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ORIGINAL ARTICLE

Effects of a Computer-Based Early Reading Program (Headsprout®) on Word List and Text Reading Skills in a Student with Autism

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Abstract This study evaluated the effects of a computer-based early reading program, Headsprout®, on accurate reading of word lists and connected text by a student with autism. The dependent measures were four word sets and four short stories that increased in difficulty. In the context of a multiple baseline design, the reading program was associated with improved reading accuracy across the word sets and stories. Data also suggested generalization of word set reading skills. We discuss elements of Headsprout® and implementing computer-based early reading programs with children who have autism.

Keywords Computer-based learning · Early literacy · Autism

To ensure development of a literate society, it is critical that *all* children have access to appropriate reading curricula and instruction. Over the years, research has indicated that an emphasis on systematic instruction based on the five core elements of reading (phonemic awareness, alphabetic principle, oral reading fluency, vocabulary, comprehension) is an effective and efficient means for building populations of competent readers (National Institute of Child Health and Human Development 2000). Given the current legislative expectations for improving literacy nationwide (No Child Left Behind Act 2001), identifying evidence-based reading curricula and instructional methods for students with autism spectrum disorder (ASD) has become more of a concern.

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Finding appropriate modalities for literacy instruction of students with autism can be challenging given the nature of the disorder, namely delayed or impaired development of language, social, and communication skills (Klinger et al. 2003, p. 409). Autism is a spectrum disorder, meaning that children may display deficits in development that range in intensity. Notably, the range of deficits observed in the reading proficiency of students with autism is often vast. Some students learn to read with fluency but struggle with comprehension, while others have difficulty acquiring basic word identification skills (Whalon et al. 2009).

Most recently, Whalon et al. (2009) reviewed a series of preliminary studies investigating instructional methodologies used to enhance skill acquisition in some of the core elements of reading for students with autism. Studies reviewed were identified as focusing either on enhancing phonemic awareness, alphabetic understanding, and/or oral reading fluency or on building vocabulary and comprehension skills. For those studies that addressed decoding skills, a computer-assisted instructional methodology developed in Sweden entitled, Alpha (later version was Delta), was used with reported success (Heimann et al. 1995). The Alpha program is an errorless learning approach that prompts students to click on words presented on the computer screen in order to develop simple sentences. Across studies that utilized this program, students showed increases in decoding, spelling, word identification, and reading sentences. Though the Alpha program did not systematically teach students to read using a phonetic-based approach, the research provides initial support for computer-assisted instruction in teaching reading to students with ASD.

Another recent study of computer-assisted instruction and a systematic Non-verbal Reading Approach was conducted with three students who had autism and other developmental disabilities (Coleman-Martin et al. 2005). This study included three conditions consisting of computer-assisted instruction only, teacher instruction only, and computer and teacher assisted instruction. The student with autism in this study demonstrated mastery of word identification across all conditions but reached criterion faster in the computer-assisted condition. These data suggest that a systematic, computer-assisted approach to instruction can be effective.

Currently, less is known about how classroom teachers can support student success in computer-based reading instruction. Tjus et al. (2001) included observations of interactions between teachers and students with ASD who were matched on several variables with other students having cognitive disabilities other than ASD during 38 computer-based reading lessons. Teachers in this study were asked to sit by the student engaged in the instruction and elaborate on their verbal expressions. Statistically significant increases in socially important behaviors were observed in students with ASD. At the end of the study, these students showed more behaviors reflective of enjoyment, independent requests for teacher assistance, and expressive language. Teacher behavior was more stable from start to finish of the intervention with the exception that fewer comments about computer procedures were made and fewer physical redirections of students to task occurred at the end of the intervention. Teachers of students with autism did show an increase in amount of praise given at the end of the intervention.

While some important preliminary studies in the area of reading instruction for students with ASD have been executed, no published studies to date have evaluated

the Headsprout® Early Reading computer program. Headsprout® is an internet-based program that aims to accelerate acquisition of early reading skills for students in primary grades. Developers of this curriculum devoted 4 years to create and research lessons based on behavior analytic principles. Lessons target the five essential elements of reading and also include built-in systems to routinely monitor student progress with the curriculum (Layng et al. 2003; Twyman et al. 2005). To date, one study has been published that outlined use of Headsprout for students with special needs, specifically attention deficit hyperactivity disorder (ADHD) (Clarfield and Stoner 2005).

In light of previous reading instruction research, the purpose of the current study was to evaluate the Headsprout® early reading program with a student who had autism. Our objective was to conduct a brief experimental analysis of Headsprout® as implemented by the student's classroom teacher in a non-simulated special education setting. Thus, to our knowledge, this is the first classroom-based evaluation of Headsprout® on reading accuracy by a child with autism.

Method

Participant and Setting

Bill was a 9-year, 10 month old boy with autism, who attended a private school servicing students with developmental disabilities. He was recruited based on his daily performance during discrete trial training involving decoding and on the Word Attack Skills Test-Beginning Level (Carnine et al. 2004). Specifically, data recorded during previous discrete trial instruction revealed that Bill was unable to independently decode and read accurately phonetically regular words with letter blends in the final position. With partial verbal prompts, his accuracy ranged from 40 to 100% with a modal accuracy percentage of 80%. On the Word Attack Skills Test, Bill was able to read accurately and independently 4/15 (27%) phonetically regular words.

Measurement

Percent reading accuracy was recorded for two dependent measures during baseline and intervention phases. The first dependent measure was derived from Word Sets, which were phonetically regular words that increased in difficulty and were selected by the Headsprout® program. Examples of words were: *an, ran, old, peel.* In total there were 4 Word Sets (10–26 words per set), presented to Bill on paper-copy lists, before and after he successfully completed instruction on the respective Headsprout® lessons. Bill was requested to read each word in the Word Set, one time, and his teacher recorded whether he responded correctly or incorrectly. Percent reading accuracy was computed by dividing the words Bill read correctly by the total words in the Word Set and multiplying by 100.

The second dependent measure was derived from Headsprout® Readers, which were short stories provided by the Headsprout® program and included words from the respective Word Sets. Bill was presented with paper-copies of the stories and requested to read them one time. His teacher recorded whether he read the words

correctly or incorrectly. Percent reading accuracy was computed by dividing the words Bill read correctly by the total words from the Word Sets contained in the stories and multiplying by 100.

Experimental Design and Procedures

We implemented a multiple baseline design across Word Sets and Headsprout® Readers.

Baseline In baseline conditions, the teacher had Bill read from the Word Sets and Headsprout® Readers, one time, without feedback or correction. That is, the teacher simply recorded his responses and did not comment about accuracy.

Intervention The Headsprout® program consists of 80 lessons that increase in difficulty of words and letter combinations presented. Lessons last approximately 20 min, are interactive, and require students to click on pictures, letter combinations, and words. Students are also required to read certain sounds, words, sentences, and stories aloud. Both visual cues and auditory cues are provided through each lesson. Lessons can be completed in one sitting or can be saved and finished during multiple sessions. For the purposes of this study, we implemented the first 23 lessons of the Headsprout® program. For the first 5 lessons, Bill completed the lessons twice so as to gain familiarity with the routine of the tasks presented. Following Lesson 5, Bill was only required to repeat a lesson if he scored below 90% on two consecutive days or if he scored below 80% on 1 day (occurring twice during Lesson 6 and Lesson 9). Following every 5–10 lessons, students are required to read connected text from *Headsprout Readers,* which are benchmark assessment stories taught online and available as printed booklets.

The teacher conducting Headsprout® lessons with Bill implemented procedures according to an instructional hierarchy that included prompting (verbal directions and non-verbal cues), positive reinforcement (praise following correct responses), and correction (repeating directions contingent on an errors). The hierarchy also specified that the teacher offer Bill a "break" from instruction if he appeared fatigued or unresponsive. In keeping with the "naturalistic" focus of the study, the teacher implemented the Headsprout® program with Bill in a designated location within his classroom and with other student present.

Pre-intervention Teacher Training The teacher who instructed Bill participated in one training session with the first author to learn the Headsprout® program and the instructional hierarchy. Training lasted approximately 60 min. The teacher subsequently practiced a sample lesson under supervision before initiating instruction with Bill.

Pre-intervention Student Training Bill received training that oriented him to using the computer. He engaged in non-literacy related activities on the computer that helped him to practice using the mouse, to point and click on pictures, and to click and drag pictures. When he was able to accurately and independently click on pictures with 90% accuracy across 3 consecutive sessions, we initiated baseline assessment and then intervention.

Intervention Integrity The first and second authors observed the teacher conducting instruction with Bill during 97% of Headsprout® lessons. The observer recorded whether the teacher implemented procedures correctly according to the instructional hierarchy she had been trained to follow. Intervention integrity averaged 97%. During 33% of intervention integrity assessments, the first and second authors conducted simultaneous but independent observations to document inter observer agreement (IOA). An agreement was scored if both observers recorded that the teacher implemented instructional hierarchy procedures correctly. Average IOA (agreements/agreements + disagreements × 100) was 99%.

Results

Figure 1 presents Bill's percent reading accuracy on the four Word Sets. Baseline data for *Word Set 1* ranged between 70 and 80%. During intervention Bill's reading

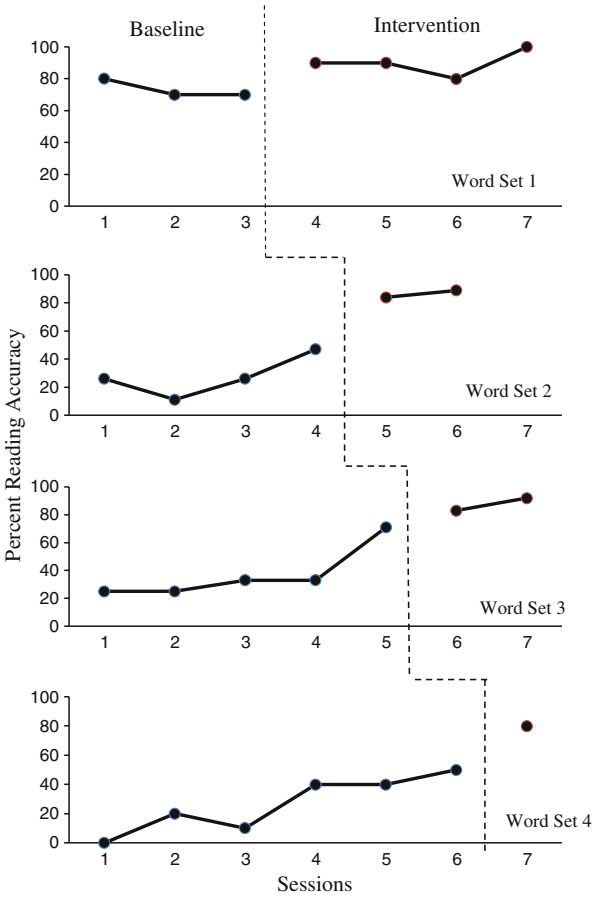

Fig. 1 Percent reading accuracy on Headsprout® word sets

accuracy for *Word Set 1* was between 80 and 100%. For *Word Set 2*, baseline reading accuracy ranged between 11 and 47%, which increased to a range of 84–89% during intervention. Bill's reading accuracy on *Word Set 3* was 25%–71% during baseline and 83–92% accuracy during intervention. Results for *Word Set 4* were 0–50% during baseline and 80% during intervention.

Figure 2 shows Bill's percent reading accuracy on the four Headsprout Readers that featured words from the four Word Sets learned in the first 23 lessons. The baseline data point for *Reader 1* suggested mastery of the material (86% accuracy); however following intervention, Bill read consistently with 100% accuracy. For *Reader 2*, his baseline reading accuracy was 69% and was 85–100% with intervention. The results for *Reader 3* were 40% at baseline and 90–100% during intervention. Finally, for *Reader 4*, Bill's baseline and intervention reading accuracy was 75% and 92% respectively.

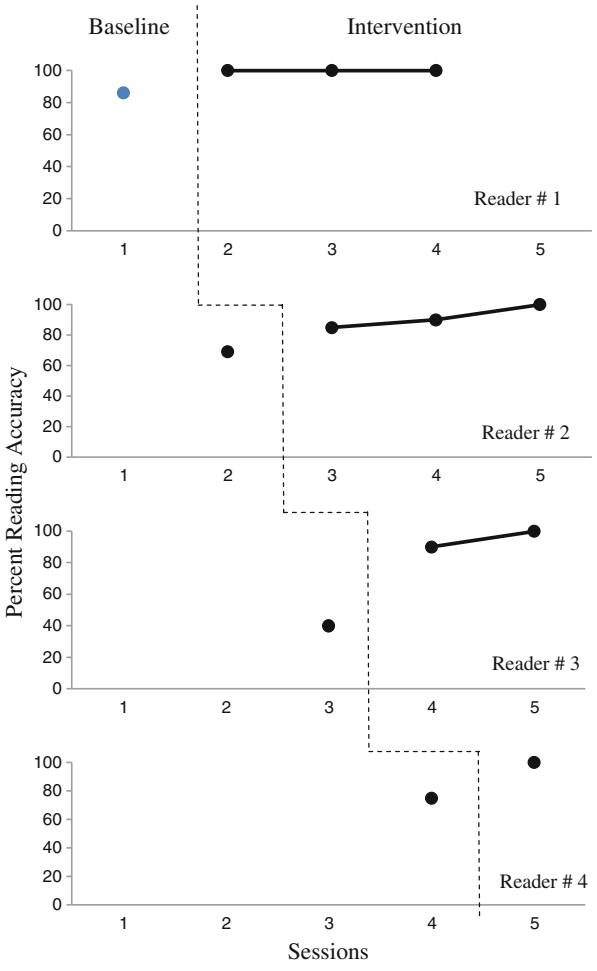

Fig. 2 Percent reading accuracy on Headsprout® readers

Discussion

The student participating in this study improved his reading of Word Sets and connected text from Headsprout® Readers following intervention. Notably, Bill's teacher was able to instruct him with good intervention integrity. In fact, implementing Headsprout® is a rather straightforward process, requiring only access to the internet and purchase of an individual or site license for use. Once a license has been obtained, users can then log on to the site and simply click on the arrow that indicates the start of a new lesson. Users are allowed to repeat lessons and are required to do so until the computer registers mastery of the material. The Headsprout® website includes many additional tips for teachers, data management strategies, and review materials. In the present study, we supplemented this information by training the teacher to implement Headsprout® according to a standardized instructional hierarchy. This element of programming is worth noting because although Headsprout® lessons represent independent work for some students, young learners who have receptive/expressive language and/or behavior challenges characteristic of ASD likely will need additional instructional support (Luiselli 2011).

While the study highlighted some promising results in using systematic, computer-assisted reading instruction for a student with autism, there are limitations. For example, the trends in baseline data shown in Fig. 1 revealed that Bill's expressive accuracy was increasing for three word sets before novel Headsprout® lessons were introduced. This outcome suggests generalization of some of the decoding/word attack skills he learned in earlier lessons. Although generalized learning effects can confuse an experimental analysis, for some time practitioners have been advised about strategically programming generalization across exemplars, settings, and people (Stokes and Baer 1977). The possibility that an instructional program such as Headsprout® may promote generalization adds to its appeal as an early reading approach for students with autism. Because of time constraints in our study and the desire to rapidly improve Bill's decoding and reading ability, we elected to introduce intervention with him on word sets 2, 3, and 4 before more stable baseline trends were evident. However, future research would do well to identify the components of instruction that facilitate generalization among young learners with autism.

We note further that although Bill continued with Headsprout® lessons, and additional stories based on the curriculum were sent home for extra practice following this study, no maintenance probes were given. Because maintenance programming is important when educating students with autism, occasional post-training data can guide further instruction. Also, assessments used in this study only measured Bill's skill with the words presented in the curriculum and not other words or print forms. One additional limitation is that we did not conduct inter observer agreement (IOA) assessment for the Word Sets and Headsprout® Readers. Informal checks before and periodically during the study indicated that Bill's teacher had no difficulty discriminating his accurate and inaccurate reading of words. Her ability to record data reliably was consistent with the high level of intervention integrity that was documented.

Considering the promising findings and acknowledged limitations of this study, future research evaluating Headsprout® with students who have ASD would be

beneficial. Replication of this study with additional students and teachers, in a variety of school settings and using alternative forms of assessment (e.g., Curriculum-Based Measurement, DIBELS) could potentially provide a powerful approach to effectively teaching students with ASD to read. Concerning implementation guidelines when using Headsprout® with students who have ASD, it is important to determine if the content presented in Headsprout® is at an appropriate instructional level for the student. The website for this program (www.headsprout.com) includes data tracking forms that highlight the reading levels of groups of lessons and compare these levels to alternate reading forms and assessments often used in schools (e.g., Developmental Reading Assessment Levels, see Beaver 1997). Once it has been determined that Headsprout lessons match the student's instructional level, it is then helpful to assess the student's computer navigation skills. Having adequate skills in using the mouse to point to and click on items on the screen is critical for using Headsprout® effectively. The Headsprout® website provides mini-lessons entitled, *Mousing Around*, in order to provide students with practice opportunities with the computer mouse. During this computer-training period, it can also be helpful to observe the student over multiple days and determine his/her tolerance for staying in his/her seat and attending to computer tasks. Because Headsprout® automatically saves lesson progress, teachers can conclude instruction before a student loses interest or displays problem behaviors, thereby ensuring successful interaction with the program.

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