Effects of Systematic Instruction and an Augmentative Communication Device on Phonics Skills Acquisition for Students with Moderate Intellectual Disability Who Are Nonverbal

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Abstract: Percentages of correct responses to decoding probes (i.e., phoneme identification, blending phonemes to identify words, blending phonemes to identify pictures) were measured across three participants with moderate intellectual disability or autism in elementary school. Time delay and system of least prompts were used in conjunction with an AAC device, which enabled participants to produce phoneme blends and receive articulatory feedback. Participants were taught the initial levels of a phonics curriculum designed by the research team. Each level introduced a new set of three phonemes. During the five lessons within each level, participants were taught to identify letter sounds, segment and blend CVC words, identify sight words, read connected text, and answer comprehension questions related to the stories. Using a GoTalk 32 Express, participants produced target phonemes and words, as well as blended phonemes to form words. All participants improved across the three target skills, indicating a functional relationship between phonics skills and the systematic delivery of the phonics curriculum using an AAC device.

If students are to become independent readers, they must develop foundational skills for decoding text. In the National Research Council’s consensus report Preventing Reading Difficulties in Young Children, Snow, Burns, and Griffin (1998) described an urgent need for children to develop an understanding of the relationship between sounds and symbols in order to become successful readers. Additionally, the National Reading Panel (NRP, NICHHD, 2000) described phonics as one of the critical components necessary for the development of independent reading skills. In contrast, the research on teaching students with intellectual disability phonics skills is sparse (Conners, 1992; Joseph & Seery, 2004). This lack of research is especially apparent for students with moderate or severe intellectual disability or autism spectrum disorder. Instead, there has been an abundance of studies on teaching students with moderate or severe disabilities to recognize functional sight words (Browder, Wakeman, Spooner, Ahlgrim-Delzell, & Algozzine, 2006). Out of 128 studies on teaching reading to students with moderate or severe disabilities, Browder et al. (2006) found only 10% of these studies targeted phonics or phonemic awareness.

A few studies have illustrated how to adapt beginning reading programs for students with intellectual disability or autism. In an exploratory study, Al Otaiba and Hosp (2004) examined the effects of a reading tutoring program on the phonological awareness, phonics, sight-word fluency, and comprehension skills of students with mild and moderate intellectual disability. The authors developed their treatment package using recommendations from the NRP (NICHHD, 2000), individual-
ized lesson plans and objectives, instructional materials used in general education classrooms for lower elementary grades, and peer assisted learning strategies (Fuchs & Fuchs, 2002). Student outcomes were measured using pretest and posttest scores on the Woodcock Reading Mastery Test-Revised (WRMT-R) as well as weekly curriculum-based measurements (CBM). Results from the WRMT-R were inconsistent across participants, though three out of four participants increased in decoding skills as demonstrated by CBMs.

Flores, Shippen, and Alberto (2004) investigated the effects of direct instruction on the on the decoding skills of elementary students with moderate intellectual disability and autism. Using the Corrective Reading Decoding, Level A, from the Corrective Reading Program (Engelmann, Carnine, & Johnson, 1988), the authors measured students’ performance on letter sound identification, continuous sound blending, sounding out words, and decoding. All participants improved their letter-sound identification and sounding out words skills, but only two participants improved their ability to decode unfamiliar words. In a related study, Bradford, Shippen, Alberto, Houchins, and Flores (2006) investigated the effects of direct instruction on the decoding skills of middle school students with moderate intellectual disability. Using the Corrective Reading Decoding, Level A, the authors measured pretest-posttest outcomes of Dolch and Edmark sight word lists (Dolch, 1955; Edmark Reading Program, 1990) as well as criterion-referenced performance of oral letter-sound correspondence, written letter-sound correspondence, word recognition, and reading fluency. All participants reached criterion in order to complete Level A over a six month time period. Posttest data indicated participants generalized decoding skills to reread untaught vocabulary words. The participants’ sight word reading gains from pretest to posttest ranged from 21% to 68%.

Allor, Mathes, Roberts, Jones, and Champlin (2004), conducted a longitudinal study in which they examined the effects of a comprehensive reading intervention on a variety of decoding and language measures (e.g., blending words, segmenting words, sound matching, passage comprehension) on students with moderate intellectual disability. The authors created a precursor to a previously validated curriculum for students without severe disabilities, Early Interventions in Reading (Mathes, 2005; Mathes & Torgesen, 2005). They developed new content for teaching foundational phonics skills using Direct Instruction (Englemann & Carnine, 1982). Results from pretest and posttest measures indicated statistically significant findings for blending nonwords, segmenting words, phonemic decoding efficiency, letter-word identification, passage comprehension, and word attack. Similarly, results from continuous progress monitoring indicated nonsense word fluency scores were statistically significantly higher in the treatment group compared to the contrast group.

While all three studies found support for using direct instruction strategies, all also focused on students who were able to make the target responses using speech (e.g., to sound out words). Browder, Ahlgrim-Delzell, Courtade, Gibbs, and Flowers (2008) evaluated The Early Literacy Skills Builder (Browder, Gibbs, Ahlgrim-Delzell, Courtade, & Lee, 2007), a scripted curriculum targeting vocabulary, comprehension, phonemic awareness, and early phonics skills in which students can use nonverbal response modes (e.g., AAC or pointing). Results of this randomized control study of 23 students demonstrated those students who received the ELSB outperformed students in the control group who received typical sight word instruction on the Nonverbal Literacy Assessment (Browder et al., 2008) and the Peabody Picture Vocabulary Test (PPVT-III, Dunn & Dunn, 1997). In a replication by Browder, Ahlgrim-Delzell, Flowers, and Baker (2012), 93 students with severe developmental disability, enrolled in grades K-4, were randomly assigned to either the ELSB or the Edmark Reading Program, a sight word approach. Results indicated that students in the comprehensive early literacy curriculum had significantly higher mean literacy scores than the students in the sight word condition. A limitation of the ELSB is that it only builds skills to the kindergarten level.

Another approach to teaching reading to nonverbal students, developed through a case study by Light, McNaughton, Weyer, and Karg (2008) for students with significant speech or motor disabilities, targets phonologic awareness, letter-sound correspondences, decoding,
sight word recognition, reading connected text, reading comprehension skills, and early writing and keyboarding skills. In the Accessible Literacy Learning (ALL; Light & McNaughton, 2009) curriculum, the instructor reads all sounds or words orally. The student responds by touching the target picture or word in print or by saying or signing the word. To decode, students are taught to think about each letter sound and blend the sounds in their head (Light & McNaughton, 2010). Consequently, the ability to blend internally is a critical component of the ALL.

In a related study, Fallon, Light, McNaughton, Drager, and Hammer (2004) examined the effects of direct instruction on the letter-sound identification and decoding skills of upper elementary and middle school students with moderate ID and severe speech impairment. Using a multiple probe design, the authors systematically taught students to use internal speech to decode letter sounds and identify target words from an array of picture symbols. All students reached mastery of letter-sound identification, but only one student reached criterion for decoding. The authors suggested future research to examine the use of AAC to provide synthetic articulatory feedback during instruction.

This use of a synthetic articulatory feedback may provide students with intellectual disability who have limited speech a more concrete means for acquiring phonics skills than internal speech alone. One option is to use a voice output communication device that provides sounds for symbols. The device would need to allow students to identify letter names when given its sound, blend sounds to identify words, and segment words into individual sounds, thus providing the articulatory feedback suggested by Fallon et al. (2004). Students with more severe disabilities might also need additional intensive instructional support to acquire these phonics skills. Browder et al. (2006) found systematic prompting and feedback to be an evidence-based practice for teaching reading skills to students with moderate and severe disabilities.

The purpose of the current study was to examine the effects of systematic instruction and an augmentative communication device on the phonics skill acquisition of students with intellectual disability or autism who had limited use of speech. The following research questions were considered for this population:

1. What is the effect of the AAC device and systematic instruction on the students’ ability to identify phonemes?
2. What is the effect of the AAC device and systematic instruction on the students’ ability to blending sounds in order to identify words in print?
3. What is the effect of the AAC device and systematic instruction on the students’ ability to blend sounds in order to identify a picture?

Method

Participants

Three students who attended public elementary school in a large, urban school district in North Carolina were purposefully selected to participate in this study. A description of the study and following inclusion criteria was sent to teachers of potential students via email by a school district administrator: (a) intellectual disability in the severe to moderate range (IQ estimated as 55 or less), (b) inability to identify at least five letter sounds using vocalizations, (c) completion or current use of a foundation literacy program or demonstration of competence in identifying at least five letters or sight words, and (d) physical capacity to use the AAC device. Nine teachers volunteered to participate and nominated 13 potential students. After an observation to verify eligibility, seven students were deemed ineligible due to their ability to verbalize more than five letter sounds or due to their lack of foundation literacy skills. These students were eliminated from the pool of potential participants. From the remaining pool of potential participants, three students were selected based on convenience of the school locations to each other.

Royce was a 10-year-old, Caucasian male with Down syndrome. He has an estimated IQ of 44 and was in a 5th grade, self-contained classroom. Royce communicated through vocalizations and gestures, including basic sign language (e.g., bathroom, more, finished) and pointing to objects or symbols. Royce demonstrated self-stimulatory behaviors (e.g., rocking, hand flapping), and these behaviors...
often escalated and distracted him during academic tasks. The teacher and interventionist often redirected Royce by using an enthusiastic tone of voice and by singing his favorite songs. Royce enjoyed hearing his own name spoken as praise, and he would often attend to tasks when task directions were presented energetically with animated facial expressions. Although he attempted to vocalize specific phoneme sounds upon request, the sound produced was not clear enough to differentiate individual phonemes. Royce had previously completed the ELSB, but he was unable to participate in an available published phonics curriculum due to his inability to respond vocally. Royce’s current literacy instruction included Edmark and Sonday System (Sonday, 2000) with teacher modifications to allow for a pointing response.

Tom was a 7-year-old, African-American male with autism and an IQ of 54. He was in 1st grade in a self-contained classroom. He communicated through vocalizations and gestures (e.g., pointing, signing “finished”). Tom typically followed every task direction the first time asked, though he sometimes expressed frustration through agitated vocalizations and shutting his eyes. His teacher would typically give him pieces of cereal for compliant behavior. During the probe sessions and intervention sessions, he received intermittent delivery of pieces of cereal. He was receiving literacy instruction in the ELSB, having completed level 6 (of seven levels) at the time of the study.

Mitchell was an 8-year-old, African-American male with autism. He was in 3rd grade in a self-contained classroom. Mitchell was unable to participate in traditional ability assessment so an IQ estimate was calculated using the Deviation IQ method. Cognitive Age equivalents were divided by his chronological age at the time of testing then multiplied by 100. This calculation yielded an estimated IQ of 31. This score, coupled with a severe deficiency in self-help and adaptive functioning skills indicates Mitchell falls within the moderate to severe range of intellectual disability. Mitchell communicated primarily through gestures (i.e., pointing), though he would occasionally produce a low, gutural sound to indicate his interest in something (e.g., pointing to an item he liked while producing a sound). Mitchell was very calm and readily responded to any task direction. He would need occasional reminders to look at the lesson materials (e.g., GoTalk Express), as he would sometimes look around the room while touching a response. In these instances, he received a verbal redirection, “Mitchell, look at your work,” and he would typically respond by looking at the GoTalk Express. He was receiving literacy instruction in the ELSB, also having completed level 6 at the time of the study.

Setting

Teachers delivered the phonics instruction to students in one-to-one daily sessions that lasted approximately 15–20 min. Royce received instruction in a separate room from the class to reduce distractions. Tom and Mitchell received instruction in classroom while other students participated in other instruction, either independently or with an aide. Mitchell’s teacher went on maternity leave before completion of the study, so a Graduate Research Assistant (and author of the study) conducted the final week of instruction.

Independent Variable and Equipment

Phonics instruction consisted of the GoTalk Phonics (GTP) curriculum, which was written by the authors specifically for this study. The GoTalk Phonics curriculum was developed by reviewing existing phonics curricula (e.g., Open Court, Reading Mastery, Early Interventions in Reading) for the types of skills being taught and the introductory sequence of phonemes. From this review, a list of identified skills and a proposed phoneme sequence for GoTalk Phonics was generated and then validated with two experts in phonics and literacy instruction for students with developmental disabilities. Each expert provided a written review with recommendations, many of which were incorporated into the curriculum (e.g., order of phonemes). Stories were developed to accompany the instruction of selected skills. Stories were written using CVC words constructed with phonemes taught in the lesson. A few additional sight words were used in each story to allow for a cohesive story line. One of the experts also reviewed the stories and pro-
vided a few wording suggestions that were incorporated into the story.

The resulting curriculum with accompanying stories were provided to the teachers along with a GoTalk 32 Express communication device. GTP consisted of eight levels, each of which contained three different targeted phonemes. Each level had seven skills including (a) phoneme identification, (b) identification of the first sound in words, (c) phoneme segmentation of CVC words, (d) blending sounds to form words, (e) blending sounds to form words with picture referents, (f) sight words needed to read the stories, and (g) reading connected text with comprehension. Table 1 describes each skill and the actions required by the teacher and student. For the purposes of this study, all three students began at level one and then moved to the next level upon two consecutive days of 80% independent correct on the daily probe.

Students responded to the instruction using a GoTalk 32 Express AAC device that was provided by the Attainment Company. This device was selected due to its ability to combine up to eight cells in a single response. Although created for a string of words, phonemes were recorded in the cells so that individual phonemes could be selected then blended into a word. The recorded phonemes were generated in a sound booth, reviewed by a phonics expert for correct pronunciation and length, and then recorded onto the device. Each level had at least one color coded overlay to designate the location of the recorded words and sounds on the device. These overlays were created with the assistance of an AAC expert. The overlay was di-

<table>
<thead>
<tr>
<th>Skill</th>
<th>Teacher Action</th>
<th>Student Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoneme identification</td>
<td>Produce targeted sound</td>
<td>Press letter button on AAC device</td>
</tr>
<tr>
<td>Identification of the first</td>
<td>Produce targeted word with emphasis on first sound</td>
<td>Press letter button on AAC device</td>
</tr>
<tr>
<td>sound in words</td>
<td>Produce targeted word (e.g., toss)</td>
<td></td>
</tr>
<tr>
<td>Identification of segmented</td>
<td>Produce targeted word</td>
<td>Press sequence of letter buttons with audio cues on AAC device (e.g., toss), then press express bar to combine sounds to form the word using text-to-speech software</td>
</tr>
<tr>
<td>CVC words</td>
<td>Produce targeted non-CVC word</td>
<td>Press word button on AAC device</td>
</tr>
<tr>
<td>Blending sounds to form words</td>
<td>Produce targeted sound stretching sounds</td>
<td>Press word button on AAC device</td>
</tr>
<tr>
<td>Blending words with picture</td>
<td>Asks student to read word by blending sounds, does not produce sounds</td>
<td>Presses picture representing the word read</td>
</tr>
<tr>
<td>referents</td>
<td>Presses picture representing the word read</td>
<td></td>
</tr>
<tr>
<td>Sight words</td>
<td>Produce targeted non-CVC word</td>
<td>Press word button on AAC device</td>
</tr>
<tr>
<td>Reading connected</td>
<td>Level 1 &amp; 2: Points to words in story, then asks literal question from text just read</td>
<td>Level 1 &amp; 2: Press words or letters to read story on AAC device, then press word button to answer to comprehension question on AAC device</td>
</tr>
<tr>
<td>Text with comprehension</td>
<td>Levels 3–8: Fading prompts for student to read story silently, then asks literal and inferential questions from text just read</td>
<td>Levels 3–8: Reads silently then press word button to answer to comprehension question on AAC (may reread story with AAC device if provides wrong answer to comprehension question)</td>
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vided into vowels, consonants, sight words, and CVC words, each with a specific color background. The number of overlays used in a lesson was contingent on the number of items taught in a lesson. For instance, levels 2 and 3 required two overlays each due to the increased number of phonemes and words taught in these lessons. Placement of phonemes and words on the overlay was made in consideration of the placement of the same words and phonemes in other levels so that, as much as possible, the location of the instructional items remained the same across levels.

**Dependent Variable**

A probe was created using three skills from the curriculum: (a) phoneme identification, (b) blending sounds to form words, and (c) blending sounds to form words with picture referents. Figure 1 displays an example of these three skills from the lessons and how they were addressed in the probe.

The items used in the probe were from the first six levels of the curriculum. The probe was limited to three skills in consideration of the time needed for students to respond to all probe items. These three skills were selected for the probe to demonstrate the most basic elements of learning to read by identifying individual phonemes in isolation, reading and selecting spoken words, and comprehending written words by selecting a picture referent. Probe items and the distractors were the same as those presented in the curriculum. Students responded to the probe items by pointing to the answer from a four-choice array. The percent of independent correct responses to the probe were collected in baseline, treatment, and maintenance phases and plotted on graphs (one graph for each skill and one graph for the total score).

**Procedural Fidelity**

Fidelity was assessed by having a GRA observe and video record teacher instruction. The observer recorded teacher actions on a form that listed the teacher actions required in the curriculum. Fidelity was calculated by dividing the number of steps completed correctly by the total number of steps required by the curriculum then converting it to a percent by multiplying by 100. Procedural fidelity data were collected for 20.97% of all sessions across all three students during the treatment phase.

Interrater reliability was assessed having a second observer (university faculty member and co-Principal Investigator) watch the video recorded session of the teacher and recording the observed actions on a second form listing the actions required in the curriculum. The forms were compared item-by-item, and discrepant codings were noted. Interrater reliability on procedural fidelity was calculated by dividing the number of items scored the same by the total number of item pairings then converting it to a percent by multiplying by 100. Interobserver agreement (IOA) of fidelity scoring was collected on 30.68% of all sessions across all three students during the treatment phase. Percent fidelity collected for each student ranged from 30.77% for Royce, 31.05% for Tom, and 30.3% for Mitchell.

**Experimental Design and Procedure**

A multiple-baseline across participants design was used to evaluate the effect of GTP on phonics skills using the criteria outlined in the What Works Clearinghouse Procedures and Standard Handbook 2.1 (2011). Once baseline was established for Royce, the independent variable, GTP, was implemented while Tom and Mitchell remained in baseline. Once the treatment effect was established for Royce, Tom entered into the treatment phase while Mitchell remained in baseline. Once the treatment effect was established for Tom, the final participant, Mitchell, entered into the treatment phase. When a participant met the level criteria of 80% independent correct for two consecutive days, he moved to the next level of the curriculum. At the end of the study, Royce and Tom had completed three levels of the curriculum and Mitchell had completed two levels.

Baseline data were collected through the individual administration of the probe assessment conducted by the GRA to establish each student’s accuracy of phoneme identification, blend sounds to form words, and blend sounds to form words with picture referents prior to the intervention. Teachers were trained individually on the GTP curriculum by
I. Phoneme identification:
/r/, point to the letter that makes the /r/ sound. After 5 seconds, if no response, say Point to the letter that says /r/. If still no response after 3 seconds go to the next item.

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<tr>
<th>p</th>
<th>v</th>
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<tbody>
<tr>
<td>r</td>
<td>y</td>
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II. Blending sounds to form words:
Listen /fffaamnm/. Point to the word /fffaamnm/. After 5 seconds, if no response, say Point to the word /fffaamnm/. If still no response after 3 seconds go to the next item.

<table>
<thead>
<tr>
<th>fan</th>
<th>fat</th>
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<tr>
<td>ran</td>
<td>not</td>
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III. Blending sounds to form words with pictures:
Read this word (point to the word) and find the picture. After 5 seconds, if no response, say Read the word and find the picture. If still no response after 3 seconds go to the next item.

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<th>man</th>
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Figure 1. Samples of three target skills from the lessons included in the probe: Identification of phonemes, blending phonemes with words, blending phonemes with pictures.

the same GRA and delivered daily instruction one-to-one with the students during the treatment phase. Each lesson lasted approximately 15–20 minutes. The GRA administered the daily probe, informing teachers when the student had reached 80% independent correct responses for the items from the level that was being taught. This benchmark served as a decision rule for determining when the student would move to the next level. Maintenance data were collected 5 and 10 days after the instruction had discontinued for Royce and Tom and 5 days after the instruction had discontinued for Mitchell.
Social Validity

Teachers and students evaluated the social validity of the GTP curriculum. The teachers participated in a five question, follow-up survey to evaluate the curriculum using a five-point Likert scale ranging from strongly agree to strongly disagree. The student survey consisted of four questions using a three-point scale ranging from I liked this to I didn’t like this with corresponding smiling/frowning face picture referents. The GRA administered the social validity measure to the students by providing examples of likes and dislikes using the picture referents (e.g., I like ice cream - points to smiley face).

Results

Figures 2 through 4 show the percent of independent correct responses for phoneme identification, blending sounds to form words, and blending sounds to form words with picture referents, respectively. Table 2 provides the percent of independent correct responses per skill for baseline and treatment phases for the three skills. All three participants demonstrated some knowledge of phoneme identification at baseline consistent with participation in the ELSB curriculum (see Figure 2). This overlap is most evident for Royce, who was able to demonstrate more consistency in correct responses over time. His identification of individual phonemes improved from a mean percent correct of 57.77% and range of 22.22% to 83.33% in baseline to 81.28% in treatment and range of 50.0% to 94.44% across the three levels of the GTP curriculum.

Both Tom and Mitchell, who had been receiving instruction using the ELSB immediately prior to beginning GTP, but had not yet completed it, had less overlap. A change in level and trend for phoneme identification between the baseline and treatment phases is most evident for Tom. Tom improved from a mean of 50.00% correct independent responses in baseline and range of 38.89% to 72.22% to a mean of 86.39% correct in the treatment phase and range of 61.11% to 100% across the three levels of the GTP curriculum. Mitchell improved from a mean 36.42% correct independent responses and range of 22.22% to 55.56% in baseline to a mean of 67.87% correct in the treatment phase and range of 38.89% to 88.89% correct across the three levels of the GTP curriculum.

Figure 3 illustrates the percent independent correct responses for blending sounds to form words. All three students’ ability to blend spoken phonemes to select written words improved. Royce improved from a mean of 23.78% correct independent responses and range of 8.1% to 43.24% correct in baseline to a mean of 58.18% and range of 27.03% to 81.08% correct in the treatment phase. Tom improved from a mean of 22.01% correct independent responses and range of 13.51% to 35.14% correct in baseline to a mean of 55.81% and range of 13.51% to 81.08% correct in the treatment phase. Mitchell improved from a mean of 24.33% correct independent responses and range of 18.92% to 29.73% correct in baseline to 39.25% and range of 18.92% to 59.46% correct in the treatment phase.

### Table 2

<table>
<thead>
<tr>
<th>Participant</th>
<th>Phoneme Identification</th>
<th>Blending Sounds to Form Words</th>
<th>Blending Words with Picture Referents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Treatment</td>
<td>Baseline</td>
</tr>
<tr>
<td>Royce</td>
<td>57.77</td>
<td>81.28</td>
<td>23.78</td>
</tr>
<tr>
<td>Tom</td>
<td>50.00</td>
<td>86.39</td>
<td>22.01</td>
</tr>
<tr>
<td>Mitchell</td>
<td>36.42</td>
<td>67.87</td>
<td>24.33</td>
</tr>
</tbody>
</table>
Figure 2. Percent independent correct identification of phonemes for Royce, Tom and Mitchell in baseline, treatment per level of curriculum, and maintenance. Lines represent cumulative % of responses for that level, Level 1 = 16.67%, Level 2 = 33.33%, Level 3 = 50%.
Figure 3. Percent independent correct blending phonemes with words for Royce, Tom and Mitchell in baseline, treatment per level of curriculum, and maintenance. Lines represent cumulative % of responses for that level, Level 1 = 5.4%, Level 2 = 18.9%, Level 3 = 32.4%
Figure 4 illustrates the percent independent correct responses for blending sounds to select picture referents. All three students' ability to select a picture referent upon reading written words improved. Royce improved from a mean of 6.67% correct independent responses and range of 0% to 18.18% correct in baseline to 42.26% and range of 18.18% to 66.67% correct in the treatment phase. Tom improved from a mean of 11.25% correct independent responses and range of 0% to 21.21% correct in baseline to 27.12% and range of 3.03% to 39.39% correct in the treatment phase. Mitchell improved from a mean of 15.00% correct independent responses and range of 0% to 20.00% correct in baseline to 30.00% and range of 20.00% to 50.00% correct in the treatment phase.

Figure 4. Percent independent correct blending phonemes with picture referents for Royce, Tom and Mitchell in baseline, treatment per level of curriculum, and maintenance. Lines represent cumulative % of responses for that level, Level 1 = 3.0%, Level 2 = 18.18%, Level 3 = 30.3%
of 17.17% correct independent responses and range of 0% to 27.27% correct in baseline to 37.55% and range of 24.24% to 60.61% correct in the treatment phase.

Percent procedural fidelity and IOA was calculated per student. Procedural fidelity was 89.01% for Royce, 93.08% for Tom, and 96.85% for Mitchell. Procedural fidelity IOA was 97.17%.

Social Validity

Teachers’ social validity responses. Responses from the two special education teachers indicated the perception that the intervention was both appropriate and effective. Both teachers indicated “strongly agree,” the highest rating, for the following items: (a) students with intellectual disability can learn phonics, (b) the stories used in GoTalk Phonics were appropriate for the students, (c) the skills taught in GoTalk Phonics were appropriate for the students, and (d) the students benefited from the systematic instruction used to teach the skills in GoTalk Phonics. The only item that was not rated as “strongly agree” by the teachers was “Phonics is a difficult skill for many students with intellectual disability.” One teacher rated this statement “agree,” and the other teacher rated “disagree.” Next to this response, one teacher wrote, “It depends on the student.”

Students’ social validity responses. All three participants rated every item “I liked this” by circling the smiley face picture and sentence “I like this.” This rating applied to the following items: (a) I read the stories all by myself, (b) I learned to read some new words, (c) I liked to use the GoTalk, (d) I want to learn how to read a book by myself. One student additionally circled “I didn’t like this” for the items: (a) I read the stories all by myself, (b) I learned to read some new words, and (c) I liked to use the GoTalk.

Discussion

A functional relationship was established between the phonics intervention and the percent of correct responses across all three skills (i.e., identifying phonemes, blending words to identify words, blending words to identify pictures). Each participant demonstrated a change in level from baseline to intervention for the total percent of correct responses across skills as well as for each of the three skills. For the measure of their total scores, all participants demonstrated low levels in baseline and fairly stable, increasing trends in intervention. Separate analysis of each skill revealed various patterns. For instance, all participants demonstrated the least amount of growth from baseline to intervention for phoneme identification. This limited increase was due to the fact that students had prior knowledge of phonemes by participating in the ELSB curriculum. One eligibility requirement of this study was completion of an early literacy curriculum in which letter sounds were previously taught. Despite their previous knowledge, all participants demonstrated a stable, increasing trend in intervention for this skill.

Overall, participants demonstrated slow but stable increasing trends for both blending skills. However, Royce’s intervention data for blending to identify words was variable during level 2 instruction. The interventionist observed behavioral resistance during probe sessions concurrent with level 2 lessons. The classroom teacher described similar behavioral challenges during delivery of intervention lessons. To increase Royce’s motivation and on-task behaviors, the interventionist sang songs during probe sessions.

Other researchers have considered the challenge of teaching phonics to students who are nonverbal. Light et al. (2008) developed the ALL curriculum for teaching students with significant speech or motor disabilities critical literacy skills. Browder et al. (2008) developed a curriculum for introducing students to phonemic awareness and phonics along with other early literacy skills. In contrast, this study provided intensive practice on phonics skills that bridged into beginning reading. The teacher used systematic prompting with feedback. For example, the teacher used time delay in which the response was modeled by the teacher in a zero (no) delay trial for errorless learning in the first lesson. In subsequent lessons, the student had the opportunity to try the response independently or wait for the teachers’ delayed model. Time delay has been used extensively in sight word research (e.g., Jameson, McDonnell, Johnson,
Riesen, & Polychronis, 2007; Mechling, Gast, & Thompson, 2008; Wolery, Werts, Snyder, & Caldwell, 1994) and found to be an evidence-based practice (Browder, Ahlgrim-Delzell, Spooner, Mims, & Baker, 2009).

A growing number of researchers have incorporated AAC devices into reading instruction. In a literature review of literacy interventions for students with physical and developmental disabilities who use AAC devices, Machalicek et al. (2010) identified 18 studies. For example, Ratcliff and Little (1996) measured the effects of corrective feedback and picture symbols on the sight word recognition of an elementary aged student with cerebral palsy. The student was prompted to use an AAC device to find specific sight words to complete sentences. In another study, Soto, Yu, and Kelso (2008) used AAC devices to measure the effects of repeated storybook reading with scaffolding and story mapping on the number of story elements, words, and clauses used by a middle school student with cerebral palsy. The student’s number of words, clauses, and story elements increased during the development of both personal and fictional stories. The devices used in most of the studies examining sight word acquisition or story elements provided students with opportunities to voice words in print or pictures of words.

Conversely, only three studies identified by Machalicek et al. (2010) addressed explicit phonics instruction. For example, Johnston, Davenport, Kanarowski, Rhodehouse, and McDonnell (2009) measured the effects of constant time delay on the letter-sound correspondence and spelling of CVC words for students with severe developmental delay. The authors used arrays of letter sounds with varied presentation orders and configurations to teach the skills. The authors also included generalization probes consisting of representations of different AAC keyboards. A functional relationship was established between the intervention and the phonics skills of both participants. Similarly, Truxler and O’Keefe (2007) examined the effects of direct instruction on the letter-sound correspondence, decoding, and spelling skills of students with complex communication needs who use AAC. The investigators provided instruction for letter-sound correspondence using printed letters, and the investigators voiced all sounds. For decoding and spelling components, the investigator modeled blending and segmenting letter sounds to form VC and CVC words. Students were prompted to identify target sounds to complete or spell words using a keyboard. The results were inconclusive across participants; while all four participants gained letter-sound correspondence skills, only one participant increased on measures of decoding and spelling. None of the participants were able to generalize skills to unlearned words.

These studies in which students were taught phonics are similar in that the interventionist is typically segmenting and blending sounds during instruction. Additionally, within this limited body of research, students are generally taught letter-sound correspondence and decoding. The current study may be the first experiment demonstrating the acquisition of these three phonics skills (letter-sound correspondence, blending to identify a word in print, blending to identify a picture) through AAC responses for students with intellectual disability and autism. One reason this study was possible was because of advance in technology. Prior AAC devices permitted creating sounds for letters or words. The GoTalk Phonics device also included a feature enabling the participant to blend sounds into words.

In the current study, students demonstrated understanding of this text by decoding a word and then finding the matching pictures. All students made marked gains from baseline to intervention for this measure of blending. Particularly, Royce and Mitchell demonstrated the greatest increase in correct responses for this skill than phoneme identification or blending to identify words in print. The students demonstrated an ability to identify not only common words (e.g., dog, sit, rug), but also words specific to the stories (e.g., Tam, Ron, Gus). Browder et al., (2006) found that a surprisingly small number of studies on reading for students with moderate or severe disabilities taught or measured comprehension. Similarly, few studies have considered comprehension for students with autism (see literature review by Chiang & Lin, 2008). Including comprehension in phonics instruction will be especially critical for students with intellectual disability or autism who might learn the
sound symbol relationship, but have no understanding of what it means.

Limitations and Future Research

While this study contributed to the small body of research on teaching phonics to students who use AAC devices, several limitations should be considered. First, the intervention began late in the school year. Although additional levels of instruction were planned covering most phonemes, only 2–3 levels could be implemented in the timeframe of the study. Research is needed to determine if students would be able to master the additional levels. More information also is needed on whether students will generalize their emerging reading skills to new text. In the first three levels, students key in every word to read it aloud before answering comprehension questions. The next step (planned for later levels) is for students to read text silently. This would be a critical level to reach to be able to generalize passage reading because it is not feasible or efficient to type in every word for most passages.

Another limitation is that the dependent variables did not include a measure of comprehension of connected text. Although the participants demonstrated comprehension at the word level (blended phonemes to identify picture), it is unknown whether they generalized this skill to a sentence or short passage. Students were given the opportunity to read connected text and answer comprehension questions in the lessons. Observations of instructional sessions suggested that students may have needed more explicit instruction in silent reading and comprehension of connected text, but this hypothesis needs to be evaluated in future research. The device itself is another limitation of this study. Although the GoTalk 32 Express provided students with the ability to blend sounds to form words themselves, the overlays were restricting in their dimensions and layout. For instance, teachers were required to use multiple overlays beginning in Level 3. As the curriculum builds and more phonemes are added, several overlays may be required to provide enough sounds for a single level. Additionally, while the size of the GoTalk Express is advantageous in regards to the large number of cells available for the student, this device is large and might prove difficult for a student to use across multiple environments. For instance, the device is much larger than the size of a typical book, which could create a stigmatizing effect for a student who might want to use this curriculum in a typical learning environment. Future research might consider incorporating this program into an application that could be used with mainstream technology, such as an iPad. The use of an iPad app might allow interventionists to execute each lesson with greater ease, increase design flexibility of the curriculum itself, and provide a less stigmatizing vehicle for AAC delivery.

Finally, conducting the non-instructional probes for the three dependent variables was arduous, and all three participants struggled to remain motivated during the probes throughout the duration of the study. The strategy used to offset motivational challenges was to add high preference activities intermittently during the probes (e.g., brief songs). An alternative would be to use instructional data once intervention began so students could be reinforced for correct responses. Another alternative would be to administer the probe using technology like a tablet or touch screen. This would enable the interventionist to program motivating features directly into the probe. For instance, students could listen to their favorite song upon completion of the probe, or even after completion of a certain number of items. Finally, perhaps the probe could be shortened. Several versions of the probe could be created with randomized selections from the total probe items for each skill.

Implications for Practice

Findings from this study suggest students with intellectual disability or autism that use AAC devices can learn phonics through systematic instruction. Specifically, this study supports the combined approach of using a voice output AAC device and systematic instruction to deliver a phonics curriculum to teach letter-sound identification, blending to identify words, and blending to identify pictures. Students need to use some internal speech with this approach. For instance, during the blending to find pictures skill, students were shown
a word and prompted to read the word in their head. The improvement in performance of this skill suggests students with moderate intellectual disability and autism may be able to blend sounds internally when also provided with the feedback of synthetic blending on the AAC device.

Findings from this study also suggest students may be able to learn more than one phoneme at a time. In the current study, three new phonemes were introduced at each level. Students were able to learn each set of phonemes in tandem. Subsequent levels reviewed previously taught phonemes. By introducing sets of phonemes, students were able to acquire a larger repertoire of sounds that could be incorporated into a variety of words and connected texts.

Finally, students were able to use the AAC device with ease in order to perform tasks in the curriculum. Observations of student lessons and feedback from teachers indicated students remained engaged through the lessons. They were able to locate and push the appropriate key on the device to produce phonemes and select words. Additionally, they were able to find multiple phonemes in order to blend phonemes to produce words. The students themselves all reported they liked the curriculum, the device, and the stories, and both teachers reported an ease of administration and high levels of student engagement.

In summary, this study contributes to the small body of research on teaching phonics skills to students with intellectual disability or autism who use AAC devices. By delivering the phonics curriculum through systematic instruction and by providing students with an AAC device that produced auditory feedback for phonemes and words, students were able to increase their ability to identify phonemes, blend sounds to form words, and blend sounds to identify pictures. By blending sounds to identify pictures, students also demonstrated comprehension at the word level. Future research should include a measure of comprehension of connected text to ensure that students not only learn to decode, but also understand the meaning of the texts they read.

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