Adapting Phonological Awareness Interventions for Children With Down Syndrome Based on the Behavioral Phenotype: A Promising Approach?

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Abstract

Many children with Down syndrome demonstrate deficits in phonological awareness, a prerequisite to learning to read in an alphabetic language. The purpose of this study was to determine whether adapting a commercially available phonological awareness program to better align with characteristics associated with the behavioral phenotype of Down syndrome would increase children's learning of phonological awareness, letter sounds, and words. Five children with Down syndrome, ages 6 to 8 years, participated in a multiple baseline across participants single case design experiment in which response to an adapted phonological awareness intervention was compared with response to the nonadapted program. Results indicate a functional relation between the adapted program and phonological awareness. Suggestions for future research and implications for practice are provided.

Key Words: phonological awareness; Down syndrome; intervention; behavioral phenotype

Phonological awareness (PA), the ability to identify and manipulate parts of spoken language, is considered a key skill in learning to read in an alphabetic language (Carnine, Silbert, Kame`enui, & Tarver, 2010). More specifically, phonemic awareness, the ability to identify and manipulate individual sounds or phonemes, combined with an understanding of letter-sound correspondences is presumed necessary for children to use the alphabetic principle to independently translate visual symbols into sounds (Adams, 1990; Ball & Blachman, 1988). In 1993, however, Cossu, Rossini, and Marshall put forth a controversial proposition that children with Down syndrome (DS) do not depend on PA to learn to read. Numerous studies conducted in subsequent years have explored the importance of PA for children with DS. Lemons and Fuchs (2010b) conducted a systematic review of this literature and concluded that children with DS are able to develop PA skills, that PA skills are associated with reading outcomes in this population, and that the research base at the time was insufficient to make claims regarding the efficacy of PA interventions for children with DS.

In general, over the past decade, there has been an increased emphasis on evaluating the efficacy of early reading interventions involving PA and phonics for individuals with intellectual disability (ID). In a review of reading intervention research involving individuals with disabilities, Connor, Alberto, Compton, and O'Connor (2014) indicated that the efficacy early reading approaches involving PA and phonics is also supported for children with ID. For example, Browder, Ahlgrim-Delzell, Courtade, Gibbs, and Flowers (2008) demonstrated that children with IQs of 55 or less who participated in a reading intervention that included PA significantly outperformed children receiving a sight-word program on PA measures. Allor, Mathes, Roberts, Cheatham, and Al Otaiba (2014) conducted a longitudinal randomized control trial involving 141 elementary-age children with IQs ranging from 40 to 80. Children in the treatment condition received approximately 45 min of daily one-on-one or small-group reading intervention that included PA instruction. Children in the treatment condition outperformed children in the control condition on measures of PA, including blending of real and nonsense words, and segmenting. Further, the
appropriateness of phonologically based reading interventions for children with ID is supported by research that demonstrates relationships between PA and reading skills are similar to children without disabilities (Barker, Sevcik, Morris, & Romski, 2013; Wise, Sevcik, Romski, & Morris, 2010).

Additional research has also been conducted to more specifically explore relationships between PA and reading outcomes for children with DS since the Lemons and Fuchs (2010b) review. Several studies support the conclusions of Lemons and Fuchs that children with DS can develop PA and that these skills are associated with reading outcomes. For example, Lemons and Fuchs (2010a) demonstrated that phoneme segmentation predicted improvements in nonword reading in a sample of 24 English-speaking children with DS (ages 7–16 years) who received a phonics-based reading intervention. Degasperi, Rocco, Giuseppe, and Calzolari (2011) demonstrated that phoneme segmentation and blending accounted for significant variance in word reading for a sample of 32 Italian-speaking children with DS (ages 7–15 years).

There are, however, conflicting findings. Steele and colleagues (Steele, Scerif, Cornish, & Karmiloff-Smith, 2013) assessed 26 children with DS (ages 5–8 years) and a sample of reading-ability matched, typically developing children at two time points separated by one year. Letter knowledge and PA assessed at time one were not predictors of reading growth for children with DS, although they were for the typically developing children. Further, PA appears to be less associated with reading outcomes for older individuals with DS. Roch and Jarrold (2012) conducted a follow-up study involving 12 individuals with DS (ages 14–30 years) to examine whether previously found statistically significant correlation between PA and nonword reading maintained. The authors were not able to replicate the correlation and suggested that PA is not a longitudinal predictor of reading outcomes for individuals with DS. Levy (2011) demonstrated that when IQ was controlled, the correlation between PA and reading of words and nonwords was no longer statistically significant in a sample of Hebrew-speaking adolescents with DS (ages 13–20 years). This disparity may reflect the diminishing role of PA as individuals get older, but it may also be due to differences in previous reading instruction provided to this group.

At the time of their review, Lemons and Fuchs (2010b) were able to identify only four studies evaluating PA interventions for children with DS. However, none of the studies were sufficiently rigorous and the authors were unable to make claims about the efficacy of PA interventions for children with DS. In the subsequent 5 years, several researchers have conducted additional research to evaluate the effectiveness of PA interventions for children with DS. In a series of A-B single-case demonstrations, van Bystervelt, Gillon, and Foster-Cohen (2010) provided 10 children with DS (ages 4–5 years) 18 weeks of intervention targeting letter sounds and PA skills. Six children demonstrated gains in letter name knowledge, two on letter sound knowledge, and eight in initial phoneme identification (although this was not above chance on their measure). Cologon, Cupples, and Wyver (2011) provided seven English-speaking children with DS (ages 2–10 years) 1-hr weekly sessions targeting PA and word reading for 10 weeks. Posttreatment assessment indicated gains in letter-sound knowledge, PA, and word reading, although there was limited evidence that learning generalized to words that were not directly taught. Cleave, Kay-Raining, Bird, and Bourassa (2011) conducted a randomized control trial involving 17 children with DS (ages 5–16 years). Children in the treatment condition participated in two 30-min intervention sessions per week for 22 weeks. The intervention targeted rhyming and identification of initial and final phonemes. Children in the treatment condition outperformed controls on final phoneme identification, but not on letter knowledge or initial phoneme identification. Burgoyne and colleagues (Burgoyne, Duff, Snowling, Buckley, & Hulme, 2013) provided daily one-on-one instruction to 10 children with DS (ages 6–10 years) over a 6-week period. The children demonstrated greater gains in phoneme blending and word reading during intervention compared to a 6-week preintervention control phase. Children did not demonstrate gains in spelling or nonword reading.

**Purpose**

In our own work, we evaluated the effectiveness of Road to the Code (RTC; Blachman, Ball, Black, & Tangel, 2000), a commercially available PA program that has been demonstrated to be effective for at-risk, typically developing children using a multiple-baseline across participants design involving four children with DS between the ages of 5 and 13 years (Lemons, Mrachko, Kostewicz, & Paterra, 2012).
We conducted this study because none of the previously published studies had evaluated the efficacy of a widely used commercially available curriculum, which is problematic for special educators who may not know how to teach PA without a structured program. The four children received 12 weeks of instruction. Results, however, indicated that the RTC intervention was not effective in enhancing the blending, segmenting, or initial sound identification skills of participants. The brief duration of the study may have limited our ability to demonstrate improvements on these skills. However, we also wondered whether adaptations could be applied to enhance the program.

Based on findings from our initial work, our aim in the present study was to evaluate whether we could enhance the commercially available RTC intervention by making adaptations that were tailored to children with DS. Specifically, we followed guidance provided by Fidler and colleagues (Fidler, 2005, 2006; Fidler, Most, & Philofsky, 2009), who suggested that outcomes for children with DS might be improved if interventions are designed to account for characteristics associated with the behavioral phenotype of DS. A behavioral phenotype includes a set of behavioral outcomes that individuals with a specific syndrome or disorder have a heightened probability of displaying relative to individuals without the syndrome or disorder (Dykens, 1995). For DS, this includes behaviors in the domains of cognition, speech, language, adaptive behavior, social-emotional functioning, and motor functioning (Chapman & Hesketh, 2000; Fidler et al., 2009; Silverman, 2007). As described by Reilly (2012), this type of research may provide guidance for practitioners regarding adaptations that may be integrated into instruction to improve student outcomes.

The research question guiding this work was “Is the introduction of an adapted PA intervention associated with an improvement in word reading, letter-sound knowledge, and PA skills?” We evaluated the efficacy of the adapted PA intervention in a multiple baseline across participants design (Gast, Lloyd, & Ledford, 2014) in which baseline instruction was delivery of the nonadapted PA program and treatment was delivery of the adapted PA program. To our knowledge, this is the first explicit attempt to explore the promise of adapting an academic intervention for children with DS based on phenotypic characteristics.

**Method**

**Participants and Setting**

**Students.** Participants were recruited through school districts and parent support organizations throughout western Pennsylvania. Project staff conducted individual screening sessions (described in Screening) in potential participants’ school. Eligible participants were (a) native English speakers, (b) able to see and hear well enough to benefit from typical classroom instruction, (c) able to communicate primarily using speech (d) behaviorally ready to attend to 20 min of instruction with minimal breaks, and (e) demonstrated mastery of fewer than 10 letter sounds, two first sounds, or two target words (see Screening). Seven children were screened for eligibility. Five eligible children with DS between the ages of 6 and 8 years were identified. Two children were excluded after screening: One child used sign language as the primary communication mode; another child was noncompliant and was unable to attend to 20 min of screening activities after multiple attempts. Additional descriptive information (i.e., IQ, reading achievement scores) is included in Table 1. The eligible children received educational services in public and private schools. Additional information is presented in Table 2 regarding the percentage of the school day children were included in the general education classroom, types of special education supports, setting for reading instruction, and reading-related individualized education program (IEP) goals. Four students were included in the general education for a majority of the school day. Three received life skills support (i.e., primarily focused on functional skills) and two received learning support (i.e., primarily focused on academics). Two children received reading instruction in both general and special education settings, one in general education only, and two in special education only. The focus of IEP goals varied across children.

**Interventionists.** The three researcher-affiliated interventionists included two certified special education teachers and one student enrolled in a special education doctoral program. All had prior experience working with individuals with disabilities. Each of the interventionists received training—provided by the first author—related to data collection, behavior management, and instructional procedures. Instructional training was conducted over the course of two separate sessions. All interventionists were first taught how to implement
the baseline program, RTC (Blachman et al., 2000). One week before an interventionist's first student entered the treatment phase (i.e., implementation of the adapted intervention), the interventionists received training on the adapted intervention components. After each training session and prior to providing instruction to students, interventionists were required to demonstrate data collection and intervention procedures with 100% fidelity.

Setting and materials. During baseline and treatment phases, interventionists provided one-on-one instruction in a quiet location at the child’s school (e.g., resource room). Interventionists sat in close proximity to participants at a small table. Materials included flashcards with printed letters and word, picture cards, small notebooks, a dry erase board with markers, and a digital timer. All intervention and assessment activities were video recorded.

Table 1
Demographics, Intelligence, Reading Achievement

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Age a</th>
<th>Score</th>
<th>Percentile</th>
<th>95% CI</th>
<th>WJ-III</th>
<th>PC Raw (W)</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pre</td>
</tr>
<tr>
<td>Lorna</td>
<td>F</td>
<td>8.6</td>
<td>40</td>
<td>0.1</td>
<td>(30-50)</td>
<td>6 (326)</td>
<td>7 (331)</td>
</tr>
<tr>
<td>Jean</td>
<td>F</td>
<td>6.3</td>
<td>54</td>
<td>0.1</td>
<td>(44-64)</td>
<td>12 (354)</td>
<td>14 (364)</td>
</tr>
<tr>
<td>Scott</td>
<td>M</td>
<td>7.2</td>
<td>42</td>
<td>0.1</td>
<td>(32-52)</td>
<td>4 (314)</td>
<td>10 (345)</td>
</tr>
<tr>
<td>Betsy</td>
<td>F</td>
<td>6.5</td>
<td>73</td>
<td>4.0</td>
<td>(63-83)</td>
<td>7 (331)</td>
<td>13 (359)</td>
</tr>
<tr>
<td>Anna</td>
<td>F</td>
<td>8.1</td>
<td>48</td>
<td>0.1</td>
<td>(38-58)</td>
<td>5 (320)</td>
<td>9 (340)</td>
</tr>
</tbody>
</table>

Note. a = in years; WJ-III = Woodcock Johnson III; Leiter-R Brief IQ = Leiter International Performance Scale-Revised; LWI = Letter-word identification; PC = Passage comprehension; CI = Confidence interval.

Screening
Before the study, we developed the scope-and-sequence for the adapted PA intervention. This included 24 letters of the alphabet (i.e., not x, z) and one highly imageable, decodable, target word that started with each letter (e.g., tub, elf). Two weeks before beginning baseline intervention, students were assessed on the target words, letter sounds, and first sounds of the target words from the scope-and-sequence. Each item was assessed across four consecutive days. Items were designated as previously mastered if a student provided the correct response for three consecutive days. The scope-and-sequence was individualized for each student by excluding previously mastered items. Students were eligible for inclusion if they demonstrated mastery of fewer than 10 letters, fewer than two of the first sounds, or fewer than 2 target words.

Measures
Dependent variables. To assess learning of directly taught content, we measured learning of letter sounds, PA (i.e., first sounds), and target words. The letter sound probe was the primary assessment that was used to move students through the scope-and-sequence. For each student, the first three letter sounds that were not known based on screening were the first three letter sounds to be taught. The three letter sounds being taught were assessed each day. After the lesson, each student was shown the letters on a flash card and asked “What sound?” Students who provided the letter...
<table>
<thead>
<tr>
<th>Participant</th>
<th>% of School Day in General Education Classroom</th>
<th>Types of Special Education Reading Services/Support</th>
<th>Classroom Setting for Instruction</th>
<th>Focus of IEP Goals Related to Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lorna</td>
<td>69% Life Skills Support, SLS, OT, PT</td>
<td>General and Special Education</td>
<td>Yes</td>
<td>Reading Comprehension, Spelling</td>
</tr>
<tr>
<td>Jean</td>
<td>80% Learning Support, SLS, OT</td>
<td>General and Special Education</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>Scott</td>
<td>91% Learning Support, SLS, OT, PT</td>
<td>General Education Only</td>
<td>No</td>
<td>Print Letters, Letter Name Knowledge, Writing Four-Word Sentences</td>
</tr>
<tr>
<td>Betsy</td>
<td>63% Learning Support, SLS, OT, PT</td>
<td>Special Education Only</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>Anna</td>
<td>0% Life Skills Support, SLS, OT, PT</td>
<td>Special Education Only</td>
<td>No</td>
<td>Sight Word Reading</td>
</tr>
</tbody>
</table>

Note. SLS = Speech language support; OT = Occupational therapy services; PT = Physical therapy services.
name were prompted one time for the sound. The child earned one point for each correctly provided sound within 5 s. No corrective feedback was provided. After a letter sound was correctly produced for three consecutive sessions, this letter sound was added to the child’s cumulative number of sounds mastered during the study and the next letter sound on the scope and sequence was added to the group of three letters on which instruction was focused. Thus, the probe includes points for any letter sounds mastered during the baseline or treatment phases and the number correct for the three letter sounds included in the currently taught lesson. Items identified during screening as mastered before the study began were not included in the cumulative total.

In addition, we followed similar procedures to assess learning of the target words and the ability to provide the first sound of the target words. For the target word probe, the interventionist assessed the student’s ability to read aloud the target word by showing the student the word printed on a flashcard and asking “What word?” For the PA probe, the student was shown a picture of the word (e.g., tub) and was asked “What is the first sound in tub?” Children earned one point for correct answers (i.e., reading the target word on the target word probe or identifying the first sound on the PA probe). Speech articulation errors were not penalized. As with the letter sound probe, items were considered mastered after a student scored correctly on three consecutive sessions. Mastered items were added to the cumulative total.

Because we anticipated it likely that some students would not master letter sounds and associated target words or first sounds at the same time, we established the following procedure. When a letter sound was mastered, the interventionist introduced the next letter sound in the scope-and-sequence along with the associated target word and first sound. If a student had not mastered a target word or first sound, we allowed up to three “trailing” items to be assessed. We used the term trailing to indicate nonmastered letter sounds, first sounds, or target words from previous lessons. Trailing items were reviewed during the lesson and were assessed at the same time as the items targeted in the lesson. To reduce the total amount of daily assessment, we capped the total number of target words and first sounds that could be assessed at six each. In the event that a student had not mastered more than six previously taught target words or first sounds, the interventionist assessed the three items that were currently being taught and the first three nonmastered items from the scope-and-sequence. As trailing items were mastered, the interventionists followed the scope-and-sequence to determine which items would be assessed daily.

Descriptive measures. Four subtests of the Leiter International Performance Scale-Revised (Leiter-R; Roid & Miller, 1998) were used to estimate IQ (i.e., Brief IQ Screener). Figure ground requires children to identify figures or patterns; form completion requires children to recognize whole objects based on an illustration of fragmented parts. On the sequential order subtest children are required to determine a logical sequence of pictures or figures; the repeated pattern subtest requires children to identify a missing portion of a repeated series of pictures or figures. The Leiter-R Brief IQ score has sufficient validity and reliability. Reliability scores are in the acceptable range for children in the age range of participants (e.g., upper .80 or greater). Two subtests of the Woodcock Johnson III (Woodcock, McGrew, Mather, & Schrank, 2001) were administered before baseline and following completion of the study. The letter-word identification (LWI) subtest requires children to identify letters and read words. The passage comprehension subtest initially requires children to select a rebus that represents a pictured object. Subsequent questions require the child to point to a picture represented by a phrase and then to read short passages and supply a missing word.

Baseline and Treatment Conditions
To evaluate the impact of adaptations on our dependent variables, we provided nonadapted PA intervention in the baseline phase and contrasted this with an adapted version of the PA intervention in the treatment phase. The study was conducted across 15 weeks. The first student entered the treatment condition when she demonstrated stable performance on two of the three dependent variables. We aimed to introduce treatment to students in subsequent tiers when the previously entered student demonstrated an observable change in level or slope on at least one dependent variable. However, we decided to have Betsy begin treatment despite Scott’s limited performance.

Baseline. RTC (Blachman et al., 2000) is an evidence-based PA program. The intervention consists of three daily lesson components. First,
students complete a “Say-It-and-Move-It” (SIMI) activity in which the instructor provides support in phoneme blending and segmenting by manipulating small plastic chips to represent the sounds in words that contain two or three phonemes. Next, students participate in an activity that focuses on learning the name and most common sound of letters. Finally, students play a variety of games to practice PA skills including isolating, blending, sorting, and matching sounds. Interventionists provided instruction four times per week in sessions that included 20 min of RTC instruction and 10 min to conduct assessment, provide a reward, and transition the student back to their regular classroom. (For a more detailed description of the program see Blachman, Ball, & Tangel, 1994; Lemons et al., 2012.)

**Treatment.** Based on guidance from Fidler (2005), we made adaptations to the baseline intervention to address facets of the DS behavioral phenotype. Our primary adaptation was to support the learning of letter sounds by teaching an accompanying target word that started with the letter. We taught this target word using a card on which the letter was printed along with the target word, a partner word (a second word that started with the letter), and two or three images that represented the target and partner word and any other salient words. Images were primarily color photographs of real objects; colored cartoon images were used when a suitable photograph could not be located. For example, for the letter t, the target word was *top* and the partner word was *tub*. The card included pictures of a top, a tub, and a turtle. An alliterative phase was sung aloud to review the letter and words on the card. For the letter t, the phrase was “Ted the turtle is turning his top in the tub.” Our rationale was that the words and images would increase engagement and would provide additional visual and working memory support for letter learning and PA.

In addition, we omitted activities in which students spent less time actively engaged with targeted content (e.g., *Go Fish*). Additionally, we (1) increased intensity by providing more explicit, direct instruction; (2) decreased working memory load by providing more practice and repetition; (3) integrated practice of targeted skills throughout the intervention; (4) increased task persistence by reviewing mastered items; (5) offered increased levels of support using an adapted most-to-least system of prompting; (6) limited verbal language and increased targeted visual support; and (7) provided students with positive reinforcement. Further descriptions of adaptations are presented in Table 3. The adapted lesson plan is available from the first author.

Interventionists delivered the adapted treatment on the same schedule as baseline treatment; however, the intervention session was 3 min longer to accommodate the added Word Instruction activity. Interventionists used the scope-and-sequencing of the original RTC manual to determine which adapted activities would be included in each daily session (See Table 3).

**Fidelity of implementation.** Fidelity scores were obtained from daily video-recordings of sessions. Using separate checklists of instructional steps aligned with baseline and treatment conditions, observers reviewed recordings until the interventionists demonstrated correctly performing 90% of instructional steps for three consecutive sessions. Interventionists who did not meet minimum fidelity criteria received additional training. Fidelity was conducted for a minimum of 24% of sessions for each student: Lorna (26%), Jean (26%), Scott (31%), Betsy (38%), and Anna (24%). Average fidelity was 99% (range = 90%–100%) for Lorna, 98% (range = 91%–100%) for Jean, 92% (range = 83%–100%) for Scott, 94% (range = 80%–100%) for Betsy, and 98% (range = 87%–100%) for Anna.

**Interobserver agreement (IOA).** Observers scored video recordings from 20% of assessments across both baseline and treatment conditions. Agreement was conducted for a minimum of 24% of assessments across students: Lorna (26%), Jean (24%), Scott (33%), Betsy (38%), and Anna (27%). We defined agreement as items on which both the interventionist and observer recorded the same response. Total agreements were subtracted from the total possible, divided by the total possible, and multiplied by 100 to calculate IOA. Average IOA was 100% for Lorna, 100% for Jean, 98% (range = 94%–100%) for Scott, 93% (range = 84%–100%) for Betsy, and 98% (range = 93%–100%) for Anna. Discrepancies in scoring were corrected through consensus discussion of scorers and an additional coauthor when necessary.

**Social Validity and Feasibility**

Social validity and feasibility was evaluated through two processes. First, interventionists sub-
### Table 3  
**Overview of Instructional Adaptations**

<table>
<thead>
<tr>
<th><strong>General Adaptations</strong></th>
<th>Increased explicit language by created a simplified script. Increased direct instruction. Decreased working memory by narrowing focus on three target words and letters per lesson. Increased practice of mastered items. Integrate review of letter sound, target word, and phonological awareness across all activities. Closely monitored student success and provided additional scaffolding as needed. Decreased unnecessary visual images and verbal language. Monitored behavior and engagement closely and provided positive behavioral supports. Expanded scope-and-sequence to include 24 letters. Instruction focused on teaching three letters at a time. Subsequent letters were introduced based on mastery. Levels of scaffolding were developed for each activity. Interventionists used an adapted most-to-least system of prompting to remove scaffolding support (e.g., remove model word or picture during sound board activity).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Word Instruction</strong></td>
<td>New activity. Students reviewed previously mastered target words. Students learned three new target words. Target words were decodable, imageable words. Taught as sight words and matched with a picture. Students practiced matching words and pictures and reading words with fluency.</td>
</tr>
<tr>
<td><strong>Say-It and Move-It</strong></td>
<td>Created a simpler SIMI card without visual distractor. Began SIMI using target words from “Word Instruction.” Supported SIMI practice with picture and printed word cards. Supported activity by using chips with letters. Omitted counting of sounds. Students began identifying first sounds, then segmenting and blending first sounds and rimes, then blending and segmenting individual phonemes. Support of picture, word, and letters was faded as students demonstrated success.</td>
</tr>
<tr>
<td><strong>Letter Sound Instruction</strong></td>
<td>Created alliterative phrase cards that included target words and pictures from “Word Instruction” paired with an alliterative phrase that was sung as a jingle to practice the letter sounds. Incorporated speech prompts where the interventionists modeled accurate articulation and ask child to repeat for the first three incorrect articulation attempts for each target letter.</td>
</tr>
<tr>
<td><strong>Introduce new letter/ Letter review</strong></td>
<td>Omitted practice of letter name. Focused on three target letters paired with picture and alliterative phrase card. Instruction focused on saying letter sound and identifying first sound of target words.</td>
</tr>
<tr>
<td><strong>Hand clapping game/ Alphabet book</strong></td>
<td>In place of these two activities, interventionists reviewed the alliterative phrase card for target letters. Students clapped along to jingle and practiced saying letter sounds and reading target words. On days when the alphabet book was included in the lesson, the student taped the target letters, words, and accompanying pictures into a notebook.</td>
</tr>
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(Table 3 continued)
<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Tracing in the air</td>
<td>Activity was done using a dry erase board and target word and picture cards. Interventionist provided a dotted outline of letters and words. The student traced the dotted outline and said the accompanying letter sound and word. Next, student erased the letter and word and repeated the sound and word.</td>
</tr>
<tr>
<td>Sound bingo</td>
<td>Interchangeable bingo cards were created using target letters, words, and accompanying pictures. Students first assembled their bingo card. The interventionist presented the student with cards that included the target letters, words, and accompanying pictures. The student was prompted to provide the sound for the letters and to say the word and first sound for the words and pictures. The student then attached each card to the bingo grid. Next, the interventionist showed the student additional cards and had the student say the letter sound or word and first sound, locate the corresponding item on the bingo card, repeat the sound or word and first sound, and place a bingo chip on the board.</td>
</tr>
<tr>
<td>I'm thinking of a word</td>
<td>Activity was changed to a blending / segmenting game. The interventionist placed three picture cards of target words in an array. Interventionist prompted student to ‘Guess the secret word’ after interventionist said the word that was segmented into onset-rime or individual phonemes. Student repeated word and identified picture. Next, the interventionist supported the student to say the sounds in the word</td>
</tr>
<tr>
<td>Go fish</td>
<td>Activity was omitted. On days Go fish was included in the lesson, the interventionists replaced the activity with Bingo, Concentration, or I’m thinking of a word.</td>
</tr>
<tr>
<td>Concentration</td>
<td>Game was played using the target letter, word, and picture cards from Sound bingo. Students initially practiced matching letters to letters and words to words in an array of six cards. When a match was made, the child repeated the letter sound or read the word and provided the first sound. Subsequent lessons increased difficulty by having the student match letters and words or picture and by increasing the size of the array.</td>
</tr>
<tr>
<td>Sound board</td>
<td>Word building activities were done using a magnetic dry erase board and magnetic letters. Students practiced building target words. Initially, the target word card and picture were provided and only one distractor letter was included. Students were prompted to check their word against the model. Students then identified the first sound in the word. Next, students practiced changing the word to a word that differed by one letter.</td>
</tr>
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| Table 3  
Continued |
<table>
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<tr>
<td><strong>Phonological Awareness (PA)</strong></td>
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</table>
| **Practice** | Activity was done using target word cards and pictures. 
Interventionist placed three pictures in an array. Interventionist pointed to each picture, said word, prompted student to provide first sound. After all three were reviewed, interventionist repeated and prompted student to identify the one that was different. Initial sound activity was practiced each day the lesson included a sound categorization activity (i.e., in place of categorization by rhyme). |
| **Sound categorization by initial sound** | A puppet was used to say a “broken” word (i.e., segmented into onset-rime or individual phonemes). Picture cards, magnetic letters, and Elkonin boxes were used to support blending of words that were presented as onset-rime or individual phonemes. |
| **Fix it** | Omitted activity. In place, students used magnetic letters and an Elkonin box to build target words. Picture of target word was provided. Students were not prompted to count sounds. |
| **How many sounds?** | Activity was done using letter, target word, and picture cards. Students “fished” for the cards from a small. When student “caught” a card, she was prompted to say the sound or word and first sound. Then, student placed the card into a pile that matched the appropriate alliterative phrase card (e.g., “m” and “man” placed under the “m” alliterative phrase card). |
| **Let’s fish** | Adapted by using letter, target word, and picture cards. Mailbox bags were placed directly in front of student on table. Target letters were attached to each bag. Then, students said word (from word or picture card), provided the first sound of the word, then placed it into the appropriate bag. |
| **Post Office** | Activity was played using picture cards. Interventionist wrote the letters included in the word plus two distractors in a list on a dry erase board. The interventionist drew a rabbit and a line of dashes for each letter in the word. The interventionist said the word and had the student provide each sound. As the student provided correct sounds, the interventionist wrote the sound on the appropriate dash. If a child provided an incorrect sound, that sound was erased from the list and a part of the rabbit was erased. Game continued until word was built or rabbit was erased. At end, the interventionist wrote in any remaining letters and the child repeated each sound and read the word |

**Note.** SIMI = Say it and move it; Elkonin box = Instructional method in which boxes and tokens are used to represent phonemes in words.
mitted a written report and completed an interview with the first author and the project coordinator. The report and interview focused on the acceptability, feasibility, and effectiveness of the intervention. Second, parents and the special education teachers of participating students were invited to attend a 2-hr meeting in which they were provided with a summary of project outcomes. Parents were provided with an individualized report of their child’s progress. Parents and teachers then participated in a focus group discussion in which they provided feedback on the acceptability, feasibility, and effectiveness of the intervention. Data were summarized in narrative notes that were reviewed for accuracy.

Results

Students participated in between 24 and 45 sessions (M = 34.4, SD = 8.7) delivered across 15 weeks. Two students, Scott and Betsy, received fewer sessions due to illness and absence. Results are depicted in Figure 1 and are formatted following a multiple baseline across participants format. Student performance on the letter sound probe is depicted in the left panel of Figure 1 (closed circles). Lorna participated in 34 sessions. Her average score across sessions was 1.22 (SD = 0.67) letter sounds correct during baseline and 4.52 (SD = 1.50) letter sounds correct during treatment. Baseline slope was 0.10 compared to a treatment slope of 0.17. This indicates a slight acceleration trend for Lorna during treatment. Jean participated in 45 sessions. Her average score across sessions was 1.62 (SD = 0.77) during baseline and 10.91 (SD = 5.23) during treatment. Baseline slope was 0.08 compared to a treatment slope of 0.55. This also represents an acceleration trend for Jean during treatment. Scott participated in 24 sessions and he consistently scored zero on this probe across baseline and treatment conditions. Betsy participated in 28 sessions. Her average score was 3.68 (SD = 3.04) during baseline and 10.29 (SD = 1.11) during treatment. Her baseline slope was 0.52 compared to a treatment slope of 0.43. This indicates a slight deceleration trend for Betsy during treatment. Anna participated in 41 sessions. Her average baseline score was 1.23 (SD = 1.15) and her average treatment score was 5.74 (SD = 1.33). She had a baseline slope of 0.14 compared to a treatment slope of 0.21. This represents a slight acceleration trend for Anna during treatment. In sum, acceleration in slope was associated with treatment for three students (Lorna, Jean, and Anna), one student exhibited a deceleration (Betsy), and one student demonstrated no change (Scott). Thus, no functional relation was established between treatment and rate of learning of letter sounds due to the countertherapeutic effect for Betsy.

Student performance on the PA probe is depicted in the left panel of Figure 1 (open squares). Lorna scored zero on all baseline probes indicating she knew no first sounds. During treatment, her average score across sessions was 0.20 (SD = 0.50) sounds correct. Her treatment slope was 0.03, representing a slight, although delayed, acceleration. Jean had an average baseline score of 1.62 (SD = 0.77) sounds correct and a baseline trend of −0.04. During treatment, Jean’s average performance was 6.38 (SD = 4.56). Her slope during treatment was 0.47 indicating acceleration in learning of first sounds. Scott earned one point on one probe during baseline (M = 0.06, SD = 0.24). During treatment, his average score was 0.83 (SD = 1.33). Scott’s baseline slope was −0.01 compared to a treatment slope of 0.31. Scott demonstrated a slight acceleration in learning in that he did provide a few correct first sounds. However, he did not master (i.e., correct three consecutive days) any individual first sounds. Betsy earned no points on this probe during baseline. Her average performance during treatment was 2.22 (SD = 1.09). Her treatment slope of 0.35 indicates acceleration in learning. Anna also earned no points during baseline compared to an average treatment score of 0.21 (SD = 0.54). Her treatment slope of 0.02 represents a minor acceleration. In sum, all five students demonstrated some level of acceleration indicating a functional relation between treatment and PA, at least in terms of first sound identification.

Performance on the target word probe is represented in the right panel of Figure 1. All five students consistently earned a score of zero on the measure during baseline. Lorna’s average performance increased to 1.72 (SD = 1.14) with a slope of 0.11 during treatment. Jean earned an average treatment score of 17.03 (SD = 10.83) with a slope of 1.15. Scott earned one point on one treatment probe. This increased his average treatment score to 0.17 (SD = 0.41) with a slope of 0.09. Betsy’s treatment average was 2.67 (SD = 2.35) with a slope of 0.80. Anna’s average treatment score was 3.95 (SD = 3.01) with a slope of 0.51. Four students demonstrated notable gains in learning of target
Figure 1. Performance on Letter Sound, Phonological Awareness, and Target Word Probes
words (Lorna, Jean, Betsy, and Anna) and one student demonstrated a minor improvement (Scott). In sum, results demonstrate a functional relation between treatment and learning of target words.

Finally, all participants exhibited higher post-test scores on the letter word identification and passage comprehension subtests of the WJ-III (see Table 1). These descriptive data are provided to contextualize each child’s reading ability. Our design does not allow us to make claims of a functional relation between these changes in scores and our intervention.

**Social Validity**

Interventionists prepared a written report and completed an interview with the first author and project coordinator in which they reported on the acceptability, feasibility, and effectiveness of the adapted intervention provided during the treatment condition. Lorna’s interventionist reported that the intervention was acceptable, feasible, and that, although the gains on the dependent variables were small, gains did represent meaningful growth for Lorna. Jean’s interventionist also rated the intervention favorably on all three indicators. She also reported that Jean’s engagement increased during the treatment condition and that classroom teachers reported seeing improvements in reading skills outside of the study. Scott made minimal progress on the dependent variables. His interventionist indicated that the intervention may have been too advanced for him and also indicated challenges with problem behavior and engagement. The interventionist indicated that Scott’s attention during instruction did increase in the treatment phase. Betsy’s interventionist indicated that the treatment was acceptable, feasible, and effective in increasing performance on the PA and target word tasks. The interventionist indicated that engagement improved following introduction of the adapted intervention; however, she also noted challenges with student attendance. Anna’s interventionist indicated that the intervention was acceptable and feasible; however, she reported that the intervention was only moderately effective. The interventionist reported an increase in engagement and a decrease in problem behavior during the treatment condition. The interventionist suggested that the intervention might have been more effective if Anna had been able to complete more sessions in the adapted intervention.

Four parents and five teachers attended the end-of-project meeting. Parents unanimously indicated that the focus of the project, increasing reading skills, was important for their children. The parents reported favorably on the effectiveness of the intervention and indicated that they believed participating in the project had benefited their children. Parents suggested that future studies could add additional focus on vocabulary and comprehension. Teachers reported that the intervention was effective for participating students and that the intervention was acceptable to integrate into their current practice. However, three of the five teachers indicated that, although they thought the intervention would benefit their students, the feasibility of implementing the intervention in a one-to-one format would decrease their ability to implement the program given the current level of support available at their school.

**Discussion**

The purpose of the current study was to evaluate the effect and feasibility of adapting a commercially available widely used PA program for children with DS based on features of the behavioral phenotype. As noted previously, we are not aware of any previous studies in which adapting instruction based on the phenotype has been explicitly empirically tested. We evaluated the efficacy of our adaptations in a multiple-baseline across participants, single subject design. Although gains were modest, findings demonstrated a functional relation between our adapted intervention and improvement in PA (i.e., providing the first sound in a word) and learning of target words. We believe our findings provide initial support for the promise of making adaptations aligned with the behavioral phenotype, particularly in light of our previous study in which the nonadapted PA program was not associated with gains in PA (Lemons et al., 2012).

Findings are aligned with the broader research base supporting the use of evidence-based reading interventions with children with ID (Connor et al., 2014). In addition, results contribute to the more focused body of work involving children with DS by demonstrating children with DS can benefit from PA intervention. Findings also provide preliminary support for scaffolding PA instruction using pictures and printed letters and words. Although other researchers who have reported positive outcomes associated with PA interventions
provided to children with DS have not explicitly stated that the phenotype was considered during intervention design, aspects of their interventions are similar to the adaptations we made during the treatment phase. For example, Burgoyne et al. (2013) integrated letters into PA activities and provided support for cognitive load and reduced working memory during the activities by using pictures. Cleave et al. (2011) also integrated letters and pictures into their intervention. Colgon et al. (2011) taught children to read printed words that included target phonemes and used pictures to support learning. van Bysterveldt et al. (2010) paired letters and printed words with PA activities.

It is possible that the types of adaptations we made in the present study may be most effective for children who are at the earliest stages of learning to read. Children in the present study were eligible because during screening they demonstrated previous mastery of fewer than 10 letter sounds, two first sounds, or two target words. In a separate study conducted in tandem with the present work, we evaluated the impact of making similar adaptations to an early decoding program, Road to Reading (Blachman & Tangel, 2008), using a multiple-baseline across participants design involving six children with DS between the ages of 5 and 12 years (Lemons, Puranik, Al Otaiba, Fidler, & Fulmer, 2013). Children were eligible for the decoding intervention if they had stronger reading skills (i.e., earned more points on the screener by being able to provide more letter sounds or first sounds, or to read more words) compared to children who were included in the present study. For the decoding intervention, we did not find a functional relation between the adapted intervention and learning of letter sounds or decodable words. Results from the decoding study support findings from our previous work (Lemons & Fuchs, 2010a; Lemons et al., 2012) in which nonadapted decoding interventions were effective at increasing letter sound knowledge and reading of decodable words. Thus, providing additional picture support may not be necessary for children who are already able to read a number of words.

Limitations and Directions for Future Research

Several limitations should be considered in evaluating our findings, but also inform directions for future research. First, our dependent variables focused on directly taught skills. In the future, it will be important to include additional phonological and phonemic awareness measures and to include some more distal curriculum based measures. Furthermore, including a generalization measure for PA would allow for a better evaluation of the intervention’s impact. Second, the intervention was conducted over a relatively brief period of time (i.e., 15 weeks) and this limited the amount of time that several children were receiving the adapted intervention. Future research could explore multiple baseline across units of content so that some students would not need to experience a lengthy baseline. Third, our design does not allow us to evaluate which adaptations may have been the most helpful to students nor does it allow us to evaluate whether our adaptations were beneficial to only children with DS or whether they would benefit a broader population of children with intellectual disabilities; additional research is warranted. Fourth, our team implemented the intervention and further research should explore what is feasible for teachers to conduct, particularly given feedback from teachers about the difficulty of providing one-to-one intervention.

Despite the limitations, we believe our findings support the pursuit of better understanding how phenotypic characteristics may be used to adapt interventions for children and adolescents with DS. First, a randomized control trial in which an adapted intervention is compared to a nonadapted intervention for two groups of children with ID, one with and one without DS, would allow for a direct evaluation of the benefits associated with modifying instruction based on the phenotype. An examination of differential performance across the two groups and of potential mediators and moderators of treatment response would enhance our understanding of the interaction between phenotype and response to instruction. Second, as demonstrated by Allor and colleagues (Allor et al., 2014), children with ID may require up to 3 years of intensive reading instruction before measureable gains are observed. Longitudinal studies involving intervention provided over several years would increase our understanding of longer term outcomes and would allow for a stronger focus on generalization beyond directly taught skills. Third, during our work involving children and adolescents with DS, we have seen a higher amount of variability on phenotypic traits than we would expect based on previous literature.
A rigorous evaluation of the sensitivity and specificity of the phenotype that examines relationships with academic skills and how to profile changes with development is necessary to guide future efforts in this area.

Regarding more general reading intervention research for children and adolescents with ID, we believe our findings suggest at least two areas for future research. First, we need to continue to study more comprehensive interventions that are delivered with greater intensity over longer durations of time. The studies should extend on the work of Allor, Browder, and colleagues (Allor et al., 2014; Browder et al., 2009; Connor et al., 2014) in considering how to support generalization and advanced literacy skills like comprehension. Second, additional information is needed on how to best support school staff in improving the reading skills of children and adolescents with ID. In the present study, there was variation across children in terms of where reading instruction was provided (e.g., general and/or special education classroom), percentage of time included in general education, and a focus on literacy in IEP goals. Interestingly, our least responsive student (Scott, age 7) received all of his reading instruction in the general education 2nd grade setting and he had only one IEP goal focused on a literacy outcome, sight word reading. Future work should explore the relationships between children's responsiveness to reading instruction and the types of special education supports provided. We need a better understanding of how to support reading instruction provided to children with ID in inclusive settings, including an understanding of the impact of alignment between the curricula used and supports provided across general and special education. Additionally, research is needed to identify when it is more appropriate to provide services outside of the general education setting and to extend our understanding of how teachers can deliver appropriately intensive interventions given the limitations of extant resources in a majority of schools.

Implications for Practice
Our primary guidance for practitioners is that chasing the sun is well worth the effort (Bareilles & Antonoff, 2013). Our findings, along with those of others, indicate that children with DS are able to benefit from early PA interventions and this type of instruction should be provided to children in their early elementary years. Although not all children with DS will need adaptations aligned with the behavioral phenotype, taking an anticipatory stance by addressing deficits associated with the phenotype may be beneficial (Fidler, Philofsky, & Hepburn, 2007). Reilly (2012) provided a framework for accommodating children's specific and shared special needs that offers guidance in considering the behavioral phenotype of children with genetic syndromes. In line with his framework, we think that teachers should consider the following in providing reading instruction to children with DS. First, teachers should be encouraged to provide reading instruction using evidence-based practices used for typically-developing peers (e.g., National Reading Panel, 2000; Snow, Burns, & Griffin, 1998). Student learning should be monitored closely; and if response is inadequate, instructors should consider adapting instruction and interventions based on a model of literacy for children with ID (Browder et al., 2009). Additional adaptations aligned with the specific features of the DS behavioral phenotype could be considered if response remains inadequate. Finally, a process using data to fully individualize intervention (e.g., curriculum-based evaluation, Hosp, Hosp, Howell, & Allison, 2014; data-based individualization, National Center on Intensive Intervention, 2013) should be applied if these adaptations are insufficient. We highlight that IQ score should not exclude a child from evidence-based reading instruction. In the present study, the student with the lowest IQ score (Lorna) exhibited greater learning than children with higher IQs.

Conclusions
Special education researchers have made substantial progress in the past 20 years in increasing our understanding of effective methods to teach children and adolescents with ID and DS how to read. However, additional research is needed to allow practitioners to maximize student outcomes for this population of learners. One line of research that may contribute to this goal is to continue to explore populations of learners with well-defined behavioral phenotypes and the interactions between the phenotype and treatment outcomes (Hodapp & Fidler, 1999). This approach could increase our abilities to provide more effective interventions to children with ID, and it may increase our understanding of learning challenges.
in the general population (Mazzocco, Murphy, & McCloskey, 2007).

References


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