Strategies for Increasing Reading Comprehension Skills in Students with Autism Spectrum Disorder: A Review of the Literature

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Abstract
As the number of students with Autism Spectrum Disorder (ASD) being prepared for statewide assessment rises, there is increased demand for effective instructional strategies to improve reading comprehension scores in these students. The authors synthesized the findings of 15 studies, which included 88 school-aged students identified with ASD. The studies were conducted between 1989 and 2015. Findings indicate that Direct Instruction (DI) and graphic organizers have positive effects, while cooperative learning, anaphoric cueing, and question generation show promise. Electronic supported text shows little to no effect on reading comprehension measures in students with ASD.

Keywords: autism, autism spectrum disorder, cooperative learning, direct instruction, reading comprehension, reading instruction, reading strategies

Reading comprehension is the act of gaining meaning from print. It is a complex task that requires the integration and coordination of numerous high-level cognitive processes, necessitating active reader engagement (Cain, Oakhill & Bryant, 2004; Garcia-Madruga, et al., 2013; Nation, Adams, Bowyer-Crane, & Snowling, 1999; Pressley & Afflerbach, 1995). Reading comprehension continues to be an area of weakness for students with ASD, though it is considered to be an essential component of developing literacy (National Institute of Child Health and Human Development (NICHD), 2000). It is now thought that as many as 70% of individuals with ASD have average to above average intelligence (Chakrabarti & Fombonne, 2005), but levels of reading comprehension for students with ASD have been reported as significantly lower than peers, even when groups are matched for reading accuracy and IQ (Brown, Oram-Cardy, & Johnson, 2013; Frith &
Snowling, 1983). As with other individuals with disabilities, performance on reading comprehension tasks is correlated to individual’s verbal ability (Snowling & Frith, 1986), however, there are factors related to reading comprehension that are unique to individuals with ASD.

Autism Spectrum Disorder (ASD) is characterized by impairments in social interaction and communication, as well as restricted, repetitive, stereotyped patterns of behavior (American Psychiatric Association, 2013). In the 2012–2013 school year, there were 498,000 students aged 3–21 years in the US receiving educational services for Autism under IDEA. This represents an average annual increase of over 36,000 students since the 2002–2003 school year when 137,000 students were receiving services in this category (U.S. Department of Education, 2013). Some individuals with ASD will be dependent on life-long support and care, while others perform at levels comparable with their typically developing peers in academic settings and go on to graduate from college (Estes, Rivera, Bryan, Cali, & Dawson, 2011). Although individuals with ASD share common characteristics, they also exhibit a wide range of capabilities and strengths Many higher-functioning, school-aged children with ASD are placed in classrooms with typically developing peers and are working toward similar academic goals in the general education curriculum (Estes et al., 2011).

Impaired reading comprehension, especially when paired with normative reading accuracy, has been reported as a specific area of deficit for individuals with ASD (Nation, Clarke, Wright, & Williams, 2006). That is, individuals with ASD often are able to read text fluently without substantial comprehension of what they have read. Individuals with ASD also show mild deficits in semantic knowledge (Brown et al., 2013). A correlation does exist between semantic knowledge and reading comprehension and this may impact reading comprehension for some individuals with ASD. Saldaña & Frith (2007) demonstrated that individuals with ASD could make inferences when a limited amount of text is presented, but had difficulty when integrating specific knowledge with a global text. Limited social knowledge may also impact reading comprehension in individuals with ASD. Students with ASD perform better on reading comprehension tasks that require limited social knowledge versus those that require a high level of social knowledge (Brown et al., 2013). For example, individuals with ASD tend to lack intuitive knowledge of social behavior and often seem to be unaware of rules that govern social actions (Baron-Cohen, Leslie, & Frith, 1985). Lack of experience and knowledge integration has been found to negatively impact comprehension for learners with ASD (Wahlberg & Magliano, 2004).
Forty-three states have adopted the Common Core State Standards (CCSS), and as such, performance assessments in reading and mathematics mandated by No Child Left Behind Act (2001) have been adjusted accordingly. While many academic skills in high functioning children with ASD are on a par with their typically developing peers, weaknesses in reading comprehension continue to manifest themselves (Whitby & Mancil, 2009). Students’ mastery in reading and interpreting complex texts is a key component of the CCSS (National Governors Association, 2010), which in turn has led to a demand for interventions, that enable students with ASD to meet grade level standards in the area of reading comprehension.

**Difficulties Related to Reading Comprehension**

Cognitive differences in students with ASD (Mesibov, Shea, & Schopler, 2005) could influence reading comprehension. Theory of mind, executive functioning, and weak central coherence have been used to explain cognitive processing differences in individuals with ASD, which potentially could influence their reading comprehension (Carnahan, Williamson, & Christman, 2011). Many children with ASD lack theory of mind (Baron-Cohen, et al., 1985; Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003) that is, the ability to imagine what others may be thinking or feeling. In the context of reading, theory of mind may affect an individual’s ability to understand characters’ perspectives, make inferences about people’s motives and behavior, or make accurate predictions (Carnahan, Williamson, & Haydon; 2009; Carnahan et al, 2011; Norbury, 2005).

Weak central coherence, evident in many individuals with ASD (Frith, 2003) can lead to difficulties understanding the whole picture, difficulties assimilating information, and difficulties with higher-order thinking. Many individuals with ASD attend to specific details rather than the overall gist of an event (Happé & Frith, 2006). This may explain why individuals with ASD are able to perform tasks related to semantic knowledge and inferential information in isolation, but are challenged when applying that knowledge to a global text. In the context of reading, many individuals with ASD may focus on insignificant details rather than on the big picture, challenging their ability to comprehend and store pertinent information (Carnahan et al., 2011).

Individuals with ASD exhibit impaired executive functioning (National Research Council, 2001). Executive functioning refers to complex inter-related skills including planning, manipulating information in working memory, organization and sequencing, and self-monitoring. Individuals with ASD experience difficulties with
organization, memory, and attention (Happe & Frith, 2006; Quill, 2000). These impairments may contribute to the repetitive behaviors and rigidity of thought seen in individuals with ASD (Boucher, 2012). In regard to reading comprehension, this rigidity of thought may impact a child’s ability to shift attention between different features of a text. In addition, in individuals with ASD, impaired executive functioning may influence the ability to set a purpose for reading, monitor understanding, and integrate or make connections between information across paragraphs, texts, or experiences (Carnahan et al., 2011).

Need for the Study

In the 2012–2013 school year, there were 498,000 students aged 3–21 years in the US receiving educational services for Autism under IDEA (U.S. Department of Education, 2013). Many higher-functioning, school-aged children with ASD are placed in general education classrooms and are working toward meeting grade level standards in reading. Practitioners need guidance on choosing which interventions in reading comprehension are designed to meet the unique learning needs of individuals with ASD.

“The application of an evidence-based practice (EBP), like any other instructional practice, represents an experiment of sorts in which special educators must validate its effectiveness for each individual child” (Cook & Odom, 2013, p. 137). Educators are placed in a position where they must determine whether or not a particular EBP will benefit their own students. This position is especially tenuous for teachers of students with ASD who are working toward the CCSS in Literacy, as no EBPs in teaching reading comprehension have yet been identified. Thus, these teachers usually rely on EBPs identified for other populations and try to extrapolate the findings or modify the procedures in ways that seem reasonable. Although reviews on interventions for reading comprehension have been recently conducted (Chiang & Lin, 2007; El Zein, Solis, Vaughn, & McCulley, 2014; Senokossoff, 2015), there are limitations that warrant an additional analysis. These reviews have included studies with participants with intellectual and developmental disabilities, and have also included oral comprehension and vocabulary recognition as dependent variables. Thus, the findings are not specific to those students with ASDs and may not be directly relevant to other dependent variables of interest.

In order to increase the likelihood that educators will use research-based interventions in a meaningful way, conventional and common use of terms such as “reading comprehension” is critical. The
Phrase reading comprehension is commonly understood to mean that students are able to

make sense of what they read ... by extracting and constructing meaning through interaction and involvement with written language. Extracting meaning is to understand what an author has stated, explicitly or implicitly. Constructing meaning is to interpret what an author has said by bringing one’s “capacities, abilities, knowledge, and experiences” to bear on what he or she is reading. (Shanahan et al., 2010, p. 5).

The purpose of this review was threefold: (a) to identify studies with interventions focusing on reading comprehension, in its conventional meaning, in students with ASD; (b) to identify which of these interventions are effective; and (c) to contrast the key components of these studies for practitioners who need to make instructional decisions for their students with ASD.

Methodology

All studies included in this review met specific selection criteria. Studies included in this review were published in English and found in a peer-reviewed journal published 1985–2015. Participants were school-aged individuals ages 5–18 and identified as having ASD, either through a diagnosis determined using the DSM IV or DSM V criteria or with a classification of Autism for educational services under IDEA. Studies included in the review had a formal research design (e.g., group experimental design, quasi-experimental design, or single-subject design) that included a replicable intervention. To be included in the review, the results of participants with ASD had to be able to be parsed out from results with other populations. In studies with a group design, participants with ASD had to comprise an experimental group comparable in size to other groups. Finally, dependent variables had to include measures of reading comprehension such as answering questions, retelling, requiring participants to “extract and construct meaning” (Shanahan et al., 2010, p. 5). Exclusionary criteria were also applied. Studies focusing on listening comprehension, social skills, isolated vocabulary comprehension, sight word or decoding, oral reading fluency were not included. Studies in which participants with ASD could not be parsed out from the remainder of the sample were also excluded.
Several steps were taken to increase the comprehensiveness of the search of intervention studies. First, electronic searches of PsycINFO, ERIC, and Academic Search Premier databases were completed to locate studies in peer-reviewed studies published between January 1985 and April 2015. All combinations of the keywords Autism or Asperger with (1) reading, (2) literacy, (3) comprehension were used, returning over 200 citations. The researchers examined all abstracts and methods (e.g., participants, procedures, measures) sections in comparison to the inclusionary and exclusionary criteria. Next, references from the studies that met the inclusionary criteria were reviewed to determine if the reference list included articles that would also meet the inclusionary criteria (i.e., an ancestral search). Finally, a hand search of recent articles was conducted of issues of the following journals, *Autism, Education and Training in Autism and Developmental Disorders, Focus on Autism and Developmental Disorders, Journal of Autism and Developmental Disorders.*

The point-by-point approach (Kazdin, 1982) was used to calculate inter-rater agreement for the determination of inclusion. From the initial electronic search, 10% of the articles \( n = 20 \) were chosen randomly. Abstracts and methods were reviewed against the inclusion and exclusion criteria by both authors independently. Inter-rater agreement was 100% for that sample of articles. Finally, the authors reviewed all the articles identified and discussed both inclusionary and exclusionary criteria. Agreement was reached on whether or not the study should be included in the review.

*Measures of Effectiveness*

Effect Sizes (ES) were used as a standard measure of intervention effectiveness for group designs. If an ES was not reported, then an ES was calculated using Hedges \( g \) (Borenstein, Hedges, Higgins, & Rothstein, 2009). An intervention with an ES of 0.8 or above was considered to have a “large” effect, an ES ranging from 0.3 to 0.8, a “medium” effect, and an ES below 0.3 was considered “small.” The percentage of non-overlapping data points (PND) was calculated for single-subject designs and interpreted using criteria recommended by Banda & Therrien (2008). A PND was calculated for each participant. A PND of 90% or higher indicated the intervention was highly effective, a PND of 70% to 90% indicated moderate effectiveness, and a PND of 50–70% indicated minimal effectiveness. A PND below 50% indicated that the intervention had little to no effect (Scruggs, Mastropieri, Cook, & Escobar, 1986). Only data from the individuals with ASD was included.
Coding Procedures

At first, the articles selected for the review were coded for their attributes. The studies were coded by (a) study design, (b) age of participants, and (c) instructional format. Second, descriptive coding was used to categorize the studies. Descriptions of each study’s dependent variables, interventions, procedures, and materials were extracted from the articles, reassembled, and grouped until meaningful patterns emerged.

All the authors’ designated a study design in their articles. Pre-test/posttest designs included either within or between groups comparisons and measured an intervention’s effectiveness through pre and post intervention measurement, either through psychometric testing, researcher-created measures or both. In repeated measures designs, the same measure was used under two or more conditions for each participant. The order of conditions (i.e., interventions) was randomly assigned to each participant. In single-subject designs with randomized interventions, interventions were presented at random to the participants. In multiple-baseline studies, two or more participants were included. In multiple-baseline studies in which there were three or more participants, effects were concurrently monitored to ensure proper control of the intervention. One study had only two participants, and the effects of the intervention were monitored across multiple behaviors. Studies with a reversal design all used an ABAB design. In studies with a multiple probe across behaviors design, a multiple-baseline with concurrent monitoring of all participants took place. Probes were conducted at the end of each sequence or step of the intervention.

The age groupings of students were coded using three factors: (a) statements in the article that indicated the level of school of the participants, (b) statements which identified the grade level of the participants, and (c) statements about the age of the participants. Results were categorized according to the level of schooling (e.g., elementary, middle school). Descriptive coding (Saldaña, 2013) was used to code information about the dependent variables, interventions, procedures, and materials in each study extracted from the articles. The information was tabulated and reassembled until themes emerged. The results of the coding procedures showed that nearly all the studies had a dependent variable measuring response to comprehension questions. Since it was not possible to categorize the studies by dependent variable in any meaningful way, studies were then coded and grouped by intervention. At this point meaningful patterns began to emerge, categories were identified by an intervention which best embodied each pattern.
The instructional format was coded according to explicit statements provided in the articles (e.g., small group). Despite the applied nature of educational research, information about the classroom setting or instructional format was not always clear and sometimes was missing. For example, if the intervention was conducted in a small group in a self-contained classroom, it was not always clear whether the study participants comprised the whole group or not. Studies were grouped according to the following guidelines: one-on-one instruction, small group instruction, and general education classroom instruction. One-on-one instruction was coded if the article indicated that the intervention was carried out with a researcher, a research assistant or teacher on an individual basis with the participant. Small-group instruction was coded if the article indicated that fewer than ten students were in an instructional group and it was unclear whether the group instruction occurred in a classroom or not. Small-group instruction in a special education classroom was coded if the article indicated that the study took place in a resource room or self-contained classroom in a small group format. In this category, it was not clearly identified in the studies whether the group was limited to the participants in the study or not. General education classroom was coded if the article indicated that the intervention was carried out in a general education classroom with 15 students or more.

Results

Participants

The 15 studies that met the criteria for inclusion in this review included a total of 198 participants, 88 of whom had ASD. The other participants were either members of comparison groups, participants in a single-subject design study, or peers participating in the instructional intervention (see Table 2). The 88 participants with ASD ranged from 7–17 years of age. Seven studies included elementary-school aged participants (Armstrong & Hughes, 2012; Bethune & Wood, 2013; Kamps, Locke, Delquadri, & Hall, 1989; Kamps, Barbuta, Leonard, & Delquadri, 1994; Kamps, Leonard, Potucek, & Garrison-Harrell, 1995; Stringfield, Luscre, & Gast, 2011; Whalon, & Hanline, 2008). Six included predominantly middle-school aged participants (Asberg & Dahlgren-Sandburg, 2010; Carnahan & Williamson, 2013; Flores & Ganz, 2007; Flores & Ganz, 2009; Knight, Wood, Spooner, Browder, & O’Brien, 2014; Mashal & Kasirer, 2011) and two studies included high-school aged students (O’Connor & Klein, 2004; William-
son, Carnahan, Birri, & Swoboda, 2014). Studies varied considerably in their descriptions of participants’ abilities; however, all participants were able to follow oral directions and read at the pre-primer level or above.

**Instructional Formats**

Four of the studies included interventions with one-on-one instruction, usually conducted by the researcher (Armstrong & Hughes, 2012; Bethune & Wood, 2013; O’Connor & Klein, 2004; Stringfield et al., 2001). These studies took place in a variety of settings, such as self-contained classrooms in public and private schools. Three of the studies included small group interventions (Asberg & Dahlgren-Sandberg, 2010; Mashal & Kasirer, 2011; Whalon & Hanline, 2008). Six studies took place in special education settings such as resource rooms and special education classrooms (Carnahan & Williamson, 2013; Flores & Ganz, 2007; Flores & Ganz, 2009; Kamps et al., 1989; Knight et al., 2014; Williamson et al., 2014). Two studies took place in the general education classroom (Kamps et al., 1994; Kamps et al., 1995).

**Dependent Variables**

Nearly all of the studies had a dependent variable which measured response to comprehension questions (see Table 1). The two studies (Flores & Ganz, 2007; Flores & Ganz, 2009) which did not use response to comprehension questions used dependent variables that included making deductions, making statements, and interpreting analogies, which all assess participants’ ability to interpret connected text. Retelling was used to measure reading comprehension in two studies (Armstrong & Hughes, 2012; O’Connor & Klein, 2004). The scores for retelling were merged with the scores for responses to comprehension question in the latter. The scoring of a completed graphic organizer was a dependent variable in two studies (Bethune & Wood, 2013; Stringfield et al., 2011), but in both the primary dependent variable was response to comprehension questions.

**Interventions**

All the studies incorporated some type of teacher-led instruction (e.g., explaining an activity, modeling an activity, prompting student activity, asking guiding questions, providing definitions). Direct Instruction (DI), a very intensive teacher-led instruction procedure, was used in two studies (Flores & Ganz, 2007; Flores & Ganz, 2009). Graphic organizers were used as interventions in five studies (Bethune & Wood, 2013; Carnahan & Williamson, 2013; Mashal & Kasirer, 2011; Stringfield et al., 2011; Williamson et al., 2014).
<table>
<thead>
<tr>
<th>Coding Variable</th>
<th>Definition</th>
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<tbody>
<tr>
<td><strong>Dependent variables</strong></td>
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<tr>
<td>Responses to comprehension questions</td>
<td>Oral response to literal question</td>
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<td>Oral response to recall questions</td>
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<td>Oral response to inferential questions</td>
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<td>Matching answers to questions</td>
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<td></td>
<td>Discourse Comprehension Test (Brookshire &amp; Nicholas, 1993)</td>
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<td></td>
<td>Placement test for Corrective Reading Comprehension A: Thinking Basics program (Engelmann, Hadox, Hanner, &amp; Osborn 2002)</td>
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<td></td>
<td>Multiple choice questions on the meaning of idioms and similes</td>
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<tr>
<td>Retelling</td>
<td>Morrow’s retelling score sheet (Morrow, 1985)</td>
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<td></td>
<td>Retelling story “in your own words” with a research-created score sheet</td>
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<tr>
<td>Completion of a Graphic Organizer</td>
<td>Sorting words into a graphic organizer</td>
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<td></td>
<td>Fill in the blank story elements on a story map</td>
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<tr>
<td>Other</td>
<td>Identify facts explaining events</td>
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<td></td>
<td>Identify statements as true/false/maybe</td>
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<td></td>
<td>Make deductions and inductions</td>
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<td>Detecting an incongruous sentence</td>
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<td></td>
<td>Formulating questions</td>
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<td><strong>Intervention/Procedures</strong></td>
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<tr>
<td>Teacher-led instruction</td>
<td>Instruction in the use of a graphic organizer</td>
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<td>Instruction in wh-questions</td>
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<td>Guiding questions</td>
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<td>Teacher directions</td>
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<td></td>
<td>Teacher explanation</td>
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<td></td>
<td>Introduction of literary terms/signal words</td>
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<tr>
<td>Direct Instruction</td>
<td>Corrective Reading Comprehension A: Thinking Basics</td>
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<tr>
<td>Graphic Organizer</td>
<td>Completion of a Venn diagram</td>
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<td></td>
<td>Instruction in the use of a graphic organizer</td>
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<td></td>
<td>Use of thinking maps</td>
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<td></td>
<td>Completing character event map</td>
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<td>Cooperative Learning</td>
<td>Peer tutoring</td>
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<td>Classwide peer tutoring</td>
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<td></td>
<td>Cooperative learning groups</td>
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<td>SCORE curriculum</td>
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<tr>
<td>Electronic Texts</td>
<td>Wynn Wizard software</td>
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<td></td>
<td>Book Builder</td>
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<td>Self-directed strategies</td>
<td>Training in Question/Answer relationships</td>
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<td></td>
<td>Previewing questions</td>
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<td></td>
<td>Anaphoric cueing</td>
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<td>Cloze tasks</td>
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In addition to the DI reading comprehension program and graphic organizers, the articles were coded as follows. Four studies used cooperative learning techniques (Kamps et al., 1989; Kamps et al., 1994; Kamps et al., 1995, Whalon & Hanline, 2008). Two studies used supported electronic texts (Armstrong & Hughes, 2012; Knight et al., 2014). The remaining two studies (Asberg & Dahlgren-Sandberg, 2010; O’Connor & Klein, 2004) were grouped together because they encouraged participants to be active independent readers by utilizing self-directed strategies. Details about each study and ESs can be found in Table 2. The interventions and the findings of each group are summarized below.

**Direct Instruction.** DI is a systematic approach to instruction that integrates a curriculum designed to build skills sequentially and cumulatively, with a scripted teacher presentation. Signals and prompts are used to elicit correct student responses (Watkins, 2008). Tasks are broken down into component parts and each skill is taught to mastery. Teacher behavior and program procedures are designed to promote effective and efficient learning (Ganz & Flores, 2009: Stein, Silbert, & Carnine, 1997).

Two studies (Flores & Ganz, 2007; Flores & Ganz, 2009) included two participants with ASD and followed a single-subject multiple probe design. Identical scores on standardized tests suggest that the same participants were used for both studies. Both studies used the curriculum *Corrective Reading Thinking Basics: Comprehension Level A* (Engelmann, Haddox, Hanner, & Osborn, 2002). The researchers taught in small groups and implemented instructional procedures as directed in the instructor’s manual, following three successive strands from the curriculum. The skills selected for the first study were statement inference, using facts, and analogies (Flores & Ganz, 2007). The skills selected for the second study were picture analogies, induction, and deductions (Flores & Ganz, 2009). The researchers created their own reading comprehension probes, modeled on the skills presented in the DI program. For example, in a statement inference probe, the instructor would read a series of questions related to a statement and allow the participant to respond to the question by saying the answer from the statement or “I don’t know.” All probes were sufficiently complex to ensure that the participant was in some way interpreting what he or she had read.

The participants met criterion (i.e., 100% correct for three consecutive questions) across all three conditions in both studies. The results indicate the intervention was highly effective, using Banda & Therrien’s (2008) criteria for PND. Statement Inference and Using Facts were calculated at 100% PND for both participants, and Analogies
<table>
<thead>
<tr>
<th>Study</th>
<th>Study Design</th>
<th>Number of Participants</th>
<th>Age of Participants (years)</th>
<th>IQ</th>
<th>Intervention</th>
<th>Length of Intervention</th>
<th>Length of Sessions (minutes)</th>
<th>Findings for Participants with ASD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armstrong &amp; Hughes (2012)</td>
<td>Single-subject with randomized intervention</td>
<td>$n=5$ ASD</td>
<td>7–8</td>
<td>P1 = 109, P2 = 84, P3 = 105, P4 = 86, P5 = 114</td>
<td>Supported electronic text: Wynn Wizard vs. oral storytelling</td>
<td>11 weeks</td>
<td>$M=47.7$ ($SD=10.97$)</td>
<td>Scores on comprehension questions were stable for both conditions. Storybook (PND = 0, 20, 100, 20, 100) Computer (PND = 20, 0, 100, 10, 90)</td>
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<tr>
<td>Asberg &amp; Dahlgren-Sandberg (2010)</td>
<td>Pretest/posttest within group</td>
<td>$n=12$ ASD</td>
<td>M = 13.4</td>
<td>MIQ = 102.83, RIQ = 83–125</td>
<td>Self-directed use of Question-Answer Relationships</td>
<td>4 weeks</td>
<td>20–30</td>
<td>Scores on Discourse Comprehension Test improved. (ES = 0.35)</td>
</tr>
<tr>
<td>Bethune &amp; Wood (2013)</td>
<td>Multiple baseline</td>
<td>$n=3$ ASD</td>
<td>8–10</td>
<td>P1 = 94, P2 = 67, P3 = 90</td>
<td>Graphic organizer: wh- questions</td>
<td>30 sessions</td>
<td>10</td>
<td>Number of wh- questions answered correctly increased. (PND = 100, 100, 71)</td>
</tr>
<tr>
<td>Carnahan &amp; Williamson (2013)</td>
<td>Reversal design</td>
<td>$n=3$ ASD</td>
<td>13.4–13.7</td>
<td>Not Reported</td>
<td>Graphic organizer: Venn diagrams</td>
<td>16 sessions</td>
<td>Not reported</td>
<td>Number of comprehension questions answered correctly increased. (PND = 100, 88, 88)</td>
</tr>
<tr>
<td>Flores &amp; Ganz (2007)</td>
<td>Multiple-probe-across-behaviors</td>
<td>$n=4$ 2 Autism 2 Intellectual Disability (ID)</td>
<td>10–14</td>
<td>P1 = 98, P2 = 67, P3 = 57, P4 = 84</td>
<td>Direct Instruction</td>
<td>40 sessions</td>
<td>20</td>
<td>Scores on all tasks improved. Statement inference (PND = 100, 100) Using facts (PND = 100, 100) Analogies (PND = 88, 100)</td>
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<tr>
<td>Study</td>
<td>Design</td>
<td>N</td>
<td>Age</td>
<td>Baseline</td>
<td>Intervention</td>
<td>Sessions</td>
<td>Results</td>
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<tr>
<td>Flores &amp; Ganz (2009)</td>
<td>Multiple-probe-across-behaviors</td>
<td>4</td>
<td>12–14</td>
<td>Not Reported</td>
<td>Direct Instruction</td>
<td>35</td>
<td>Scores on all tasks improved. Analogies (PND = 100, 100) Deductions (PND = 100, 100) Induction (PND = 100, 100)</td>
<td></td>
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<tr>
<td>Kamps, Locke, Delquadri, &amp; Hal (1989)</td>
<td>Multiple baseline across behaviors</td>
<td>6</td>
<td>9–11</td>
<td>P1 = 50</td>
<td>Peer tutoring</td>
<td>60</td>
<td>Performance in academic skills improved. Money skills (PND = 100, 91) Expressive language (PND = 97, 100) Oral reading (PND = 74, 75)</td>
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<tr>
<td>Kamps, Barbetta, Leonard, &amp; Delquadri (1994)</td>
<td>Multiple baseline with reversal</td>
<td>17</td>
<td>8–9</td>
<td>P1 = 101</td>
<td>Classwide peer tutoring</td>
<td>23 weeks</td>
<td>25–30</td>
<td></td>
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<tr>
<td>Kamps, Leonard, &amp; Potucek (1995)</td>
<td>Reversal design</td>
<td>42</td>
<td>8–13</td>
<td>P1 = 101</td>
<td>Cooperative learning groups</td>
<td>75</td>
<td>Improvement on responding to comprehension questions and number of social interactions. (PND = 93, 89, 93)</td>
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<tr>
<td>Knight, Wood, Spooner, Browder, &amp; O’Brien (2014)</td>
<td>Multiple probe with changing criteria</td>
<td>4 ASD</td>
<td>11–14</td>
<td>P1 = 55</td>
<td>Supported electronic text using Bookbuilder and explicit instruction</td>
<td>40</td>
<td>Scores in comprehension scores improved with explicit instruction (e.i.). Electronic text (PND = 50, 50, 0, 0) Electronic text + e.i. (PND = 91, 71, 0, 57)</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Study Design</td>
<td>Number of Participants</td>
<td>Age of Participants (years)</td>
<td>IQ</td>
<td>Intervention</td>
<td>Length of Intervention</td>
<td>Length of Sessions (minutes)</td>
<td>Findings for Participants with ASD</td>
</tr>
<tr>
<td>----------------------------------------</td>
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</tr>
<tr>
<td>Mashal &amp; Kasirer (2011)</td>
<td>Pretest/posttest between groups</td>
<td>n = 60</td>
<td>12–15</td>
<td>Not Reported</td>
<td>Graphic organizer: thinking maps</td>
<td>2 sessions</td>
<td>Not reported</td>
<td>Significant improvement in interpreting conventional metaphors (ES = 0.62). No improvement in interpreting novel metaphors.</td>
</tr>
<tr>
<td>O'Connor &amp; Klein (2004)</td>
<td>Repeated measures</td>
<td>n = 20</td>
<td>M = 1.5.11</td>
<td>MIQ = 88.15</td>
<td>Self-directed strategies: previewing question, cloze, and anaphoric cueing</td>
<td>1 session</td>
<td>60</td>
<td>Significant improvement on reading comprehension measures. Procedural facilitation in general (ES = 0.12) Anaphoric cueing (ES = 0.42)</td>
</tr>
<tr>
<td>Stringfield, Luscre, &amp; Gast (2011)</td>
<td>Multiple baseline</td>
<td>n = 3 ASD</td>
<td>8.1–11.2</td>
<td>P1 = 70</td>
<td>Graphic organizer: story maps</td>
<td>42 sessions</td>
<td>15</td>
<td>Scores on comprehension test improved. (PND = 100, 88, 85)</td>
</tr>
<tr>
<td>Whalon &amp; Hanline (2008)</td>
<td>Multiple baseline</td>
<td>n = 12</td>
<td>7–8</td>
<td>P1 = 101</td>
<td>Cooperative learning: reciprocal questioning</td>
<td>22 sessions</td>
<td>30</td>
<td>Improvement in all measures. Unprompted question generation (PND = 85, 91, 100) Responses to peer questions (PND = 100, 100, 100)</td>
</tr>
<tr>
<td>Williamson, Carnahan, Birri, &amp; Swoboda (2014)</td>
<td>Multiple baseline</td>
<td>n = 3 ASD</td>
<td>16–17</td>
<td>P1 = unknown</td>
<td>Graphic organizer: character map</td>
<td>20 sessions</td>
<td>Not reported</td>
<td>Number of comprehension questions answered correctly increased. (PND = 100, 100, 100)</td>
</tr>
</tbody>
</table>
was 88% PND for participant 1 and 100% for participant 2 (Flores &
Ganz, 2007). Analogies, Deductions, and Induction (Flores & Ganz,
2009) were all calculated at 100% PND for both participants, indicat-
ing the intervention was highly effective. Results for maintenance
were mixed, showing a functional relation between the DI and the
reading comprehension skills measured but only on the skills mea-
sured for Corrective Reading Thinking Basics: Comprehension Level A
(Engelmann et al., 2002). It is not possible to draw general conclusions
about the effectiveness of DI for improving the reading compre-
sension skills of an individual with ASD from these two studies. More
research is needed in this area to determine the extent to which DI is
an effective intervention for teaching individuals with ASD reading
comprehension. Further, there is no indication these skills could be
generalized to novel text.

**Graphic organizers.** Graphic organizers provide a meaningful
framework for readers to form relationships between what they know
and textual information, structuring the cognitive effort required to
interpret and comprehend text (Wittrock, 1992). Learners can then see
how those concepts are connected, which in turns helps them under-
stand and retain new information (Darch & Evans, 1986). A total of 32
students aged 8–12 years with ASD participated in the five studies re-
viewed. Each study used a different type of graphic organizer: think-
ing maps (Mashal & Kasirer, 2011), wh- question organizers (Bethune &
Wood, 2013) story maps (Stringfield et al., 2011), Venn diagrams (Car-
nahan & Williamson, 2013), and character event maps (Williamson
et al., 2014).

Mashal & Kasirer (2011) used thinking maps to enhance meta-
phoric competence. Three equal groups of 20 participants were com-
pared: typically developing (TD), students with learning disability
(LD), and students with ASD. During pre-testing, participants in the
TD group scored significantly higher than the other two groups on
measures testing their ability to interpret metaphoric expressions and
identify meaningless expressions. During intervention, teachers
worked with the participants to discuss the meaning of common
metaphoric expressions with the assistance of thinking maps. For ex-
ample, the expression “train of thought” is written in a bubble at the
center of the thinking map and associations (i.e. travel/movement,
brain/ideas) are then written in surrounding bubbles. The thinking
map shows how the two ideas are connected to facilitate comprehen-
sion. All three groups showed significant improvement in their under-
standing of conventional metaphoric phrases after the intervention.
However, unlike other groups, the participants with ASD were unable
to generalize the strategy to novel metaphors.
The other four studies (Bethune & Wood, 2013; Carnahan & Williamson, 2013; Stringfield et al., 2011; Williamson et al., 2014) utilized a single-subject design. All participants were able to read, with most having higher scores in decoding than comprehension on standardized measures (Bethune & Wood, 2013; Carnahan & Williamson, 2013; Stringfield et al., 2011). Only one participant had comprehension scores higher than his decoding scores (Williamson et al., 2014). The interventions (i.e., graphic organizers) varied according to specific needs of the participants. A wh-question graphic organizer (Bethune & Wood, 2013) focused on improving participants’ comprehension of wh-questions (e.g., who, where, what). This organizer facilitated a higher number of correct responses to these questions in novel stories. A story map providing a visual depiction of basic story elements (Gardill & Jitendra, 1999) eliminated the requirement for participants to actively remember when considering relations between elements and responding to comprehension questions (Stringfield et al., 2011). A Venn diagram illustrated similarities and differences described in expository texts to assist participants in responding to comprehension questions about science (Carnahan & Williamson, 2013). A character event map was used to help participants organize their thoughts and interpret events in each chapter of the novel The Hunger Games (Collins, 2010), before being asked to respond to comprehension questions (Williamson et al., 2014). In all studies, participants were allowed to look back in the text for the answers. Two studies included additional supports in their intervention: a list of signal words like “both” and “different” (Carnahan & Williamson, 2013), and instruction on literary terms such as “foreshadowing” (Williamson et al., 2014).

In all four studies, the intervention was effective in improving scores on participants’ response to comprehension questions. Using a graphic organizer was found to be highly effective in increasing the number of “wh” questions answered correctly (Bethune & Wood, 2013) with PND reported for participant 1 at 100%, participant 2 at 100%, and participant 3 at 71% (moderate effectiveness). The use of Venn diagrams to answer comprehension questions (Carnahan & Williamson, 2013) was found to be highly effective with PNDs of 100%, 88%, and 100%. The use of story maps was found to be moderately to highly effective in improving the scores on comprehension tests (Stringfield et al., 2011) with PNDs of 100%, 88%, and 85%. The use of thinking maps (Mashal & Kasirer, 2011) had a moderate effect on interpreting conventional metaphors and no effect on interpreting novel metaphors. The use of a character map was found to be highly effective in increasing the number of comprehension questions answered cor-
rectly with PND of 100% for all three participants (Williamson et al., 2014). The studies varied on the type of questions posed with two studies including only literal questions in their probes (Bethune & Wood, 2013; Stringfield et al., 2011) while the other two included inferential questions (Carnahan & Williamson, 2013; Williamson et al., 2014). The type of question does not seem to have impacted the overall results. All studies showed that participants were able to maintain and generalize the skills they had been taught by applying the intervention to new chapters or stories. In one study, scores on comprehension questions improved even when participants chose not to use the intervention (Stringfield et al., 2011). In two of the studies, students were able to use the graphic organizer independently (Carnahan & Williamson, 2013; Stringfield et al., 2011) while participants continued to rely on instructional support from an adult even in the maintenance phase in another study (Bethune & Wood, 2013).

The research supports the use of graphic organizers to support reading comprehension in students with ASD. When choosing an intervention, it is important to match the graphic organizer with the needs of the student and the text. From these studies, it is unclear the extent to which additional elements of instruction (e.g., signal words, discussion of text, teacher prompting) enhanced the ability of participants to answer comprehension skills. The elements of instruction described were similar to those, students would encounter in a general education classroom and cannot easily be separated out. The most promising interventions are those which participants could use independently, could generalize with texts they had not previously seen and improved scores on both literal and inferential comprehension questions (Carnahan & Williamson, 2103; Williamson et al., 2014). Additional research is needed to investigate if instruction on identifying and interpreting figurative language will improve the reading comprehension scores of students with ASD.

Cooperative learning. Cooperative learning is another intervention that reflects common activities in general education classrooms. In cooperative learning, students work together toward a common learning objective (e.g., working together on a project to learn a specific domain or skill). Cooperative learning has been shown to have a positive effect on academic achievement, interpersonal relationships and self-esteem (Slavin, 1981). Four single-subject design studies used cooperative learning to enhance academics, including reading comprehension, in students with ASD (Kamps at al., 1989; Kamps et al., 1994; Kamps et al., 1995; Whalon & Hanline, 2008). A total of 11 elementary students with ASD, aged 7–13 years, participated in the studies alongside typically developing peers. All of the participants with
ASD were able to read independently, but exhibited difficulties in the area of reading comprehension. Each study used a different cooperative learning arrangement: peer tutoring (Kamps et al., 1989), class wide peer tutoring (Kamps et al., 1994), cooperative learning groups (Kamps et al., 1995), and cooperative pairs (Whalon & Hanline, 2008).

All of these studies embedded activities related to reading comprehension into a unit of instruction, which included previewing instructional activities (Whalon & Hanline, 2008); peer training (Kamps et al., 1989; Kamps et al., 1994); practice on other reading skills (Kamps et al., 1994, Kamps et al., 1995) and academic skills (Kamps et al., 1989; Kamps et al., 1994); and practice in social skills (Kamps et al., 1994; Whalon & Hanline 2008). Two studies used the SCORE curriculum (Vernon, Schumaker, & Deshler, 1993, 1996), which provides direct instruction on following cooperative learning behaviors (Kamps et al., 1995; Whalon & Hanline, 2008). One study also provided participants with a checklist so that they could monitor their own progress through the activity while focusing on reading comprehension (Whalon & Hanline, 2008). All studies used widely available reading materials and all but Kamps et al. (1995) incorporated grade-level reading material. Teachers and paraprofessionals provided reinforcement and corrective feedback to participants with ASD and their typically developing peers. In three of the studies, cooperative learning was used primarily to practice reading skills in fluency, vocabulary, and responding to comprehension questions (Kamps et al., 1989; Kamps et al., 1994; Kamps et al., 1995). Whalon & Hanline (2008) had participants engaged in reciprocal questioning about key elements of a story (e.g., setting, character, event, problem, solution).

Peer tutoring was highly effective in increasing academic skills in the areas of money and expressive language and moderately effective in oral retelling (Kamps et al., 1989). Class wide peer tutoring was moderately effective (81% PND) for one participant in increasing comprehension and not effective for two participants (27% and 0% PND) (Kamps et al., 1994). It was found to be effective for increasing social interactions for one participant (93%) and not effective for two participants (67% and 68%) using PND. Cooperative learning groups was a highly effective intervention for increasing response to comprehension questions and social interactions for one participant (93% PND), moderately effective for one participant (89% PND), and not effective for one participant (0% PND). Cooperative learning with a focus on reciprocal questioning was moderately effective for one participant (85% PND) and highly effective for two participants (91% and 100% PND) in unprompted question generation (Whalon & Hanline, 2008). It
was highly effective for all three participants (100% PND) for responses to peer questions.

The results of all four studies showed that the number of correct responses to comprehension measures increased when participants with ASD engaged in cooperative learning with their peers. Although the results of the studies are promising, with such a small sample of studies and participants, conclusions about the effectiveness of cooperative learning on reading comprehension skills in students with ASD should be made cautiously, especially since each study incorporated so many different elements. Further research is needed to determine whether peer tutoring would be effective if the sole focus was reading comprehension. Generalization of intervention effects is difficult to determine for cooperative learning. Ideally, one would need to know if participants applied cooperative learning behaviors learned in one subject area to another subject area, and this is beyond the scope of these studies. Although studies date back to 1989, they cannot be overlooked, as elements of their design have been incorporated into more recent studies. In addition to Whalon and Hanline’s (2008) research, which incorporated the SCORE curriculum (Vernon et al., 1996), other studies in this review have included small group discussions in their interventions (Carnahan & Williamson, 2013; Mashal & Kasirer, 2011; Williamson et al., 2014).

**Supported electronic texts.** In contrast to cooperative learning, supported electronic texts encourages independent study. Supported electronic text is a form of computer-assisted instruction, in which texts are enhanced to promote content area learning and comprehension (Anderson-Inman & Horney, 1996). Supported electronic text is becoming more commonly used and aligns with the principles of Universal Design for Learning, increasing access to understanding with inbuilt supports (e.g., text to speech, illustrations, definitions). Two single-subject design studies (Armstrong & Hughes, 2012; Knight et al., 2014) used supported electronic texts. The nine participants were aged 7–14 years and all diagnosed with ASD. In Knight et al. (2014), the reading comprehension scores of the participants were in the low or very low range, while in Armstrong & Hughes (2012), all participants were at the 2nd grade level on the *Jerry John’s Basic Reading Inventory* (Johns, 2005). Armstrong & Hughes focused on just the text-to-speech component of supported electronic text, which was compared to traditional instructor-led read aloud of text. Knight et al (2014) utilized all the in-built features of *BookBuilder* (CAST, 2014), which included vocabulary definitions, illustrations, text-to-speech, concept maps, and an embedded coach, which guides the reader with questions and explanations.
Armstrong & Hughes (2012) followed a strict protocol for the repeated reading intervention they used. In the storybook condition, the researcher introduced and read the book to the participant, tracing the words with his or her finger. The participant read along with the researcher, and was given an additional opportunity to retell and reread the book, before being asked to retell the story and answer questions. The computerized condition was identical except a text-to-speech book was used with the computer highlighting words in place of the researcher tracing with his or her finger. Results showed the three participants responded well to comprehension questions during both interventions, whereas two had similar scores to the baseline condition. Scores for retelling (e.g., recall and summarize what was read) were generally low. In Knight et al., (2014) two of the four participants had an increase in the percentage of correct responses to comprehension question, but a functional relation could not be established. The intervention was then modified to include explicit instruction, which included clear instructional objectives, explanations, modeling, guided, and independent practice with corrective feedback. When explicit instruction was added, the number of correct responses increased for three of the four participants.

The use of supported electronic text in the form of Bookbuilder (Knight et al., 2014) was not found to be effective in increasing reading comprehension, with PNDs of 50%, 50%, 0%, and 0% for the four participants. With the inclusion of explicit instruction, the intervention became somewhat more effective for some participants at 91%, 71%, 0%, and 57% PNDs. The use of Wynn Wizard was found to have varied effectiveness on comprehension with PNDs of 20%, 0%, 100%, 10%, and 90%.

There is not sufficient evidence to suggest that supported electronic text effectively improves reading comprehension. The results of these studies suggest other features of the interventions such as repeated reading (Armstrong & Hughes, 2012) or explicit instruction (Knight et al., 2014) might be the critical intervention component in improving the reading comprehension scores for some participants.

**Self-directed strategies.** Like the studies on supported electronic text, the remaining two studies prompted independent engagement with the text (Asberg & Dahlgren-Sandberg, 2010; O’Connor & Klein, 2004). In both studies, the researcher modeled a strategy before requiring the participants to use the strategy independently. A total of 32 participants with ASD, aged 10–18 years, were included in the studies. All participants had close to normative decoding skills, but showed weaknesses in reading comprehension. Asberg & Dahlgren-Sandberg (2010) used a pretest/posttest design and measured reading
comprehension using the *Discourse Comprehension Test* (Brookshire & Nicholas, 1993). O'Connor & Klein (2004) used a repeated measures design, in which participants read randomly assigned passages under four different instructional conditions and answered comprehension questions after each. Analysis of the variance was conducted to detect differences between the reading comprehension scores.

Asberg & Dahlgren-Sandberg (2010) conducted a study in which 12 students with ASD received instruction using Question-Answer Relationships (QARs) (Raphael, 1982). QARs provide a framework for helping students understand that there is a relationship between the type of question asked and where the answer can be found in a text. In QARs, the answer is either “In the Book” or “In My Head.” If the answer is “In the Book,” the answers to literal questions will be found “Right There” (i.e., written somewhere in the text), whereas “Think and Search” questions will require readers to link ideas from several points in the text to figure out the answer. Questions that can be answered “In My Head” may be questions that the reader can answer “On My Own” using his or her personal experiences, or “Author and Me” questions that require the reader to connect his or her background knowledge about text structure with the intentions of the author. The instruction in using QARs was derived from a specially designed training manual (Franzén, 1997). During the three- to four-week intervention phase, small group discussions were encouraged, and students either read independently or had text read-aloud to them. Post-test results showed significant improvement after training for the students with ASD. However, individual results suggested that more support during the intervention phase might be required for some students.

O’Connor and Klein’s (2004) study had four conditions: (a) pre-reading questions, (b) completing cloze sentences, (c) anaphoric cueing, and (d) a control condition. Each condition was described as a procedural facilitation, in which a reading strategy was explained to the participants. The sequence of the interventions was randomized across participants. In the pre-reading questions conditions participants were instructed to review the questions before reading the text (adapted from a 6th grade reading series). In the completing cloze sentences condition, participants had to fill in words into 12 blank spaces from information given previously in the text. In the anaphoric cueing condition, participants had to from a list of three possible referents for twelve pronouns underscored in a passage. No procedural facilitation was given in the control condition. Five passages were prepared for each condition and randomly assigned. The researchers used their own test to measure retelling and responses to both literal
and inferential questions after each condition. Although means were higher in all the conditions with procedural facilitation than for the control conditions, results showed that anaphoric cueing significantly improved students reading comprehension scores.

The self-directed use of QAR (Asberg & Dahlgren-Sandberg, 2010) was found to have a small effect (ES = .35) on the participants’ scores on a discourse comprehension text. The overall use of O’Connor and Klein’s (2004) procedural facilitations was found to have a small effect (ES = .12) and the use of anaphoric cueing was found to have a moderate effect (ES = .42) on reading comprehension.

These two studies demonstrate that students with ASD can independently use strategies that will facilitate their reading comprehension. Both studies were conducted over a relatively short period of time and showed positive results. Asberg & Dahlgren-Sandberg (2010) worked with participants in small groups while O’Connor & Klein (2004) worked with participants one-on-one. It would be useful to know whether anaphoric cueing would also be effective if taught in a small group setting. It is not possible to determine from the results of these studies whether the participants were able to maintain their skills over time. However, skill generalization is implied as participants were presented with novel texts during data collection.

Discussion

There were 15 studies that met the criteria for this review. Results showed that the effectiveness of the interventions used varied (see Table 2). Four studies were found to have highly effective interventions (Flores & Ganz, 2007; Flores & Ganz, 2009; Whalon & Hanline, 2008; Williamson et al., 2014), four studies included interventions that showed a moderate to high effect (Bethune & Wood, 2013; Carnahan & Williamson, 2013; Kamps et al., 1989; Stringfield et al., 2011), two studies included intervention showing a moderate effect (Mashal & Kasirer, 2011; O’Connor & Klein, 2004), one study had a small ES (Asberg & Dahlgren-Sandberg, 2010), and one study had interventions that showed little to no effect (Armstrong & Hughes, 2012). It was not possible to draw firm conclusions and extrapolations about the effectiveness of the interventions used in three studies (Kamps et al., 1994; Kamps, et al., 1995; Knight et al., 2014) because results varied considerably amongst participants. Kamps et al. (1994) and Kamps et al. (1995) were the only two studies that were conducted in a general education setting, so their findings may be relevant to teachers practicing in those settings. In all three studies, there were participants who
benefited from the interventions. Given that students with ASD have a wide range of capabilities, which in turn can impact reading comprehension, these studies cannot be discounted. Educators using these interventions should closely monitor their students’ responses to evaluate their effectiveness for each individual.

Interventions that were highly effective included DI (Flores & Ganz, 2007; Flores & Ganz, 2009), cooperative learning (Whalon & Hanline, 2008), and the use of a graphic organizer (Williamson et al., 2014). Overall, the use of graphic organizers appears to be the most effective intervention. Interventions addressing comprehension of figurative language (e.g., metaphors, analogies) showed moderate to high effects (Mashal & Kasirer, 2011; Flores & Ganz, 2007; Flores & Ganz, 2009). This finding is important as it demonstrates that students with ASD are able to interpret and comprehend complex elements of connected text. The effects of anaphoric cueing and the use of question-answer relationships were each evaluated in only one study. The findings showed promise. Mixed results were found for cooperative learning. Supported electronic text without any teacher-led instruction does not appear to be to improve performance on reading comprehension measures in students with ASD.

Limitations

First, ESs from studies with different designs should be interpreted with caution. When conducting research with a low incidence population, such as students with ASD, a single subject design (e.g., multiple baseline; multiple probe) may be preferable to a group design due to the limited student population and the variability in characteristics of students with ASD. However, study design does have an impact on the calculation of ESs. Studies (Asberg & Dahlgren-Sandberg, 2010; Mashal & Kasirer, 2011; O’Connor & Klein, 2004) that had a sample size of ten or more and used statistical analysis to interpret results showed that the intervention had a small to moderate effect. In contrast, single-subject studies in which participants were matched in IQ, age, and reading ability showed higher ESs. However, in practice students with ASD may not be grouped in this way and may be placed in classrooms with students with a range of characteristics.

Second, variations in the dependent variable make comparisons between the effects obtained in each study difficult. The results of the coding procedures showed that nearly all of the studies had a dependent variable that measured response to comprehension questions. Some studies used literal wh-questions that referred to textually explicit answers (Bethune & Wood, 2013; Stringfield et al., 2011),
whereas other included inferential questions (Armstrong & Hughes, 2012; Carnahan & Williamson, 2013; O’Connor & Klein, 2004; Williamson et al., 2014). In addition, in some studies participants were required to answer questions from memory (Armstrong & Hughes, 2012; Kamps et al., 1994), in others participants were allowed to look back at the text (Carnahan & Williamson, 2013; O’Connor & Klein, 2004; Williamson et al., 2014). This repetition may have helped participants remember details in a text that they may not have recalled with only one reading. Two other issues related to recall are also apparent. The first issue that occurs relates to answer choice. Most of the studies asked open-ended comprehension questions to participants, but some gave participants several answer choices (Knight et al., 2014), from which to select the correct one. These choices may have prompted participants’ memory. Additionally, the format in which questions were presented varied from study to study, for example, digital (Knight et al., 2014), oral (Armstrong & Hughes, 2012), and written (Carnahan & Williamson, 2013; Williamson et al., 2014). In many studies, the nature of the comprehension questions was not clear. The two studies (Flores & Ganz, 2007; Flores & Ganz, 2009) which did not use response to comprehension questions used dependent variables that included making deductions, making statements, and interpreting analogies: all of which assess participants’ ability to interpret connected text. All of the dependent variables measured participants’ ability to interpret connected text. The range of measures used to determine a student’s reading comprehension is inherent in the nature of reading instruction. Tasks will differ according to text complexity and purpose. Unless researchers use standardized measures, it is not possible to conclude that one intervention is more effective than another by comparing across studies.

Third, the overall sample size was small. Only 15 studies met the criteria for this study. In turn, the overall sample size of participants with ASD from all of those studies was relatively small for a comprehensive review. Even for those interventions that were highly effective (e.g., graphic organizers), there were not enough data points to clearly determine whether or not the intervention can be considered evidence-based practice.

Finally, two of the studies were conducted in languages other than English (Asberg & Daulgren-Sandberg, 2010; Mashal & Kasirer, 2011), which may influence the results and the extent to which the findings can be extrapolated to English-speaking studies. The strategies used in these studies could be used in an English language setting and future research needs to be done to determine whether the instructional language impacted the results of the studies.
Implications for Practice

Nearly half of the studies included satisfaction surveys as a measure of social validity. This practice has become more common since social validity was identified as a quality indicator within single-subject designs by Horner, Carr, & Halle (2005). Data on whether or not the intervention was beneficial and would be used again was collected from both teachers and students. Most teachers would agree that reading comprehension is important and dependent variables measuring skills in reading comprehension are socially valid. This has been established by NICHD (2000) and by the CCSS (National Governor’s Association, 2010).

Most of the studies were conducted in small group settings or classroom-like settings across different grade levels. Many included participants’ typically developing peers, which also simulates a classroom like setting. Although it is not possible to draw conclusions about the connection between peer relationships in academics and social domains, it is suggested throughout the studies that one impacts the other. The interventions used (e.g., graphic organizers, self-directed reading strategies, and cooperative learning) can be applied in classroom settings. The length of an intervention did not appear to have any impact on the effectiveness of the intervention. Practicing teachers may be inclined to choose short-term interventions, such as procedural facilitation or instruction on question-answer relationships, which show a moderate effect over a short period of time, over those interventions (e.g., DI), that show a high effect over a long period of time. All of the interventions used materials that were practical and cost effective. Knight et al. (2014) did suggest that the creation of supported electronic texts was time consuming, suggesting this might not be a first choice intervention for teachers with larger class sizes. Additionally, training for peer tutors takes time (Kamps et al., 1989). Teachers would be better advised to focus on interventions like graphic organizers that are readily available and effective, if time is a constraint. Interestingly, studies that included question and answer strategies, which can be done with no additional materials, show positive outcomes (Asberg & Dahlgren-Sandberg, 2010; Whalon & Hanline, 2008). Teacher to student ratio is also a concern. Staffing costs are significant, and school districts may not be able to hire additional staff required to implement one-on-one interventions, so it is encouraging to see positive outcomes for group instruction.

Generalization was addressed in many of the studies, most notably those that used graphic organizers (Bethune & Wood, 2013; Carnahan & Williamson, 2013; Stringfield et al., 2011; Williamson et al.,
Participants showed that the skills they had learned could be applied to text they had not previous seen before. The ability of participants to generalize a skill was also demonstrated in the same manner for anaphoric cueing (O’Connor & Klein, 2004) and reciprocal questioning in cooperative learning groups (Whalon & Hanline, 2008). Generalization did not occur when participants were asked to interpret novel metaphors (Mashal & Kasirer, 2011). This reflects the literature showing that students with ASD often have difficulty interpreting figurative language, but it is an area that teachers still need to address when asking students to read complex texts.

Implications for Future Research

One trend in the research is that more studies are replicating naturalistic classroom settings, with interventions that incorporate small group instruction, teacher-led discussion and group discussion. The inherent difficulty is controlling for the different potential confounding variables. Knight et al. (2014) did attempt to do this, by marking the introduction of a new variable, and researchers should consider this approach in future studies.

In their review El Zein et al. (2014) stated that many of the studies “appear to have been influenced largely by findings within the National Reading Panel” (p. 1318). Many of the interventions used in the studies included in this review were interventions and strategies that have been found effective for other populations. More research needs to be done on interventions, such as anaphoric cueing, that address the unique needs of students with ASD. Researchers should also consider developing interventions that address some of the unique needs of students with ASD, including interpreting figurative language. In addition, to meet the standards for EBP studies need to replicated and the results published.

References


Armstrong, T. K., & Hughes, M. T. (2012). Exploring computer and storybook interventions for children with high functioning...


Cain, K., Oakhill, J., & Bryant, P. (2004). Children’s reading comprehension ability: Concurrent prediction by working memory,
verbal ability, and component skills. *Journal of Educational Psychology, 96*(1), 31–42. doi: 10.1037/0022–0663.96.1.31


Estes, A., Rivera, V., Bryan, M., Cali, P., & Dawson, G. (2011). Discrepancies between academic achievement and intellectual dis-


Wahlberg, T., & Magliano, J. P. (2004). The ability of high function individuals with autism to comprehend written discourse. Dis-


