Enhancing the Reading Development of Learners with Autism Spectrum Disorder

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ABSTRACT

Foundational to autism spectrum disorder (ASD) are difficulties developing joint attention, social reciprocity, and language/communication. These challenges place children with ASD at risk for future reading failure. Research suggests that many school-aged children with ASD will learn the decoding skills necessary to effectively read text, but will struggle with comprehension. Yet, the reading profiles of learners with ASD also show great heterogeneity, with some also unable to effectively decode new words. The range of challenges associated with ASD highlights the need for comprehensive literacy/reading instruction that addresses both code- and meaning-focused skills from the earliest grades. This article will provide an overview of effective interventions that support both the code- and meaning-focused skills of learners with ASD. Specific examples of effective instructional practices for learners with ASD will be shared.

KEYWORDS: Autism, reading, comprehension, phonics, intervention

Learning Outcomes: As a result of this activity, the reader will be able to (1) explain the reading profiles associated with autism spectrum disorder (ASD); (2) identify methods to assess skills associated with word recognition and listening comprehension; (3) explain issues with assessing the word recognition and listening comprehension skills of learners with ASD; (4) describe evidence of effective instruction targeting code- and meaning-focused skills of learners with ASD; and (5) define the components of effective reading instruction for learners with ASD.

Reading is an essential skill for success in adult life.[1] Defined broadly as "gaining meaning from print,"[2(p.3)] reading is an active process because the reader engages with text to attain information and generate meaning.[3] One well-supported theory,[4,5] the Simple View of Reading, asserts that effective reading is the product of two distinct skills: (1) word recognition or decoding and (2) language comprehension.[6] Difficulties learning to read are often classified

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in terms of the Simple View of Reading with some children struggling to learn effective word recognition skills, others learning to decode but unable to comprehend, and others experiencing difficulty learning to decode and comprehend text.[4] Although a useful framework, the term *simple view* may be misleading because reading is dependent on several developmental skills including language, cognition, and social,[2] and there are several complex component skills necessary for decoding and listening comprehension.[7]

READING AND LEARNERS WITH AUTISM SPECTRUM DISORDER

Research related to the reading development of learners with autism spectrum disorder (ASD) suggests great heterogeneity, with some learners performing in the average range and others unable to reliably respond to items on reading measures.[8,9] Three reading profiles are typically associated with ASD: (1) readers scoring in the average range on reading measures (i.e., average readers); (2) readers with average or above average scores on word recognition assessments and scores of at least one standard deviation below the mean on comprehension measures (often referred to as specific comprehension deficit[4] or poor comprehenders[10]); and (3) readers with scores below average on both word recognition and comprehension measures.[9,11–14] What has not emerged in the literature is a profile consistent with dyslexia: scores in the average or above average range on language comprehension and below average on measures of word recognition.[4]

Skills associated with word recognition are often referred to as code-focused and those that contribute to comprehension are meaning-focused skills. This article will review the code- and meaning-focused skills of learners with ASD, practices and issues related to assessing these skills, and evidence of effective instruction targeting code- and meaning-focused skills.

WORD RECOGNITION AND CODE-FOCUSED SKILLS AND LEARNERS WITH AUTISM SPECTRUM DISORDER

Decoding or code-focused skills are influenced by phonological (speech sounds), orthographic (print symbols or letters in text), and semantic (word meanings) knowledge.[15] To decode, children learn to apply the alphabetic principle or to map sounds to their corresponding letters, and blend those sounds together to form words.[16] Practice applying this skill to decode new words builds orthographic knowledge as children begin to visually recognize word parts and later whole words, which enhances the speed and accuracy of word recognition.[17] When learning to decode, pairing what is known about phonological decoding with knowledge of word meanings can assist children with accurate decoding.[18] Over time, children rely less on decoding letter by letter and begin chunking by larger units of sound or meaning, eventually recognizing whole words without relying on phonetic decoding.[16] This shift occurs through opportunities and experience reading text.[19]

Code-Focused Skills and Learners with Autism Spectrum Disorder

Learners with ASD have difficulty with comprehension, but there is also great variability on measures of word identification, with some learners with ASD struggling to decode and others scoring in the average to above average range on word recognition measures.[8] Assessment of word reading often includes word identification and nonword measures to evaluate the extent to which children apply decoding strategies. Learners with ASD are observed to have average to above average performance on both measures[11–13,18–21]; however, some studies have shown a portion of these readers scoring better on word recognition than nonword decoding measures, indicating that some learners with ASD may not consistently apply decoding skills.[9,12–14,20,21] Like their peers who struggle to decode, there is some evidence that phonological awareness and syntax predict word recognition skills.[12,21–23] Yet, more research is needed, because there is also evidence that scores of young children with ASD on phonological awareness (i.e., elision and sound blending) measures failed to predict word recognition performance.[20]

To fully understand the reading profiles of children with ASD, it is important to assess

their word identification skills in isolation and when reading connected text. For example, some learners with ASD experience greater difficulty decoding irregular words when reading connected text; unlike their typically developing peers, they may fail to pair their decoding skills with context to decipher irregular words.[24] This difficulty reading connected text has implications for reading fluency. Reading fluency is necessary for effective comprehension, because fluent readers read text accurately at a rate that will not compromise comprehension.[25] That is, when readers are not laboring to decode words, their attention can be focused on reading for meaning. Not all learners with ASD who are effective word readers become fluent readers; some perform well on word recognition tasks but are unable to read sentences or connected text fluently.[12,16,27]

LISTENING COMPREHENSION AND MEANING-FOCUSED SKILLS

Reading for meaning is dependent on listening comprehension or generating meaning from spoken words, sentences, or discourse.[6] The process of constructing meaning from print is the same whether one is listening to or reading text, and requires understanding at the word, sentence, and discourse levels to generate a clear, accurate representation of text. This process of deriving a representation of text is referred to as developing a mental model or a situation model.[28] When constructing a mental representation of text, the reader applies foundational language skills (i.e., vocabulary and grammar) and advanced linguistic and cognitive processing to integrate background knowledge with information from the text to generate inferences.[28] This process is active and flexible as readers apply strategies to build and refine their mental models by keeping relevant and discarding irrelevant inferences.[29] Creating and refining mental representations of text involves higher-order language and cognitive skills, such as making inferences from background knowledge; inferring character intentions, thoughts, and feelings (i.e., theory of mind); having knowledge of text structure; and monitoring understanding.[7,28] Mental models of text are compromised when children lack sufficient background knowledge or when they fail to integrate that knowledge when reading. Creating a mental model becomes increasingly difficult when there is irrelevant information to sort through and when mental representations must be frequently altered based on new information.[28]

Meaning-Focused Skills and Learners with Autism Spectrum Disorder

Many learners with ASD develop effective word recognition skills but struggle to comprehend text.[9,11,12,18] These children are often described as poor comprehenders. The proportion of children with ASD with reading skills consistent with this profile (one in three) surpasses that of their typically developing peers (7 to 10%).[11–13,26] The difficulties children with ASD experience related to comprehension have been linked to vocabulary, language comprehension, and advanced oral language skills (e.g., inferencing).[8,9,12,18,24] Emerging research also suggests that comprehension skills may be influenced by the social deficits foundational to ASD. That is, higher scores on measures of autism symptomology are associated with lower scores on reading comprehension measures.[11–13,18,24] Ricketts and colleagues also found a relationship between comprehension and theory of mind (i.e., inferring the mental states of others) in learners with ASD.[18] Challenges related to theory of mind are inherent in ASD and may interfere with interpretation of narrative texts, because research has shown children with ASD are more likely to struggle in comprehending text that requires social knowledge or understanding.[8] This is not surprising, because the comprehension of narrative text requires the reader to make connections between character actions and events to infer their thoughts, feelings, and motivations, and adjust these initial inferences as the plot evolves.[30] There are several higher-order language processing tasks that are necessary for reading comprehension and have been shown to affect the comprehension of learners with ASD: integrating information, using sentence context to infer word meanings, and organizing narrative structure.[12,26] McIntyre and colleagues found that such higher-order language

processing tasks mediated the relationship between social communication and reading comprehension.[12] Difficulties with these higher-order language processing tasks seem to correspond to the challenges learners with ASD experience organizing information, connecting past and present experiences, linking concepts, determining relevant from irrelevant information, and planning.[31]

ASSESSMENT TO PLAN INSTRUCTION

For children at risk for reading failure, there is an emphasis on early identification and prevention that involves assessing and teaching the early language and literacy skills related to future reading.[32] For example, several areas assessed in kindergarten or earlier are predictive of future word identification skills, including alphabet knowledge, phonological awareness, rapid naming (i.e., letters, digits, objects, colors), ability to write own name, phonological memory, and letter naming fluency (often identified as the strongest predictor).[1] It is unclear if these same measures are as predictive of the future reading performance of children with ASD. Generally, young children with ASD (ages 3 to 7) score as well or better than their typically developing peers on alphabet knowledge measures.[33–36] In fact, recent research finds higher scores on measures of autism symptomology are associated with higher alphabet recognition scores.[36]

As is true of reading measures in general, there is greater heterogeneity in performance on phonological awareness tasks among young children with ASD.[34,36] Some young children with ASD (3 to 7 years old) score in the average range on initial sound identification measures and score below their typically developing peers on more advanced phonological skills, including blending and elision tasks.[20,34,36] In an initial sound identification task, the child is often shown a target picture and asked to select a picture from an array that has the same first sound. In contrast, a blending task may ask the child to blend together parts of words often beginning with larger chunks such as compound words (e.g., "What word do these make: *sun* [1- to 2-second pause] *flower*"), and onset and rime (e.g., *b-at*), and ending with individual phonemes (e.g., *d-i-sh*). In an elision task, the child is asked to say a word with a portion of that word deleted. This task also often begins with larger units of sound ("Say *cowboy*. Now say *cowboy* without *boy*.") and progresses in difficulty to individual phonemes ("Say *smile*. Now say *smile* without */s/*"). These skills differ in level of complexity with mastery of initial sound identification often preceding proficiency with tasks that require the blending and manipulation of sounds in words.[37] Lower performance on measures of advanced phonological tasks may indicate that some children with ASD develop these skills at a slower rate than their typically developing peers, have had limited exposure to similar tasks, and/or, as others have contended, have difficulty interpreting the complicated, multistep directions often associated with these tasks.[14]

In the early grades, it is challenging to distinguish difficulties with decoding versus reading comprehension, because decoding is necessary for effective reading comprehension.[38] Therefore, in the early elementary years, oral language comprehension measures are likely better for screening future reading comprehension problems.[38] Although there is a need to screen early for children at risk for reading comprehension failure, more attention has been focused on screening tools associated with word identification.[39] Research suggests that complex oral language skills are predictive of future reading comprehension.[1] Catts and colleagues found that vocabulary (i.e., expressive and receptive), recalling sentences (i.e., repeating a sentence without changing meaning or structure), and narrative skills (i.e., storytelling and understanding) predicted future reading comprehension, with vocabulary being the strongest predictor.[39]

A combination of assessments will likely be necessary for learners with ASD, because some children with ASD who struggle with reading comprehension may score well on expressive or receptive vocabulary measures, but poorly on recalling sentences and narrative measures.[12,36] For young children, vocabulary measures that extend beyond labeling to defining words (e.g., child is shown a picture of an item such as a zipper and is asked, "What is this? What is it

for?") are likely a better indicator of future comprehension.[1] Young children with ASD experience more difficulty providing meanings of words than simply labeling words.[33,34]

When individuals with disabilities fail to progress in a comprehensive reading program, data are used to design more targeted, intensive interventions.[40] For children with ASD, ongoing progress monitoring will be an essential component of reading instruction because many of their challenges associated with reading (e.g., reading comprehension, fluency) may not manifest until later in their schooling. That is, children with ASD may develop many of the skills associated with effective early reading (e.g., alphabet recognition, letter-sound correspondences, initial sound identification, letter identification, labeling vocabulary), yet struggle as these skills become increasingly complex.

There is evidence that some younger children with ASD score higher on measures of word reading, comprehension, decoding, and picture vocabulary than older children with ASD.[14] In addition, research suggests the performance of learners with ASD on measures of comprehension and word identification declines over time.[24,41] Newman and colleagues suggested that the strong word recognition abilities of young children with ASD may indicate early development of word recognition skills rather than advanced word recognition because scores become more commensurate with age over time.[14] As a result, some early reading indicators may be misleading and fail to capture risk factors that impede more advanced reading skills.

One form of assessment that may yield useful information for planning with children with ASD is dynamic assessment. Dynamic assessments are specifically tied to instruction and allow opportunities for feedback during testing to determine how children respond to instruction related to the target skill.[32] In one example of a dynamic assessment of phonological awareness, a portion of a word was removed, and the child was asked to say what remains ("Say *butterfly* without *fly*"). Feedback and predetermined prompts were provided until the child responded correctly. Higher scores reflected more independent responses (i.e., no or fewer prompts).[42] Such an assessment provides information on the child's current level of independence with a skill/task and how responsive the child is to instruction targeting that skill.[36]

READING INSTRUCTION FOR LEARNERS WITH AUTISM SPECTRUM DISORDER

A quality, comprehensive reading program addresses skills for word identification, fluency, and comprehension and is responsive by incorporating ongoing progress monitoring to meet individual needs.[15] Unfortunately, the research base on the effects of comprehensive reading interventions on the reading development of children with ASD is limited. Studies of comprehensive programs include computer-based programs (e.g., Headsprout (Learning A to Z; Tucson, AZ) and ABRACADABRA [ABRA] (Concordia University; Montreal, Canada)), and direct instruction methods (e.g., Reading Mastery (McGraw-Hill Education; New York, NY)).[43–47] These commercially available programs teach foundational reading skills to mastery and include lessons that target skills necessary for word reading and comprehension. Table 1 provides a list and links to more information of all commercially available programs reviewed.

ABRA is a free computer-assisted program that incorporates 15 minutes of word-level reading (alphabet, phonics, word identification, word spelling) instruction, 20 minutes of fluency and comprehension instruction, and 15 minutes of adult-led extension activities (e.g., shared reading, word games).[43] The computer activities include engaging videos and apply a systemic instruction (i.e., least to most prompting hierarchy). Two studies using ABRA included the same 20 participants with ASD ages 5 to 11 years old with varying levels of ability. These studies added reward contingencies to increase engagement and motivation.[43,44] Following 13 weeks of instruction in a one-to-one context, the intervention group outperformed the wait list control group on measures of word-level reading, passage reading accuracy, and reading comprehension measures.[43] Although children with ASD did not improve their conventional spelling following participation in ABRA, they did improve their ability to apply phonemic, orthographic,

Table 1 Commercially Available Curriculum Used in Studies

Curriculum	Publishing Information
Headsprout	A computer-based early reading program https://www.headsprout.com
ABRACADABRA	A comprehensive computer assisted reading program http://www.concordia.ca/research/learning-performance/tools/learning-toolkit/abracadabra.html
Reading Mastery	A comprehensive early reading program https://www.mheducation.com/prek-12/program/MKTSP-UQM08M02.html
Corrective Reading	A decoding and comprehension program for struggling readers in third grade and above https://www.mheonline.com/directinstruction/corrective-reading/

Abbreviation: ABRACADABRA (Concordia University, Montreal, Canada); Corrective Reading (McGraw-Hill Education, New York, NY); Headsprout (Learning A to Z, Tucson, AZ); Reading Mastery (McGraw-Hill Education New York, NY).

or morphologic knowledge when attempting to spell words.[44]

Headsprout is a computer-based program with 80 15- to 20-minute lessons that teach decoding, fluency, and beginning comprehension skills up to a second-grade level.[46] Two studies of Headsprout have included a total of seven children with ASD, ages 4 to 6, all with some vocal speech. In both studies, adaptations were required including direct instruction (e.g., discrete trial training) to teach some tasks (e.g., identifying examples/nonexamples). Both studies also added reinforcement schedules. Results suggest that learners with ASD can complete Headsprout lessons and increase their correct responding during Headsprout lessons.[45,46] Grindle and colleagues added additional reading measures and found that children with ASD increased their performance on at least three of four reading fluency measures (i.e., initial sound fluency, phoneme segmentation fluency, word use fluency, letter naming fluency, and nonsense word fluency) and word recognition measures.[45]

Finally, the Reading Mastery program includes direct instruction using scripted lessons that explicitly teach phonemic awareness, letter-sound correspondence, decoding, and beginning comprehension skills.[47] Reading Mastery provides frequent practice and error correction until target skills are taught to mastery. In a study of 56 young children (5 to 6 years old) with ASD, children receiving Reading Mastery instruction outperformed a business-as-usual comparison group on measures of word reading and letter-sound knowledge, but not reading fluency or passage comprehension; however, the majority of participants completed only early reading lessons, which primarily addressed word recognition skills.[47]

These studies suggest that direct instruction delivered by computer or adult can be effective for learners with ASD, but receiving instruction by computer alone is likely insufficient, because learners with ASD required additional instruction to fully participate in some Headsprout games/tasks, and ABRA, although partially computer-based, incorporates targeted teacher-led activities to enhance skill acquisition. In addition, because many children with ASD will experience difficulty with comprehension, it is likely essential to select comprehensive reading programs that also address language comprehension from the earliest grades or to pair programs that emphasize word recognition with supplemental programs or evidence-based strategies shown to improve language comprehension while children with ASD are still learning to decode words.

Targeted Code-Focused Instruction

For young children (ages 3 to 5), effective code-focused interventions are generally taught in individual or small-group contexts and consist of detecting and/or manipulating sound units in words, learning the alphabet, and simple phonics tasks.[1,37] As children begin to learn to read, their phonological skills, including phonemic awareness and the application of the alphabetic principle, significantly impact their ability to

decode, making these important instructional targets for school-aged children.[17] Instruction addressing word identification skills emphasizes the ability to phonetically decode, using letter-sound correspondence.[48] This direct instruction focusing on mapping sounds to letters to decode words is organized in a logical progression of increasing difficulty, with each new skill building on the preceding skills.[49] Table 2 provides examples of code-focused skill instruction.[37,49]

No targeted studies have explicitly addressed the phonological awareness or print awareness skills of children with ASD, and few have addressed alphabet recognition or phonics. One study targeted 3- to 6-year-old children with ASD struggling to learn the alphabet.[50] Following explicit instruction, participants with ASD learned alphabet recognition,[50] letter-sound correspondence,[51,52] and beginning decoding[51,53,54] skills. In two studies, learners with ASD read the whole word, segmented each sound in the word, said the sounds slowly to form the word, then said the word fast.[53,54]

In another study, participants with ASD used an augmentative and alternative communication device to engage in a variety of literacy activities to improve letter-sound corresponding, blend sounds to form words, and begin decoding. The device included an array of four options for each task. Given a spoken phoneme, spoken segmented word, or written word,

Table 2 Examples of Code-Focused Skill Instruction

Skill	Example
Phonological awareness: Ability to identify sounds in spoken words. Children generally progress from identifying, blending, segmenting, and manipulating larger units of sounds in words (e.g., words in compound words like *cow-boy*; syllables in two syllable words like *wa-ter*) to smaller units of sound (e.g., onset rime in one syllable words like *ch-op*; individual phonemes in words /*b*//*u*//*s*/).	**Initial sound identification:** "Find the picture that starts with /*m*/." **Blending sounds in words:** Given two puzzle pieces illustrating a picture of a word, the teacher asks, "What word do we get when we put *win-dow* together?" while putting the puzzle pieces together to make a picture of a window. **Segmenting sounds in words:** The child is given a picture of jam and three pieces of felt. The child moves each piece of felt into an Elkonin box as he or she says the individual phonemes /*j*/ /*a*/ /*m*/. **Manipulating sounds in words:** The child is given three picture options and asked to find the picture of *lunchbox* without the *lunch*.
High-frequency sight words: Words students encounter frequently in text. High-frequency words include decodable words that follow typical phonetic rules and irregular words inconsistent with common phonetic rules.	Present a variety of opportunities to become fluent reading high-frequency words • Build fluency by repeatedly reading target high-frequency words on flash cards • Intentionally provide opportunities for children to encounter target high-frequency words in connected text
Phonics: Teaching children to map sounds to letters and segment and blend those sounds to form words.	On a small dry-erase board, the teacher writes the word *mat* and puts a finger under the first letter as children say the sound, sweeps finger to the second letter as children make the sound, and sweeps finger to the final letter as children make the sound. The teacher sweeps her finger under the entire word and the children "say it fast." Children write each letter sound the teacher speaks to create and say a word.

children were taught to identify the corresponding phoneme, written word, or picture representing the written word from the array.[51] Together these studies suggest that children with ASD and complex communication needs can develop and apply the alphabetic principal to decode words.

Few studies have addressed the reading fluency of children with ASD.[55,56] Studies suggest that learners with ASD (ages 9 to 12) have benefitted from fluency instruction that includes (1) repeated reading of a passage more than two to four times paired with corrective feedback on errors,[56,57] (2) a passage preview strategy with the adult modeling fluent reading and asking the participant to then read the same passage paired with error correction,[55,57] and (3) graphing the number of words read correctly per minute.[55,57] One study compared a listening passage preview strategy with repeated reading, and participants experienced greater gains in the repeated reading condition.[57] These studies suggest that when learners with ASD experience difficulty with fluency, repeated reading with error correction and graphing may improve their reading speed and accuracy. This is consistent with reading research that suggests repeatedly reading text aloud until a predetermined goal related to rate and/or accuracy is reached, providing adult or peer corrective feedback (e.g., prompting students to decode the word, providing the correct word, and asking the student to reread it), and graphing performance build fluency.[58]

Targeted Meaning-Focused Interventions

To form a mental representation of text, good readers (1) set a purpose for reading, (2) apply their knowledge of syntax and grammar by linking information within sentences and combining sentences, (3) make inferences by connecting ideas/events read to prior knowledge, (4) apply vocabulary knowledge, (5) use knowledge of text structure, and (6) monitor understanding at the word, sentence, and text levels.[59] To improve reading comprehension, research supports teaching comprehension strategies, building vocabulary and content knowledge, and teaching various text structures while also providing opportunities to learn with peers and enhance motivation by offering choice.[30] Two approaches to comprehension include strategy instruction and content-focused instruction. Strategy instruction involves explicitly teaching the mental processes used to gain meaning from text (e.g., prediction, question generation, summarization). Content-focused instruction engages students in the reading process through active, ongoing discussion about the text being read to instantaneously build a mental model of the text while reading.[60] These approaches are based on two different interpretations of the problems experienced by individuals who struggle to comprehend. Strategy instruction is based on the premise that poor comprehension reflects a failure to apply the strategies that good readers use to gain meaning from text, whereas content-focused instruction stems from the belief that learners struggling to comprehend have trouble engaging in the processes necessary to build and refine mental representation of text while reading.[30]

Because children with ASD are at risk for future reading comprehension failure, instruction targeting comprehension should begin in the earliest grades. In the preschool years, instruction emphasizing language comprehension often includes building vocabulary and listening comprehension. An effective early literacy curriculum includes instruction that facilitates interactive dialogue about text that intentionally promotes learning, scaffolds language, and supports comprehension.[61] At present, preschool interventions that address language comprehension of children with ASD emphasize shared reading. Shared reading interventions have improved spontaneous verbalizations,[62–64] vocabulary,[64] and correct responding.[65,66] Dialogic reading (DR) is a shared reading intervention that enhances the oral language skills necessary for future reading comprehension,[5] and is well supported in the literature.[1] Fleury and colleagues found that DR improved the verbal participation and vocabulary of children with ASD.[63,64] Whalon and colleagues adapted DR to include systematic instructional procedures shown to support the learning of children with ASD, including visual supports, prompts to promote joint attention, and a least-to-most prompting hierarchy.

Children with ASD increased their correct, spontaneous responding to fact- and inference-based questions,[65,66] and some children increased their spontaneous initiations.[65]

Several reviews have synthesized findings from listening and comprehension studies of school-aged learners with ASD.[67–72] Together the reviews suggest that children with ASD benefit from comprehension instruction that is consistent with reading research, including components of strategy and content-focused instruction. For example, some strategies have focused on understanding sentences, including connecting anaphors to their referents. One of the more frequently read anaphors in text are pronouns, which have little meaning without making the connection to the antecedent.[10] Learners with ASD have difficulty using and understanding pronouns.[73] Anaphoric cueing teaches learners with ASD (ages 10 to 17) that "shortcuts" are often used in place of some words in text. For example, in the sentences *Sally went to the mall to buy a sweater. She spent 20 dollars*, participants are expected to supply the referent for the underlined word. In understanding the relationship between pronouns and referents, students with ASD have improved their comprehension of text.[73,74] Solis and colleagues found that scores were higher when anaphoric cueing was paired with a graphic organizer, token economy, and selection of books based on interest, rather than anaphoric cueing alone.[74]

Corrective reading is a direct instruction program that has been used to teach learners with ASD (ages 11 to 14) to interpret sentences.[75,76] Participants identified whether they had enough information to answer a question, then used a fact statement to determine if a given scenario was possible, completed analogies, and/or created a rule given a statement about a phenomenon. Direct instruction involved modeling the skill, guiding the students as they practiced the skill, and independent practice. Students responded chorally, and any errors were corrected by the adult modeling the correct response and asking students to repeat. Following direct instruction, participants improved their performance on all target tasks.[75,76]

At the text level, comprehension studies designed for learners with ASD (ages 7 to 17) incorporated before-, during-, and after-reading activities to enhance understanding of text. Prereading activities set the purpose for reading by accessing or building prior knowledge, making predictions, and/or reviewing key vocabulary.[74,77–82] During reading, participants were encouraged to monitor their comprehension by identifying text they did not understand,[79,81] responding to text cues such as underlined signal words,[77] or responding to embedded true-or-false statements or main idea questions.[78,81] Another strategy used to monitor comprehension during reading involves teaching children with ASD to generate and respond to fact-based and/or fact- and inference-based questions about text through adult modeling and corrective feedback.[74,82] Other studies emphasized organization, prompting, and feedback with children with ASD. After reading, learners with ASD completed graphic organizers,[77,81] summarized important information from the reading,[79–81] or shared information about the reading.[82] Following participation in these multicomponent interventions, participants improved their responses to fact and/or inference comprehension questions about text,[77–82] ability to generate fact-based or fact- and inference-based questions about text,[74,82] or retells.[79]

Explicitly teaching text structure to learners with ASD (ages 8 to 17) can support comprehension.[77,83–86] Studies investigating the effectiveness of text structure have focused on both fiction and nonfiction text,[77,83–86] and learners with ASD improved their ability to respond to fact questions or fact and inference questions.[77,83–85] Studies focusing on narratives targeted elements of story grammar (i.e., characters, setting, event, problem, and/or solution) and embedded graphic organizers.[83,85,86] Studies teaching nonfiction text addressed sequencing or compare/contrast using graphic organizers.[77,84] Some interventions incorporated systematic instructional procedures (e.g., least to most prompting hierarchy[83–85]) to correctly complete the graphic organizer, and others provided adult scaffolding and corrective feedback.[77,86]

Involving peers in comprehension activities is effective for students with ASD across a range of outcomes.[56,81,82] Using a partner reading format,[82] peer tutoring, or cooperative learning

Table 3 Comprehension Instruction Components and Supports Embedded for Learners with Autism Spectrum Disorder (ASD)

Comprehension Instruction	Components of Instruction	Added Supports for Learners with ASD
Before reading	Accessing or building prior knowledge	Selecting readings based on preferences
	Making predictions	Graphic organizer
	Reviewing key vocabulary terms	
During reading	Anaphoric cueing	Visual supports
	Adult scaffolding using think-aloud and corrective feedback	Scripts to generate questions
	Direct instruction (adult modeling, guided practice, independent practice)	Cues embedded in text to monitor comprehension or connect anaphors with referents
	Text structure	Least to most prompting hierarchies
	Graphic organizers	Contingent reinforcement
	Fact and inference question generation and/or responding	Self-monitoring checklists
	Identifying unclear text	
	Peer tutoring/cooperative learning	
After reading	Summarizing	Least to most prompting hierarchy
	Adult scaffolding using think-aloud and corrective feedback	Contingent reinforcement
	Responding to fact and inference questions about text	Self-monitoring checklist of task completion
	Graphic organizers	

activities,[56,81] participants with ASD and their peers took turns reading passages and providing feedback on errors,[56] asking and responding to comprehension questions,[56,81] providing a summary of the reading,[81] and reviewing key vocabulary words.[56,81] Learners with ASD and their peers also worked together to preview the text,[81] monitor comprehension by responding to embedded true-or-false statements in text and identify unclear sections,[81] and complete an academic game that involved identifying characters and facts in a story.[56] Although findings were variable for some participants, others improved their ability to respond to fact- and inference-based questions about text.[56,81,82] In addition, participants increased their social interactions[56,81] and engagement.[56,81]

To enhance participation and engagement or accuracy of correct responses,[68,79,85] meaning-focused studies have also incorporated token economies. Solis and colleagues added strategies designed to support learners with ASD (i.e., preferred interests, visual supports, self-monitoring checklists) that improved performance over comprehension instruction.[74] Overall, interventions targeting meaning-focused skills included several practices consistent with comprehension research. Table 3 provides an overview of these activities and the additional evidence-based practices specifically for learners with ASD.

CONCLUSIONS

The reviewed studies provide evidence that learners with ASD need access to high-quality, comprehensive reading programs with some supports (e.g., visual supports, systematic instruction, contingent reinforcement) that address both code- and meaning-focused skills from the earliest grades. Although an effective comprehensive reading program may be sufficient for some children with ASD, several children with ASD will require more targeted and intensive instruction to develop foundational reading skills, making ongoing progress monitoring essential to reading development. The reviewed studies were intensive; participants were taught in small-group or one-to-one contexts, providing multiple opportunities to

engage in the target skills. In addition, all studies provided consistent prompting and/or corrective feedback to ensure a correct response. More research is needed on the level of intensity needed for children with ASD struggling to develop meaning- and/or code-focused skills. When planning instruction or intervention, the reviewed studies suggest that pairing established reading interventions with supports known to enhance the learning of children with ASD can improve reading performance.

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