Improving Literacy Skills in Students with Complex Communication Needs Who Use Augmentative/Alternative Communication Systems

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Abstract: A structured intervention package including direct, scaffolded, instructional lessons was implemented using an error correction learning system and a picture book-based phonological and phonemic awareness activity for four participants with complex communication needs, ranging from 12 to 15 years, in a junior high school setting. Although variability in participant results was noted, a functional relationship between the structured literacy intervention package and sound to letter matching ability was found. Results of this investigation indicate that this intervention package appears promising for facilitating learning of sound-to-letter matching skills in students with complex communication needs who use augmentative/alternative communication systems. However, due to the nature of single-subject research, generalizability of results is in question. Additionally, further research is needed to determine the effect of this intervention on word decoding and reading comprehension skills.

One of the primary goals for the education of all students, including those with complex communication needs (CCN) who use alternative and augmentative communication (AAC), is the development of literacy. As clearly stipulated by the No Child Left Behind (NCLB) Act and the Individuals with Disabilities Education Improvement Act ([IDEIA] IDEIA, 2004; NCLB, 2004), instruction and assessment of reading and literacy skills must be addressed for children with disabilities. The IDEIA specifically requires “consideration” of assistive technology (AT) devices, which include AAC and services when developing Individualized Education Plans [IEPs; 20 U.S.C. § 1401(1)-(2)]. For students who are AAC users, literacy takes on heightened importance. For students with developmental disabilities, literacy can foster new experiences and for students with severe physical limitations the acquisition and demonstration of literacy skills may be their primary entry into the job market (Smith & Blischak, 1997). Literacy development for students who use AAC is a complex issue, since their language development, their opportunities to practice skills associated with reading, and their ability to produce oral reading can be impaired or extremely limited.

Components of Literacy

Literacy requires knowledge of language components, such as phonology, morphology, syntax, semantics, and pragmatics (Strum & Clendon, 2004). Specific skills associated with these components include those that have been identified as preliteracy skills. These include components of phonemic awareness, alphabetic principle, fluency, concepts about print, vocabulary development, and comprehension (Clay, 1975; National Reading Panel, 2000; Teale & Sulzby, 1986). Collectively, these skills provide the foundation for the development of reading which is fundamental for independence in our society (International Reading Association [IRA] & National Association for the Education of Young Children [NAEYC], 1996).

Typically developing children begin to learn preliteracy skills very early through ex-
posure to language and print, which includes story reading and observing adult literacy activities. Preliteracy skills begin to develop when children understand the relationship between word and print, are able to identify phonemes in words, and are able to actively practice this knowledge through speech (Hetzroni, 2004). Language is the vehicle through which literacy is learned, refined, and mastered.

Language development in children with CCN can be severely impaired due to accompanying intrinsic deficits, such as cognitive, physical, perceptual, or sensory impairments (Smith & Blischak, 1997) and significantly different language learning opportunities (Sturm & Clendon, 2004). Students with CCN may have restricted access to their environments, limited interactions with communication partners, and fewer opportunities to communicate (Light & Drager, 2007; Sutton, Soto, & Blockberger, 2002). Not only may these opportunities be limited, but when they do occur, the quality may also be significantly altered due to variables associated with the child, the environment, the communication partner, and the mode or lack of expression.

Children with CCN who use AAC may not have the opportunity to experience language as children without speech impairments (Sutton et al., 2002). If language is delayed or impaired, development of literacy will also be affected. Language and literacy skills do not develop in isolation but over time and are dependent on students’ skills as well as environmental exposure and demands (Scherz & Hart, 2002). Students with CCN may face access barriers to developing literacy due to limited speech, lack of conversational opportunities, and/or concomitant sensory, cognitive, or motor disabilities (Hetzroni, 2004). Barriers that may affect literacy development are limited opportunities to ask questions or provide input to vocabulary selection, limited practice with books, and low literacy expectations from education professionals (Hetzroni, 2004; Light & Drager, 2008; Sturm & Clendon, 2004). These obstacles in language and literacy acquisition are not faced by typically developing children (Blockberger & Johnston, 2003). Research focusing on students with CCN who use AAC has highlighted the discrepancy between their cognitive abilities and predicted literacy skills (Dahlgren Sandberg, 2001; Dahlgren Sandberg & Hjelmquist, 1996; Foley, 1993; Sutton, Soto & Blockberger, 2002). Therefore, it is incumbent on professionals who work with students with CCN to identify appropriate AAC to promote literacy and to develop effective strategies that foster acquisition of skills necessary for literacy development.

**Phonological Awareness**

Phonological awareness, which is awareness of the sound structure of spoken language, has been identified as vitally important to reading and an unequivocal predictor of successful reading ability (Adams, 1990; Dahlgren Sandberg, 2001). Adams identified three levels of phonological awareness: (a) words in sentences, (b) syllables in words, and (c) sounds in syllables and words. The term *phonemic awareness* refers to the segmenting and manipulating of phonemes (Blischack, Shaw, Lombardino, & Chiarella, 2004) and these two skills are vital to developing reading ability. Segmentation strongly correlates with word reading and comprehension. Manipulation involves the ability to segment a word and then to manipulate one or more of the phonemes in that word. An example of this would be asking a student to identify the sounds in *cat* and then replace the first phoneme with a different one such as /m/ to create a new word, *mat*. AAC users, who may not have the ability to produce speech, face unique challenges in the development of phonological awareness skills (Smith & Blischak, 1997).

Recently, research has empirically validated strategies for teaching phonological and phonemic awareness skills to children with CCN who are AAC users (Blischak et al., 2004; Fallon, Light, McNaughton, Drager, & Hammer, 2004; Johnston, Buchanan, & Davenport, 2009). Blischak et al. used a single-subject multiple baseline design to investigate the effect of a literacy intervention with three students, ages 7.0, 5.0, 6.2, with severe speech impairment. The intervention taught students phoneme-grapheme awareness followed by instruction in segmenting, manipulating, and encoding consonant-vowel-consonant (CVC) pseudowords. Two of the participants met the criterion on the grapheme-phoneme aware-
ness tasks after three instructional sessions. One student had repeated difficulty and was not able to be advanced to segmenting, manipulating, and encoding CVC pseudowords. Interestingly, this is the one student who was using an AAC device. He was also the youngest participant in the investigation, which may have affected learning rate and/or amount. The two students who received instruction in segmenting, manipulating, and encoding CVC pseudowords met criterion and retained these abilities during maintenance probes.

In Fallon et al.’s (2004) investigation, instruction in phonemic awareness and phonics was implemented using 3-in. x 3-in. laminated picture cards that were created using Boardmaker® Software version 3.5. These instructional tools were successfully used to teach single-word reading skills to five children, ages 9.5 to 14.0 years, with severe speech impairments. Within this program, phonemic awareness and phonics instructional lessons were taught using multiple instructional strategies that included scaffolding instructional tasks to promote errorless learning and direct instruction (Ellis, Worthington, & Larkin, 1994). Results of Fallon et al.’s investigation indicated improvements in reading target words, novel words, and generalization to book contexts. Although pictures were paired with consonant-vowel-consonant (CVC) words as a stimulus for reading tasks in the Fallon et al. investigation, contextualized instruction using books and/or stories was not a feature of instruction. Two recommendations for modifications for future investigations made by the researchers included “increased phonological awareness instructional time” and “the addition of written words during phonological awareness activities” (p. 1436).

Johnston, Buchanan, and Davenport (2009) investigated the rate of letter-sound acquisition with two preschoolers with autism spectrum disorder (ASD). An alternating treatments design was used and the target letters were presented in two conditions: (a) gradual array and (b) fixed array. In the gradual array condition the target letter was presented in isolation and seven distracter letters were gradually added. In the fixed array condition seven letter distracters were presented with the target letter. Results were that acquisition of letter-sound correspondence was faster when the letter was presented in the fixed array condition for both participants. The authors contend that the fixed array condition was more efficient for letter-sound acquisition and call for more research on effective strategies that teach literacy skills to children with CCN.

Recently, Strasser and Seplocha (2007) described the importance of using picture books to facilitate literacy instruction in young children. Picture books plus printed words have been reported to be effective in helping children gain general knowledge, practice cognitive thinking, and learn about the rhythms and conventions of written words (Neuman, 1999). Picture books also expose children to a rich vocabulary (Strasser & Seplocha). Use of picture books may provide a contextualized basis for phonological awareness instruction that facilitates phonemic awareness, awareness of alphabetic principle, phonics, and even recognition of sight words. Use of picture book-based reading interventions may be similarly important for children with CCN.

There has been a call in the literature to further investigate literacy acquisition in students with CCN who use AAC (Dahlgren Sandberg, 2001; Hetzroni, 2004; Johnston, Buchanan, & Davenport, 2009; Sturm & Clendon, 2004; Sturm, Erickson, & Yoder, 2002). Unfortunately, few published reports have measured the efficacy of instructional programs in preliteracy and literacy skills of these students. This information is needed to help professionals determine the most effective and efficient instructional programs in literacy for students with CCN who use AAC.

The purpose of this investigation was to determine the effects of a structured intervention package on junior high school students’ sound-to-letter matching skills and decoding of novel words. The structured intervention package included direct, scaffolded, instructional lessons that were implemented using an error correction learning system. Additionally, a picture book-based phonological and phonemic awareness component was added to each instructional lesson. The primary goal of the investigation was to determine the effects of this intervention package on the preliteracy and literacy skills of students with CCN who use AAC.
Method

Participants

Four youths (2 boys and 2 girls) ranging in age from 12 years, 5 months to 15 years, 11 months participated in this investigation. Participants attended junior high school in an urban setting in the Midwest. All participants were educated in two self-contained special education classrooms with an emphasis on improving and maximizing functional communication and life skills. In this setting, a speech-language pathologist with more than 20 years of experience and advanced training in AAC partnered with each highly experienced special education teacher for co-teaching and collaboration for approximately 40% of each school day. Three of the four students participating in the project had been identified with ASD and all had been identified with moderate cognitive disabilities and CCN. Additionally, all used a variety of AAC systems ranging from low- to high-tech. Low-tech AAC systems in place included use of visual strategies and schedules, communication books, and single- or multi-level switches. High-tech AAC systems used by several participants included electronic devices with dynamic displays and speech output.

Lucy was a 15-year old female with primary diagnoses of Down syndrome, moderate cognitive impairment, and CCN. Although Lucy was highly verbal, her utterances were largely unintelligible to unfamiliar communication partners. Communication partners familiar with Lucy also found her verbal language highly unintelligible, even with the use of contextual cues such as body language and gestures. When the combination of words plus gestures was not successful in getting her message across, Lucy independently accessed her high-tech communication device. With it, she was able to successfully convey her intended messages in approximately 90% of her attempts. According to Lucy’s teachers, Lucy was unable to decode new words, although she had sight recognition of approximately 100 words and understood their general meaning in context. Lucy’s IEP goals related to language and/or literacy included (a) matching a sentence to a photo that depicted the sentence given a choice of two or three sentences; (b) production of consonant blends; (c) correct use of new vocabulary words from categories including nouns, verbs, and attributes in structured tasks; and (d) identification of 12 to 15 survival words using her AAC device.

Randy was a 15-year old male with primary diagnoses of ASD, moderate cognitive impairment, and CCN. Randy’s verbalizations were typically one word in length and intelligibility was estimated by his teachers at 80% in typical interactions. However, his spontaneous verbalizations were largely off-topic and often repetitive. When not understood, Randy tended to grow frustrated, and showed his frustration with maladaptive behaviors, such as yelling or moving out of his seat. When prompted by a staff member, Randy was able to successfully use a low-tech communication system, such as pre-printed communication pages with familiar icons. Randy was able to recognize most of the words paired with icons on his communication board. According to his teachers, Randy did not have a good understanding of the meaning of many of the words that he could accurately recognize by sight. He was consistently unable to decode new words. Randy’s IEP goals related to language and/or literacy included (a) using vocabulary words accurately in noun, verb, and attribute categories; (b) increasing utterances to two words in length; (c) matching a written sentence to a picture; and (d) using single-word responses to correctly answer ‘wh’ questions after a teacher read aloud a paragraph.

Amy was a 12-year old female with primary diagnoses of ASD, moderate cognitive impairment, a classification of other health impairment due to gastrointestinal health issues, and CCN. Amy was estimated at 100% intelligible in connected speech; however, in approximately 90% of interactions, her utterances were off-topic. When not understood, she often used maladaptive behaviors such as yelling or hitting. When prompted, Amy was able to use a low-tech communication system with a small number of symbol-plus-word choices. Although not confirmed, Amy’s teachers suspected that she also had some undiagnosed visual discrimination deficits, as she had consistently exhibited difficulty accurately discerning between symbols. According to her teachers, Amy was consistently unable to accu-
rately read commonly used single words when not paired with pictures or symbols, nor could she accurately decode unfamiliar words. Amy’s IEP goals related to language and/or literacy included (a) composing a 3–4 word sentence using vocabulary associated with a picture provided; (b) accurately using new vocabulary (nouns, verbs, and attributes) to describe a picture; (c) following a two-step direction to complete school-related tasks; and (d) identification of 12–15 written survival words.

Matthew was a 13-year old male with primary diagnoses of ASD, moderate cognitive impairment, a sensorineural hearing loss, and CCN. Matthew’s preferred method of communication was use of gestures combined with some manual signs. When not understood, he was often able to write, using “invented” spelling to help his communication partner understand him. The accuracy of his invented spelling was consistently poor, according to his teachers. When these methods were unsuccessful, Matthew would often independently attempt to get his message across with his high-tech communication device. This was moderately successful, depending on the content of his intended message. According to his teachers, Matthew was able to recognize words commonly paired with icons in his classroom. His teachers reported his decoding skills as “poor” for novel words. Matthew’s IEP goals related to language and/or literacy included (a) answering a ‘wh’ question accurately after a teacher read a story or paragraph; (b) increasing appropriate vocabulary use for verbs, nouns, and attributes; (c) producing a 3–4 word utterance on his AAC device using vocabulary associated with a photo; and (d) matching a word to a photo given a choice of two words. See Table 1 for a summary of participant demographic information.

Materials

A phoneme-loaded picture book was made for each of the 18 targeted phonemes. For example, the phoneme-loaded /m/ picture book was entitled “Matt’s Monday Morning Swim.” All 18 phoneme-loaded books were produced using Boardmaker® symbols and all were written to meet the following criteria: (a) the story included 48-point Arial font print plus associated Boardmaker® symbols; (b) the target phoneme was used a minimum of 15 times at the beginnings or ends of words; (c) book topics were chosen to be age-appropriate, but storylines were simple; (d) books contained as many concrete, picturable words as possible; (e) words were taken directly from instructional lessons when possible; (f) use of consonant blends was minimized around target phonemes (i.e., Bob instead of Brad); (g) target phonemes were underlined within words; and (h) each target word was represented with the same picture symbol that was used consistently throughout all books and during intervention activities. A data recording form was developed for the purpose of collecting procedural reliability data for each of these criteria (see Table 2). During individual assessments for sound-letter matching and word decoding, 2-in. by 4-in. cards with the targeted phonemes or words in 48-point Arial font print were made using Boardmaker® and then laminated.

Intervention

The structured literacy intervention had two distinct components. The first component involved an interactive reading experience with a phoneme-loaded book to all participants in the intervention group. The next component consisted of individual scaffolded phoneme lessons. Intervention occurred in the same two classrooms and the students were paired with graduate speech-language clinicians during all evaluation and intervention sessions. The first intervention component, reading a phoneme-loaded book with all participants, took about 5 minutes. A graduate student clinician in each classroom read the phoneme loaded book to the group of participants and their paired graduate student clinicians and paused after each page. During the pause, the paired graduate student clinicians provided emphasis of targeted phonemes. For example, when reading the /m/ phoneme-loaded book, the clinician would say, “Look — here is the letter [shows m] that makes the /m.../ sound.” In addition, the clinician pointed to the words as they were read for the purpose of increasing the participants’ print awareness skills, such as left-to-right reading and stop-
ping at the ends of sentences to emphasize punctuation.

Next, prior to initiating individualized instruction for the day’s targeted lesson, graduate student clinicians completed brief individual sound-to-letter assessments which took approximately 3–5 minutes to complete. At the end of every 3 weeks, graduate student clinicians also completed brief single-word probe assessments during this time. All brief assessments immediately followed the reading of the phoneme-loaded target book and were completed in the two classrooms by the graduate student clinicians. All words used in word probe assessments were two to four letters in length, but all contained two to three sounds in each word (e.g., putt, egg, and up).

The second component of the intervention was individual phoneme scaffolded lessons and these lessons took about 20 minutes per intervention session. A total of 10 lessons were developed for this project; these were structured and scaffolded to target specific phonemes and skills, beginning with preliteracy skills and ending with word decoding. The 18 target phonemes were divided into one of three sound-letter sets and each sound-letter set was targeted for 3 weeks of instruction.

### TABLE 1

**Participant Demographic Information**

<table>
<thead>
<tr>
<th>Participant Name</th>
<th>Lucy</th>
<th>Randy</th>
<th>Amy</th>
<th>Matthew</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnoses</strong></td>
<td>Down syndrome</td>
<td>ASD</td>
<td>ASD</td>
<td>ASD</td>
</tr>
<tr>
<td></td>
<td>Moderate cognitive impairment</td>
<td>Moderate cognitive impairment</td>
<td>Moderate cognitive impairment</td>
<td>Moderate cognitive impairment</td>
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<tr>
<td></td>
<td>CNN</td>
<td>CNN</td>
<td>CNN</td>
<td>CNN</td>
</tr>
<tr>
<td><strong>Communication Status (as reported by school speech-language pathologist)</strong></td>
<td>Estimated at 20% unintelligible in verbal exchanges</td>
<td>Estimated at 80% unintelligible in verbal exchanges, however, 60% of speech off-topic and repetitive</td>
<td>Estimated at 100% intelligible, however, 90% of speech off-topic</td>
<td>Estimated at 100% unintelligible in verbal attempts</td>
</tr>
<tr>
<td></td>
<td>Consistent use of body language and gestures with verbal messages</td>
<td>Consistent, spontaneous use of one word utterances</td>
<td>Low-tech communicative device used for topic maintenance when cued</td>
<td>Consistent use of invented spelling to aid communication breakdowns using high-tech communication device</td>
</tr>
<tr>
<td></td>
<td>High-tech communicative device used in approximately 80% of spontaneous exchanges</td>
<td>When use prompted, low-tech AAC facilitated 3–4 word utterances and on-topic essages</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Estimated Pre-literacy/Literacy Skills</strong></td>
<td>Unable to decode new words</td>
<td>Unable to decode new words</td>
<td>Unable to decode new words</td>
<td>Unable to decode new words</td>
</tr>
<tr>
<td></td>
<td>Recognized approximately 100 sight words in context</td>
<td>Poor understanding of word meanings, although has sight vocabulary of 50 words</td>
<td>Poor semantic understanding (word meanings), No reported sight vocabulary</td>
<td>Recognizes approximately 50 words when paired with picture icons. No reported sight vocabulary</td>
</tr>
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<td></td>
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</tr>
</tbody>
</table>
The first sound-letter set consisted of phonemes /m, f, a, t, p, o/; the second sound-letter set consisted of phonemes /b, g, i, s, l, e/; and the third sound-letter set consisted of phonemes /d, n, u, r, w, c/.

The 10 individual phoneme lessons were scaffolded by difficulty level, beginning with a sound-to-letter matching identification task and ending with novel word decoding skills. Each lesson included the following steps.

1. Sound-to-letter matching identification (i.e., Which letter says m-m-m-?)
2. Sound/letter identification, beginning of a word (i.e., Which letter says m-m-m- in this word: "m-m-m-ap")
3. Sound/letter identification, end of a word (same cue as #2 but with word ending in target sound such as "h-a-m-m-m.")
4. Sound/letter identification in beginnings and ends of words within sentences (same cue as #2 with sentences).
5. Corresponding letter/sound production using voice or AAC (i.e., What sound does this letter make?)
6. Identification of words that start with target sounds in picture choices (Which picture word starts with the letter that makes the sound m-m-m-?)
7. Identification of target letter at the beginning of a word produced by clinician (i.e., Which letter makes the sound at the beginning of the word m-m-m-a?)
8. Identification of target letter at the end of a word produced by clinician (i.e., Which letter makes the sound at the end of the word sa-m-m-m-a?)
9. Identify telescoped words (i.e., Which picture shows m-m-m-a-a-a-a-t?) produced by clinician by pointing to a picture paired with the word that represents it.
10. Identify (decode) a word produced normally by a clinician by pointing to a word that represents it (Which word says mat?).

The graduate student clinician chose the
step with which to begin the lesson based on the student’s individual performance data from the previous session. The graduate student clinician began each lesson by presenting the participant with a fixed array of two of the six target phonemes from the current sound-letter set. As the participant demonstrated success with the fixed array, s/he was given an additional letter/sound choice until there was a possible choice of six target phonemes. For example, in the first lesson, a participant would be explicitly taught to recognize the target letter ‘m’ and associate it with the /m/ sound. The student was then provided opportunities to show comprehension by choosing the target phoneme from a choice of two letters. Once the student chose the correct letter in 100% of trials, an additional letter choice was added until the participant could correctly identify the target letter in 100% of opportunities with a choice of all six letters in the set. These lessons were loosely modeled after the Fallon et al. (2004) description of preliteracy-to-literacy intervention and modified per teacher suggestion for specific sound targets across students. That is, the classroom teachers determined final letter/sound targets for students in the project prior to lesson development. The lessons were delivered in a systematic fashion for 9 weeks.

An error correction strategy was included in the instructional program. For example, if a student chose an incorrect letter after hearing the phoneme cue, the clinician told the participant that the choice was incorrect, held up the correct letter, and said, “This is the letter that makes the sound /m-m-m-/.” The clinician then immediately provided the stimulus question again (i.e., “Which letter makes the sound /m-m-m-/?”) and helped the participant choose the correct response by looking, pointing, and/or physical assistance as needed. If the participant then chose the correct response or initially chose the correct response independently, the clinician positively reinforced the correct choice (i.e., “Yes, this is the letter that makes the sound /m-m-m-/. Great work!”). Some of the participants were indifferent to verbal praise. In this classroom, a system of food reinforcers was used to reinforce desired behaviors, so with some participants (Randy and Amy), a food reinforcer, such as an apple slice or a piece of cracker, was paired with verbal praise. All reinforcers were given for independent correct choices only, not for correct responses that resulted from the error correction system.

Assessment

The week prior to beginning intervention was dedicated to pretesting sound-to-letter matching skills and conducting an assessment of word decoding skills for all students. An additional week was dedicated to posttesting using the same assessments following the 9-week intervention period. A total of three different sets of six letters/sounds were targeted using these structured lessons every 3 weeks, so that by the end of the project, students had received instruction on a total of 18 sound/letter targets (see Table 3 for sample lessons). Additional posttests using the same assessments were conducted 5 months after the completion of the project to assess maintenance and generalization of gains achieved during the project.

Research Design

A single-subject multiple baseline design (Baer, Wolf, & Risley, 1968) replicated across four students was employed to evaluate the effectiveness of a structured intervention package. The goal of the investigation was to determine the effects of the instructional package on two dependent variables: (a) sound-to-letter matching skills and (b) single-word decoding tasks involving novel words. The project included baseline, intervention, and maintenance conditions with data collection on sound-to-letter matching skills occurring during each session.

Data collection on single-word decoding tasks occurred every 3rd week, for a total of three probes. These single-word assessments consisted of an identification/decoding task of 18 target words chosen from a total pool of 54 words not used during intervention activities (i.e., ‘novel’ words). Each of the 18 words began with a different one of the 18 letters targeted in the intervention. Three novel words beginning with the same letter were presented to each participant. The interventionists’ cue was “Which word says [target

Improving Literacy Skills / 359
TABLE 3

Sample Lessons 1 and 5

Lesson Activities:

1. sound-letter matching task
   a. Clinician makes the phoneme sound while showing the letter (i.e., This is the letter that says /mmmm/. You can hear it in the word ‘money’ “m, m, m money”. Did you hear the /mmmm/ sound? This letter says /mmm/. Next, give the student a choice of 2 letters to pick from, 10 trials. Begin with /m, f/; change their position on the table each time. **Use error correction strategy with each incorrect choice. If participant misses, clinician instructs while pointing to the correct choice. (i.e., That’s not the letter that says /m-m-m/. Here is the letter that says ‘m-m-m’). Then, start on the next trial. Continue correcting until the student chooses correctly. Use positive reinforcement when correct. (i.e., That’s right! That’s the letter that says m-m-m).

   When accurate at 100% 10 trials (10 times in a row with or without error correction strategy) move to next letter below:
   b. Increase to 3 letters /m, f, a/ documenting % accuracy
   c. Increase to 4 letters /m, f, a, t/ documenting accuracy
   d. Increase to 5 letters /m, f, a, t, p/ documenting accuracy
   e. Increase to 6 letters /m, f, a, t, p, o/ documenting accuracy

   When student can correctly identify the target letter (i.e., /m/) from a choice of 6, start back at step a., beginning with the next target letter/phoneme (f)

   When the student can accurately complete all of the steps (a–c) with all target letters and phonemes, proceed to # 2.

5. Given a letter, the student will produce the sound that it makes. The cue is: What sound does this letter make?
   a. /m, f/ 10 trials of each, can mix up presentation order.

   When accurate at 100% 10 trials of each letter with or without error correction strategy -
   b. 3 letter choices /m, f, a/
   c. 4 letter choices /m, f, a, t/
   d. 5 letter choices /m, f, a, t, p/
   e. 6 letter choices /m, f, a, t, p, o/

   When student can correctly produce (verbally or with AAC system) the target letter from a choice of 6 to criterion, proceed to # 6.

word]?” The participants were instructed to indicate their choice from the array of three choices provided.

Data on sound-to-letter matching skills for all 18 sounds were collected prior to each lesson. Additionally, pretesting and posttesting sessions of sound-to-letter matching skills and word decoding tasks occurred during 1 week prior to and after the 9-week intervention period. Sound-to-letter matching assessments were conducted three times during baseline and posttesting conditions, while the word decoding skills assessment of all 54 words (each assessed twice per assessment session for a total of 108 word trials) was conducted once during the baseline and posttesting conditions.

Graduate student clinicians recorded individual accuracy data on all steps in the lessons. When a performance criterion of 100% accuracy was reached on each step of the lesson (with or without the use of the error correction strategy), the graduate student clinician began instruction on the next step of the les-
son. When all steps in the lesson were completed with 100% accuracy with or without the error correction strategy, a new step of the lesson was introduced.

Results

Individual Participant Results

Lucy’s performance data. As shown in Figure 1, Lucy made progress in accuracy of sound-to-letter matching identification in all three of the targeted letter sets during the project. In the first letter set, /m, f, a, t, p, o/, she improved from a mean 58% to 69% accuracy in the sound-to-letter matching task, a gain of 11 percentage points from the baseline condition through the intervention condition. During the 9 weeks of the intervention condition, each letter set was targeted for only 3 weeks, so this represents considerable progress. Lucy made the least amount of progress in the second letter set, /b, g, i, s, l, e/, improving from a mean 57% to 59% accuracy. She improved from a mean 41% accuracy in sound-to-letter matching during the baseline condition to a mean 45% accuracy for Letter Set 3, /d, n, u, r, w, c/, demonstrating an increase of 4 percentage points in the sound-to-letter matching task for Letter Set 3. Due to a family trip, Lucy missed 5 consecutive school days while Letter Set 2 was targeted. This may have impacted the amount of progress that she made on Letter Set 2. Sound-to-letter matching skills were reassessed 5 months after completion of the intervention to determine level of maintenance of skills. Lucy’s score on the assessment yielded the following results: 75% accuracy (Set 1 letters), 67% accuracy (Set 2 letters), and 42% accuracy (Set 3 letters). According to these results, progress continued on Set 1 and 2 letters, while a decrease of only 3% accuracy was measured in the sound-to-letter matching task associated with Set 3 letters.

Lucy’s pre-intervention assessment of decoding of all 54 novel words (assessed two times each) yielded accuracy levels for decoding these novel words at 36% (Word Set 1), 42% (Word Set 2), and 56% (Word Set 3). Intermittent word probes were also conducted to assess eight of these words, once every 3 weeks. These three assessments yielded the following accuracy levels: 16%, 16%, and 83% (Set 1 words), 33%, 42%, and 58% (Set 2 words), and 25%, 42%, and 58% (Set 3 words). Lucy’s accuracy increased for all probe assessments over the course of the intervention. Postintervention assessments of all words yielded decoding accuracy levels of 50% (Set 1 words), 42% (Set 2 words), and 42% (Set 3 words), indicating an increase in this skill in two of the three word sets. All words were reassessed 5 months following the completion of the intervention. This time, Lucy scored 75% accuracy (Set 1), 67% accuracy (Set 2), and 42% accuracy (Set 3). These scores reflected an increase of 39 percentage points for Set 1 words and 25 percentage points for Set 2 words in Lucy’s ability to decode the novel words. A decrease in accurate decoding of 14 percentage points was recorded for Set 3 words.

Randy’s performance data. Randy made progress in accuracy of sound-to-letter matching identification in all three of the targeted letter sets during the project (see Figure 2). In the first letter set, /m, f, a, t, p, o/, he improved from a mean 27% to 44% accuracy in the sound-to-letter matching task, a gain of 17 percentage points from the baseline condition through the intervention condition. Randy made the greatest progress in the second letter set, /b, g, i, s, l, e/, improving from a mean 26% to a mean 69%, a gain of 43 percentage points from pre-to postintervention. He also improved from a mean 25% accuracy in sound-to-letter matching during the baseline condition to a mean 43% accuracy for Letter Set 3, /d, n, u, r, w, c/, demonstrating an increase of 18 percentage points in the sound-to-letter matching task for Letter Set 3.

Randy’s pre-intervention assessment of decoding of all 54 novel words yielded accuracy levels at 28% (Word Set 1), 56% (Word Set 2), and 53% (Word Set 3). Intermittent word probes were also used to assess eight of these words, once every 3 weeks. These three assessments yielded the following accuracy levels: 25%, 42%, and 83% (Set 1 words), 42%, 58%, and 92% (Set 2 words), and 25%, 67%, and 50% (Set 3 words). Randy’s accuracy increased for all probe assessments over the course of the intervention. Postintervention
assessments of all words yielded decoding accuracy levels of 53% (Set 1 words), 56% (Set 2 words), and 53% (Set 3 words), indicating an increase of 25 percentage points in Set 1 letters, while the accuracy level was maintained for Set 2 and 3 letters. All words were reassessed 5 months following the completion of the intervention. At the 5-month follow-up, Randy continued to show improvement in decoding skills, with an 83% accuracy (Word Set 1), 83% accuracy (Word Set 2), and 75% accuracy (Word Set 3). These scores reflected an increase of 11 percentage points for Set 1 words, 12 percentage points for Set 2 words,
and 11 percentage points for Set 3 words in Randy’s ability to decode these novel words.

Amy’s performance data. Amy’s performance data are shown in Figure 3. She made progress in accuracy of sound-to-letter matching identification in two of three targeted letter sets during the intervention. In the first letter set, /m, f, a, t, p, o/, she improved from a mean 23% to 36% accuracy in the sound-to-letter matching task, a gain of 13 percentage points from the baseline condition through the intervention condition. Amy also evidenced a gain of 11 percentage points in the sound-to-letter matching task for Letter Set 2, /b, g, i, s, l, e/, moving from 23% accuracy to 34% accuracy. A decrease of 1% was measured for the sound-to-letter matching task for Letter Set 3, /d, n, u, r, w, c/, from 22% mean accuracy pre-intervention to 21% accuracy during intervention sessions. Amy’s graduate
student interventionist specifically noted Amy’s great difficulty in visually differentiating /n/, /u/, and /i/ and /l/.

Amy’s pre-intervention assessment of decoding of all 54 novel words yielded accuracy levels at 33% (Word Set 1), 33% (Word Set 2), and 39% (Word Set 3). Intermittent word probes were also used to assess 18 of these words, once every 3 weeks. These three assessments yielded the following accuracy levels: 50%, 25%, and 50% (Set 1 words), 68%, 42%, and 68% (Set 2 words), and 42%, 25%, and 50% (Set 3 words). With two exceptions during probe evaluations, Amy’s accuracy increased for all probe assessments over the course of the intervention. Post-intervention

Figure 3. Graphic display of Amy’s performance data.
assessments of all words yielded decoding accuracy levels at 53% (Set 1 words), an increase of 20 percentage points. An accuracy level of 39% was measured for Set 2 words, reflecting an increase of 6 percentage points. Accuracy was measured at 36% for Set 3 words, reflecting a decrease of 3 percentage points. All words were reassessed 5 months following the completion of the intervention. At the 5-month follow-up probe, Amy’s novel word decoding accuracy was measured at 33% (Set 1 words), 42% (Set 2 words), and 25% (Set 3 words). These scores reflected Amy’s maintenance of word decoding skills for Set 1 words, an increase of 6 percentage points for Set 2 words, and a decrease of 14 percentage points for decoding Set 3 words.

Matthew’s performance data. Matthew made progress in accuracy of sound-to-letter matching identification in two of three of the targeted letter sets during the project (see Figure 4). In the first letter set, /m, f, a, t, p, o/, he improved from a mean 33% to 40% accuracy in the sound-to-letter matching task, a gain of 7 percentage points from the baseline condition through the end of the intervention condition. Matthew made the greatest progress in the second letter set, /b, g, i, s, l, e/, improving from a mean 38% to 62%, a gain of 24 percentage points from pre- to postintervention. Matthew maintained sound-to-letter matching accuracy at 35% for Letter Set 3, /d, n, u, r, w, c/.

Matthew’s pre-intervention assessment of decoding of all 54 novel words yielded accuracy levels at 42% (Word Set 1), 44% (Word Set 2), and 44% (Word Set 3). Intermittent word probes were also used to assess 18 of these words, each assessed twice per assessment once every 3 weeks. These three assessments yielded the following accuracy levels: 50%, 8%, and 83% (Set 1 words), 66%, 33%, and 83% (Set 2 words), and 50%, 33%, and 75% (Set 3 words). Matthew’s accuracy increased during the majority of probe assessments over the course of the intervention. Postintervention assessments of all words yielded decoding accuracy levels of 53% (Set 1 words), reflecting an increase of 11 percentage points. Matthew received a score of 33% accuracy for Set 2 words, reflecting a decrease of 11 percentage points. For Letter Set 3 words, he scored 39% accuracy, which reflects a decrease of 5 percentage points. All words were reassessed 5 months following the completion of the intervention. At the 5-month follow-up probe, Matthew achieved 50% accuracy in Set 1 words, 75% accuracy in Set 2 words, and 33% accuracy in Set 3 words. These scores reflected a slight decrease of 3 percentage points in Matthew’s ability to decode these novel words for Set 1 words, an increase of 42 percentage points in word decoding ability for Set 2 words, and a decrease of 6 percentage points for Set 3 words.

Trends across Participants

Each participant demonstrated overall improvement in sound-to-letter matching skills in at least two of three sound-letter sets targeted across the 9-week intervention. All of the participants exhibited some variability in skills across intervention sessions, which was often associated with decreased attention to tasks during intervention sessions. Of the four participants, Randy made the most consistent gains across all sound-letter sets. Matthew made the next highest gains overall in sound-to-letter matching skills. He had a significant hearing loss, and just as the 3rd sound-letter set was targeted, his graduate student clinician was informed that he had received a new hearing aid which was worn during his assessments and intervention activities. He had previously worn hearing assistance inconsistently. His teachers had mentioned that it was often “acting up,” needed repair, or was left at home. Matthew’s data clearly show the positive effect of the use of this hearing assistance that enabled him to make connections from the sound/visual cue and target letters. Amy and Lucy also made moderate increases in sound-to-letter matching skills in two of three and one of three letter sets, respectively.

Gains were observed for Randy and Amy in the whole-word decoding task. Matthew and Lucy did not make consistent or lasting progress in word decoding. Laura and Randy continued to evidence marked progress at the 5-month follow-up probe. Matthew’s scores decreased minimally in Letter Set 1 and 3 words, and increased by 42 percentage points in Letter Set 2 words. Amy’s word decoding scores, however, decreased at the 5-month follow-up assessment.
Procedural and Performance Reliability Data

Graduate student clinicians assigned to collect interrater and performance reliability data collected data for 93% of intervention and 77% of assessment sessions. Procedural reliability data were calculated at a correlation coefficient of .96 for intervention procedures, which was considered acceptable at above .90. Likewise, interraters collected independent participant performance data for assessment and intervention sessions. A correlation coefficient was calculated at .94 for all assessment data, which was above the predetermined acceptable level of .90.

Discussion

Results of this study indicate a functional relationship between the structured literacy intervention and improved sound-to-letter
matching skills. Results of all participant data did not clearly establish a functional relationship between identification/decoding of novel words, although two participants (Randy and Matthew) clearly improved and/or maintained progress made in decoding novel words during the investigation and at the 5-month follow-up assessment. These findings are similar to those reported in Fallon et al.’s (2004) investigation and confirm the importance of literacy instruction for students with CCN. Laura’s results appear to have been negatively impacted in Set 2 letters, when she missed several days of intervention due to a family trip. Conversely, Matthew’s individual results appear to have been positively affected by a new hearing aid device worn more consistently during assessments and interventions than he had made previously with the old, inconsistently word hearing aid device.

The structured literacy intervention included reading a phoneme-loaded picture book to the whole group, individual assessments, and individual scaffolded lessons with error correction instruction. Results of this investigation provide evidence of the importance of the use of picture book-based phonological and phonemic awareness interventions. Picture books have been identified as a developmentally appropriate way to introduce reading skills (Strasser & Seplocha, 2007) in young children. Results of the current investigation suggest that these interventions may be equally important in children with CCN. Unfortunately, specific effects attributable to the inclusion of a picture book-based intervention were not isolated in participant outcomes in this investigation. Because of the combined nature of the intervention package, it is not clear what effect(s) individual components of the intervention had on gains achieved by participants. Component analyses of such intervention “packages” are recommended to determine which aspects of the interventions are more salient—and for which types of learners and AAC users.

All of the participants exhibited some variability in skills across intervention sessions. The researchers attributed this variability to participants’ inconsistency in their ability to focus on tasks at hand across intervention sessions. This inconsistency has been described as a characteristic of students with ASD and moderate cognitive disabilities (Sherer & Shreibman, 2005).

Limitations of the Study

The interventions were provided in two classrooms during school hours. Therefore, classroom noises and activities were noted by graduate student clinicians to have distracted the students on more than one occasion, which may have limited the effects of the intervention. However, noise and activities are typical of naturalistic junior high level classroom environments. Therefore, additional methods to minimize typical classroom noise and activities were not attempted.

Letter sets were originally selected in this project for sound combinations only, without consideration of the visual characteristics of the letters. Two of the graduate student clinicians reported that the students with whom they worked had difficulty with visual discrimination of similar-looking letters. For example, Letter Set 1 contained both /i/ and /l/. When these letters were printed in 48-point Arial font and bold text, these participants often incorrectly chose the /l/ for /l/ and vice versa during sound-to-letter matching tasks. These visual similarities between some of the letters in the letter sets may have also decreased individual participant accuracy.

Conclusion

Attaining literacy is a complex process that is made more difficult if students have CCN. However, literacy is a skill that is vital and contributes immensely to leading a productive and fulfilling life. More research is needed to develop and determine the effectiveness of interventions to develop literacy in individuals with CCN. This study attempted to develop and evaluate one literacy intervention for youths with CCN that can be implemented in older students with limited literacy skills.

References