spectrum disorders to perform academically and regulate their emotions and behavior at school. *Research in Autism Spectrum Disorders, 4*, 18–27. doi:10.1016/j.rasd.2009.07.002.

Bellon-Harn, M., & Harn, W. (2008). Scaffolding strategies during repeated storybook reading: An extension using a voice output communication aid. *Focus on Autism and Other Developmental Disabilities, 23,* 112–124. doi:10.1177/1088357608316606.

Browder, D. M., Wakeman, S. Y., Spooner, F., Ahlgrim-Delzell, L., & Algozzine, B. (2006). Research on reading instruction for individuals with significant cognitive disabilities. *Exceptional Children, 72*(4), 392–408. doi:10.1177/001440290607200401.

Brown, H., Oram-Cardy, J., & Johnson, A. (2013). A meta-analysis of the reading comprehension skills of individuals on the autism spectrum. *Journal of Autism and Developmental Disorders, 43*(4), 932–955. doi:10.1007/s10803-012-1638-1.

Collins, B., Evans, A., Creech-Galloway, C., Karl, J., & Miller, A. (2007). Comparison of the acquisition and maintenance of teaching functional and core content sight words in a special and general education settings. *Focus on Autism and Other Developmental Disabilities, 22,* 220–223.

Constantino, J., & Gruber, C. (2005). *Social responsiveness scale (SRS).* Los Angeles: Western Psychological Services.

Davidson, M., & Ellis, W. S. (2014). Characterization and prediction of early reading abilities in children on the autism spectrum. *Journal of Autism and Developmental Disorders, 44*(4), 828–845. doi:10.1007/s10803-013-1936-2.

Dunn, L., & Dunn, D. (2007). *PPVT-4 manual.* Bloomington: NCS Pearson, Inc.

El Zein, F., Solis, M., Vaughn, S., & McCulley, L. (2014). Reading comprehension interventions for students with autism spectrum disorders: a synthesis of research. *Journal of Autism and Developmental Disorders, 44*(6), 1303–1322. doi:10.1007/s10803-013-1989-2.

Engelmann, S. (1997). Theory of mastery and acceleration. In J. W. Lloyd, E. J. Kameenui, & D. Chard (Eds.), *Issues in educating students with disabilities* (pp. 177–195). Mahwah, NJ: Lawrence Erlbaum Associates.

Engelmann, S., & Bruner, E. (2003). *Reading mastery* (Classic ed.). Columbus, OH: SRA/McGraw-Hill.

Flores, M., & Ganz, J. B. (2009). Direct instruction on the reading comprehension of students with autism and developmental disabilities. *Education and Training in Developmental Disabilities, 41*, 39–53.

Flores, M. M., Nelson, C., Hinton, V., Franklin, T. M., Strozier, S. D., Terry, L., & Franklin, S. (2013). Teaching reading comprehension and language skills to students with autism spectrum disorders and developmental disabilities using direct instruction. *Education and Training in Autism and Developmental Disabilities, 48*, 41–48.

Fossett, B., & Mirenda, P. (2005). Sight word reading in children with developmental disabilities: a comparison of paired associate and picture-to-text matching instruction. *Research in Developmental Disabilities, 27*, 411–429.

Ganz, J., & Flores, M. (2009). The effectiveness of Direct Instruction for teaching language to children with autism spectrum disorder. Identifying materials. *Journal of Autism and Developmental Disorders, 39,* 75–83.

Gersten, R., Carnine, D., & Woodward, J. (1987). Direct instruction research: The third decade. *Remedial & Special Education, 8,* 48–56.

Goldstein, G., Minshew, N. J., & Siegel, D. J. (1994). Age differences in academic achievement in high-functioning autistic individuals. *Journal of Clinical and Experimental Neuropsychology, 16*(5), 671–680. doi:10.1080/01688639408402680.

Grindle, C. F., Carl Hughes, J., Saville, M., Huxley, K., & Hastings, R. P. (2013). Teaching early reading skills to children with autism using Mimiosprout® early reading. *Behavioral Interventions, 28*(3), 203–224. doi:10.1002/bin.1364.

Griswold, D. E., Barnhill, G. P., Myles, B. S., Hagiwara, T., & Simpson, R. L. (2002). Asperger syndrome and academic achievement. *Focus on Autism and Other Developmental Disabilities, 17*(2), 94–102. doi:10.1177/10883576020170020401.

Hanser, G., & Erickson, K. (2007). Integrated word identification and communication instruction for students with complex communication needs: preliminary results. *Focus on Autism and Other Developmental Disabilities, 22*, 268–278.

Kame'enui, E. J., & Simmons, D. C. (2001). Introduction to this special issue: the DNA of reading fluency. *Scientific Studies of Reading, 5*, 203–210. doi:10.1207/S1532799XSSR0503_1.

Kaminski, R. A., & Good, R. H. (1998). Assessing early literacy skills in a problem solving model: dynamic indicators of basic early literacy skills. In M. R. Shinn (Ed.), *Advanced Applications of Curriculum-Based Measurement* (pp. 113–142). New York: Guilford.

Kamps, D., & Greenwood, C. (2005). Formulating secondary-level reading interventions. *Journal of Learning Disabilities, 38*(6), 500–509.

Kamps, D., Barbetta, P. M., Leonard, B. R., & Delquadri, J. (1994). Classwide peer tutoring - an integration strategy to improve reading skills and promote peer interactions among students with autism and general education peers. *Journal of Applied Behavior Analysis, 27*(1), 49–61.

Kamps, D., Leonard, B., Potucek, J., & Garrison-Harrell, L. (1995). Cooperative learning groups: an integration strategy to improve academic and social performance for students with autism and regular classroom peers. *Behavioral Disorders, 21*, 88–108.

Kamps, D., Potucek, J., Gonzalez-Lopez, A., Kravits, T., & Kemmerer, K. (1997). The use of peer networks across multiple settings to improve interaction for students with autism. *Journal of Behavioral Education, 7*, 335–357.

Kamps, D., Potucek, J., Dugan, E., Kravits, T., Gonzalez-Lopez, A., Garcia, J., et al. (2002). Peer training to facilitate social interaction for studenys with autism. *Exceptional Children, 68,* 173–187.

Kamps, D., Greenwood, C., Wills, H., Veerkamp, M., & Kaufman, J. (2008). Effects of small group reading instruction for students most at risk in kindergarten: two year results for secondary and tertiary level intervention. *Journal of Learning Disabilities, 41*, 101–114.

Kamps, D., Thiemann-Bourque, K., Heitzman-Powell, L., Schwartz, I., Rosenberg, N., Mason, R., & Cox, S. (2014). A comprehensive peer network intervention to improve social communication of children with autism spectrum disorders: a randomized trial in kindergarten and first grade. *Journal of Autism and Developmental Disorders, 45*, 1808–1824.

Kasari, C., & Lawton, K. (2010). New directions in behavioral treatment of autism spectrum disorders. *Current Opinions in Neurology, 23*(2), 137–143.

Kliewer, C., & Biklen, D. (2001). "School's not really a place for reading": a research synthesis of the literate lives of students with severe disabilities. *Research and Practice for Persons with Severe Disabilities, 26*(1), 1–12. doi:10.2511/rpsd.26.1.1.

Koppenhaver, D. A., Erickson, K. A., Harris, B., McLellan, J., Skotko, B. G., & Newton, R. A. (2001). Storybook-based communication intervention for girls with Rett syndrome and their mothers. *Disability Rehabilitation, 23*(3–4), 149–159.

Ledford, J. R., & Wehby, J. H. (2015). Teaching children with autism in small groups with students who are at-risk for academic problems: effects on academic and social behaviors. *Journal of Autism and Developmental Disorders, 45*, 1624–1635.

Minshew, N. J., Goldstein, G., & Siegel, D. J. (1995). Speech and language in high functioning autistic individuals. *Neuropsychology, 9*, 255–261.

Mirenda, P. (2003). He's not really a reader...: Perspectives on supporting literacy development in individuals with autism. *Topics in Language Disorders, 23*(4), 271–282.

Nation, K., & Norbury, C. (2005). Why reading comprehension fails: insights from developmental disorders. *Topics in Language Disorders, 25*, 21–32.

Nation, K., Clarke, P., Wright, B., & Williams, C. (2006). Patterns of reading ability in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 36*(7), 911–919. doi:10.1007/s10803-006-0130-1.

O'Connor, I., & Klein, P. (2004). Exploration of strategies for facilitating the reading comprehension of high-functioning students with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 34*(2), 115–127. doi:10.1023/B:JADD.0000022603.44077.6b.

Plavnick, J., Marchand-Martella, N., Martella, R., Thompson, J., & Wood, A. L. (2014). A review of explicit and systematic scripted instructional programs for students with autism spectrum disorder. *Review Journal of Autism and Developmental Disorders, 1*, –12. doi:10.1007/s40489-014-0036-3.

Plavnick, J., Thompson, J., Englert, C., Mariage, T., & Johnson, K. (2016). Mediating access to Headsprout® early reading for children with Autism Spectrum Disorders. *Journal of Behavioral Education*. doi:10.1007/s10864-015-9244-x.

Radley, K. C., Dart, E. H., Furlow, C. M., & Ness, E. J. (2015). Peer-mediated discrete trial training within a school setting. *Research in Autism Spectrum Disorders, 9*, 53–67.

Ryndak, D. L., Morrison, A. P., & Sommerstein, L. (1999). Literacy before and after inclusion in general education settings: a case study. *Journal of the Association for Persons with Severe Handicaps, 24*, 5–22. doi:10.2511/rpsd.24.1.5.

Schopler, E., Reichler, R., & Rochen Renner, B. (1988). *The childhood autism rating scale*. Los Angeles: Western Psychological Services.

Smith Gabig, C. (2010). Phonological awareness and word recognition in reading by children with autism. *Communications Disorders Quarterly, 31,* 67–85.

Sparrow, S., Balla, D., & Cicchetti, D. (1984). *Vineland adaptive behavior scales.* Circle Pines: American Guidance Service.

Spector, J., & Cavanaugh, B. (2015). The conditions of beginning reading instruction for students with Autism Spectrum Disorder. *Remedial and Special Education*. doi:10.1177/0741932515579277.

Stringfield, S. G., Luscre, D., & Gast, D. L. (2011). Effects of a story map on accelerated reader postreading test scores in students with high-functioning autism. *Focus on Autism and Other Developmental Disabilities, 26*(4), 218–229. doi:10.1177/1088357611423543.

Tager-Flusberg, H., & Joseph, R. M. (2003). Identifying neurocognitive phenotypes in autism. *Philosophical Transactions of the Royal Society of London., 358*(1430), 303–314. doi:10.1098/rstb.2002.1198.

Torgesen, J. K., Alexander, A. W., Wagner, R. K., Rashotte, C. A., Voeller, K. K. S., & Conway, T. (2001). Intensive remedial instruction for children with severe reading disabilities: immediate and long-term outcomes from two instructional approaches. *Journal of Learning Disabilities, 34*(1), 33–58. doi:10.1177/002221940103400104.

Vellutino, F., Scanlon, D., Zhang, H., & Schatschneider, C. (2008). Using response to kindergarten and first grade intervention to identify children at-risk for long-term reading difficulties. *Reading and Writing, 21*, 437–480.

Wanzek, J., & Vaughn, S. (2007). Research-based implications from extensive early reading intervention. *School Psychology Review, 36*, 541–561.

Wei, X., Christiano, E., Yu, W. M., & Spiker, D. (2015). Reading and math achievement profiles and longitudinal growth trajectories of children with an autism spectrum disorder. *Autism, 19*, 200–210.

Westerveld, M., Trembath, D., Shellshear, L., Hons, B., & Paynter, J. (2016). A systematic review of the literature on emergent literacy skills of preschool children with autism Spectrum disorder. *The Journal of Special Education, 50*, 37–48.

Whalon, K., & Hanline, M. (2008). Effects of a reciprocal questioning intervention on the question generation and responding of children with autism spectrum disorders. *Education and Training in Developmental Disabilities, 432,* 367–387.

Whalon, K., & Al Otaiba, S., & Delano, M. (2009). Evidence-based reading instruction for individuals with autism Spectrum disorders. *Focus on Autism and Other Developmental Disabilities, 24*, 3–16.

Whitcomb, S., Bass, J., & Luiselli, J. (2011). Effects of a computer-based early reading program (Headsprout®) on word list and text reading skills in a student with autism. *Journal of Developmental and Physical Disabilities, 23*, 491–499.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock Johnson III tests of achievement (WJ-III)*. Itasca, IL: Riverside Publishing.

Zumeta, R., Compton, D., & Fuchs, L. (2012). Using word identification fluency to monitor first-grade reading development. *Exceptional Children, 78*, 201–220.