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Teaching Word Recognition to Children with Intellectual Disabilities

Michael J. Maiorano[1*] & Marie Tejero Hughes[1]

[1] College of Education, University of Illinois at Chicago, Chicago, IL USA

[*] Correspondence: Michael J. Maiorano, College of Education, University of Illinois at Chicago, Chicago, IL USA. E-mail: mmaior1@uic.edu

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Abstract

Learning to read affords individuals with intellectual disabilities (ID) a means to function in a literate society. However, one of the most overwhelming challenges for children with ID to accomplish is learning how to read independently. In this study a three-step decoding strategy was used with a constant time delay procedure to teach word reading to children with ID using a phonics-based curriculum. A non-concurrent multiple baseline design with two intervention phases was used to examine the percentage of letter-sounds correctly decoded and the percentage of words read correctly. The findings indicated that all the children learned to read words using the three-step decoding strategy and constant time delay procedure. It was also noted that across all children letter-sound decoding accuracy outpaced word reading accuracy. Although each child made gains in reading words, these gains were not sufficient to infer generalization. These results suggest that the decoding strategy and time delay procedure may be effective at instructing children with ID who are having a difficult time blending sounds together to read word, but additional supports are warranted.

Keywords: special education, disabilities, reading, phonics

1. Introduction

For all populations, illiteracy or low literacy levels impacts multiple domains of life including social dynamics, health care, and employment status. For persons with disabilities and especially those with developmental disabilities, the impact is even greater. Research shows that persons with disabilities who are illiterate have less successful face-to-face communication with others (Ballin &

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Balandin, 2007), are less likely to gain acceptance by the non-disabled community (McLaughlin, Bell, & Stringer, 2004), and are perceived as being less competent in daily activities (Gerber, 2012). In the area of health care, there is evidence that medical care is adversely impacted for individuals with low literacy due to difficulties associated with understanding oral and written medical direction along with the associated problems of prescription management (Smith, Nutbeam, & McCaffery, 2013). With regard to personal finances, data shows that economic hardships due to low literacy rates are protracted due to sustained periods of unemployment for the majority of adults with disabilities (Yamaki & Fujiura, 2002), and that these hardships are made more pejorative by fewer overall job choices (Snyder, Dillow, & Hoffman, 2008). Because the effects of illiteracy are linked so closely to a person's quality of life, it is reasonable to conclude that to prosper in a progressive society learning to read is an imperative. This is especially true for persons with developmental disabilities who are often further marginalized by society because of low intelligence, atypical physical features, and atypical social behaviors.

Of the developmental disabilities, intellectual disabilities (ID) is the most commonly occurring with over 200 identified etiologies of organic ID among the populations of the world. Of these, Down syndrome is the most common genetic form (Roberts, Price, & Malkin, 2007). Available data shows that about six thousand infants are born each year with Down syndrome (about 1 in 691 live births) affecting 400,000 families, and statistics show that this number is increasing (Centers for Disease Control and Prevention, 2010). Thanks to continuing advancements in clinical treatments, life expectancy for individuals with Down syndrome has increased dramatically with as many as 80 percent of individuals with Down syndrome today predicted to reach age 55 or older (Cuskelly, Hauser-Cram, & Van Riper, 2009). With the birth rate for children with Down syndrome increasing along with an increased life expectancy rate, it is reasonable to believe that the future number for children with Down syndrome attending neighborhood elementary schools will likely increase as well. In point of fact, current enrollment figures indicate that approximately 80,000 children with Down syndrome are receiving services from public and private institutions (Pre-K through grade 12) in the United States (US) (Snyder *et al.*, 2008).

Given the impact that illiteracy has on individuals with ID later in life, it is critical that teachers lay a solid foundation for literacy by using evidence-based practice to instruct children with ID how to read. The importance of learning to read is a key component in several federal mandates, which established a national goal that all children will read at grade level by the end of third grade (No Child Left Behind [NCLB], 2002). Most recently, the US Common Core Standards Initiative (2012) put in place a highly rigorous set of goals for literacy designed to help all children become proficient readers. To meet this unprecedented challenge, teachers are required to use evidence-based practices based on decades of research (National Institute of Child Health and Human Development [NICHD], 2000; 2008). Not surprisingly, much of this research has also informed reading instruction for children with disabilities. Research examining the specific literacy needs of children with disabilities suggests that a strong foundation in phonics based instruction is essential for later reading success (e.g., Allor, Mathes, Roberts, Jones, & Champlin, 2010; Browder, Flowers, & Wakeman, 2008; Conners, Rosenquist, Sligh, Atwell, & Kiser, 2006). Similarly, research specifically examining reading of children with Down syndrome suggests that, phonics based skills are a significant predictor for future reading success, although attainment levels very widely (e.g., Baylis & Snowling, 2012; Lemons & Fuchs, 2010; Lemons, Mrachko, Kostewwicz, & Paterra, 2012).

Since the evidence supporting the importance of a phonics instruction for children with ID and the critical role it plays engendering literate adults with disabilities is increasing, one would expect to find teachers using phonics based instruction with this population (e.g., Al Otaiba & Hosp, 2004; Baylis & Snowling, 2012; Rose, 2006). However, this has not been the case. Children with ID including children with Down syndrome appear to receive very little exposure to phonics based instruction (Fredrick, Davis, Alberto, & Waugh, 2013). In a comprehensive review of the research on reading instruction for children with developmental disabilities, only 19 percent of teachers implemented phonics based instruction with this population (Browder, Wakeman, Spooner, Alghrim-Delsell, & Algozzine, 2006). Clearly, many educators working with children with ID appear to favor a curriculum based on memorization of words, which typically focuses on teaching children a functional sight vocabulary pertaining to the accomplishment of daily routines such as grocery shopping and traversing on public transportation (i.e., “stop”, “go”, “exit”) (Cologon, Cupples, & Wyver, 2011; Kay-Raining Bird, Cleave, & McConnell, 2000). Although this type of instruction can undoubtedly increase the number of words a child with ID recognizes, it limits the number of words due to difficulties this population may have with memory capacity, and it does little to develop the child’s decoding ability, which is fundamental to becoming an independent reader (Naess, Melby-Lervag, Hulme, & Lyster, 2012).

Studies, although limited, on phonics based instruction for children with ID, particularly children with Down syndrome, have shown promising results. Research shows that children with ID can perform all of the same tasks related to phonics based instruction as their peers without disabilities (Al Otaiba & Hosp, 2004). Moreover, an increasing number of children with Down syndrome have demonstrated competency in completing phonics based tasks akin to their peers without disabilities resulting in both groups becoming successful readers (Naess *et al*., 2012; Roch & Jarrold, 2008; Verucci, Menghini, & Vicari, 2006). Furthermore, when children with Down syndrome were instructed in an inclusive setting and presented with the same sequence of reading instruction as their peers without disabilities, children with Down syndrome showed similar progress to that of their peers in phonological awareness, phonics, vocabulary, comprehension, and fluency (e.g., Browder, Ahlgrim-Delzell, Courtade-Little, & Snell, 2006; Cupples & Iacono, 2002; Snowling, Hulme, & Mercer, 2002).

Although several studies have determined that individuals with Down syndrome can succeed in completing most phonemic awareness and phonetic tasks, they also suggest that in some respects, reading might qualitatively develop differently for children with Down syndrome (e.g., Boudreau, 2002; Cardoso-Martins, Michalick, & Pollo, 2002). For instance, for children without disabilities, rhyme identification generally precedes the development of more difficult phonemic awareness skills such as phoneme blending and segmentation. Children with Down syndrome, however, may not follow on this same trajectory. In point of fact, some researchers have determined that children with Down syndrome show a particular weakness in ability to rhyme (e.g., Boudreau, 2002; Snowling *et al*., 2002). Several researchers theorize that deficits in rhyming skills might be a result of weaknesses in the phonological loop processes of the individuals (e.g., Gombert, 2002). An additional explanation suggests that children with Down syndrome might simply be more sensitive to sounds that occur at the beginning rather than at the end of words (Snowling *et al*., 2002). Nevertheless, the available research demonstrates that a phonics based reading curriculum can be effective at teaching many children with Down syndrome to read, albeit at a slower pace than their peers without disabilities. At the same time, research suggests that tasks requiring children with Down syndrome to recall sounds from memory may prove to be arduous given limitations to auditory memory, which may result in children with Down syndrome developing reading related skills on a path that is fundamentally different from that of their peers without disabilities.

Although studies examining phonics based reading instruction for children with Down syndrome have spawned impressive results and have provided the research community with an impetus for further study (e.g., Baylis & Snowling, 2012; Cologon *et al*., 2011), very few have focused on teaching children with Down syndrome to use evidence based decoding strategies. Of those studies in which decoding strategies were explicitly taught, most adopted to use words previously learned as part of the child’s sight word vocabulary (e.g., Cupples & Iacono, 2000). Pre-exposure to the words in this way may make the decoding strategy easier for the child to master and may not be a true indicator for the viability of the decoding strategy (Buckley, Bird, & Byrne, 1996).

1.1. Focus of the Study

This study is an attempt at extending the research on reading instruction for children with ID particularly children with Down syndrome. Children in the study were instructed to use a decoding strategy to read words not previously established as part of their sight-word vocabulary. Instructional features shown to be efficacious for children with ID, such as focusing on expressive and receptive language abilities, supplementing letter-sound correspondence instruction with visual supports, minimizing demands on auditory memory, and providing a highly structured, predictable learning environment were implemented, utilize a decoding strategy (Naess *et al*., 2012). In addition, the study employed a constant time delay (CTD) procedure, which is a procedure considered to be one of the most effective and efficient procedures for teaching children with ID (Browder *et al*., 2008; Jameson, McDonnell, Polychronis, & Riesen, 2008). CTD incorporates the principles of effective instruction, which include a rapid pace of delivery, active engagement on the part of the child, and a systematic approach that includes advanced cuing and prompting with repetitive instruction to promote mastery (Hughes, Fredrick, & Keel, 2002). The pairing of a decoding instruction with CTD to teach decoding skills to children with Down syndrome may aide their ability to successfully read words. Thus, this study sought to investigate two questions:

1. Is the simultaneous pairing of a CTD procedure with phonics instruction effective at teaching word reading to children with Down syndrome?
2. Does the pairing of a CTD procedure with phonics instruction lead to generalization or increased decoding efficiency from taught words to untaught words?

2. Methods

2.1. Participants

Table 1

Child Characteristics, WRMT-III, and PPVT-IV Scores

	Age	IQ[a]	PPVT[b]	Letter ID[c]	Phonological Awareness[c]	Rapid Automatic Naming[c]	Word Attack[c] (Pre)	Word Attack[c] (Post)
Ben	11	65	108	K.0	<K.0	<K.0	<1.0	<1.0
Anna	11	59	73	>1.0	<K.0	<K.0	<1.0	<1.0
Eddie	9	59	104	>1.0	<K.0	>K.9	<1.0	1

Note: WRMT-III= *Woodcock Reading Mastery Test- 3rd edition*
PPVT-IV= *Peabody Picture Vocabulary Test*

[a] Parent report

[b] PPVT-IV Standard Score Equivalent

[c] WRMT-III Subtest Grade Equivalent Score

After contacting special education organizations in a large, urban area in the US, three children (Ben, Anna, and Eddie) ages 9 to 11 and their parents agreed to participate in the study and met eligibility. Each child had a documented genotype for Down syndrome with mild ID. The criteria for ID for this study follow the US IDEA (2004) Sec. 300.8(c)(6) definition, which defines ID as an individual who has "significantly sub-average general intellectual functioning, existing concurrently with deficits in adaptive behavior and manifested during the developmental period, that adversely affects a child's educational performance." All three children met the following criteria for participation: (a) age 9-11 years; (b) enrolled in school; (c) assessment data showing IQ scores ranging between 69-55; (d) minimal hearing and visual difficulties; (e) demonstrated good receptive language (i.e., child is able to answer a simple question); (f) demonstrated good expressive language (i.e., others able to understand the child when he or she speaks); and (g) ability to follow a simple one-step, oral direction (i.e., respond to directions to stand; attend to an object) (see Table 1 for child information).

2.2. Assessment Instruments

Students were administered a variety of assessment including:

Peabody Picture Vocabulary Test. The PPVT-IV measures the receptive word processing of examinees from two to over 90 years (Dunn & Dunn, 2007). The assessment was used to get a sense of each child's verbal ability and vocabulary knowledge and took approximately 15 minutes to complete.

Woodcock Reading Mastery Test-III. All the children were given four subtests (Letter Identification, Phonological Awareness, Rapid Naming, and Word Attack) of the WRMT-III (Woodcock, McGrew, & Mather, 2011). The WRMT-III is designed to assess the reading levels of test takers within an age range from four to 75 years and over.

Letter Checklist. A letter checklist was used to determine the child's ability to name and provide the sound for all 26 letters of the alphabet. Each letter was presented on an index card in random order. Each child was required to show knowledge of ten different letter-sound correspondences, including at least one vowel sound, to be included in the study.

Assessment of Target-word Knowledge. The overarching goal for the Assessment of Target-word Knowledge was to construct a cadre of 14 words the child could not read consistently by sight or by decoding. This assessment was divided into two phases: a) the assessment of short vowel word patterns, and b) the assessment of targeted word families. To determine which short vowel sounds and short vowel word patterns were difficult for the child to decode the researcher constructed five word lists, one list for each short vowel sound. Consonants used in each word were limited to letters for which the child demonstrated mastery on the Letter Checklist assessment. Each list was unique for each child. All words conformed to a simple c-v-c pattern with no irregular words. Each of the five lists contained six words that represented three rhyming short vowel word patterns. For example, words from the short /a/ vowel family may include: "dam" "ram" "had" "mad" "fat" "sat". The researcher held up each word card and asked the child to read the word printed on the card. If a decoding error was made on both words from the same word family (e.g., decoding errors made reading "fat" and "sat"), it was interpreted to mean that words from the "at" word family were difficult for the child to read. The goal was to determine the short vowels and short vowel word patterns the child had difficulty decoding.

During the second phase, short vowel word patterns previously shown to be difficult for the child to decode during the short vowel word pattern assessment were used as a base to construct additional words from those same word families. For example, if the child could not accurately decode "sat" and "mat," additional words from the "at" word family such as "rat" and "fat" were constructed for this assessment. Consonants used in each word were limited to letters the child mastered on the Letter Checklist assessment. To accomplish this, the researcher started crafted unique lists of words for each child. Each child was tested on each word during six trials. If a child could read the word correctly 33 percent of the time or more, the word was excluded from the intervention. In the end, each child's individual list contained between 14-18 words. From these list, 14 words were chosen for each child to use in the study six words were used during the first intervention phase (list A) and six words were used during the second intervention phase (list B). The remaining two words were used for training purposes. Each word was composed so that it had a corresponding rhyme in each list. For example, if the word "sat" was used during the first intervention phase, then the word "mat" was used during the second intervention phase.

2.3. Procedures

A 3 step decoding strategy (3-SDS) with a 4 second constant time delay procedure (4-CTD) was used to teach blending skills. A non-concurrent single case multiple baseline design with two intervention phases was used to assess decoding efficiency with words composed of a similar phonetic structure. A probe was administered between the phases to assess generalization of decoding skills from taught words to untaught words. A non-concurrent multiple design allows for data to be collected over an asynchronous span of time (Harvey, May & Kennedy, 2004) and allows the researcher to pre-determine the length of time for each baseline session (e.g., 3-trials, 6-trials, or 9-trials). Then, each participant is randomly assigned to one of the three baseline trials, and the baseline is carried out for the designated number of trials followed by implementation of the intervention. A benefit to this approach includes allowing researchers flexibility by allowing the researcher to start the intervention phase without waiting for each participant to reach criterion (Kennedy, 2005).

Once eligibility and two word lists were established for each child, arrangements were made to meet with each child individually two to three times per week. The duration of the study varied by child with Ben and Eddie participating for 11 weeks for a total of 19 and 24 sessions respectively. Anna participated in the study for 7 weeks for a total of 16 sessions. Each session generally lasted less than ten minutes. Every effort was made to keep the learning environment as similar as possible across all three children. Parents were asked not to practice the intervention with the child during the course of the study. However, parents were given the opportunity to learn the intervention at the conclusion of the study.

2.3.1. Baseline

Children were randomly assigned to one of three baselines with each trial consisting of two presentations of words from list A without any instruction or feedback. Ben was assigned to three baseline sessions, Anna to six baseline sessions, and Eddie to nine baseline session. Baseline sessions occurred no more than three times a week.

2.3.2. Instruction

Before each intervention session, the researcher modeled and prepared the children to use the decoding strategy with the 0 second CTD procedure. The purpose of this preparation was to allow the child to gain confidence using the decoding strategy through a routine that establishes systematic, predictable and nearly errorless learning (Stevens & Lingo, 2005). All three children caught on to the decoding strategy very quickly and by the second session they were able to execute the strategy without hesitation.

The three steps in the decoding strategy are: (a) Step 1 (Attention Getting); (b) Step 2 (Decoding); and (c) Step 3 (Reading the Word). Because the child had an immediate model of the behavior to be performed, only minor errors were experienced during the instruction. In Step 1 (Attention Getting), the researcher simultaneously delivered the cue (model word) and the controlling prompt (touch the card) to the child. The researcher instructed the children to "Touch the word on the card." and said, "Let's look at it." In Step 2 (Decoding), the same model word as in Step 1, the researcher simultaneously delivered the cue (model word) and the controlling prompt (i.e., the letter-sound correspondence) to the participant. The researcher instructed the children to "Touch each letter on the card as you slowly say each letter sound in the word." In Step 3 (Reading the Word), the researcher simultaneously delivered the cue (model word) and the controlling prompt (i.e., read the word) to the child. The researcher instructed the children to "Say the entire word without stopping while you run your finger along the bottom of the word card".

2.3.3. Intervention Phase I

After the preparation trials, the researcher guided the children immediately into the first intervention phase by stating, "It is your turn to read." followed by, "Let's read your new words." The sequence of steps used during both intervention phases is exactly the same as those used during the preparation trials (see Table 2 for intervention procedures). Children were instructed to use the decoding strategy to read words not previously established as part of their sight-word vocabulary. Two presentations (words on individual index cards) of all six words from list A made up one complete session. During both intervention phases, a 4-second CTD was in place. Criterion for completion of the first intervention phase was two consecutive sessions at 92 percent or greater with one session at 100 percent for combined decoding and word reading to promote generalization for the second intervention phase. Criterion for each of the three decoding steps are as follows: (a) Step 1 (Attention Getting) not scored and did count toward criterion; (b) Step 2 (Decoding) counted towards criterion if the child identified all the letter-sounds in the word correctly without hearing the controlling prompt within the 4-CTD. If the child missed any letter-sounds, it was considered an error and counted against criterion; and (c) Step 3 (Reading the Word) counted towards criterion if the child read the word correctly without hearing the controlling prompt within the 4-CTD. Criterion was met only when the child scored correct responses on Step 2 and Step 3.

Table 2

Intervention Phase I and Phase II

	Step 1: Attention Getting	Step 2: Decoding	Step 3: Reading the Word
Instructions Delivered by Researcher	"Point to the word and lets look at it."	"Slowly point to each letter while you slowly say each letter-sound."	"Now say the sounds together without stopping while you run your finger along the bottom of the card."
Correct Child Responses	(a) Points to card	(a) Points to each letter saying the corresponding letter-sound	(a) Reads the word while moving finger across the card
Incorrect Child Responses	(b) Fails to point to the card	(b) Fails to say the corresponding letter-sound within the 4-CTD	(b) Fails to read the word within the 4-CTD
Corrective Statement	"Touch the card."	"No the sounds are___. "Say them with me___."	"No, the word is ___. "Say the word with me ___."
Counts Towards Criterion*	No	Yes	Yes

**Note:* Criterion for the first intervention phase: two consecutive sessions at 92% or greater with one at 100%
Criterion for the second intervention phase: two consecutive sessions at 92% or greater accuracy

2.3.4. Probe

Following immediately after the first intervention phase and before starting the second intervention phase, a probe was given to each child. During the probe, words from list B were shown to each child twice. Since both word lists were made-up of phonetically similar words, the probe was intended to investigate if the child could generalize decoding skills learned from the first intervention phase to decode words from the second intervention phase that were unfamiliar to the child.

2.3.5. Intervention Phase II

The second intervention phase was a replication of the first intervention phase. During the second intervention phase, words from the list B were shown to each child using the same procedures used during the first intervention phase. Criterion for completing the second intervention phase was 92 percent correct or better throughout two consecutive sessions.

2.4. Data Analysis

Two data points were recorded for each session: a) one for the percentage of letter-sounds in a word decoded accurately during the second step and b) one for the percentage of target-words that were correctly decoded and read during the third (the first step was an attention getting step and was not recorded). To receive credit for the third step (word reading), each child must decode each letter-sound correctly and read each word accurately. All three children reached criterion for the first intervention phase in 10 sessions or less and all children reached criterion for the second intervention phase in seven sessions or less.

Data for baseline, both intervention phases and the probe phase were visually analyzed for trends and rate of increase (Zhan & Ottenbacher, 2001). The process of inspecting graphically is a very powerful way of seeing the functional relationship between the dependent and the independent variables (Kennedy, 2005). Graphed data were examined for the rate of learning target-words during the first intervention phase and compared to the rate of learning words during the second intervention phase. In addition, baseline scores were compared to performance during the probe and letter-sound decoding accuracy was compared to word decoding accuracy. Child responses were examined for the number of decoding and word reading steps performed correctly, as well as for error patterns while decoding and reading words.

3. Results

The study used a single case non-concurrent multiple baseline design to examine the effects of pairing a 3-SDS with a 4-second CTD procedure to teach word reading to three children with mild ID who were identified with Down syndrome. Findings are reported by child and include all the data points collected from baseline to the second intervention phase.

3.1. Ben

Ben is an 11-year old in the fourth grade with an IQ of 65. He has one older sister and one younger sister. Ben attends a public elementary school in the suburbs of a major city in the Midwest. Ben's time is split evenly between resource room and general education classroom. He receives math and reading instruction in the resource room and is included with his peers for all other subjects. Ben has a full-time instructional aide and receives private therapy for articulation weakness one day a week. He is actively involved in Special Olympics where he competes in track and field activities.

3.1.1. Baseline and Intervention Phase I

During Ben's three baseline sessions (see Figure 1), his letter-sound decoding accuracy ranged from 17% (6 letter-sounds) to 67% (24 letter-sounds) and consistently remained higher than his combined letter-sound and word reading accuracy, which ranged from 0% to 17% (2-words). During the first intervention phase, Ben made consistent progress accurately decoding 17% of his list A target-words during his first session and reaching criterion by the eighth session. Similar to his baseline performance, Ben's overall letter-sound decoding accuracy remained consistently higher than his combined letter-sound decoding and word reading accuracy (see Figure 1).

3.1.2. Probe and Intervention Phase II

On the probe Ben was presented with letter-sounds to decode and target-words to read using target-words from his list B. Ben decoded 72% accurately and read and decoded 58% of his words correctly. During the second intervention phase, Ben reached criterion after the seventh session showing a 12% increase in efficiency in learning words from list B. Overall Ben's letter-sound accuracy remained consistently higher than his combined decoding and word reading accuracy.

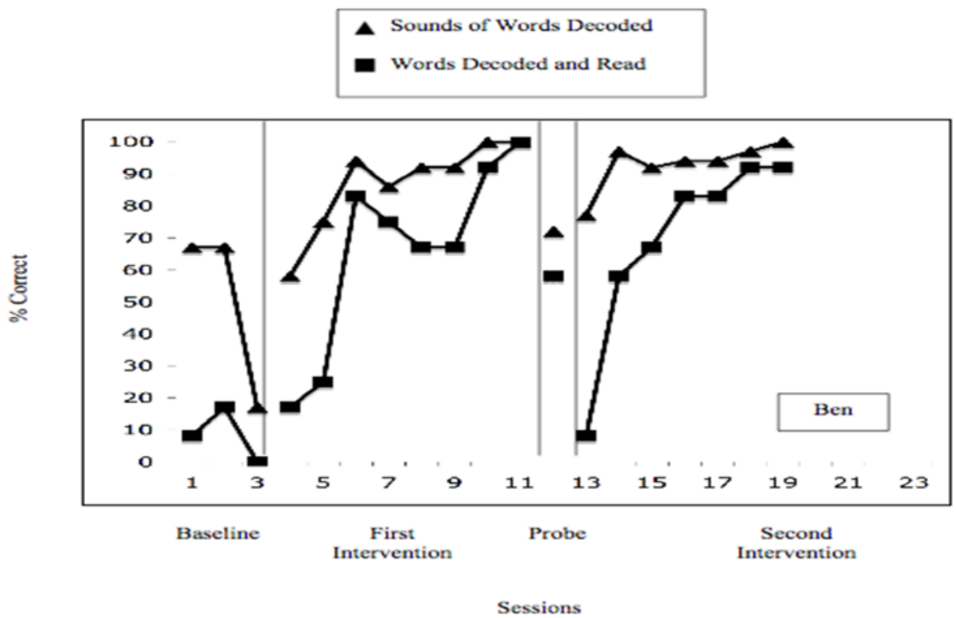

Figure 1. Ben's Data

3.2. Anna

Anna is an 11-year old in the fifth grade with an IQ of 59. She is one of four female children in her family and is the second oldest child. Anna attends a public elementary school in the suburbs of a major city in the Midwest. Her time is split evenly between resource room and general education instruction. In the resource room, Anna receives small group instruction for math and reading. Her classes outside the resource room include history, science, art, music and physical education. Anna also receives in-school speech (articulation) therapy, occupational therapy, and counseling from social services. Her mother, who is a physical therapist, provides Anna with limited therapy at home.

3.2.1. Baseline and Intervention Phase I

During Anna's six baseline sessions (see Figure 2), her letter-sound decoding accuracy ranged from 64% to 86% and consistently remained higher than her combined letter-sound decoding and word reading accuracy, which ranged from 33% to 50%. During the first intervention phase, she made steady progress accurately decoding 58% list A target-words during the first session and reaching criterion by the fifth session. Similar to her performance during baseline, Anna's overall letter-sound decoding accuracy remained higher than her combined letter-sound decoding and word reading accuracy.

3.2.2. Probe and Intervention Phase II

On the probe Anna decoded 97% accurately and read and decoded 67% of her words on list B correctly. During the second intervention phase, Anna reached criterion after the fourth session showing a 20% increase in efficiency in learning the words from list B. Anna made far fewer decoding errors during the second phase, but exhibited many more timing errors. Anna's overall letter-sound accuracy remained higher than her combined decoding and word reading accuracy.

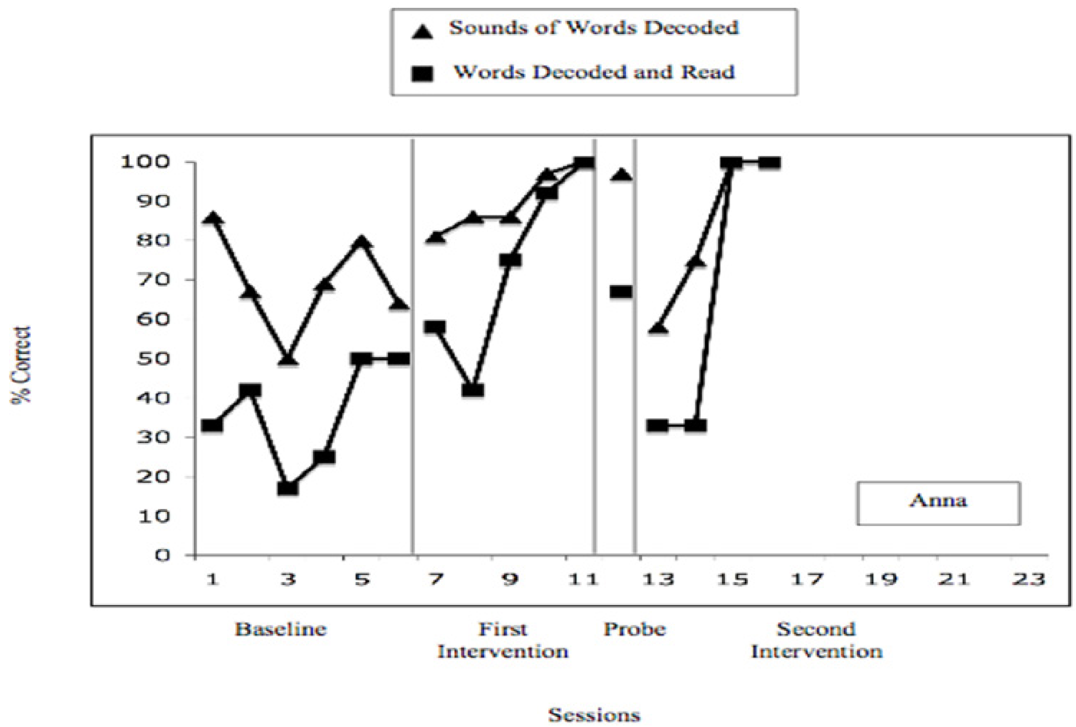

Figure 2. Anna's Data

3.3. Eddie

Eddie is a 10-year old in the fourth grade with an IQ of 59. He is the younger of two boys in his family. He is instructed in a general education classroom and his assisted by a full-time instructional aide. His parents strongly believe that in addition to the social benefits of having Eddie attend all classes with his peers without disability, Eddie also benefits academically from having his peers "pushing him" to succeed. Eddie receives private speech (articulation) therapy. His mother is a pediatric physical therapist and provides him with limited therapy at home when she sees the need. His mom works with Eddie on reading and math activities at home for about five hours a week. He is very involved in athletics and participates in swimming, soccer, baseball, and track. He is also a member of the Special Olympics competing in Track and Field activities.

3.3.1. Baseline and Intervention Phase I

During Eddie's nine baseline sessions (see Figure 3), his letter-sound decoding accuracy ranged from 53% to 78% and consistently remained higher than his combined letter-sound and word reading accuracy, which ranged from 0% to 42%. During the first intervention phase, Eddie made steady progress increasing his combined letter-sound and word reading accuracy from 17% during the first session to reaching criterion by the tenth session. Similar to his performance during baseline, Eddie's overall letter-sound decoding accuracy remained higher than his combined letter-sound decoding and word reading accuracy.

3.3.2. Probe and Intervention Phase II

On the probe Eddie decoded 47% of the letter-sounds accurately and read and decoded 75% of his words on list B correctly. During the second intervention phase, Eddie reached criterion after four sessions showing a 60% increase in efficiency in learning the words from list B. Eddie's letter-sound accuracy remained consistently higher than his combined decoding and word reading accuracy.

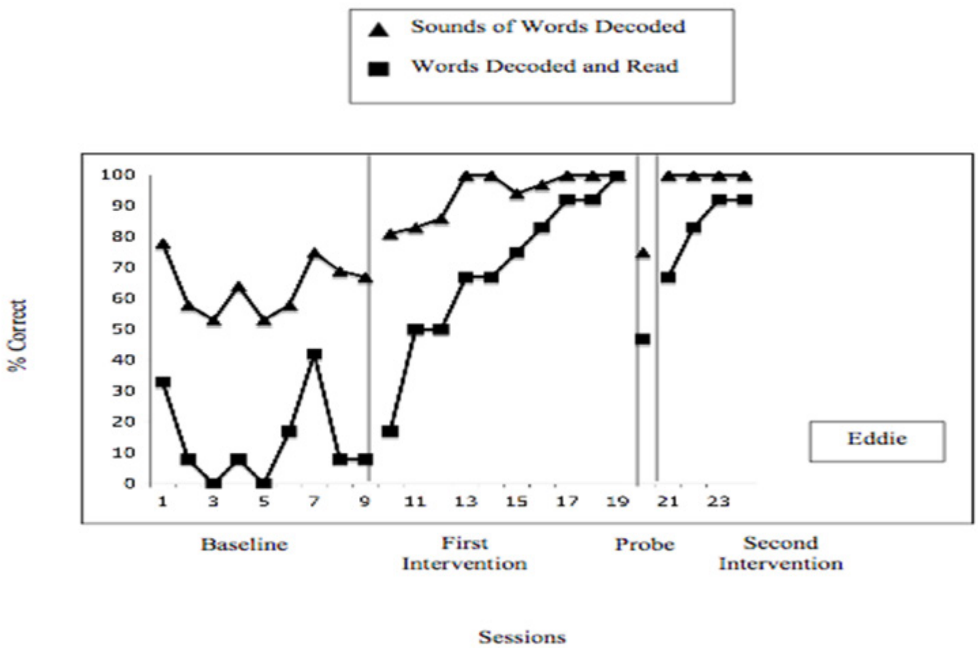

Figure 3. Eddie's Data

4. Discussion

Research has shown the benefits of implementing effective reading strategies that are developmentally appropriate and targeted to meet the individual learning needs of children with ID including children with Down syndrome (Burgoyne, Duff, Snowling, Buckley, & Hulme, 2013; Steele, Scerif, Cornish, & Karmiloff-Smith, 2013). The decoding strategy used in the present study has been successfully used to teach children with mild to moderate ID to read words (Cohen, Wolff Heller, Alberto, & Fredrick, 2008). Given its rapid delivery of repetitive instruction, active engagement, advanced cuing and prompting, immediate correction, and positive reinforcement it is structured to meet many of the instructional needs of a variety of children including those with mild ID who have Down syndrome; thus expanding the number of children who can benefit from this type on instruction. Thus, this study examined the effectiveness, efficiency, and generalizability of the 3-SDS with this population. Data from the study support the use of a 3-SDS used simultaneously with a 4-second CTD procedure to teach three children between the ages of 9-11 with mild ID who were identified with Down syndrome to read words. The 3-SDS approached was effective and efficient for all three children. During the intervention, each child significantly improved his or her accuracy for letter-sound decoding and word reading over baseline. Furthermore, during the second intervention, all children had marked learning efficiency in letter-sound decoding and word reading. Graphic analysis and error examination clearly indicate that the decoding strategy is an effective method to teach phonics skills to children with Down syndrome who participated in the intervention. However, analysis reveals that good decoding skills did not necessarily translate into reading efficiency for all the children. Children were able to generalize their decoding skills from known words to untaught words from analogues word families. The results from the probe showed increases for all three children's letter-sound decoding and word reading abilities over baseline, but none of were able to completely generalize reading untaught words during the probe. However, each child's marked increase over baseline demonstrates the effects of prior instruction and their ability to transfer or leverage previous learning experiences to more efficiently learn related concepts (Yang, Hanneke, & Carbonell, 2013).

In terms of the 3-SDS as a strategy, the children had the most difficulty with the blending the sounds together to read words, which is what others have found as well (Cohen *et al*., 2008). Graphic analysis shows that each child was significantly more efficient at decoding letter-sounds than blending the sound together to read the words. Although each child reached word reading mastery in a fewer number of sessions in the second intervention phase compared to the first intervention phase, still word reading lagged significantly behind letter-sound decoding for each child. Hence, teachers using the strategy may need to spend more time explicitly working on blending skills prior to implementing the strategy. The concept of blending (i.e., the coming together of two elements to become one) might be foreign to some children and cause confusion. The children in the present study did not have a problem understanding the "blending concept" used in the strategy, but children in other studies did demonstrate some consternation during the blending assessment (Cohen *et al*., 2008). Reading applications for tablet devices, however may offer an effective solution. Computer animation showing letters floating across the screen then coming together to form words may make the strategy more visually stimulating for children. Children are better able to engage with the letters, as some applications respond to the child's touch. These types of applications are now becoming more accessible through niche companies specializing in applications and software for education.

In regards to the CTD procedure, this study adds further support to the use of constant time delay as an instructional procedure to teach phonics skills to children with disabilities (e.g., Cohen *et al.*, 2008). The procedure has been used widely to teach sight-word instruction to children with ID and less frequently to teach phonics skills (e.g., Browder & Xin, 1998; Conners, 1992). In the present study, all children were able to show increased letter-sound decoding efficiency and word reading efficiency on the probe and during the second phase. With the exception of one child, during the second intervention phase, all three children consistently made non-wait errors (a non-wait error occurs when a child incorrectly responds before the prompt is given). These errors occurred more frequently during the early stages of both intervention phases, as one would expect with a time delay procedure. Initially, the errors were split almost evenly between decoding and the word reading. As time advanced, however, more errors were eventually made during word reading. This is not too surprising since each child came into the study with relatively good letter-sound decoding skills and poor reading skills. Over time and with correction letter-sound decoding skills improved quickly, whereas the more difficult task of word reading improved slowly and not to the same levels as letter-sound decoding.

When examining child characteristics as they relate to the results of this study, questions arise as to what factors may have affected results. Researchers have long suspected that children with Down syndrome have short-term memory deficits that are greater than in children with unspecified causes for intellectual disability in individuals who are of equivalent chronological age and IQ level (e.g., Baddeley & Jarrold, 2007). Deficits in short-term memory may inhibit children from recalling sounds because they lack the ability to refresh information in their short-term memories for recall at a later time (Gombert, 2002; Snowling *et al*., 2002). These results suggest that poor performance on measures of phonological memory and/or phonological awareness do not prohibit children from decoding words. This was especially apparent in the cases of Anna and Ben, who both had poor phonological memory and phonological awareness abilities, yet demonstrated measurable improvements in reading ability. For these children, decoding mastery is achievable, but it may take them longer to acquire these skills. The results presented here add support that children with mild ID can learn to blend phonemes in words when provided with targeted instruction in a short period of time (Burgoyne *et al*., 2013). This study adds further evidence that supports the efficacy of phonics-based reading programs for children with ID (Baylis & Snowling, 2012).

5. Limitations

Although the researcher made every effort to standardize all procedures, there is always trade-off between threats to internal and external validity. All the children attended school fulltime, making it difficult to know what was covered during reading instruction. Given the reading levels of the children, it is possible that some of the letter-sound blending skills taught during the intervention were also being taught simultaneously during the child's typical classroom reading instruction. The added exposure of which could have affected study outcomes by giving some children an advantage during the intervention. In addition to reading instruction at school, each child was also heavily immersed in reading activities at home. These additional engagements with reading related activities might have also impacted study outcomes.

In terms of threats to external validity, the most apparent threat is the small sample size and the homogeneity of the group (e.g., all within a similar age range, with a similar IQ levels, and all diagnosed with Down syndrome). Therefore, generalizing the results of the present study to all children with Down syndrome or to a more heterogeneous group of children with Down syndrome should be done with caution. However, because this study replicates the intervention used in Cohen *et al*. (2008) the external validity of the present study is made somewhat more robust. With respect to generalizing these findings to children with different genotypes for intellectual disability, more research is needed.

6. Implications

The decoding strategy and time delay procedures can be used for one-on-one instruction and with some modifications also used for small group instruction. In addition, the strategy can be effective at teaching decoding skills to students with or without special needs. In addition to preparing para-professionals on how to use strategy with students, other modification may include incorporating technology to make the strategy more dynamic or color-coding the vowels and consonants to make the identification of specific letters more apparent. In addition, a small group format, by nature of the number of children in the group, may make it difficult to work on discrete blending problems, as it is unlikely that all children will have the same blending deficits. However, words that are new to the entire group, such as words from a new vocabulary unit might be more adaptable to using the decoding strategy.

In today's society, it is absolutely critical that every child has the fullest opportunity to become an accomplished reader. Anyone unable to read faces enormous social, personal and economic limitations in today's fast-paced information driven world. As educators we are obligated to ensure that all children are endowed with the knowledge of learning how to read. This mission is especially important for teachers who instruct special populations of children. Of these populations, children with Down syndrome make the largest class of children with ID in our schools. Historically, children with Down syndrome where instructed to read using a sight-word curriculum. Although effective, it does little to inform decoding, which is fundamental to becoming a successful independent reader. Simply memorizing words does not provide this level awareness. Today, research has demonstrated that in time children with Down syndrome can become successful, accomplished readers through a phonic based curriculum (see Lemons & Fuchs, 2010 for a review). However, what is less clear is how specific phonemic skills and phonemic memory ability correlate with becoming a successful reader, much more work needs to done in this area. The present study was an attempt to extend the research on reading instruction for children with Down syndrome. The results presented demonstrated that by using a direct instructional strategy that incorporates features shown to be effective for teaching children with Down syndrome such as focusing on expressive and receptive language abilities, using visual supports, minimizing demands on memory, children with Down syndrome can increase their efficiency for reading previously unknown words.

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