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Article · February 2017
DOI: 10.1177/0162643417690606

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Technology-Based Shared Story Reading for Students With Autism Who Are English-Language Learners

Caryn Alison¹, Jenny R. Root², Diane M. Browder¹, and Leah Wood³

Abstract

Demonstrating comprehension of text is a complex skill that is an area of difficulty for many students with autism spectrum disorder (ASD). Shared story reading is an intervention that has a history of effectiveness in teaching literacy skills to students with extensive support needs. This study used a multiple probe across participants design to evaluate the effects of shared story reading using e-texts and embedded prompting on vocabulary and reading comprehension of grade-aligned narrative texts by elementary students with ASD who were also English-language learners. Outcomes indicate shared story reading with the embedded technological supports was effective for teaching comprehension of WH questions as well as identification of WH rules and definitions. Implications for future research and practice are discussed.

Keywords

literacy, content/curriculum area, autism, exceptionality, tablets/iPad, technology perspectives, low-incidence disabilities, exceptionality

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Comprehension requires simultaneous application of many subskills including accessing text, understanding what is being asked, and constructing a response. Students with autism spectrum disorder (ASD) often have difficulty in comprehending text, even if their ability to decode words and read text is within normal limits (Nation, Clark, Wright, & Williams, 2006). The reason behind these difficulties is difficult to pinpoint, as the process of reading comprehension requires numerous complex language processes (Brown, Oram-Cardy, & Johnson, 2013). When students with ASD are also English-language learners (ELLS), language processing required for comprehension further compounds difficulties (Rivera, Wood, & Spooner, 2012). Researchers have successfully addressed academic challenges such as comprehension of text for students with ASD, including those who are also ELL, through the use of technology (Knight, McKissick, & Saunders, 2013; Root, Stevenson, Ley-Davis, Geddes, & Test, 2016).

Technology-Based Shared Story Reading

One method that has been used to promote comprehension of grade-aligned texts by students with severe disabilities, including ASD, is shared story reading (or read aloud), which focuses on reader–listener interactions (Hudson & Test, 2011). In a literature review evaluating the evidence of shared story reading to promote literacy for students with extensive support needs, including ASD, Hudson and Test (2011) defined two critical components of shared story reading as (a) reading a text aloud and (b) providing support for student interaction. Technology can be used to support the goal of shared story reading, which is to make the text both physically and cognitively accessible for the student.

In order to access the text in shared story reading, an adult or peer reader typically provides a read aloud. Recently, technology has been used to allow students with ASD to independently access a read aloud that is not dependent on another person, such as recordings of a text (Williamson, Carnahan, Birri, & Swoboda, 2015) or e-text (Knight, Wood, Spooner, Browder, & O’Brien, 2015; Spooner, Kemp-Inman, Ahlgren-Delzell, Wood, & Davis, 2015). These studies have allowed students with limited basic reading skills to access grade-aligned text. The benefit of teaching students to use technology to access text is increased independence. Technology can also be used to enhance response options. For example, technology allows for response options to be dynamic and adaptive to...
student responding (e.g., Mechling & Hunnicutt, 2011; Spooner et al., 2015). However, despite the increased access to instructional materials, students with ASD who are also ELL will need systematic instruction to make the text cognitively accessible as well.

Technology to Support Vocabulary Instruction

To address the need to both understand what is being asked and elicit a response, shared story reading teaches both vocabulary and listening comprehension. This twofold instructional approach is especially beneficial for students who have ASD and are ELL. Communication and language skills are one of the three core deficits in individuals with ASD (Quill, 2000), and during academic instruction, they can make it difficult to assess what a student with ASD knows. An incorrect response to comprehension questions does not necessarily mean that students do not know the answer, but rather it is possible that they do not understand the vocabulary in the question. Students who are also ELL will have increased difficulty in academic tasks when faced with unknown vocabulary, as they are still in the process of acquiring the language (Rivera et al., 2012). Therefore, the explicit vocabulary instruction in shared story reading is especially beneficial for students who have ASD and are ELL.

Direct teaching of academic vocabulary during shared story reading ensures students understand the text as well as what is being asked of them through comprehension questions. Vocabulary acquisition is a critical component of literacy development, and preteaching vocabulary relieves the linguistic demands that ELLs face during academic tasks (National Reading Panel, 2000). Constant time delay (CTD) is an evidence-based practice for teaching vocabulary to students with severe disabilities (Browder, Ahlgrim-Delzell, Spooner, Mims, & Baker, 2009) and has been used to teach students vocabulary from the text (e.g., Spooner et al., 2015), story elements (Browder, Root, Wood, & Allison, 2015), and WH words and rules (e.g., Browder, Hudson, & Wood, 2013; Mims, Hudson, & Browder, 2012) within shared story reading.

Technology to Support Comprehension Instruction

The second component of instruction in shared story reading interventions is supporting comprehension responses, possibly through a modified system of least prompts. Mims, Hudson, and Browder (2012) introduced a modified system of least prompts where the prompting hierarchy involved referring the student to narrowing portions of the text containing the answer. These procedures build upon a previous procedure in which a system of least prompts hierarchy included motor responses for selecting an answer from text (Browder, Lee, & Mims, 2011; Browder, Mims, Spooner, Ahlgrim-Delzell, & Lee, 2008; Browder, Trela, & Jimenez, 2007). As with any application of this prompting system, it allows the student to first attempt to make a response with the least amount of outside assistance before using increasingly more intrusive prompts as needed (Wolery & Gast, 1984).

One strength of this modified system of least prompts is that it teaches students to systematically locate the answer within the text. By directing students back to the text with each prompt, students may learn to perform this strategy on their own. After the discriminative stimuli of the instructional cue (e.g., “Who was this story about?”), the student is given the opportunity to respond independently. If the student does not respond or makes an error, the teacher prompts the student to locate the answer from the text. The initial prompt presents a larger section of text that is reread, such as three to four sentences or a paragraph. Subsequent prompts present a narrowing selection of text (e.g., one sentence, then phrase, then word). If students are unable to independently make a correct response when prompted to reexamine the text, a model prompt is provided. For example, the teacher will point to the correct answer on a response board or say the correct answer aloud. The teacher will then ask the student to indicate or repeat the correct answer. The goal of the modified system of least prompts when used within shared story reading is to transfer stimulus control by using prompts most resembling the natural stimuli, which is the text (Wolery & Gast, 1984).

A system of least prompts procedure is self-fading by nature; the purpose is for students to eventually locate answers in the text independently when asked a question. While the modified system of least prompts systematically teaches students to refer to narrowing portions of the text to retrieve answers to literal questions, prior studies have traditionally relied on a skilled reader (e.g., peer, paraprofessional, or teacher) to be aware of an incorrect response and facilitate prompts (e.g., Browder et al., 2013, 2015; Mims et al., 2012). Recent research on shared story reading with students with ASD who are ELL has explored how technology can replace the skilled reader in providing a modified system of least prompts.

Technology-Based Shared Story Reading With Students With ASD Who Are ELL

There is an emerging research indicating shared story reading can be effective in teaching–listening comprehension to students with developmental disabilities (Intellectual Disability [ID] or ASD) who are ELL (e.g., Browder et al., 2015; Spooner et al., 2015). These studies have demonstrated the importance of systematic instruction on both vocabulary and answering comprehension questions are important components of shared story reading and that technology can provide students opportunities to access and engage with text.

Systematic instruction is effective in teaching students with ASD to participate in technology-based shared story reading. Spooner, Ahlgrim-Delzell, Kemp-Inman, and Wood (2014) evaluated the effects of systematic instruction with an iPad on shared story reading of four elementary students with autism, including one student who was also an ELL. Researchers adapted four picture books by placing them on an iPad using the GoTalk NOW app, which allowed for text to speech,
highlighting key vocabulary, the addition of repeated story lines, and multiple response opportunities. Participants were taught to follow the steps of a task analysis for participating in shared story reading through CTD. The task analysis included steps of “reading behavior” (e.g., identifying title and author, turning pages, text pointing, etc.) and comprehension. A total of six comprehension questions (three inferential and three literal) were asked throughout each story, although only one question was asked in each session. In intervention, researchers taught students to answer comprehension questions with a system of least prompts which included (1) reread of the text, (2) model, and (3) physical prompts. All participants were able to increase the number of steps of the task analysis they were able to independently complete, demonstrating effectiveness of CTD to teach the steps of shared story reading on an iPad. While all participants were also able to increase the number of comprehension questions they were able to answer across the four picture books, progress was slow for all participants, especially the student who was an ELL. The authors recommended future research directly teach vocabulary and provide repeated opportunities to answer literal comprehension questions before moving onto inferential questions.

In a follow-up study, Spooner, Kemp-Inman, Ahlgrim-Delzell, Wood, and Davis (2015) taught elementary students with ASD and ID, two of whom were also ELL, to follow the steps of a shared story task analysis and answer vocabulary and comprehension questions when presented with a grade-aligned novel presented on an iPad. Building on the recommendations of Spooner et al. (2014), researchers pretaught vocabulary from the chapters using CTD and provided two opportunities per session for participants to answer literal comprehension questions. A modified system of least prompts was used to teach students to return to narrowing portions of the text to find the answer to the literal comprehension questions. Interventionists taught students to touch an icon on the iPad that displayed a question mark to access these text-based prompts. Using a multiple probe across participants design, researchers found a functional relation between the shared story intervention and steps of a task analysis completed independently. In addition, participants were able to answer literal comprehension questions. The results of Spooner et al. (2015) demonstrated technology and systematic instruction is effective in teaching students with ASD who are ELL to participate in shared stories and answer literal comprehension questions. The authors suggested future research extend the modified system of least prompts to include other metacognitive instruction such as teaching rules for answering certain types of comprehension questions in an effort to further generalize skills.

Recent research has shown that teaching rules for answering comprehension questions and providing multiple opportunities to respond within shared story reading are effective in teaching comprehension of narrative text to students with ASD who are ELL. Browder, Root, Wood, and Allison (2015) taught elementary students with ASD, including one student who was also an ELL, to complete story maps and answer comprehension questions using their completed maps. Participants were first taught story element words and definitions (e.g., character, setting, problem, solution, and outcome) on an iPad using CTD. After listening to a short grade-aligned story that had a problem–solution structure, students were taught to fill in a story map on an iPad with each of the story elements. A modified system of least prompts that included a definition of the story element and narrowing text-based prompts was used to teach participants to fill in the story map. After completion of the story map, participants answered literal comprehension questions about story elements, such as “What caused trouble for John” or “Where did the story take place?” Results of the multiple probe across participants design showed a functional relation between CTD and identification of story element definitions as well as modified system of least prompts and both filling out the electronic story map and answering literal comprehension questions. Results of Browder et al. indicate technology can be used with CTD to teach rules for answering literal questions, in this case story element definitions, as well as for supporting creation of graphic organizers.

Prior research on technology-based shared story reading for students with ASD who are ELL has established key components of instruction. Spooner et al. (2014) highlighted the need for vocabulary to be directly taught within shared story reading. Spooner et al. (2015) and Browder et al. (2015) demonstrated technology, and CTD is effective for teaching both vocabulary words from a story and rules for answering comprehension questions. However, Browder et al. (2015) only taught participants’ definitions for story element words (e.g., setting means where and when) but did not assess whether participants were able to identify examples of story elements until they had to find them within the passages to complete the graphic organizer. While visual supports such as graphic organizers are an evidence-based practice for teaching students with ASD (Wong et al., 2014), students do not always have access to graphic organizers as a comprehension support tool. Studies on the effects of WH definitions and rules have established teaching rules for WH words as an effective preteaching strategy that positively influences comprehension of WH questions for students with intellectual disability (e.g., Browder et al., 2013; Hudson & Browder, 2014), but these investigations did not teach students to identify examples of the WH words, which may have limited generalization of knowledge. Research on the effectiveness of teaching student to identify examples of rules for answering questions without creating a graphic organizer is warranted.

Research supports the use of technology, specifically iPads, to display adapted grade-aligned text in shared story readings as well as to provide systematic instruction, such as a modified system of least prompts (Spooner et al., 2015). Spooner et al. (2015) programmed the iPad to deliver the prompts when participants pressed a “question mark” button in an effort to prevent guessing. A benefit of this method was to allow participants to return to the text to find the answer to a comprehension question before having to emit a response, which is how skilled readers are able to use text to answer questions. Two limitations of this study highlight the need for further research on technology-based shared story reading, especially for students
who have ASD and are ELL. First, when participants incorrectly answered a question, the interventionist had to provide the error correction and prompt them to hit “I don’t know” using verbal, model, and physical prompts. This could result in a student going through numerous prompts before reaching a final answer to the comprehension question. Research is needed that examines the effectiveness of technology that delivers both the text and prompts upon incorrect responses on the comprehension of emerging readers with ASD who are also ELL. Second, participants were only given two opportunities to answer comprehension questions in each session. These comprehension questions were all literal WH questions but were not consistent across sessions. It is unknown based on provided data whether participants were successful in answering all types of literal questions. Both Spooner et al. (2014) and Spooner et al. (2015) highlighted the need for repeated opportunities to practice comprehension skills within each shared story session.

Therefore, the purpose of the current study was to investigate the impact of shared story reading using e-texts and embedded prompting on the vocabulary and listening comprehension of elementary students with ASD who were ELL using a technology platform. Specifically, the study aimed to examine the effects of teaching rules for answering WH questions as well as examples of WH words as shown in CTD. In addition, the study investigated the use of shared story reading with a modified system of least prompts that included narrowing portions of text delivered through an iPad app upon emission of an incorrect response. The following research questions were addressed:

1. What is the effect of CTD on WH pairings (definitions and examples) by students with ASD who are ELL?
2. What is the effect of a shared story reading using modified system of least prompts embedded in a technology platform on comprehension of WH questions by students with ASD who are ELL?

Method

Participants

Three elementary students participated in the study. Students were eligible for participation based on the following criteria: (a) participation in a special education program under the eligibility area of autism, (b) participation in alternate assessment aligned with alternate achievement standards if enrolled in a tested grade, (c) ability to manipulate buttons on a tablet computer, and (d) language other than English spoken in the home. Three boys aged 8–10 years participated in this study.

Nathan was an 8-year-old African American male student in the second grade. His mother was deaf and therefore American Sign Language (ASL) was his first language. Both ASL and English were used in his home. Nathan had an educational identification of ASD and an IQ of 62 according to the Wechsler Individual Achievement Test, third edition (WIAT-III; Wechsler, 2009). In the area of reading, Nathan’s Individualized Education Program (IEP) goals related to word identification and basic comprehension of WH words. According to Nathan’s teacher, his decoding skills were at a kindergarten level, and he was unable to answer basic recall comprehension questions after accessing text. He displayed behavioral issues associated with his autism diagnosis that affected his academic progress, namely, a firm adherence to routines and schedules, which often undermined instructional flexibility.

Sal was an 8-year-old Hispanic male student in the second grade with an educational identification of ASD and an IQ of 58 according to WIAT-III. He received English as a second language (ESL) services from the school, as Spanish was his first language and the primary language spoken in his home. Sal’s reading IEP goals related to letter recognition, vocabulary identification, and WH-word identification. Sal was becoming proficient in letter recognition, according to his teacher, but his ability to identify and label basic vocabulary, WH words, and sight words was inconsistent. Sal’s reading curriculum was centered around letter and word recognition; reading and listening comprehension were not targeted for instruction. Sal developed perseverations on staff members within the school and became extremely anxious and agitated when he was denied access to staff. He would often cry and fail to maintain attention to task when certain staff walked by the classroom or came to class to interact with the teacher or other students.

Juan was a 10-year-old Hispanic male student in the fourth grade with an educational identification of ASD and an IQ of 51 according to WIAT-III. Juan’s family spoke Spanish in the home and as a result he received ESL services in school. Juan’s most recent IEP reflected letter and sight word recognition goals in the area of reading. Juan demonstrated the ability to identify all letters of the English language but was unable to consistently match letters to their sounds. His word decoding skills were reported by his teacher to be at a kindergarten level, but his reading and listening comprehension skills had not yet been targeted through classroom curricula.

Setting

The study took place in a self-contained classroom for students with ASD in a suburban public elementary school in the southeastern United States. The classroom had eight students with ASD, one teacher, and two paraprofessionals. The environment featured independent workstations and centers for the students. The interventionist was a doctoral student in special education with 7 years of classroom experience with students on the autism spectrum. The interventionist taught each student in a one-to-one format at a table in the classroom for 30 min during daily literacy centers. Participants rotated through several other centers during the 90-min literacy block, including direct instruction on early literacy skills with the teacher, independent work at their desks and on the computer related to phonics and spelling, and vocabulary work with a paraprofessional. During the course of the study, the only direct reading comprehension instruction came from the interventionist.
Table 1. WH Pairings.

<table>
<thead>
<tr>
<th>WH Word</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who</td>
<td>Person</td>
<td>Dr. Smith</td>
</tr>
<tr>
<td>What</td>
<td>Thing</td>
<td>Hat</td>
</tr>
<tr>
<td>When</td>
<td>Time</td>
<td>Tomorrow</td>
</tr>
<tr>
<td>Where</td>
<td>Place</td>
<td>Hospital</td>
</tr>
<tr>
<td>Why</td>
<td>Reason</td>
<td>He was hungry</td>
</tr>
<tr>
<td>How</td>
<td>Way</td>
<td>By looking</td>
</tr>
</tbody>
</table>

Materials

All materials for the study were created and displayed on an iPad using the GoTalk NOW (Attainment Company, 2012) application. Six WH words were taught along with the corresponding definitions and examples (see Table 1). The words, definitions, and examples were chosen based on previous research teaching WH comprehension to students with moderate and severe disabilities (Browder et al., 2013; Hudson & Browder, 2014; Mims et al., 2012). For each WH word, the interventionist created a screen in GoTalk NOW that included the target WH word and definitions for all six WH words listed beneath it. One definition matched the target WH word, and the other five WH definitions served as distractors. This screen was duplicated so that each WH word was targeted for a total of six screens, each one featuring a different WH word. Similarly, a screen was created that included the target WH word, with a pictorial example of each WH word underneath it (i.e., a picture of a hospital served as an example of “where”). One of the pictures was an example of the target WH word, while the other five picture examples corresponded to the other five WH words and served as distractors. This example screen was also duplicated so that each WH word was targeted for a total of six screens, each one featuring a different WH word. Using the “page jump” feature in GoTalk NOW, the interventionist linked the answer on each screen to the next screen, in order for the participants to seamlessly advance through all 12 screens just by touching the answer. The page jump feature works by allowing the creator to link two or more pages together by touching pictures or words on the screen.

The interventionist consulted with the classroom teacher to select the two novels used over the course of the intervention. The Case of the Sassy Parrot (Howard, 2002) and Because of Winn-Dixie (DiCamillo, 2000) were chosen based on student interest and alignment with novels taught in the general education classroom. The interventionist adapted the novels by shortening the length of each chapter through summaries of key plot events and maintaining essential vocabulary and using a considerate text level of second to third grade based on Lexile scores. Each page of the e-text featured approximately three paragraphs of adapted text from the book. The participants were able to activate an audio recording of the text read in a young male’s voice on each page by touching the text on the iPad. The vocal output was created by linking the text to a text-to-speech feature embedded in GoTalk NOW. A young male’s voice was chosen out of a large array of different computer-generated voices because of similarities to the age and gender of participants.

Six literal comprehension questions, one for each WH pairing, were written for each chapter by the interventionist. The question and response arrays with four choices were displayed on the iPad with both words and pictures. The response options included the correct answer from the book, two distracters from the book, and one distracter that was not from the book. For example, a question that asked “Who was going to send the dog to the pound?” had the following response options: (1) the manager (correct answer), (2) Opal (distractor from book), (3) the preacher (distractor from book), and (4) Aunt Betty (distractor not from the book). The placement of the correct answer in the array of four choices was randomized. Each question and response featured a read-aloud option that was touch activated. The interventionist used the page jump feature of GoTalk NOW to create a celebratory “You got it right!” page that appeared during intervention phase if the participant selected the correct answer. If an incorrect answer was provided during intervention, the iPad automatically advanced to a screen that provided the appropriate level of prompting and then automatically reverted back to the comprehension question. This sequence of prompting and question asking was also created for use during intervention through the page jump feature of GoTalk NOW. An expert in elementary literacy instruction reviewed all materials, including the adapted texts, WH pairings, and comprehension questions for content validity.

Design

This study employed a single-case multiple probe across participants design (Gast & Ledford, 2014). All participants entered baseline simultaneously. Once baseline data were stable and at least five data points had been collected, the first participant entered intervention. Baseline probes continued for the second and third participants at least every eight sessions until they entered intervention. Once the first participant demonstrated an increasing trend in both WH pairings and answering comprehension questions, the next participant entered intervention. This systematic introduction continued for the third participant. To reach mastery, participants needed to answer five out of the six comprehension questions correct for two consecutive sessions.

Dependent Variables and Data Collection

Two dependent variables were measured. The first measure was the number of independent correct pairings of WH words with definitions and examples. Participants were given one opportunity to match each WH word to the definition and one opportunity to match each WH word to an example, for a total of 12 opportunities each session. The second dependent variable was the number of correct responses to comprehension questions. In each session, participants answered one question related to each WH word, for a total of six questions each session. For both measures, a correct response was recorded.
if the participant independently responded verbally or by selecting the correct response on the iPad when presented with six choices (one correct and five distractors). Only independent correct responses were graphed.

**Procedures**

**General procedures.** During each session, participants began with the WH pairing task. Next, they listened to one adapted chapter from a novel that had been recorded onto an iPad, while they followed along with the text onscreen. The participants were encouraged to point and look at each line of text as it was read. Finally, the participants were asked comprehension questions pertaining to the chapter. Participants received reinforcement for completing each session by playing a high-interest, age-appropriate, and grade-appropriate game that was not related to literacy on the iPad. This reinforcement was available in both baseline and intervention and was provided for compliance, not contingent upon accuracy of performance.

**Baseline.** During baseline, the participants were assessed on both dependent variables. Chapters were randomly selected from both novels to control for practice effects. Participants did not receive prompting, error correction, or feedback for their responses.

**WH pairings.** The interventionist placed the iPad in front of the participant on the table, with the GoTalk NOW application running and the WH graphic organizer selected. On the iPad screen, a WH word appeared in a center green box. Six blue boxes, each containing a WH definition, were arranged around the center green box (see Table 1 for each WH word and corresponding definition and rule). The interventionist instructed the participant to “match the WH word with its definition.” Each word was presented once for a total of six trials each session. The interventionist then advanced the iPad to the WH examples screen. This display similarly showed the WH word in a center green box surrounded by six blue boxes. Instead of WH definitions, however, each blue box contained an example of the WH word (e.g., *tomorrow* as an example for WH word *when*). The interventionist then asked participants to “match the WH word with its example.” Each of the six words was presented once, bringing the total trials of WH pairings to 12 in each session.

**Comprehension questions.** After listening to a randomly selected adapted chapter on the iPad, the interventionist advanced to a screen that displayed a comprehension question from the chapter and response options. The interventionist asked each question and read aloud the accompanying response options. There were six questions per chapter, beginning with each WH word. Participants had access to the story on the iPad, and one of the response options was a request to “listen again.” There were a total of six comprehension questions asked per session.

**Intervention.** During intervention phase, each session began with instruction on WH pairings using CTD. After the WH pairing task, the interventionist instructed the student to listen to the adapted chapter and answer comprehension questions. The participants first read *Because of Winn Dixie* and upon completion began *The Sassy Parrot*. The interventionist taught participants to answer comprehension questions using a modified system of least prompts embedded on the iPad. More detailed explanations of session components are described below.

**Teaching WH pairings using CTD.** The interventionist placed the iPad on the table in front of the participant, following procedures established in baseline. The format, appearance, and randomized display of WH words and definitions remained exactly the same as in baseline. In the first trial, the interventionist used 0-s CTD to teach the WH definitions. First, the interventionist read the WH word (e.g., *who*) and then immediately touched the definition (e.g., *person*). In the next trial, the interventionist read the word and then waited 4 s before delivering a model prompt if needed. If participants made an error or waited 4 s before making a response, a model prompt was given. WH examples were taught using the same procedure. Specific verbal praise (e.g., “Yes, Mr. Smith is an example of *who*”) was given after correct answers.

**Teaching comprehension of WH questions using modified system of least prompts.** During each session in the intervention phase, participants were presented with one adapted chapter from the selected text. The chapters were read chronologically. The interventionist programed the application to deliver a modified system of least prompts to teach the participants to go into the text to locate information in order to answer comprehension questions.

If the participant independently selected the correct answer on the first opportunity, the interventionist recorded it as an independent correct response and the screen automatically advanced to the next question. If the participant requested to listen again, selected an incorrect response, or failed to respond within 5 s, the application advanced to the first level of prompting. On this screen, the chapter was displayed with three sentences containing the answer highlighted in yellow. The corresponding audio recording read only those three sentences. Following the reread, the application advanced to screens displaying the comprehension question and response options again. If the participant failed to respond within the time frame or selected an incorrect response, the application advanced to the second level of prompting. The chapter was displayed again, with the sentence containing the answer highlighted in yellow. The corresponding audio recording was of the highlighted sentence only. After the text was reread, the application again advanced to screens displaying the WH question and response options. If the participant failed to respond in 5 s, or responded incorrectly, the application advanced to the third level of prompting. On this screen, the chapter was displayed, and the only word highlighted in yellow on the screen, and read by the audio recording, was the correct answer. After this prompt, the application advanced to the WH question and response option screens. If the participant failed to answer, or answered incorrectly, the interventionist delivered the fourth
and final prompt. The interventionist located the answer on the response board, pointed to it, and stated, “The answer is... Touch...” The interventionist then restated the question and answer and waited for the participant to touch or say the correct answer. The interventionist provided specific verbal praise (e.g., “Yes, the manager was going to send the dog to the pound”) after correct responses.

Reliability and Validity

Interobserver agreement. A second member of the research team served as an observer throughout the duration of the study. The observer collected data on the two dependent measures using the same data collection instrument as the interventionist. Interobserver agreement, conducted during 30% of baseline and intervention sessions, was calculated by dividing the total number of agreements by the total number of observed responses. The mean agreement during baseline was 98% for WH pairings and 100% for comprehension questions. The mean agreement during intervention was 100% for WH pairings and 97% for comprehension questions.

Procedural fidelity. The second observer also collected procedural fidelity data to ensure the intervention was being implemented with fidelity. Data were collected using a procedural fidelity checklist aligned to time delay and system of least prompts intervention procedures. As the interventionist implemented the intervention, the observer indicated whether or not each step was implemented as intended. Procedural fidelity was determined by dividing the number of correctly implemented steps of the intervention by the total number of steps and multiplying the resulting number by 100. The mean agreement was 100% across 30% of sessions.

Results

Figure 1 displays the number of independent correct WH pairings made by Nathan, Sal, and Juan. The x-axis represents sessions and the y-axis represents the number of independent correct responses during each session. Nathan, Sal, and Juan demonstrated an increase in level after receiving instruction on WH pairings using CTD. For the first five sessions in intervention, Nathan immediately and indiscriminately selected the response option that was located on the lower left of the response board. The interventionist utilized a specific verbal prompt (i.e., “Is that the answer you want to choose?”) prior to the controlling prompt beginning with the fifth session in intervention, and Nathan quickly demonstrated an increase in level of independent correct responding. For Sal and Juan, the increase was immediate.

Nathan’s average independent correct response to WH pairings was 1.4 in baseline and 7.9 in intervention. In the five sessions prior to the implementation of the specific verbal prompt, Nathan’s responses were variable (i.e., a range of 1–8) and displayed a large amount of overlap with his performance in baseline. The effect of the intervention was not immediate, and this may be due to Nathan’s propensity to automatically select the lower left response option for every question. After the introduction of the specific verbal prompt, Nathan quickly increased his ability to respond correctly as illustrated by the ascending trend of his responses and consistency of his performance. He met mastery criteria in 11 sessions and demonstrated his ability to maintain the skill after 5 and 8 sessions postintervention. Sal independently responded correctly to WH pairings, an average of 0.4 in baseline. In intervention, Sal reached mastery criteria in nine sessions with an average of 9.6 independent correct responses and maintained the skill by performing 11 out of the 12 correct responses five sessions after intervention. The final participant, Juan, performed with an average of 0.7 correct in baseline conditions. In intervention, his average increased to 8.4 and he met mastery criteria after 10 sessions. In addition to immediacy of effect, both Sal and Juan’s responses show a dramatic change in level and trend, with no overlap between baseline and intervention phases.

Figure 2 shows the number of independent correct responses to comprehension questions made by Nathan, Sal, and Juan.
The $x$-axis represents sessions and the $y$-axis represents the number of independent correct answers during each session. All three participants demonstrated an increase in level of performance. As with WH pairings, Nathan immediately and indiscriminately selected the response option that was located on the lower left of the response board during the first five intervention sessions. An immediacy of effect was not observed during those sessions, and while Nathan’s performance was consistent, his responses overlapped with his baseline performance. The interventionist utilized the same specific verbal prompt (i.e., “Is that the answer you want to choose?”) prior to the least intrusive prompt hierarchy beginning with the sixth session in intervention, and Nathan quickly demonstrated an increase in level of independent correct responding with an ascending trend. Sal and Juan demonstrated more immediate increases.

Nathan’s average independent correct response to comprehension questions was 1.0 in baseline and 4.1 in intervention. He met mastery criteria in nine sessions and demonstrated his ability to maintain the skill after four and eight sessions postintervention. Sal independently responded correctly to comprehension questions, an average of 1.0 out of the 6 in baseline. In intervention, Sal reached mastery criteria in eight sessions with an average of 3.9 independent correct responses and maintained the skill by performing six out of the six correct responses five sessions after intervention. The effect of the intervention wasn’t immediate, with Sal’s performance during the first three sessions of intervention overlapping with his baseline performance, but he quickly demonstrated an increase in level and an ascending trend of independent correct responding. Juan responded with an average of 0.5 correct answers in baseline conditions. In intervention, his average increased to 4.2 and he met mastery criteria in nine sessions. Of the three participants, Juan showed the most immediacy of effect. His first session during intervention overlapped with his performance during baseline, but second and subsequent sessions during intervention displayed a consistent ascending trend and an increase in level over baseline.

**Discussion**

The purpose of this study was to investigate the impact of shared story reading using e-texts and embedded prompting on the vocabulary and reading comprehension of elementary students with ASD who were ELL. The results of this study add to the body of literature citing effectiveness of CTD to teach academic vocabulary to students with developmental disabilities including those with ELL (Rivera, Spooner, Wood, & Hicks, 2013; Rohena, Jitendra, & Browder, 2002; Spooner, Rivera, Browder, Baker, & Salas, 2009). In addition, these findings demonstrate the effectiveness of shared story reading using a technology platform with embedded prompting on comprehension for individuals with ASD who are ELL. Maintenance data demonstrate all participants were able to maintain performance of these skills.

Comprehension of text can be challenging for students with ASD (El Zein, Solis, Vaughn, & McCulley, 2014). While students with ASD can acquire reading skills, progress may be delayed when students have additional language challenges due to intellectual disability or learning a second language. Students need a way to access and comprehend passages of text even while going through the sequence of skills needed to learn to read. Shared story reading has provided a means for students with developmental disabilities to learn to access and comprehend text (Hudson & Test, 2011). More recently, researchers have shown how shared story reading interventions can be adapted to technology platforms (Browder et al., 2015; Spooner et al., 2015). In the current study, students were able to access both the text and the instructional prompts using a tablet format.

The use of e-text formats alone will rarely be enough for students to build comprehension skills. In the current study, the students were able to hear the stories using e-text in baseline but did not demonstrate comprehension or even understanding of the WH questions. Students with ASD who have some level of intellectual disability also need systematic prompting with feedback to learn to use the text to find the answer. First, these
students learned what the WH question meant (e.g., “who” is a person) and then through the system of least prompts learned to listen for the answer as the text was read aloud. For students with ASD who are ELL, teaching the meaning of the WH question and how to listen closely for the answer in the text read aloud may be especially critical. The student is learning how to apply emerging English skills to the task of comprehension. The simplified passages and literal comprehension questions make it possible to gain early success. The next step would be to move toward nonadapted text and more complex questions.

Although this study extended prior research using e-text for students with developmental disabilities (e.g., Knight et al., 2015; Spooner et al., 2015), the current intervention extended this methodology by embedding the prompts within the technological supports. In prior studies, the teacher usually administered the prompting system by rereading portions of the text to help the student to locate the answer. In the current study, the students could access this rereading along with highlighted text to locate the answer with minimal to no teacher assistance. Visual supports have been found to be an evidence-based practice for students with ASD (Wong et al., 2014). Embedding the prompting with text highlighting offered a visual support for comprehension. Over time, the students were able to answer new comprehension questions with no highlighting after hearing the text read aloud one time. The visual support offered a temporary means to listen closely to the text as it was read aloud.

Limitations and Future Research

One of the limitations of this study was the choice of children’s literature. The books chosen were ones used frequently within elementary schools. The advantage was that students were learning the same literature as their peers. In contrast, the books were not chosen for personal cultural relevance. Spooner, Rivera, Browder, Baker, and Salas (2009) and Rivera et al. (2013) gave consideration to selecting literature that would have themes familiar to the participants’ cultural background. Although this study was effective for the participants, consideration might be given to seeing if books with familiar contexts or themes would enhance further learning. Because hearing books read aloud is an option for leisure as well as academic learning, it also would be useful to determine if culturally relevant books would be preferred by the students.

Another limitation is that the scope of generalization was not assessed. It is not known whether the students might have generalized their skills to traditional paper book format or to nonadapted versions of the books. It also is not known whether they might have generalized to new types of questions and to informational or other genres of text. Due to the school year ending, maintenance data were also not collected, which is an additional limitation of the design of this study. Future research should include generalization measures to determine whether or not these broader reading skills would emerge or need direct instruction as well as maintenance measures.

Much more research is needed on promoting comprehension for emergent readers with ASD who are ELL. Although schools in the United States have an increasingly diverse demographic, few studies for students with developmental disabilities have also addressed this diversity. In the current study, the shared reading intervention developed for students with developmental disabilities also worked when participants were ELL. Future research could identify the extent to which evidence-based practices are replicable for students who are both ASD and ELL and which ones need modifications to responsive to additional language challenges. For example, it is unclear that the extent to which the technology platform which offered a consistent voice recording may have been critical to the students’ success in this study compared with a person reading aloud whose cadence, style, dialect, or pronunciation might have fluctuated from day to day.

Implications for Practice

While a technology platform may be motivational to students with ASD and offer consistency for students who are also ELL, it is not enough alone to promote comprehension. After creating the technology-based materials, teachers will need to use systematic prompting to help students learn how to listen to the text closely and answer comprehension questions. Many students will need to begin with learning what the comprehension questions themselves mean. One way to teach the meaning of WH words is through CTD as used in this study. CTD is an evidence-based practice for teaching vocabulary to students with moderate and severe disabilities, including autism (Browder et al., 2009). Students will also need strategies like the reread prompts used in this study to learn to locate the answer to questions in the text.

Conclusion

Success in reading comprehension requires simultaneous deployment of multiple skills (Brown et al., 2013), many of which are areas of weakness for individuals with ASD (El Zein et al., 2014). This study used embedded systematic instruction in a technology platform to provide support for comprehension of an adapted text during shared story reading. In addition, the academic vocabulary repertoires of participants were supported through the teaching of WH pairings (rules and definitions). The participants, who all had ASD and were ELL, were able to master both WH pairings and answering WH questions over the course of the study and maintain those skills over time. These findings support the use of technology within shared story reading for diverse students.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.
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