Using a Decoding Strategy with Constant Time Delay to Teach Word Reading to Children with Down Syndrome

BY

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THESIS
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This body of work is lovingly dedicated to my parents
Carmen R. Maiorano, Sr., and Nancy M. Maiorano
Thank you for believing in me

And to every child who has sat in a classroom struggling to blend two or more letters together to read a word. It will happen…it did for me.

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LIST OF ABREVIATIONS

3-SDS	Three Step Decoding Strategy
APACS	Alternate Phonological Awareness Composite Score
CTD	Constant Time Delay
CTOPP-2	Comprehensive Test of Phonological Processing, Second Edition
CVC	Consonant Vowel Consonant
NRP	National Reading Panel
PACS	Phonological Awareness Composite Score
PL	Phonological Loop
PMCS	Phonological Memory Composite Score
PPVT	Peabody Picture Vocabulary Test
TBI	Traumatic Brain Injury
WRMT-III	Woodcock Reading Mastery Test, Third Edition
WS-A	Word Set-A
WS-B	Word Set-B

SUMMARY

In the United States, about 6,000 infants are born each year with Down syndrome or about 1 in 691 live births affecting approximately 400,000 families. Arguably, one of the most overwhelming challenges for children with Down syndrome to accomplish is learning how to read and master the phonology of the language. Understanding how sounds map to specific letters and letter combinations is a critical skill to acquire and affords individuals with Down syndrome a means to function in a literate society.

In this study a three-step decoding strategy was used with a constant time delay procedure to teach word reading to three children with Down syndrome and mild intellectual disabilities using a phonics-based curriculum. Although this strategy and procedure are not exclusive to instruction with children with Down syndrome, it does incorporate many of the elements that have shown to be effective with this population. 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 by the children. Rhyming CVC words were used for the intervention and a probe was administered between intervention phases to test for generalization.

The data indicated that all three students learned to read words using the three-step decoding strategy and constant time delay procedure. This was replicated with increased learning efficiency using words composed from a similar phonemic structure. However, across all children letter-sound decoding accuracy out-paced word reading accuracy. Although each child made gains, 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 Down syndrome who are having a difficult time blending sounds together to read words.

I. INTRODUCTION

For all populations, illiteracy and/or low literacy levels affect multiple domains of life including social dynamics, health care, and employment status. For persons with disabilities and especially those with developmental disabilities, the impact may be even greater. Research shows that persons with disabilities who are illiterate are likely to have less successful face-to-face communication with others (Ballin & Balandin, 2007; Koppenhaver, Coleman, Kalman, & Yoder, 1991), are less likely to gain acceptance by members of non-disabled communities (McLaughlin, Bell, & Stringer, 2004), and may be perceived as less competent in daily activities (Kliewer, Biklen, & Kasa-Hendrickson, 2006; Geber, 2012; Koppenhaver & Yoder, 1993). In the area of health care, there is evidence that medical care can be adversely affected 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, & McGaffrey, 2013;Schillinger, Bindmana, Wang, Stewart, & Piette, 2003). With regard to personal finances, data shows that economic hardships due to low literacy rates may be protracted due to sustained periods of unemployment for the majority of adults with disabilities (Yamaki & Fujiura, 2002), and that these hardships are made more pernicious by fewer overall job choices (National Center for Educational Statistics, 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 imperative. This is may be 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 are the most commonly occurring with over 200 identified etiologies of organic intellectual disabilities among the populations ofthe world. Of these, Down syndrome is the most common genetic form (Roberts, Price, & Malkin, 2007). The Center for Disease Control and Prevention (2010) reports that the prevalence of Down syndrome increased 31 percent (an increase from nine to 12 per 10,000 live births) in 10 U.S. regions between 1979-2003. The most recent data available show that about 6,000 infants are born each year with Down syndrome (about 1 in 691 live births) affecting 400,000 families (American Pregnancy Association, 2010; Center for Disease Control and Prevention, 2010). This figure represents a 6 percent increase in children born with Down syndrome from statistics reported in 2009 (National Down Syndrome Society, 2011).

The occurrence of Down syndrome in newborns is split almost evenly along gender lines with males edging out females only slightly (National Down Syndrome Society, 2011), and thanks to continuing advancements in clinical treatments, life expectancy for individuals with Down syndrome has increased dramatically. Recent data shows that as many as 80 percent of individuals with Down syndrome will reach age 55 or older (Cuskelly, Hauser-Cram, & Van Riper, 2008).

Such a sharp increase, over time, places strong demands on the U.S. health care system, as it struggles to care for these children and their families, and the U.S. education system, as local school systems wrestle with ways to educate special populations in the face of staff and monetary short falls. With the birth rate for children with Down syndrome increasing dramatically along with an increased life expectancy rate, it is reasonable to believe that the future demographics 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 U.S. (National Center for Educational Statistics, 2008). Moreover, data from math and science assessments indicate that children with Down syndrome instructed in inclusive settings out perform their peers instructed in self-contained classrooms (Buckley, Bird, Sacks, & Archer, 2006). Hence, given the rise in school enrollment for children with Down syndrome and the potential benefits of inclusive instruction, it is reasonable to expect that children with Down syndrome will continue to be included into the "child mix" of the general education classroom, and that special education teachers along with their general education teacher collaborators will continue to be challenged to design effective evidence-based instruction that addresses the needs of all learners and allows children with and without disabilities to reach their full potential. To this point, recent research has demonstrated the benefits of designing instruction that is tailored to cognitive strengths in children with intellectual disabilities (Scerif & Steele, 2011; Steele, Karmiloff-Smith, Cornish & Scerif, 2012; Steele, Scerif, Cornish, & Karmiloff-Smith, 2013). For example, vocabulary development and phonemic awareness (PA) skills have shown to be strong predictors for later reading success for some children with intellectual disabilities, but have shown to predict smaller reading growth for some groups of children (e.g., Williams syndrome) (Steele et al., 2013). Hence, designing instruction that targets the specific needs of children with intellectual disabilities could potentially be a benefit.

Characteristics of Individuals with Down syndrome

Chromosomes. Down syndrome is a genetic condition that occurs at conception when an individual inherits an extra copy of the 21st chromosome. Genes contained within this extra copy are responsible for all the characteristics associated with Down syndrome (National Down Syndrome Society, 2011). Normally each cell contains 23 pairs of different chromosomes, which are responsible for the proper development and maintenance of our bodies. Under typical circumstances an individual inherits 46 chromosomes, one copy from each parent (i.e., 23 chromosomes from each parent) (Mayo Clinic, 2012). In the case of Down syndrome, at conception the individual inherits one copy of chromosome 21 from the father and two copies of chromosome 21 from the mother for a total of 47 chromosomes (Mayo Clinic, 2012). Therefore at birth, the individual will have three copies of chromosome 21 instead of the usual two copies. This condition is called trisomy 21 and is the most frequently occurring type of Down syndrome manifesting in about 92 percent of live births of infants born with Down syndrome (National Institute of Child Health and Human Development (NICHD), (2010).

A second form of Down syndrome is called translocation trisomy 21. Also occurring at conception, translocation trisomy 21 manifests when an individual inherits some extra chromosome 21 genes, but not the entire extra copy of chromosome 21. With the possibility of inheriting the genes from either parent, the extra genes from chromosome 21 typically move or relocate to chromosome 14, hence the use of the term “translocation” (Mayo Clinic, 2012). Often the translocations are random events and occur in approximately 3 to 4 percent of individuals born with Down syndrome (NICHD, 2010).

A third form of Down syndrome is called mosaic trisomy 21. This manifestation occurs at conception when an individual inherits some genes from chromosome 21, but not the entire extra copy of chromosome 21. Again, the inheritance can come from either parent. However, unlike trisomy 21 and translocation trisomy 21, only a few random cells in the individual are affected by the inheritance (Mayo Clinic, 2012). The term “mosaic” refers to the random disbursement of genes in the individual’s body. For example, an individual may inherit genes that affect the functioning of the heart while leaving cognition and muscle development almost untouched. Likewise, an individual can have the physical characteristics of a person born with Down syndrome (i.e., not limited to, but including upward slanting eyes and a flattened face and nose), but have cognitive abilities well above that of a person with trisomy 21. Mosaic trisomy 21 occurs in approximately 2 to 4 percent of infants born with Down syndrome (NICHD, 2010).

Characteristic features of individuals with Down syndrome. The over expression, relocation and random disbursement of the 21st chromosome in trisomy 21, translocation trisomy 21, and mosaic trisomy 21 respectively, cause a wide variety of observable traits in individuals with Down syndrome. Although some traits are almost always present, trait type and pervasiveness will vary by the individual (i.e., some individuals with mosaic trisomy 21 have shown to have almost no difference in physical appearance) (National Association for Down Syndrome, 2011). The most commonly occurring physical characteristics are: atypical facial features including a flattened face and nose, a short neck, a small mouth sometimes with a large, protruding tongue, small ears, upward slanting eyes that may have small skin folds at the inner corner (epicanthal fold) (NICHD, 2010); white spots (also known as Brushfield spots) may be present on the colored part of the eye (iris); other physical features may include short and broad hands with short fingers along with a single crease in the palm, and poor muscle tone and loose ligaments (National Association for Down Syndrome, 2011).

In addition to these physical characteristics, individuals with Down syndrome may have poor verbal processing abilities with expressive language typically lagging behind receptive language, poor motor control, poor verbal memory, stronger visual memory relative to verbal memory with particular strengths in visual fixation, visual attention, and visual imitation, a wide range in behavior temperament with social development tending to be typically strong, and cognitive development that starts out slow during childhood and tends to stay the same or diminish as the child matures (e.g., Buckley, 2005; Fildler, Most, & Guiberson, 2005; Wood, 2005). Additionally, IQ levels range from mild intellectual disability (IQ scores ranging between 50-69) to profound intellectual disability (IQ scores below 20) with about 80 percent of individuals falling into the moderate intellectual disability range (IQ scores ranging between 35-49) (Roizen, 2007).

Pre-linguistic and linguistic abilities of children with Down syndrome. In addition to almost 50 physical characteristics, infants born with the syndrome frequently have atypical (internal) cranial features, which have been shown to have a direct effect on later language development. The syndrome causes malformation of the external ear along with the potential for bones in the inner ear to develop abnormally (NICHD, 2010; Roizen, 2007). These malformations are manifested in the narrowing of the child's auditory canals resulting in about 96 percent of children with Down syndrome suffering from some hearing loss greater than 15 to 20 decibels in at least one ear (Venail, Gardiner, & Mondain, 2004). Moreover, in about 75 percent of cases, sound conduction is severely affected by extra tissue in the tympanic cavity of the ear (Venail et al., 2004). Hearing loss of this type has been shown to be pervasive and worsen over time, as well as having a deleterious effect on speech and language acquisition for children with the syndrome (Stoel-Gammon, 1997).

In addition to hearing deficits, other atypical facial characteristics that contribute to poor speech intelligibility, reduced enunciation speed, and articulation problems include a small oral cavity, a relatively large tongue with a narrow high arch, a cleft palate, and thick underdeveloped facial muscles (Miller & Leddy, 1998; Stoel-Gammon, 1997). These types of facial features combined with low levels of cognition and hearing loss are thought to adversely affect the language abilities of children with Down syndrome (Miller & Leddy, 1998). Research demonstrates that developmentally infants with Down syndrome are on a similar trajectory as their peers without disabilities (for a review, see Stoel-Gammon, 1997). Strong similarities exist between the two groups in vocalizations produced and the onset of canonical babble. However, canonical babble in infants with Down syndrome typically lags behind that of their peers without disabilities by about two months and generally occurs with less frequency (e.g., infants with Down syndrome typically begin canonical babble at the age of 9 months) (Fidler et al., 2005). Research also suggests that infants with Down syndrome can have deficits in parent-to-child vocal imitation ability, which may be linked to later deficits in working memory, lower receptive and expressive language skills in adolescents. This deficit may ultimately impact language, and later reading acquisition (Filder, 2005; Roch & Jarorld, 2008).

Given that early language development for infants with Down syndrome is nearly commensurate to that of infants without disabilities, there is an assumption that language acquisition in both groups would follow on the same developmental path. This, however, is not so. As the child with Down syndrome matures, new word production lags significantly behind that of their peers without disabilities. Indeed, Buckley (2000) found that at 24 months of age a child with Down syndrome is likely to have an average vocabulary of 28 words compared to an average vocabulary of 250 words for a child without disabilities. By age 3, a child with Down syndrome will typically produce about 116 words, by age 4, word production will increase to approximately 248 words, and by age 6, word production will likely increase to about 350 words. Conversely, by age 6, children without disabilities can develop a vocabulary of several thousand words. Since oral language skills have been shown to predict literacy skills in children with Down syndrome (e.g., Boudreau, 2002; Fowler et al., 1995; Kay-Raining Bird, Cleave, &

McConnell, 2000; Laws & Gun, 2002), receptive and expressive language strengths and weakness are likely to extend to reading and writing skills (Kay-Raining Bird et al., 2000).

Short-term memory deficits and children with Down syndrome. Research has demonstrated that children with Down syndrome are likely to score lower on short-term memory scales than children with any other form of genetic or non-specific genetic intellectual disability (Bower & Hayes, 1994). Along with deficits in language acquisition, deficits in verbal short-term memory are suspected to stymie children with Down syndrome from learning to decode letter-sounds and ultimately read (Cardoso-Martins, Peterson, Olson, & Pennington, 2009; Fowler, Doherty, & Boyton, 1995).

Cognition and memory researchers Baddeley and Jarrold (2007) theorize that a child's memory for the sound structures of language or phonological memory is part of the brain's working memory called the Phonological Loop (PL). The PL is responsible for the child's ability to recall the sounds of language. Deficits in the PL processes may prevent children from acquiring some phonics-based skills. The PL has three primary components: the first component *short-term phonological memory* (also called the phonological store) is responsible for short-term storage of auditory information. Here, information is usually held in short-term memory for approximately 2 seconds before it decays. The second component, the *phonological rehearsal process* is a sub-vocal process that automatically refreshes auditory information stored in the short-term memory. This process allows individuals to recall sounds of language, such as words from a previously heard song or the ability to successfully rhyme words. Once refreshed, verbal information can then be maintained in working memory for use in reading or language. The final component long-term phonological memory (also called working memory) is responsible for long-term storage of auditory information. Here, auditory information previously learned can be stored in an individual's working memory for long periods of time and made available for recall.

Researchers suspect that for many children with Down syndrome, the rehearsal process lies dormant causing a great deal of consternation for children when they are asked to produce sounds from memory (Gombert, 2002; Snowling, Hulme, & Mercer, 2002). Specifically, this deficit may account for difficulties during activities such as rhyme identification, alliteration production, and other phoneme-level tasks requiring the child to produce a sound-based response from recall (Fowler et al., 1995).

Families and Children with Down syndrome

A majority of the research on family relationships and children with Down syndrome has focused on issues of parent stress and parent well-being. The majority of studies concluded that parents of children with Down syndrome are likely to experience higher levels of stress than parents of children without disabilities, but conversely, can experience lower levels of stress than parents of children with other disabilities such as autism (e.g., Cuskelly, Jobling, Chant, Bower, & Hayes, 2002; Hedov, Anneren, & Wilblad, 2002; Pisula, 2006; Ricci & Hodapp, 2003). Moreover, research suggests that compared to other developmental disabilities, parental stress levels increase as the child with Down syndrome ages. Possible reasons for this increase are related to the serious medical issues that occur as the individual with Down syndrome matures (e.g., digestive tack problems, heart irregularities, ear and hearing related problems) (National Down Syndrome Society, 2011).

Within the parenting dyadic, mothers of children with Down syndrome continue to take the primary care giving role in their families (Hedov, 2006). Moreover, when fathers were asked about their parenting role in relation to their child with Down syndrome, 46 percent said that their wife took almost full responsibility for raising their child (Bower, Cuskelly, & Jobling, 2005). This is not to say the fathers do not contribute, however. When researchers examined sick childcare (e.g., cold and flu virus), fathers of children with Down syndrome spent more time caring for their child than parents of children who did not have a disability (Bower et al., 2005).

Examining the sibling relationship has proven to be somewhat more difficult than looking at the parent-to-child relationship because there are few measures available to evaluate the sibling experience (Hodapp, Glideen, & Kaiser, 2005). However, the few studies to examine this issue report that siblings without disabilities develop more patience and tolerance because of their interactions with a sibling with Down syndrome (Skotko, 2006; Van Riper, 2000). Moreover, when looking at sibling adjustment, research shows that siblings without disabilities report no significant differences in adjustment than if a newborn without disabilities entered the family (Hannah & Midlarsky, 2005).

The Great Debate: Sight-word Instruction vs. Phonics-based Instruction

Arguably, few topics in the American education system have garnered more attention or stirred more controversy than reading instruction. Historical data tracing reading instruction as far back as the 17th century shows that even while the Pilgrims were landing at Plymouth Rock academics were engaged in fervent discourse on how children should be instructed to read (Rodgers, 2001). Ironically, over time little has changed. Today, as in the past there are two primary approaches to reading instruction:

1) A *sight-word approach*, which focuses instruction on teaching children the semantic pathways linking word orthography (e.g., the standardized rules for writing a language) to word meaning (Hulme, Gotez, Brigsticke, Nash, Lervag, & Snowling, 2012). Typically, grapheme-phoneme instruction, also known as decoding instruction, is not

included in this approach. Instead, sight-word instruction teaches children to recognize individual words presented as wholes through a variety of prompting and fading strategies such as time delay, response prompting, and stimulus prompting (Browder, Ahlgrim-Delzell, Flowers, & Baker, 2012; Cologon, Cupples, & Wyver, 2011). In the absence of learning how to decode, children become more reliant on their memory to recall the familiar form of words (Naess, Melby-Lervag, Hulme, & Lyster, 2012), and

2) A *phonics-based approach*, which focuses instruction on teaching children how to manipulate the phonological features of language along with providing instruction on linking orthography to phonology in print media (Burgoyne, Duff, Clarke, Buckely, Snowling, & Hulme, 2012). Children are schooled on the unique relationships between the 24 letters of the English alphabet and their corresponding letter-sounds. Through this process, the child begins to recognize semantic patterns in words and to develop the skills required to “generalize” this knowledge to read previously unknown words (Flores, Shippen, & Albert, 2004).

Early reading instruction in American elementary school classrooms in the United States has vacillated between the two approaches for centuries. Over time, differences between the two approaches evolved into a polemic debate with both sides posturing to change the status quo of reading instruction in American classrooms. However, during the latter part of the mid-20th century a paradigm shift in the American mindset began to take shape. Starting with Jeanne Chall (1967), who published a comprehensive review on reading instruction called *Learning to Read: The Great Debate*, which was one of the first to review hundreds of studies on reading instruction. The results of her work provided evidence-based support for the important role that phonics-based reading instruction plays in learning to read. In 1983, Chall updated her research with new findings strengthening the case for phonics-based instruction over sight-word instruction. However, as important as Chall's work was at highlighting the benefits of phonic-based instruction, it is widely recognized that the publication of Rudolf Flesch's book *Why Johnny Can't Read: And What You Can Do About It* (1995) was the spark that started a national firestorm focused squarely on the abysmal illiteracy rate in the U.S (Chall, 1996). In his book, Flesch critiqued the popular sight-word approach (called the look-say method during this period) and equated the high illiteracy rates among American children to what he called a "flawed approach to reading" (Chall, 1996, p. 345). Flesch's panacea for the nation's ills was a return to phonics-based reading instruction.

The Critical Role of Federal Mandates and Reading Instruction

Less than two decades after Chall's second publication and perhaps in response to the continuing down turn in reading scores by children in the United States and the United Kingdom, three large evidence-based studies conducted between 2000-2006 in the United States, Australia, and England all recommended that effective reading instruction pivots on explicit phonics-based instruction (Development of Education, Science and Training, 2005; NICHD, 2000; Rose, 2006).

In the United States, 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 (NCLB, 2001). Most recently, the Common Core Standards Initiative, (2012) put in place a highly rigorous set of goals for literacy designed to help students become proficient readers. To meet this unprecedented challenge, teachers are required to use evidence-based practices based on two decades of research. Summaries of this research are found in reports by the National Reading Panel (NRP) (NICHD, 2000), the Partnership for Reading (2001), the National Early Literacy Panel (NELP), 2008, (NICHD, 2003), and in a syntheses of evidence-based instruction supporting struggling readers (Roberts, Torgesen, Boardman, & Scammacca, 2008).

Although over a decade old, the NRP report continues to have an extensive impact on reading instruction in today's classrooms. In their exhaustive review of the research, drafters of the NRP identified five critical components (or strains) of reading instruction. The first component, *phonemic awareness* pertains to a child's ability to hear and manipulate the smallest units of sound; the second component, *phonics* pertains to the child's ability to understand the relationship between written letter patterns (graphemes) and the sounds (phonemes) of language; the third component, *fluency* pertains to the child's ability to read text accurately, quickly and with expression; the fourth component, *vocabulary* pertains to the child's ability to understand the meaning of words; and the fifth and final component, *comprehension* pertains to the child's ability to understand the meaning of text (NICHD, 2000).

Although often described autonomously, the five components actually work in consort with each other, each playing an intricate role in the development of successful readers. However, of the five components, most scholars would likely agree that becoming a successful reader is predicated on acquiring phonemic awareness and phonics skills (e.g., phonics-based skills) (e.g., Black, Waller, Pullin, & Able, 2008; Cologon et al., 2011; Ehri & Masataka, 2001; Hulme, et al., 2012; NICHD, 2000; Cohen, Wolff Heller, Alberto, & Fredrick, 2008). Coming to a similar conclusion, the National Early Literacy Panel (NELP) (NICHD, 2003) reviewed over 500 empirical studies on early literacy development and determined that a phonics-based curriculum is highly correlated to a child's later reading success. Similar to the work completed by the NRP and the NELP in the U.S., a commission established in England to research key components of reading instruction reached a similar conclusion as their U.S. counterparts by determining that becoming a successful reader is predicated on an early exposure to a phonic-based reading curriculum (Rose, 2006).

Not surprisingly, much of this research has also informed reading instruction for children with disabilities. Corroborating the results of the NRP (NICHD, 2000) and the NELP (NICHD, 2003), research examining the specific literacy needs of children with disabilities also suggests that a strong foundation in phonics-based instruction is essential for later reading success (e.g., Allor, Mathes, Jones, & Roberts, 2010; Browder, Flowers, & Wakeman, 2008; Cupples & Iacono, 2002; Conners, Rosenquist, Sligh, Atwell, & Kiser, 2006; Kennedy & Flynn, 2003). Similarly, research specifically examining reading and 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; Byrne, MacDonald, & Buckley, 2002; Cologon et al., 2011; Conners, et al., 2006; Cupples & Iacono, 2000; Goetz, Hulme, Brigstock, Carroll, & Nasir, 2008; Kay-Raining Bird et al., 2000; Laws & Gunn, 2002; Lemon & Fuchs, 2010a, 2010b; Lemon, Mrachko, Kostewwicz, & Paterra, 2012; Van Brysteveldt, Gillon, & Moran, 2006).

Reading Acquisition and Children with Intellectual Disabilities

With mounting evidence supporting the importance of a phonics-based curriculum for children with intellectual disabilities and the critical role it plays engendering literate adults with disabilities, one would expect to find more emphasis given to phonics-based instruction over sight-word instruction in the classrooms (e.g., Al Otaiba & Hosp, 2004; Baylis & Snowling, 2012; NICHD, 2000; Rose, 2006). However, this has not been the case. Children with intellectual disabilities including children with Down syndrome appear to receive very little exposure to phonics-based instruction (Fredrick, Davis, Alberto, and Waugh, 2013). In their comprehensive review of the research on reading instruction for children with developmental disabilities, including children with Down syndrome, Browder, Wakeman, Spooner, Alghrim-Delsell, and Alogozzine (2006) found that 72 percent of reading instruction favored sight-word instruction with only 19 percent favoring phonics-based instruction.

Clearly, many educators favor a curriculum based on sight-word instruction, which typically focuses on teaching children with intellectual disabilities a functional vocabulary pertaining to the accomplishment of daily routines such as grocery shopping and traversing on public transportation (i.e., words taught may include: “stop”, “go”, “entrance/exit”, and “train station”) (Cologon et al., 2011; Conners, 1992, 2003; Kay-Raining Bird et al., 2000). Although this approach limits the child’s vocabulary to a small cadre of memorized words and does little to inform decoding skills, it is nevertheless not without some benefit.

In a comprehensive review of the literature from 1990 to 1997, Browder and Xin (1998) found that most studies involving sight-word instruction showed a 100 percent increase in word recognition when incorporating learning strategies such as constant time delay, instructive feedback, and post-response prompting with the largest gains attained by children with moderate intellectual disabilities. The authors surmised that sight-word instruction appears to be highly effective at teaching word reading to children with moderate to severe intellectual disabilities when evidence-based strategies are incorporated into instruction. In studies of children with Down syndrome, there is also considerable support in the literature for sight-word instruction, although this is not surprising since research has shown that visual processing is a relative strength for children with Down syndrome (e.g., Browder, et al., 2006; Browder & Xin, 1998, Fidler, et al., 2005; Fowler et al., 1995; Joseph & Seery, 2004; Katims, 2000). Although sight-word instruction can undoubtedly increase the number of words a child recognizes, it does little to develop the child's decoding ability, which is fundamental to becoming an independent reader (Naess et al., 2012). Moreover, as encouraging as some of these findings are, there still appears to be an over emphasis on sight-word instruction combined with an under emphasis of phonics-based skill instruction for children with Down syndrome (Cologon et al., 2011). The theoretical underpinnings for this marked reliance on sight-word instruction for children with Down syndrome can be traced to these two presumptions:

1. As stated previously, children with Down syndrome frequently demonstrate relatively good visual processing abilities. This has led parents and teachers to conclude that children with Down syndrome are primarily "visual learners" and, thereby, an assumption that sight-word instruction is a more appropriate approach to reading instruction for this population (Cologon et al., 2011; Fidler et al., 2005), and
2. A pertinacious belief by parents and teachers that IQ level equates to reading ability, and thereby, a further assumption that because of lower IQ levels, children with Down syndrome will not be able to understand phonic-based reading instruction (Basil & Reyes, 2003; Laing, 2002; Katims, 2000).

In spite of these assumptions, research, although limited, on phonics-based instruction for children with Down syndrome has shown promising results. Research shows that children with Down syndrome can perform all of the same tasks related to phonics-based instruction as their peers without disabilities, and that the evidence-based instructional methods as outlined by the NRP are effective for children with Down syndrome (Al Otaiba & Hosp, 2004). Moreover, research within the past 10 years has shown that 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 (Gombert, 2002; 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, 2000, 2002; Gombert, 2002; Kay-Raining Bird et al., 2000; Snowling et al., 2002).

In the intersection of research on phonics-based instruction, reading acquisition, and children with Down syndrome, the role that phonemic awareness plays has received a prolific amount of attention (for a review see Lemons & Fuchs, 2010). Research suggests that children with Down syndrome have the ability to successfully perform many higher order phonemic awareness tasks such as: (a) segmenting syllables in words (Verucci et al., 2006), (b) deleting syllables in words and reading regular and irregular words (Gombert, 2002), (c) blending letter-sounds together (Snowling, et al., 2002), (d) spelling words (Kennedy & Flynn, 2003), (e) reading non-words (Groen, Laws, Nation, & Bishop, 2006), (f) demonstrating letter-sound correspondence understanding (Cupples & Iaconco, 2002; Cohen et al., 2008), and develop phonological awareness and decoding skills regardless of limitations to their auditory short-term memory (Cologon, et al., 2011).

Although several studies have determined that individuals with Down syndrome can succeed in completing most phonemic awareness tasks, they also suggest that in some respects, phonemic awareness skills and reading might qualitatively develop differently for children with Down syndrome (e.g., Boudreau, 2002; Cardoso-Martins, Michalick, & Pollo, 2002; Gombert, 2002; Snowling et al., 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; Cardoso-Martins, et al., 2002; Gombert, 2002; Snowling et al., 2002). In their concluding remarks, both Gombert (2002) and Snowling et al. (2002) theorized that deficits in rhyming skills might be a result of weaknesses in the phonological loop processes of the individuals (See page 8 of this document). 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). In sum, the available research demonstrates that a phonics-based reading curriculum is likely to be effective at teaching most 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 many of the studies examining phonics-based reading instruction for children with Down syndrome have demonstrated impressive results and have provided the research community with an impetus for further study (Al Otaiba & Hosp 2004; Balylis & Snowling, 2012; Cologon, Cupples, & Wyver, 2007; Goetz et al., 2008), 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 (Buckley, Bird, & Byrne, 1996; 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 et al., 1996).

Focus of the Study

This study is an attempt to extend the research on reading instruction for children with intellectual disabilities including children with Down syndrome. Children in the study were instructed to use an evidence-based decoding strategy to read words not previously established as part of their sight-word vocabulary. Instructional features shown to be efficacious for children with intellectual disabilities including children with Down syndrome, 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 an evidence-based procedure considered to be one of the most effective and efficient procedures for teaching children with and without intellectual disabilities (Browder et al., 2008; Jameson, McDonnell, Polychronis, & Riesen, 2005; Cohen et al., 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 an evidence-based decoding instruction with CTD to teach decoding skills to children with Down syndrome may aide their ability to successfully read words.

The present study is a replication of the reading intervention completed by Cohen et al. (2008), but with a more focused population of children with mild intellectual disabilities. The researchers combined 4-second constant time delay (4-CTD) procedure with a 3-Step Decoding Strategy (3-SDS) to instruct seven participants between the ages of 7-11 years old with mild to moderate intellectual disabilities to decode and read words phonetically. Data from their study demonstrated that all children showed increased levels in word reading and decoding ability.

The present study employed a non-concurrent multiple baseline design with a probe administered between two intervention phases. Participants in the study included three children with Down syndrome between the ages of 9-11. The present study used an evidence-based, 3-SDS with a 4-CTD procedure to teach word reading to three children with Down syndrome. All the children had a mild form of intellectual disability with IQ scores ranging between 55-69. The researcher taught the children to decode and read words. The purpose of this study was to determine the answers to the following two research questions:

1. Is the simultaneous pairing of a 4-CTD procedure with a 3-SDS effective at teaching word reading to children with mild intellectual disabilities who are also identified with Down syndrome?
2. Does the pairing of a 4-CTD procedure with a 3-SDS lead to generalization or increased decoding efficiency from taught words to untaught words of a similar phonemic structure?

II. REVIEW OF THE LITERUATURE

This chapter begins with a look at the two most widely accepted approaches to reading instruction, the sight-word approach and the phonics-based approach followed by a review of the literature on reading instruction with children identified with mild intellectual disabilities who are also identified with Down syndrome.

Reading Approaches

Sight-word approach. The sight-word approach begins instruction at the whole word level and emphasizes the connection between written text and the child's own experiences (Gilles, 2006). Readers gain meaning from text not by applying decoding skills to read unknown words, but by predicting or "guessing" the meaning of unknown words based on the context clues of the surrounding words (Harste, 1990). Specifically, children are taught to predict the meaning of an unknown word by looking at: the shape of the word (i.e., the letters that make the word); semantics (i.e., based on the meaning of the sentence, what would the unknown word likely be; syntax (i.e., what part of speech is most likely to make the most sense); and pragmatics (i.e., the overall purpose of the text) (Goodman, 1982; Tracey & Morrow, 2006). Arguably, the strongest proponent of the sight-word approach is Kenneth Goodman. Goodman's theories drew from the works of American linguist Noam Chomsky. Goodman believed that reading was a natural process that developed much in the same way as language developed in humans, where the focus is on constructing meaning from text not on understanding how sounds map to letters (Ryder, Tunmer, & Greaney, 2008).

Gove (1983) suggests that advocates for this approach believe: (a) readers can understand a section even though they do not understand every word on the page, (b) readers can learn strategies to identify unfamiliar words, (c) reading is more about participating in meaningful activities than learning sounding-out strategies, (d) reading sentences and whole passages should be the focus of reading over learning decoding skills for individual words, and (e) reading for meaning is primary focus of reading, not the sound to letter relationship.

Phonics-based approach. The phonics-based approach centers on phonemic awareness instruction and phonics instruction, which teaches the alphabet principle. Although often confused, phonemic awareness instruction is fundamentally different from phonics instruction. Phonemic awareness is considered to be "the ability to reflect explicitly on the sound structures of spoken words" (Hatcher, Hulme, & Ellis, 1994, p.41), and includes large units such as syllables and rhymes, and smaller units such as phonemes. Instruction progresses on a developmental continuum, typically beginning with rhyming tasks (e.g., "Which word rhymes with *goat*: *coat* or *box*?") advancing to more complex tasks such as word segmentation (e.g., *mat*= /m/-/a/-/t/) and word blending (e,g., /c/-/a/-/t/=*cat*) (Mengoni, Nash, & Hulme 2013).

Phonics instruction, on the other hand, focuses on establishing the alphabet principle by teaching children the relationship between written letters and the sounds of spoken language (Bursuck & Damer, 2007). To better understand the relationship between phonemic awareness and phonics, it is helpful to have a general understanding of the orthography of the English language. The English language is comprised of an orthography based primarily on the alphabet system. The exceptions are the handful of symbols such as the exclamation point, the question mark, and the ampersand, which are used to convey meaning symbolically. Unlike some languages (e.g., the Chinese language), which are composed almost exclusively of symbols, the English language derives meaning from the arrangement of 24 letters. A primary characteristic of an alphabet-based language is that speech is mapped to print at the level of the phoneme (i.e., smallest unit of sound in a language) (Yopp & Yopp, 2000). Thus, children learning to read in an alphabet-based orthography such as the English language will usually progress from easier tasks requiring them to orally manipulate the sounds of language to more complex tasks such as mapping sounds to specific letters or groups of letters (Yopp & Yopp, 2000). This process is best realized during the early elementary school years when children begin to practice the transfer of sounds to print through invented spelling. During this transfer of knowledge, children begin to discover that the sounds of language can be written down in meaningful ways.

The phonics-based approach lends itself to several instructional pathways of which there are four primary types: analytic phonics teaches children to read whole words before letter-sound correspondence instruction is introduced (National Literacy Trust, 2009), analogy phonics teaches children to use letter patterns found in known word families to read unknown words that are part of the same word family (Skudiene, 2002), phonics through spelling teaches children to break words into phonemes (i.e., smallest unit of sound) and to translate the sounds into letters in order to spell words (NICHD, 2000), and synthetic phonics teaches children to follow a skills-in-isolation approach, which uses a prescribed format that begins at the most basic level, letter recognition and progresses methodically, slowly to more complex tasks such as letter-sound correspondence instruction, letter blending and segmenting, word reading, and finally sentence reading (Skudiene, 2002).

Review of the Literature on Phonics-based Instruction.

The following review of the literature will examine the salient research at the intersection of phonic-based reading instruction with children with mild intellectual disabilities who are identified with Down syndrome. A primary focus for many researchers has been the role that phonemic awareness plays in the context of reading acquisition for children with Down syndrome, with comparatively few studies examining the role phonics instruction plays in reading acquisition for this population. Of the studies that have looked specifically at phonics instruction, reading acquisition, and children with Down syndrome most have a small sample size, short intervention cycles, and lack a comparison group (e.g., Cologon et al., 2011, Goetz et al., 2008, Lemons and Fuchs, 2010b). For this reason, the present review is divided into two sections: the first section reviews the descriptive and intervention studies focused on the connection between phonemic awareness instruction and reading acquisition for children with Down syndrome, and the second section reviews descriptive and intervention studies focused on the connection between phonics instruction and reading acquisition or children with Down syndrome.

Phonemic Awareness and Reading. As a child matures, weakness in an early ability to manipulate the sounds of language is thought to be the single most reliable predictor for later reading problems and academic failures (Catts, 1993; Catts & Kamhi, 1999; Magnussen & Naucler, 1990, see Stahl, Duffy-Hester, Stahl, 1998, for a review). In point of fact, after an extensive review of 20 years of research on early literacy instruction for children with disabilities, Torgesen and Mathes (1999) determined, "The most important single conclusion about reading disabilities is that they are most commonly caused by weaknesses in the ability to process the phonological features (italics added) of language." (p. 579). Today we know that a child's path to becoming a successful reader has much less to do with his or her IQ level and much more to do with the early development of phonemic awareness (i.e., the child's ability to manipulate the sounds of language at an early age). To this point, research has repeatedly demonstrated that children with intellectual disabilities (including children with Down syndrome) can perform most phonemic awareness tasks that belie their IQ levels (e.g., Cohen et al., 2008; Conners, et al., 2001; Cardso-Martins & Frith, 2001; Fletcher & Buckley, 2002; Laws and Gunn, 2002; Lemons & Fuchs, 2010; Roch & Jarrold, 2008). However, understanding how phonemic awareness develops for children with Down syndrome and understanding if it unfolds differently for children without disabilities or for children with other forms intellectual disabilities has puzzled researchers for years (Gombert, 2002; Snowling et al., 2002).

Descriptive studies. Two early influential studies examining the relationship between reading acquisition and children with Down syndrome came from Italian researchers in the early 1990's. In both studies, researchers presented results showing that children with Down syndrome, who possessed little to no ability to successfully complete phonemic awareness tasks, could nevertheless, auspiciously complete single word reading tasks without errors. At the time, the research community was bewildered by these findings because they represented a view that was contrary to the gestalt view of reading at that time, which cultivated the idea that reading was an outgrowth of speech. Hence, if children could not properly execute the sound structures of language (as the children in both studies could not), it was highly unlikely that they would be able to read.

In the first of the two studies, Cossu and Marshall (1990) reported on one Italian boy with Down syndrome, (age 8 years and 11 months; IQ score of 47) comparing his performance on phonemic awareness measures to his performance on a reading task. Assessment data revealed that although the boy could not successfully rhyme words or blend phonemes together and that his ability to delete phonemes was extremely poor he was still able to attain a perfect score when reading real words and non-words. Although this result should be tempered given the small sample size, it was, nevertheless, one of the first documented studies showing a child with Down syndrome reading in the presence of a significant defect in phonemic awareness aptitude.

Based on these findings, the researchers came to the controversial conclusion that phonemic awareness skills are not a necessary prerequisite to becoming a successful reader for children with Down syndrome. Moreover, when describing their result, the researchers intimated that children with Down syndrome might have a unique ability that allows them to read in ways that are different from children with other types of intellectual disabilities and from children without disabilities. Interestingly, over time and under different experimental conditions, other researchers will come to a similar conclusion.

Three years later, Cossu, Rossini, and Marshall (1993) conducted a follow-up study comparing ten Italian children with Down syndrome (mean age: 11.4; mean IQ score of 44) to ten children without disabilities (mean age: 7.4; mean IQ score of 111) matched on reading ability and phonological awareness abilities. Children were given standardized and non-standardized assessments to measure word and non-word reading. Phonemic awareness skills were measured with phoneme recognition exercises (i.e., tapping-out sounds in words) and a series of phoneme deletion and blending tasks. Confirming the findings first reported in Cossu and Marshall (1990), the researchers once again demonstrated that children in the Down syndrome group were able to successfully complete reading tasks in spite of their failure to successfully complete phonemic awareness tasks. Scores on reading assessments for children in the Down syndrome group indicated that they achieved reading levels equal to young children without intellectual disabilities.

With these results in hand, Cossu and colleagues reaffirmed the conclusions made in Cossu and Marshall (1990) by demonstrating that phonemic awareness acquisition is not a prerequisite to reading acquisition for children with Down syndrome. Moreover, the researchers suggested that elementary school administrators consider deemphasizing phonemic awareness instruction in favor of more time given to phonics instruction. Once again, these conclusions contradicted years of research supporting the foundational role phonemic awareness plays in early reading instruction. However, the researchers did concede that phonemic awareness might be an important skill for some children with Down syndrome to acquire prior to reading. Nonetheless, the conclusions reached by Cossu and colleagues (1990; 1993) provided fodder for many who criticized their results and ultimately their methodology.

The most vocal critic of was Bryan Byrne (1993), who found several inconsistencies with the researchers' methods in Cossu et al. (1993). First, based on the performance of the experimental group on phonemic awareness tasks, Byrne expected to find children scoring at zero or near zero on the sub-tests of phoneme segmentation, phoneme deletion, spelling, and phoneme synthesis. Upon review, however, Byrne found that some children scored as high as 62 percent on some of the phonemic awareness sub-skill tests. The high achievement by some of the children in the Down syndrome group, Byrne suggested, may have been the result of children entering the study with a low, but still sufficient level of phonemic awareness ability and that these levels may have been enough for them to successfully complete the reading tasks. Moreover, Byrne intimated that the measures used by Cossu and colleagues to assess phonemic awareness skills may have been too general and were perhaps used in place of more sensitive assessments that would have revealed a higher level of phonemic awareness ability in some children. Given these two points, Byrne asserted that the findings provided by Cossu and colleagues did not provide clear evidence that children could read in the absolute absence of phonemic awareness acquisition. Bryne's comments suggest two issues: 1) the results provided by Cossu et al. (1993) are not conclusive hence, phonemic awareness acquisition may still be a prerequisite for reading acquisition and 2) the true issue might be to discover how much phonemic awareness aptitude is required for reading acquisition.

Byrne did not stand alone in his criticism. Paulesu, Demonet, Fazio, and McCrory (2001) suggested that the findings have limited value with respect to more complex languages. As an example, the researchers noted that the orthography of the Italian language is much simpler than the orthography of a language such as English, which has a much more complex alphabet orthography. Hence, the limited phonemic awareness abilities demonstrated by the Italian-speaking children in Cossu et al. (1993) may have been sufficient enough for them to successfully read in a language that requires less taxing sound to letter correspondence knowledge.

Additional criticism by Cupples and Iacono (2000) suggested that Cossu and colleagues did not account for limits to the children's working memory. Citing the phoneme synthesis task, Cupples and Iacono noted that assessment data clearly showed the children in the study had a limitation for only keeping two to four digits in their working memory. The phoneme task used during in Cossu et al. (1993) however, required the children to keep four to six phonemes in their working memory. Cupples and Iacono suggested that performance might have been stronger if the words on the phonemic awareness measurement were constructed using fewer phonemes, and thereby more inline with child's working memory capacity with the end result being scores on the phonemic awareness measure that are more indicative of the child's reading ability.

Finally, Bertelson (1993) suggested that children in the Down syndrome group might not have understood the instructions well enough to satisfactorily perform the phonemic awareness tasks. Cossu and colleagues countered this argument by offering data showing that some children where able to complete some phonemic awareness tasks successfully, suggesting that since some children were able to successfully complete the tasks, they must have understood instructions.

Although the conclusions made by Cossu and Marshall (1990) and Cossu et al. (1993) were not widely accepted by the research community, their studies demonstrated that phonemic awareness abilities vary greatly for children with Down syndrome, and that some phonemic awareness tasks such as rhyming are more difficult for children with Down syndrome to successfully complete. The conclusions made by Cossu and his colleagues (1990; 1993), arguably, raised more questions than they answered. Their work precipitated a multiplicity of follow-up studies investigating how children with Down syndrome learn to read and the role that phonemic awareness instruction plays in reading acquisition. Several of those studies will be reviewed next.

Lemons and Fuchs (2010a) reviewed 20 studies published between 1995-2006 examining the role that phonemic awareness plays in reading acquisition for children with Down syndrome. The researchers looked at four issues: a) the relationship between performance on phonemic awareness tasks between children with and without disabilities, b) the relationship between phonemic awareness acquisition and later reading success for children with Down syndrome, c) differences in the relationship between phonemic awareness and reading when comparing children with Down syndrome to peers without disabilities, and d) the reciprocal relationship between phonemic awareness interventions and reading skills for children with Down syndrome. Results demonstrated that children with Down syndrome matched on reading ability, cognitive characteristics, and chronological age performed worse on phonemic awareness tasks than their peers without disabilities. Although contrary to the conclusions reached by Cossu et al. (1990; 1993), their poor performance on phonemic awareness tasks were not held up as proof for a disassociation between reading and phonemic awareness. In point of fact, just the opposite was true. Results indicated a significant relationship between phonemic awareness achievement and later reading success across all studies. These conclusions provide evidence that phonemic awareness plays an essential role in learning to read for children with Down syndrome. Moreover, phonemic awareness and phonics instruction were shown to improve comprehension, fluency, and decoding skills for unknown words among children with Down syndrome. However, the researchers stress that although traditional phonemic awareness is typically taught without visual aides, for some children with Down syndrome acquisition might be enhanced if it is supplemented with visual aides and manipulatives. It should also be noted that similar to conclusions made by others (e.g., Cossu et al., 1993; Evans, 1994; Snowling et al., 2002; Verucci et al., 2006) Lemons and Fuchs noted that children with Down syndrome generally performed worse on tasks of rhyme judgment and rhyme detection.

Studying a group of 33 young adults with Down syndrome (matched on reading ability), Fowler et al. (1995) investigated the connection between phonemic awareness and reading ability. The authors correlated the results of an Auditory Analysis Test (AAT) and two sub-tests of the Woodcock Reading Mastery Test-Revised (WRMT-R) (e.g., Word Identification and Word Attack). The researchers found that decoding skills (as measured by the Word Attack subtest) were far below word identification abilities for most participants. Reading age equivalents were as much as two and half years above performance levels on phonemic awareness assessments (i.e., reading levels as high as 8.5 years with phonemic awareness levels equivalent to age 6). These findings were similar to the findings in Cossu et al. (1993), in so much as both studies found that performance on phonemic awareness tasks did not necessarily equate to reading ability for individuals with Down syndrome.

However in contrast to the conclusions made in Cossu et al. (1993), Fowler and colleagues concluded that when cognitive ability was controlled there was a strong relationship between phonemic awareness abilities and reading ability with phonemic awareness abilities accounting for 36 percent of the variance in word recognition and 49 percent of the variance in decoding non-words. The researchers also noted that although some of the children could not read even though they had some phonemic awareness ability, there was not a single example of a child who could read that did not have some level of phonemic awareness ability. The researchers interpreted these results as evidence that some ability in phonemic awareness is necessary to decode words. With their study, Fowler et al. (1995) introduced new breadth into the conversation by suggesting that levels of mastery may be an important consideration when looking at the connection between phonemic awareness and reading acquisition. Their findings advance the theory first proposed by Bryne (1993) in his criticism of Cossu et al. (1993) that children with Down syndrome might be able to successfully read even with lower levels of phonemic awareness (aptitude).

Gombert (2002) investigated the relationship between phonemic awareness and reading with 11 French language-speaking children and young adults with Down syndrome (age range 10-20 years; mean IQ score of 47). Participants in the Down syndrome group were matched on reading ability with 11 French-speaking children without disabilities (age range 6-8.1 years). Reading measurements included: 14 regular words, 6 irregular words, 14 neighbor non-words (constructed by changing the first letter of the 14 regular words), and 18 non-words with no orthographic neighbor. Phonemic awareness aptitude was measured by performance on tasks for rhyme judgment, rhyme oddity, onset oddity, phoneme synthesis, phoneme counting, phoneme deletion, and oral spelling. An additional task called, non-linguistic control, was used to assess the children's ability to follow testing directions.

Study results demonstrated that children with Down syndrome performed almost at the same level as children without disabilities on composite measures for phonemic awareness including phoneme spelling, phoneme counting, and phoneme deletion. On reading tasks, performance was equally as strong with children in the Down syndrome group again performing at levels similar to controls on reading regular words, reading irregular words, and reading non-words. However in the category of non-words without an orthographic neighbor, there was a strong trend for children with Down syndrome to do worse. The researchers interpreted these results as evidence that children with Down syndrome "used analogies with known words to read non-words and had difficulty in applying grapheme-phoneme correspondence rules to items that were not lexically related to words" (Gombert, 2002, p. 461). The performance of the children in the Down syndrome group suggests that they have some ability to learn, remember, and apply knowledge across instructional models, as long as the models are closely related to each other. However, when the models are not closely related to each other, as in the case of non-words with no orthographic neighbor, children with Down syndrome falter. Contrary to the findings reported in Cossu et al. (1993), Gombert provided support that phonemic awareness skills have a positive effect on reading ability for children with Down syndrome with higher levels of phonemic awareness predicting reading ability. Finally, data on specific phonemic awareness tasks such as onset oddity and phoneme deletion, both of which require the recognition and manipulation of initial phonemes in target-words showed very strong correlations to reading ability, suggesting that beginning phonemes in words play a significant role in learning to read for children who have Down syndrome.

In a study investigating the relationship between letter-sound correspondence and letter naming, Snowling et al. (2002) compared 21 children with Down syndrome (age range 6.11-17.6 years) to 31 children without disabilities (age range 4.6-6.5 years) matched on reading ability. Results on the reading measures showed the two groups had similar scores on environmental print, word reading, and non-word reading. Additionally, both groups had similar results on letter-sound and letter-name knowledge. Performance on phonemic awareness tasks however, revealed a startling difference between the groups. Children with Down syndrome performed significantly lower in syllable segmentation (-4.66) and phoneme detection (-2.72), with the most notable deficits observed in rhyme detection. Similar to the findings of Evans (1994) and Cossu et al. (1993), only one out of the 29 children in the Down syndrome group was able to complete the rhyme detection task. From these results, Snowling and colleagues concluded that: 1) letter-sound and letter-name knowledge are not necessarily predictors for reading ability in ways that are similar for children without disabilities, and 2) perhaps children with Down syndrome use letter-sound knowledge in different ways from children without disabilities.

In a follow-up study (reported in the same article), Snowling and colleagues extend their first study by examining the specific relationship between rhyming ability and phoneme detection in children with Down syndrome (children performed very low on rhyming tasks in the first study). To lessen the demands on cognition, a factor that may have affected the results in the first study, the researchers simplified the rhyming task.

This time the researchers compared 23 children with Down syndrome and 34 children without disabilities on tasks for rhyme judgment and phoneme detection. To assess rhyme judgment, the researchers used 30 picture cards, 15 of which showed pictured pairs that represented rhyming words (e.g., swing and ring). Children were then presented with two pictures and tasked with determining if the names of the pictured pairs sounded the same. To assess phoneme detection, children were presented with three pictures and tasked with naming each picture as it was shown. To assess initial phoneme identity, children were tasked with matching an initial phoneme to a picture (e.g., Which word begins with the sound /b/: bike, car, deer?). The final assessment, ending phoneme identity, tasked the children to match a final phoneme to a picture (e.g., Which word ends with the sound /s/: bus, car watch?).

The results, similar to their original findings, indicated no group differences on the phoneme tasks. Both groups had a difficult time identifying initial phonemes as opposed to final phonemes, but, overall, children with Down syndrome performed worse than controls on tasks of final phoneme detection. Twenty-seven out of 34 children in the control group scored above chance with only 9 out of 23 children in Down syndrome group performing above chance with the largest division between the two groups seen in performance levels on rhyming tasks. Results indicated that children with Down syndrome scored significantly lower than children without disabilities. The authors interpreted these results as evidence that children with Down syndrome have a significant deficit in rhyming ability along with a particular weakness in their ability to detect final phonemes in words.

Although it is generally agreed that rhyming ability is proceeded by phoneme identification ability for children without disabilities, Snowling and colleagues found the opposite to be true for children with Down syndrome. Results from their studies advance the argument that children with Down syndrome might proceed down a fundamentally different phonological awareness path than children without disabilities. With the first and second study providing similar results using a dissimilar rhyming task, the researchers conducted a third study to rule out any chance that the rhyming task affected the outcome. This time, the researchers replicated the exact rhyming task from the second study along with incorporating the letter-sound task from the first study. Participants in the comparison group for the third study included 20 children with Down syndrome and 7 children without disabilities. The results here corroborate the findings from the first two studies and showed that children in the Down syndrome group demonstrated a clear deficit for rhyming but performed above chance on the alliteration task. In addition, results also showed that children in the Down syndrome group who had better phonological awareness skills were also better readers and that letter-sound knowledge did not predict reading ability.

These studies were an important milestone in understanding the connection between phonemic awareness and reading ability in children with Down syndrome. Whereas it was widely accepted that letter-sound correspondences was a necessary perquisite to reading acquisition for children without disabilities, results from Snowling et al. (2002) suggested it may not be as equally predictive for children with Down syndrome. Moreover, Snowling and colleagues concluded that although children with Down syndrome can complete higher order (more difficult) phonemic awareness tasks like syllable segmentation, albeit at a depressed level, these same children have significant difficulty completing lower order (easier) phonemic awareness tasks such as rhyming. The authors interpreted these results as an affirmation of their earlier suggestion that children with Down syndrome learn to read in ways that are different from children without disabilities.

In another study investigating the relationship between phonemic awareness and reading, Cardoso-Martins and Frith (2001a) examined the performance of 33 young adults with Down syndrome (mean age 23 years) matched on reading ability to 33 children and young adults without a disability (mean age 18 years). Four tasks were used to assess phonological awareness abilities: phoneme segmentation, phoneme deletion, oral spelling, and phonemic synthesis. Reading tasks included letter knowledge, word reading, non-word reading, and non-word spelling. Overall, the young adults with Down syndrome scored comparatively well on all phonemic awareness tasks with the exception of the phoneme deletion task, where they performed at ceiling.

Extending their work, Cardoso-Martins and Firth (2001b) followed-up their first study with 93 individuals with Down syndrome (age range 9 to 50 years). The researchers were specifically examining the connection between phoneme detection and reading, an issue that surfaced stemming from the findings in the first study. The participants were divided into two groups: readers and non-readers. All participants were administered the following assessments: letter knowledge, word reading, and phoneme detection. The results showed a strong correlation between performance levels on the phoneme detection task and the word-reading task. The correlation was significant enough for the authors to conclude that performance on phoneme detection tasks can be used to distinguish readers from non-readers. These results refute the conclusions by Cossu et al. (1990, 1993) and advance the theory that some phonemic awareness ability is needed to acquire reading ability.

In another study examining the connection between phonemic awareness and reading ability in children with Down syndrome, Roch and Jarrold (2008) compared 12 children and young adults with Down syndrome (age range 10-27 years) to 14 children without disabilities matched for reading ability (age range 6-8 years). The researchers assessed all the participants with a battery of three reading tests and three phonological measures, along with the British Picture Vocabulary Scale II (BPVS-II; Dunn, Dunn, Whetton, & Burely, 1997). The researchers examined the relationship between non-word reading and irregular word reading, on one hand, and the relationship between phonemic awareness and non-word reading on the other.

Overall, the children with Down syndrome scored lower on all phonological awareness measures than the children without disabilities. However, the same relationship between phonemic awareness and non-word reading emerged for both groups. Across both groups a higher score on phonemic awareness tasks equated to a higher score on the non-word reading task. However for the children in the Down syndrome group, non-word reading and irregular word reading were not significantly correlated, as they were for controls. The researchers interpreted these results as support that children with Down syndrome perform at the same trajectory level as children without disabilities, but at much delayed rate.

In a follow-up study conducted four years later, Roch and Jarrold (2012) examined the same 12 children and adults with Down syndrome to once again track the relationship between non-word reading and irregular word reading, and phonological awareness and non-word reading. The same assessment batteries used during the first study where repeated in the follow-up study. Scores on all the assessments indicated that all twelve participants showed a significant increase or close to a significant increase on all assessment measures. The authors interpreted these results as support that individuals with Down syndrome can continue to develop and improve their reading skills throughout their lives. Of even greater significance however, was the change in the relationship between the variables. The results from the first study showed that phonemic awareness was strongly correlated with non-word reading whereas, non-word reading and irregular word reading were not significantly correlated with each other. At the follow-up, phonemic awareness was no longer strongly correlated with non-word reading, whereas the correlation between irregular word and non-word reading was now significant. This startling change was significant. Given the strong relationship that phonemic awareness has to decoding and reading (i.e., Lemons & Fuchs, 2010a), it would be reasonable to assume that both move on a similar trajectory. Hence, as reading scores increase so should phonemic awareness scores. This however, was not the case. The authors suggested that overtime and with more exposure to printed words, individuals with Down syndrome become less dependent on phonemic awareness to decode non-words and instead rely on visual analogies to decode non-words (Gombert (2002) came to a similar conclusion). For example, an individual might be able to read the non-word, “splut” because the word is closely related to “splat”, a word previously recognized.

In another study predicated on the work of Cossu and colleagues (1990, 1993), Fletcher and Buckley (2002) examined the relationship between phonemic awareness and reading with 17 children with Down syndrome (age range 9-15 years). A battery of standardized tests were used to measure reading, spelling, and non verbal abilities including: the British Ability Scales (BAS); Word Reading Test A, BAS Spelling Test; Wechsler Objective Reading Dimensions (WORD) Comprehension subtests; and BAS Recall of Digits. In addition to administering standardized tests a battery of non-standardized tests were also administered to assess reading ability, spelling ability, and phonological awareness. Results demonstrated that literate children with Down syndrome have a measurable level of phonological awareness. Although reading ability was variable, data indicated that children who performed well on spelling tasks and on phonemic awareness tests scored higher on reading measures with older children scoring the higher. Additionally, phoneme blending demonstrated a strong correlation to reading ability and the ability to spell non-words. However, similar to the results of Verucci et al. (2006) some children who scored well on phonemic awareness tasks had a difficult time reading non-words. The authors interpreted these results as evidence that some sensitivity to phoneme awareness may be necessary to read regular words, but low levels of phonemic awareness aptitude were not sufficient to decode non-words. Moreover, results showed that children who demonstrated decoding ability also demonstrated strong phonemic awareness abilities. Once again, these results challenge the conclusions drawn by Cossu et al. (1990, 1993). Moreover, Fletcher and colleague suggest, as others have (i.e., Byrne, 1993; Fowler et al., 1995), that perhaps the instruments used by Cossu et al. (1993) were not sensitive enough to detect the phonemic awareness abilities of the children in their study.

In another attempt to examine the conclusions made by Cossu and colleagues, Cupples and Iacono (2000) designed a two-year study examining the relationship between phonemic awareness tasks and reading ability. Twenty-two children with Down syndrome (mean age of 8.5 years) were selected to participate in a longitudinal study over two testing periods. Each participant completed a range of cognitive, linguistic, reading and phonemic awareness measures during assessment period one, with a follow up assessment period occurring 7-12 months later. The follow-up assessments consisted of measures to determine phonological memory, reading ability, and phonemic awareness abilities. Regression analysis was conducted to examine the predictors of reading accuracy and non-word reading. Although the authors did not provide correlations for each variable, results showed that children with better phoneme segmentation skills were better at reading non-words. This research provided a direct association between phonemic awareness skills and reading ability, and thereby added support to the argument that children with a stronger phonemic awareness aptitude may become stronger readers.

In a study examining the relationship between phonemic awareness, reading, and IQ level, Conners et al. (2001) examined 65 children with Down syndrome considered to be poor readers ranging in age between 8 and 12 years with an IQ<70. The children were split into two groups based on their decoding ability. Group One comprised stronger decoders and Group Two comprised weaker decoders. Two types of phonological sub-tests were used: the Lindamood Auditory Conceptualization Test (LACT) was used to measure phonemic awareness, and to measure phonological working memory, the researchers created tasks to measure articulation speed and recall mono and multi-syllabic words. The results showed that the weaker decoders (Group Two) had a significant inability to refresh phonological codes in their working memory. That is, when all things were equal (IQ level, age, and phonemic awareness aptitude), the only factor that distinguished the better decoders from the poor decoders was their ability to keep information in their working memory. These results add support for the argument that reading is tied more closely to the functioning of working memory than IQ level. Not surprisingly, others too have found that deficits in working memory may cause negatively impact phonemic awareness skills and decoding (Cupples & Iacono, 2000; Evans, 1994; Gombert, 2002; Kay-Raining Bird et al., 2000; Snowling et al., 2002).

Verucci et al. (2006) examined the relationship between phonemic awareness abilities and reading ability in children with Down syndrome. The researchers compared 17 children with Down syndrome (mean age: 16.5 years) to 17 children without disabilities (mean age: 7.6 years) using a battery of assessments measuring reading ability, comprehension, and phonological awareness. Contrary to the findings of Cossu et al. (1993), results indicated that children with Down syndrome were able to perform all the required phonemic awareness tasks, albeit at an impaired level. Children with Down syndrome made more errors than controls on first syllable deletion, syllable segmentation, and rhyme recognition tasks (contrary to results found in Snowling et. al., 2002). Both groups scored at the highest levels for syllable blending and first syllable recognition tasks. The Down syndrome group had the most difficulty with reading non-words, but did well at reading irregular words (Roch and Jarrold, 2008 found the opposite to be true). Similar to suggestions made by Gombert (2002), the authors here intimated that perhaps children with Down syndrome use lexical access strategies to decode irregular words, but were unable to use these same strategies during word attack tasks to decode non-words words. Although, Gombert suggested that children used lexical access strategies to read non-words not irregular words, as is the case here. The authors concluded that early intervention for children with Down syndrome should include intensive instruction in phonemic awareness.

In a review of the literature on successful methods for teaching children with Down syndrome to read, Burgoyne (2009) determined that several methods used to instruct children without disabilities are effective at instructing children with Down syndrome. Specifically, studies that combine phonemic awareness interventions with letter-sound correspondence were shown to be the most effective at teaching children with Down syndrome to read, although several studies used a small sample size, were relatively short, and were not effective at teaching all children with Down syndrome to read. Oral language was also shown to be an important predictor of reading accuracy for children with Down syndrome.

Section summary. This section began with a discussion on two early descriptive studies investigating the connection between phonemic awareness and reading in children with Down syndrome. Both studies showed evidence that children with Down syndrome could successfully read in spite of demonstrating little to no ability to successfully complete phonemic awareness tasks (Cossu et al., 1990; 1993). These findings, although controversial at the time, arguably helped to advance future research in this area. Out of the 13 studies that followed, only one came to a similar conclusion as Cossu and colleagues (Fowler et al., 1995) with the majority of studies finding a measurable level of phonemic awareness ability in children with Down syndrome (e.g., Fletcher & Buckley, 2002; Gombert, 2002; Lemons & Fuchs (2010a); Roch & Jarold, 2008; 2012). Moreover, contrary to the conclusions made by Cossu and colleagues, many studies found a correlation between one or more specific phonemic awareness skills and reading ability including tasks involving phoneme deletion (Gombert, 2002); phoneme detection (Cardoso-Martins & Firth (2001a; 2001b); phoneme blending (Fletcher & Buckely, 2002); and phoneme segmentation (Cupples & Iacono, 2000). Of equal significance was evidence supported by several studies that children with Down syndrome have a particular deficit in their ability to rhyme (e.g., Cossu et al., 1990; 1993; Evans, 1994; Lemons & Fuchs, 2001a; Snowling et al., 2002; Verucci et al., 2006), possibly resulting from deficits in short-term memory ability (Conners et al., 2001a). With regard to instructional strategies, two studies determined that letter-sound correspondence combined with explicit and direct phonemic awareness instruction were effective at teaching reading to children with Down syndrome (Burgoyne 2009; Lemons & Fuchs, 2010a). Finally, among the important conclusions drawn from this body of research was evidence showing that although children with Down syndrome could read real words with low levels of phonemic awareness (Byrne, 1993; Gombert, 2002; Fowler et al., 1995), they were not able to read non-words as successfully (Fletcher & Buckley, 2002; Roch & Jarrold, 2008; Verucci et al., 2006). This finding suggests that teachers may need to pay close attention to the individual performance levels of their students when planning instruction. In summary, the studies in this section demonstrate that children with Down syndrome can generally perform phonemic awareness tasks on a similar trajectory as children without disabilities, but at a much-delayed rate. Next, a review of the literature on phonemic awareness intervention studies and children with Down syndrome is provided.

Intervention studies. In a multiple-baseline study, Kennedy and Flynn (2002) examined three children (age range: 6.9 – 8.3 years) with Down syndrome investigating the connection between phonemic awareness tasks (e.g., alliteration, phoneme isolation, spelling, and rhyme detection) and reading. The intervention consisted of eight one-hour sessions over a four-week period. The alliteration component consisted of having each child listen to a phoneme voiced by the researcher. The child was then tasked with marking a picture that represented (matched) the phoneme. The phoneme isolation component consisted of presenting each child with a picture, and the child was tasked with voicing the initial phoneme represented by the picture. For the spelling component, each child was tasked with identifying onsets and rhymes for both regular words and non-words. Finally, for the rhyming component, each child was orally presented with a target-word along with several printed words. The child was then tasked with choosing a card that rhymed with the target-word. Baseline data was obtained from three sessions of assessments over a one-week period followed by one session of post-testing. The results of the study demonstrated that even in a relative short period of time, some of the children benefited from direct phonemic awareness instruction. All three participants showed a marked improvement in grapheme-phoneme connection as evidenced by the growth in their spelling skills (i.e., all participants increased their spelling percent correct on the post assessment by over 50 percent). The authors interpreted these results as evidence that explicit letter-sound correspondence instruction is effective at teaching reading and spelling skills to children with Down syndrome. However, considering two larger descriptive studies found that letter-sound knowledge was not a significant predictor for reading ability (i.e. Boudreau, 2002; Snowling et al., 2002) these results should be taken with caution. Researchers in both larger studies showed results of children with Down syndrome and children without disabilities having similar scores on assessments for letter-sound knowledge. However between the two groups, their performance on reading measures varied greatly with children in the Down syndrome group performing worse than controls. The researchers in both studies intimated that children with Down syndrome might have difficulty applying letter-sound knowledge to reading.

Finally, as others have also documented (e.g., Conners et al., 2001; Cupples & Iacono, 2000; Evans, 1994; Gombert, 2002; Kay-Raining Bird et al., 2000; Snowling et al., 2002), Kennedy and Flynn found that rhyming proved to be the most troublesome component of phonemic awareness for children with Down syndrome to show improvement. As a point of fact, one child's scores increased dramatically on every phonemic awareness task except for rhyming, which showed no improvement at all during post-assessment. The researchers were unclear as to why this occurred, but suggested that rhyme awareness may not be a perquisite to developing more advanced phonemic awareness skills such phoneme segmentation. Still, the researchers emphasized that later reading and spelling abilities are predicated on instruction that emphasizes phonemic awareness skill development.

In a follow-up study to their earlier research in Conners et al. (2001), Conners et al. (2006) extended their work in an experimental study with 45 non-reading children with Down syndrome examining the relationship between phonemic awareness and reading. In their first study, the researchers found that between weaker decoders and stronger decoders, weaker decoders were less able to keep information in their working memory. In the present study, children were matched on IQ level, age, non-word reading accuracy, phonemic awareness, and language comprehension. The children were divided into two groups. The instructional group received a pre-instruction assessment, instruction in phonemic awareness skills (over ten weeks; 22 lessons), and a post-assessment. The control group received a pre-instruction assessment and the post-assessment with no instruction in phonemic awareness. Children in the control group however, continued to receive instruction in general literacy from their regular classroom teacher.

The results showed that children in the instructional group achieved a significantly higher score over the control group on post-assessment measures. However, children in the control group did perform better than expected, perhaps due to the effects of ongoing literacy instruction in their classrooms. Children in the instructional group achieved higher scores on tasks of voicing letter sounds for simple words with the VC or VCV patterns (i.e., scores for the instructional group were in the 72^{nd} percentile and scores for the control group were in 48^{th} percentile). In addition, children in the instructional group also achieved higher scores on tasks involving blending sounds (i.e., scores for instructional group were in the 59^{th} percentile and scores for the control group were in the 37^{th} percentile). The researchers interpreted these results as evidence that children with Down syndrome can improve their reading ability through intensive phonemic awareness instruction.

In another study examining an explicit phonemic awareness intervention, Lemons and Fuchs (2010b) tracked reading growth for twenty-four children with Down syndrome between the ages of 7 and 16 years (IQ levels were not provided). Children were given two 30-minute tutoring sessions delivered daily for five days per week for approximately six weeks. During the first tutoring session, children received explicit and systematic instruction on targeted letters, letter-combinations, decodable words, and sight words. During the second session (after reviewing the activities from session one), children read connected text composed of ten letters and letter-combinations learned during the first session for ten minutes. The last few minutes of the second session were spent reviewing specific areas each child struggled with in sessions one and two. Review activities included playing word games and fluency practice. Reading measures consisted of segmenting words and word identification tasks taken from a segmenting measure designed by consisting of 22 one-syllable words. During this measure the children were tasked with listening to a word (e.g., cat) and then segmenting the word into individual sounds (e.g., /c/ /a/ /t/). Children also completed the Woodcock Johnson Reading Mastery Tests-Revised (WRMT-R). To assess cognition, each child was given the Kaufman Brief Intelligence Test, Second Edition (KBIT-2). Additional background information was obtained from surveys completed by the child's tutor and parents. Results showed that most children demonstrated growth in taught sight-word reading and letter-sound knowledge. Generally, gains in non-word reading were linked to gains in regular word reading, and gains in regular word reading were linked to gains in letter-sound knowledge. These results were similar to the findings in Kennedy and Flynn (2002), who also found the benefit of explicit letter-sound correspondence instruction for children with Down syndrome. Similar to the finding in Roch and Jarrold (2008), performance across measures suggested that children learn to read in much the same manner as children without disabilities, but at a much slower rate of acquisition. Not surprising, results also indicated that decoding ability was predicted by performance on word identification tasks. Suggesting, perhaps that children with Down syndrome are likely to make more significant gains during phonemic awareness instruction if the words used during instruction are already know to them as sight-words. Work completed by Naess et al. (2012) also found a similar link between vocabulary and reading for children with Down syndrome. Lemons and Fuchs also concluded that performance on phoneme segmentation tasks predicted word attack skills for most children. These results are similar to findings of Kay-Raining Bird et al. (2000), who also found that segmentation tasks correlated with word attack skills for children with Down syndrome.

In a longitudinal study spanning over four and half years, Kay-Raining Bird et al. (2000) examined 12 Canadian children with Down syndrome (age range: 6.5-11.6 years; IQ level is unknown) over three time (t) periods tracking phonemic awareness skills and reading ability. Children were instructed in general education classrooms with resource room support. Reading ability was measured with the Woodcock Reading Mastery Tests-Revised. Phonemic awareness ability was measured with the Liberman, Shankweiler, Fischer, and Carter (1974) tapping task ability assessment. Post-assessment results showed gains in both areas of reading with word recognition gains stronger than decoding abilities (word attack skills) for all but two children (Fowler et al., 1995 showed similar results). Regular word reading scores progressed from a high of 12 words during t1, to a high of 15 words during t3, while nonsense word scores progressed from four words in t1, to six words in t2, and seven words in t3.

Kay-Raining Bird et al. (2000) interpret these results to suggest that children with Down syndrome use a logographic strategy to memorize the form of words giving them and edge on the word identification subtest. However, this ability will only take the children so far. Since word attack skills do not keep pace with regular word reading ability, the researchers suggest that phonemic awareness instruction needs to be combined with sight-word instruction to advance reading beyond a cadre of memorized words. The authors have three reasons for the lower scores on decoding ability tasks: 1) children with Down syndrome may find it easier to hold the overall image of the word in their visual memory and access its associated lexical representation in contrast to the skills required to decode a word (i.e., break the word into component parts; relate those components to stored knowledge of grapheme-phoneme correspondence; and construct meaning), 2) children with Down syndrome have the ability to decode, but teachers (and parents) do not recognize this ability, so they do not provide instruction in phonemic awareness instruction, (see Katims, 2000 for a review), and 3) children with Down syndrome simply do not have the ability to gain phonemic awareness skills developmentally over time. Still, based on the small, but nevertheless increased word attack scores over the three periods, the results suggest that phonemic awareness skill instruction may have a direct correlation to improved reading for children with Down syndrome. These findings stand in contrast to the findings of Cossu et al. (1990; 1993), who suggested that phonemic awareness is not correlated to word reading for most children with Down syndrome.

In a study evaluating the effects of an intensive intervention that combined phonemic awareness instruction with reading instruction, Goetz et al. (2008) divided 15 children with Down syndrome between the ages of 8-14 years into two treatment groups. The first group (n=8) received the intervention for 16-weeks and the second group (n=7) received the intervention for 8-weeks, allowing the potential benefits to be compared to regular classroom instruction. Each session for both groups was forty minutes in length, five times a week. During the first eight weeks, only the first group received the intervention, while the second group was in a "waiting" status. Intervention for the second group started at the ninth week and continued until the intervention was terminated at the end of 16th week. The intervention combined two commercial reading programs: Jolly Phonics and the Reading Intervention program developed by Hatcher Hulme, & Ellis (1994). The intervention targeted phoneme segmentation, phoneme blending in the contexts of learning letter sounds, and working with words in books. After the first eight weeks of the intervention, results demonstrated that all the children in the first group made significant gains in letter-sound correspondence knowledge and early word recognition ability. Children in the second group however, did not make significant gains over their pre-intervention performance; although, they did show some gains in letter knowledge and early word recognition. These results suggest that combining reading instruction with intensive and direct phonemic awareness instruction is effective over long and short periods of time. However, children are more likely to show significant improvement when instruction occurs over longer periods of time.

In a comparison of two training programs, Cologon, et al. (2007) divided 15 children with Down syndrome between the ages of 2-10 years into two randomly assigned groups. Eight children were placed for instruction in the Comprehension/Silent Reading program (Group 1), and seven children were placed for instruction in the Phonological Awareness program (Group 2). Training in both programs occurred over a ten-week period. Children in Group 1 were tasked with silently reading training words, matching training words to pictures, silently reading an action sentence and completing the action by choosing a correct corresponding picture, responding to a sentence completion task where they were tasked with choosing one of three words (no pictures) to complete a sentence, and finally orally reading the training words. Children in Group 2 were tasked with responding to phonics and phonemic awareness prompts. Tasks included orally reading training words (phonics), orally reading training words with a picture match (phonics), orally blending an onset and rhyme with a picture match (phonemic awareness), blending individual phoneme using plastic letters (phonics), orally blending individual phonemes without plastic letters (phonemic awareness), orally reading a sentence while simultaneously choosing one of three words to complete the sentence (phonics), and finally orally reading the training words (phonics). Results were derived based on pre- and post-assessments, with a maintenance post-test given six months after the last training. Results showed that both training programs led to significant gains on measures of phonemic awareness, letter-sound correspondence knowledge, and comprehension. After six months, performance on maintenance post-test results indicated that every child was able to maintain or improve upon their gains. The authors concluded: 1) children with Down syndrome could develop phonemic awareness and phonics skills regardless of deficits in their short-term memory, 2) comprehension skills can improve or develop when the child is engaged in comprehension activities, and 3) reading instruction may improve oral language development for children with Down syndrome. This study adds further evidence that some of the components for effective reading instructions as outlined in the NRP's (2000) report are also effective at teaching reading to children with Down syndrome.

In a study examining the effects of an intensive phonemic awareness and decoding intervention, Cologon et al. (2011) instructed seven children with Down syndrome (age range 2 to almost 11-years; IQ scores not provided) for ten weekly, one-hour sessions. Pre- and post-assessments were given with the children serving as their own controls. The intervention consisted of seven steps. The first step required each children to read the training word for the week out loud, the second steps tasked the children with reading a word out loud and match it to a picture, the third step tasked the children to complete to orally blend an onset with a rhyme, the fourth step tasked the children to orally blend individual phonemes and match the word to a picture, the fifth step tasked the children with listening to individual phonemes, blending the sounds together to form a word, and match the word to a picture (i.e., researcher says, c/a/t; child blends the sounds to form "cat" and choices a picture of cat), the sixth step tasked the children with completing a sentence using word cards, once completed the sentence was read out loud, the final step was a review and tasked the children with reading five words printed on separate cards. In addition, each child was provided with homework sheets to practice rhyme families covered during the preceding week's instruction.

The results of study showed that every child demonstrated an improved on post-assessment results for phonemic awareness, decoding skills, and short-passage comprehension. In addition, every child was able to maintain progress six month after the last intervention session. It is worth noting that four of the children were not yet in school and made less progress than the old children, suggesting that gains might have been greater if all the children were school aged. However, this study does demonstrate that from an early age children can benefit from a combination of phonemic awareness and phonics instruction.

In a recent meta-analysis, Naess et al. (2012) examined the roles that vocabulary and phonemic awareness play as predictors for reading ability. The researches reviewed the reading profiles (matched on word level reading ability) of children with Down syndrome and children without disabilities. Out of 781 potential studies, eight met the inclusion criterion. Results demonstrated that between the two groups non-word decoding ability were almost equal. These results are contrary to the conclusions made by Kay-Raining Bird et al. (2000), which suggested that decoding skills for children with Down syndrome are generally poor. In point of fact, the authors here interpreted their results as an indication that decoding skills are a relative strength for children with Down syndrome. The authors caution however, that children in the comparison group were very young (between the ages of five and eight years) and only beginning to develop non-word decoding skills.

Moreover, the authors found that vocabulary was a significant predictor for non-word reading ability. These results are contrary to results found in other studies (i.e. for a review see, Lemons & Fuchs, 2010a) that support a reliable relationship between phonemics awareness and reading. Based on these results the authors suggested that: 1) children with Down syndrome have the ability to access the alphabet principle to decode non-words, and 2) reading instruction for children with Down syndrome should emphasize decoding strategies over phonemic awareness skill acquisition (a suggested also made by Cossu et al., 1993). Furthermore, given the evidence that links vocabulary to reading ability, the authors further suggested that increasing the amount of direct and targeted vocabulary instruction would prove to highly valuable in teaching children with Down syndrome to read.

Section summary. Although limited in quantity, the intervention studies examining the relationship between phonemic awareness instruction and children with Down syndrome found that the most children benefited from instruction in phonemic awareness, especially when that instruction is explicit and direct (e.g., Cologon et al., 2007; Conners et al., 2001b; Goetz et al., 2008; Kennedy & Flynn, 2002; Lemons & Fuchs, 2010b). In addition, further investigations demonstrated that the benefits of phonemic awareness instruction are not necessarily bounded by length of instructional time or the age of participants. Results from several studies showed phonemic awareness instruction can be effective over short and long periods of instructional time (i.e., Cologen et al., 2011; Goetz et al., 2008), and that very young children, as well as, older teens can benefit from instruction (i.e. Cologen et al., 2011; Lemons & Fuchs, 2010b). In so much as phonemic awareness skills have a shown to have a correlation to reading for children without disabilities, the majority of the studies demonstrated that children with Down syndrome learn to read in much the same way. However, results from an older study and a recent study suggested that vocabulary knowledge and not phonemic awareness demonstrated a much stronger relationship to later reading success (i.e., Kay Raining-Bird et al., 2000; Naess et al., 2012).

Phonics

Between 1980-1990 there were only seven research studies specifically examining the relationship between phonics instruction and children with intellectual disabilities (see Conners, 1992 for a review). Of these seven studies, two studies found positive results when a stimulus-connected prompt-fading technique was implemented to teach letter-sound correspondence to children with intellectual disabilities (Hoogeveen, Smeets, & van der Houven, 1987; Hoogeveen, Smeets, & Lancioni, 1989). Two additional studies demonstrated that phonics instruction used simultaneously with error correction was beneficial in helping children with intellectual disabilities reduce word recognition errors over time (Singh, J. N. & Singh, 1986; Singh, N. N. & Singh, 1988). Additionally, commercial phonics programs such as DISTAR and The Flour Blocks were also found to be effective at helping children with mild to moderate intellectual disabilities blend sounds together and sound out words (Gersten & Maggs, 1982; Hedrick, Katims, & Carr, 1999).

Twelve years later, Joseph & Seery (2004) reviewed seven additional studies published between 1990-2002 all of which examined the effectiveness of phonics instruction and children with mild to moderate intellectual disabilities. All seven studies showed that children in these studies learned to use some form of word analysis or benefited from phonics-based instruction when learning how to read. Although none of the studies examined the effectiveness of direct and explicit phonics instruction, three studies (e.g., Barudin & Hourcade, 1990; Calhoon, 2001; Lane & Critchfield, 1998) demonstrated that children with intellectual disabilities were able to make generalizations from practiced target-wordss to new words that were in the same word families.

Most recently, a third meta-analysis identified fourteen studies between 1975 through 2003 that examined the relationship between reading instruction and phonics. Several studies focused on a repeated trials format and strategies such as sandpaper letter drawing while other studies used computer based instruction models and augmentative communication technology (see Browder et al., 2006 for a review). The following is review of the literature on recent descriptive and intervention phonics studies and children with Down syndrome.

Descriptive studies. Cardoso-Martins et al. (2009) investigated the word reading ability of 19 children and young adults with Down syndrome (age range: 10-19 years) and 19 children without disabilities (mean age: 4.9 years) examining the relationship between reading and oral/language abilities. All participants were given a battery of assessments including: the Differential Ability Scales (DAS); Test for Reception of Grammar (TROG) (Bishop, 1983); Peabody Picture Vocabulary Test-III (PPVT-III) (Dunn & Dunn, 1977); Woodcock-Johnson III (WJ-III) (Woodcock, McGrew, & Mather, 2001); and two computerized tests used to assess visual and spatial memory. Results showed that children in the Down syndrome group, who performed well on measures of phonemic awareness, generally performed better tasks for reading regular and irregular words and spelling. However, this was not true for all the children. Indeed, the researchers also showed that some of the children in the Down syndrome group had difficulty generalizing skills used to read regular words and applying them successfully to read irregular words. The researchers theorized that perhaps some children have word rely on word specific processes that affords them ability to read irregular words only when are closely matched to readable regular. In addition, results also showed that children in the Down syndrome group, who performed well on language assessments also performed better on reading measures.

This evidence suggests that language and reading are linked in similar ways for children with Down syndrome and children without disabilities.

Researchers Groen et al. (2006) investigated the performance of an 8-year old girl (K.S.) with Down syndrome in three separate but related studies. The following discussion will address the first two studies. The third study did not directly correspond to reading ability. In the first study, 13 children with Down syndrome were compared to K.S. on measures of word recognition, decoding ability, oral language, and memory. K.S. along with all the children in the control group were readers. Controls were matched to K.S. on cognitive ability, chronological age, and hearing ability. Results showed that K.S. scored significantly higher than controls on subtests for word and non-word reading. Moreover when the researchers compared her scores using the scoring matrix provided with the assessment tool, results showed her performance on measures for non-word reading were significantly above children without disabilities. The authors interpreted these results as evidence that K.S. has an exceptionally well-developed orthographic system that allows her to use her knowledge of grapheme-phoneme correspondences to read non-words on levels above that of children without disabilities.

In the second study, the researchers focused on a more in depth examination of her exceptional phonological processing. Reflecting on the work of Gombert (2002) and Snowling et al. (2002), both of which suggested that children with Down syndrome might rely less on decoding ability to read non-words and more on analogies that are linked closely to orthographic real word neighbors, the researchers here seeking to understand if K.S.'s stellar performance on non-word reading measures were a result of her exceptional grapheme-phoneme ability or if her abilities were derived from using analogies with words she could already read. Two measures for non-word reading were used: the Graded Non-word Reading Test (GNWR) and second measurement consisting of non-words that vary in their similarity to real words. Phonological skills were measured by a variety of standardized and non-standardized tests and included assessments in rhyme analysis, phoneme identity, phoneme segmentation, and alliteration. Results from both reading measures indicated that K.S. was not using word analogies to read non-words. In point of fact, based on the scoring matrix provided with GNWR assessment, K.S. even out performed children without disabilities on tasks for reading non-word/non-orthographic neighbor words. Her high score on the phonemic awareness assessments including the rhyming tasks were equally impressive, especially in light of studies that showed rhyming to be a particular weakness for children with Down syndrome (i.e., Cardoso-Martins et al., 2002; Gombert, 2002). The results presented here, albeit for one individual, still demonstrated that some children with Down syndrome have the ability to show exceptional decoding abilities resulting in reading scores equal to or higher than children without disabilities. Although K.S.'s performance is likely an anomaly, it demonstrates that each child comes with a unique set of abilities.

In a recent study that examined the cross-syndrome predictors for later reading ability in children with Williams syndrome and children with Down syndrome, Steele et al, (2013), found that reading growth is predicted by both similar and distinct factors in both groups. Twenty-six children with Down syndrome and 26 children with Williams syndrome were assessed with a battery of tests examining letter knowledge, receptive vocabulary, PA, and word reading. Letter knowledge, receptive vocabulary and PA were used because they support reading development in children without intellectual disabilities. The researchers found that only letter knowledge was a strength between the two syndrome groups. The researchers also found that predictors of literacy development in children with Williams syndrome operate differently compared to children with Down syndrome and children without disabilities, with greater vocabulary and PA skills predicting less reading growth in children with Williams syndrome than children with Down syndrome. These findings suggest that teaching interventions should be targeted to address the unique needs of children with specific types of intellectual disabilities.

Section Summary. Although there is a dearth of descriptive studies in this area, results from the two studies reviewed provide valuable insight into phonics instruction and children with Down syndrome. The results from Cardoso-Martins et al. (2009) corroborate the findings from other descriptive studies that found links to performance levels on phonemic awareness tasks and reading ability (Fletcher & Buckley, 2002; Gombert, 2002). In addition, similar to findings in Gombert (2002) and Fowler et al. (1995), Cardoso and colleagues found that children with Down syndrome perform better on tasks for regular word reading than on task for non-word and irregular word reading. The researchers also determined that language and reading are closely related for children with Down syndrome. Arguably, Groen and colleagues presented one of the most interesting cases of a young child with Down syndrome possessing an extraordinary decoding ability. Results presented clearly showed that as educators we should not make assumptions based solely on a “perceived” level of ability. In this profile, K. S. demonstrated an ability to successfully decode regular words and irregular words above levels demonstrated by children with and without disabilities. The following is review of the literature on intervention studies and reading.

Intervention studies. In light of their earlier findings examining the relationship between phonemic awareness tasks and reading for children with Down syndrome, Cupples and Iacono (2002) extended their work comparing the effectiveness of two instructional techniques for teaching oral reading skills to seven children with Down syndrome, a whole-word condition, and word-analysis condition. The participants were seven English-speaking children (ages: 8.6-11.1; IQ scores ranging between 40-55). Every child demonstrated little to no reading ability. Five intervention steps were used in the whole word condition with all the training words for a given week taken from different word families. The first step (a week long process) was used to familiarize the children with the training words and the pictorial representation for the words. The second step tasked the children to match a picture to one of the five training words (three words were presented at a time). The third step removed the pictures from the exercise and tasked the children to match three of the five training words to a spoken target-word. The fourth step tasked the children to name one of the five training words displayed on a computer screen. The fifth step required the children to complete a sentence that was simultaneously displayed on a computer screen and read aloud by the researcher. The children were then tasked with choosing one of the three training words to fill the gap in the sentence.

In the word-analysis condition, a computer was used to instruct each child how to use the five intervention steps. The first step tasked the children with becoming familiar with the training words and the corresponding picture for each word. The second step tasked the children with selecting the correct onset to complete a rhyme displayed on a screen. The third step required the children to identify the onset for the picture that was displayed on the screen. The fourth step required the children to use groups of letters displayed on the screen to match an onset to a rhyme. The fifth step was the same as step five under the whole word condition.

The results from the pre- and post-intervention (conducted in weeks two and seven, respectively) using 30 training words showed that although children had greater gains in reading words in the word-analysis condition, children instructed in the whole word condition still exhibited measurable increase in reading abilities. In some ways these results support the claims made by Cossu et al. (1993), in so much as it shows that children can learn to read, at some level, without word-analysis instruction. However, the results from this study also showed that if children with Down syndrome are instructed to analyze word parts at the phoneme level some can acquire the skills well enough to make generalizations from reading real words to reading untaught, novel words. Moreover, the study also suggested that despite research to the contrary children with Down syndrome could successfully rhyme in the framework of explicit instruction.

In a follow-up study to the findings in Burgoyne (2009), Burgoyne et al. (2012) conducted a randomized control study with 57 children with Down syndrome. The children were randomly allocated to an intervention group, which received 40-weeks of daily intervention or to a waiting control group, which received 20-weeks of daily intervention, allowing for a comparison with their regular reading instruction. Children in both groups were assessed four times (i.e., at screening, before the intervention, after the first 20-week intervention period, and after the second 20-week intervention period. Reading measures included: single-word reading, letter-sound knowledge, phoneme blending, non-word reading, and spelling. Language measures included: expressive and receptive single-word vocabulary, and basic grammar. The reading intervention focused on a combined program of reading instruction with phonics instruction with the language intervention focused on teaching vocabulary and the appropriate use expressive language. Results from the study showed that children in both groups improved their single-word reading by an average of 4.5 words, per 20-weeks of intervention. Although this gain was modest and included a wide degree of variability, it is important to note that 48 out of the 53 children were able to score on the reading assessment after the second 20-week intervention compared with 32 children before the intervention. On the language measures, results indicated that receptive language (vocabulary), and not phonemic awareness, accounted for the strongest variance in reading growth. This finding is similar to the results shown in Hulme et al., 2012 and Naess et al., 2012, who also found that vocabulary measures and not phonemic awareness were a stronger predictor for reading accuracy. Again, the findings here are contrary to the findings of Lemons and Fuchs (2010b), who found the opposite to be true.

In research designed to study the effects of a curriculum based on the recommendations of the National Reading Panel (NRP) (i.e., phonological awareness, phonics, sight word fluency, vocabulary, and comprehension), Al Otaiba and Hosp (2004) examined four children with Down syndrome (age range 7-12 years; IQ scores were not provided). Over a period ten weeks, children were given one-on-one tutoring three times per week. Progress was monitored using curriculum based measures and standardized testing. Results demonstrated that all but one child made gains in decoding ability (ranging in gains from 7 months to 3 years). Similarly, word reading gains increased with one child making a gain of one year and a second child making a gain of 4-months. The final two children showed relatively smaller gains. However, the two lowest performing children did demonstrated stronger gains on curriculum-based measures, while the two children who entered the study as stronger initial readers showed gains on the standardized measures. These results show support that the recommendations made by the NPR are effective at teaching reading instruction to some children with Down syndrome.

In their longitudinal spanning four-year study, Baylis and Snowling (2012) investigated the effects of a phonics-based reading program with ten children with Down syndrome from the United Kingdom (ranging in age from 9-15 years; IQ scores were not reported). Reading abilities among the ten varied widely, ranging from emerging (i.e., able to identify a few sight-words to developing (i.e., able to read simple first level reading books). The study employed a single subject design with each of the ten children acting as their own control group. The first group,

Group A was assessed and instructed over two-terms of an academic school year followed by the second group of children in Group B. The intervention had four main goals: 1) to develop alphabet skills, 2) to develop onset-rhyme awareness, 3) to improve sight-word vocabulary, and 4) to develop skills in decoding ability. The intervention involved twenty individualized teaching lessons following a highly structured format incorporating wooden alphabet blocks to: 1) develop letter knowledge and letter-sound knowledge, 2) spell onset-rhymes, 3) spell small CVC words, and 4) spell digraphs. In addition, the children were also tasked with identifying rhyming words from shared reading activities (substituted with a "running record" protocol with the second group), and completing worksheets on rhyming activities. Finally, children were given comprehension, spelling, and writing tasks based on the shared reading activity. Results demonstrated that children in both groups improved reading scores with the average score increasing by almost six months (two children exhibited gains of one year). Moreover, three months after the training finished, reading scores were maintained for most children with only one child not maintaining his score. Additionally, results on phonics-based measures demonstrated that every child increased their scores in letter-sound knowledge and tasks involving alliteration. However, similar to results shown by other researchers (i.e., Snowling et al., 2002; Verucci et al. 2006) and despite a strong emphasize on tasks involving rhyming instruction during the intervention, every child performed poorly with only marginal improvements demonstrated by two children. Reading scores derived from measures of completing non-word reading tasks demonstrated four children significantly improved their reading scores while the remaining six children made appreciable improvements. The researchers concluded that a phonic-based approach to reading instruction is beneficial to children with Down syndrome, however results are variable.

In a recent study examining to effects of phonics and phonemic awareness interventions for children with Down syndrome, Lemons et al. (2012), investigated the effects of using two commercial reading programs, Road to Reading (RTR) and Road to the Code (RTC) with 15 children with Down syndrome (IQ scores ranging between 26-43) between the ages of 5-13 years for approximately 12-weeks. Both reading programs shown to be effective at helping struggling readers without intellectual disabilities improve phonics and phonemic awareness skills. The RTR program consists of six levels, which increase in difficulty ranging from identifying consonant and short vowel sounds at the lowest level to reading and working compound and multisyllabic words at the highest level. The RTC program consists of games and activities to teach children phonemic awareness skills such as common letter sounds, sound categorization, and segmenting and blending. Researchers were interested to determine if these same benefits would extend to children with Down syndrome. Based on initial assessment results, children were placed into one of three intervention groups. The six higher performing children were placed in the RTR program group, five children who performed well on the initial assessments, but demonstrated some difficulty with phonemic awareness were placed in the RTR+phonemic awareness (PA) program with the addition of supplementary phonemic awareness instruction, and finally the four lowest performing children were placed in the RTC reading program.

Results from the study demonstrated that children in all three groups made only moderate gains in reading taught words. Children in the RTA made no increases in fluency performance, and children in RTA +PA group made no improvement in their ability to identify initial sounds in words. Three children in the RTC group made only minor improvements in letter-sound knowledge; however the researchers noted that this increase may have been due to learning during baseline and not the effects of the intervention. In addition, researchers found no increase in the segmenting and blending levels for children in this group. Researchers discussed limitations to the study including phonemic awareness assessments that may have not been sensitive enough to measure subtle increases in ability for children in the RTC group and the possible effects of a short intervention period.

In an 18-month longitudinal study Allor et al. (2010) evaluated the effectiveness of an intensive phonics-based direct instruction reading program for 28 children with moderate intellectual disability (IQ scores ranging between 40-45). The ages of the children were not provided, but all were in grades first through fourth. Children in this study had a range of intellectual disabilities including Down syndrome, Williams syndrome, and Autism. Sixteen children were randomly assigned to the treatment group and 12 children were randomly assigned to the control group. The researchers were seeking to determine if the effects of a comprehensive reading program taught to primary-grade students with moderate intellectual disability (IQ scores ranging between 40-55) resulted in better early reading outcomes than typical special education instruction. Children in the intervention group received 40 to 50 minutes of small group instruction. The intervention consisted of systematic and explicit instruction in concepts about print, phonemic awareness, oral language, letter knowledge, word recognition, vocabulary, fluency, and comprehension instructed in context. Children in the control group received their usual special education instruction from their usual classroom teachers.

The researchers showed that the intervention group outperformed the control group on all measures. The most notable improvements were demonstrated on phonemic awareness measures, where students in the intervention group showed moderate to strong increases on post-assessments. The authors noted that the children progressed slowly until about the 17-week of the intervention. However, after additional sessions were completed, students in the intervention group made marked improvements over controls. This study adds support to other researchers, who emphasis the connection between lengthier studies and comparatively better results (Goetz et al., 2008).

Byrne et al. (2002) compared the effects of two-year longitudinal study with 24 children with Down syndrome (age range between 4-12) with 31 children matched on reading age (mean age of 7:1 years), and 42 children with average reading ability (mean age of 7:3 years). IQ scores were not provided for any group. Pre- and post-assessments were given and maintenance assessed after six months. The study was designed to assess the reading and language skills of children with Down syndrome and compare those results with the cognitive abilities associated with the reading process. The researchers employed a battery of standardized tests used to assess reading ability, language ability, and cognitive ability and compared these results across all there groups of children.

The researchers determined that overall young children with Down syndrome made significant and steady progress in learning how to read over the two-year period with scores on reading measures ahead of scores on receptive vocabulary and grammar measures. These finding corroborate the findings from other researches that children with Down syndrome can make marked improvements in reading ability over time if provided with extended periods of instruction (Allor et al., 2010; Goetz et al., 2008). Additional findings suggest that although the children made marked improvements on single word reading assessments results on spelling and comprehension assessments showed slower, but still significant progress over the two-year period. The authors suggest that perhaps the overall poor language abilities of the children with Down syndrome are related to their poor performance on comprehension measures. With respect to cognitive processes, visual and verbal memory showed the strongest correlation with reading accuracy. However, the authors caution that after controlling for age there is no clear evidence these cognitive abilities were related to reading competency. The researchers suggest, as other before them have also suggested (i.e., Buckley, 1995; Snowling et al., 2002a, 2002b) that children with Down syndrome may perform well on reading assessments relative to performing poorly on related measures (i.e., spelling and comprehension) because they use a visual approach to decode words and to read. Roch & Jarrold (2012) came to a similar conclusion and suggested that individuals with Down syndrome may use phonemic awareness early on in learning how to read, but may replace it with word analogies to decode unknown words. However, the authors in Byrne et al. (2002) caution that although a “visual method” of reading might prove to be effective at decoding single words, it may prove to be ineffective when the individuals are presented with larger blocks of text.

In a study comparing seven children with Down syndrome to seven children without disabilities on tasks of initial phoneme identity, letter naming and letter-sound knowledge, and print concepts, Van Bysterveldt et al. (2006) instructed parents to act as reading tutors. During shared oral readings using alphabet books, plastic letters, and magnetic boards, parents were instructed to focus their child’s attention to identify rhyming words. Parents were instructed to draw the child’s attention to targeted letters and letter-sounds during the shared book reading by: 1) stating the name for the letter while simultaneously pointing to the letter in the book, 2) demonstrating the sound the letter makes, and 3) showing the child a word that begins with target letter and demonstrating the initial letter-sound in the word (i.e., “M” makes the /mmmm/ sound. /mmmm/ is the first sound in “man”).

Results on post-assessments showed that children in the Down syndrome group made significant gains on tasks involving letter-sound knowledge, print identification, and initial phoneme identity. Not surprising, children in the control group achieved higher post-assessment scores in addition to making significant gains on the letter-naming task. Most notable, however were the scores for children in the Down syndrome group on tasks for phoneme identification and letter-sound. Results indicated that these children performed better on the phoneme identification task if the phonemes used were comprised of letter-sounds the children could identify on the letter sound task. The researchers intimate that these results provide some evidence that children with Down syndrome should be instructed on phonemic awareness tasks in the context of letters and letter-sounds they can already identify in isolation (see Lemons & Fuchs, 2010a, 2010b for similar results).

A two-year longitudinal study Hulme et al. (2012) compared the results to 49 children with Down syndrome (age ranging between 6-17 years) educated in included classrooms with 61children without disabilities (age ranging between 6-11 years) matched on reading aged equivalent scores; although, there was wide variability in the reading abilities for children in the Down syndrome group. Children in both groups were assessed three times with a 12-month hiatus between testing points. Results demonstrated that children with Down syndrome did make progress on reading abilities, albeit at a very slow rate. Most notable however, were the correlates for reading ability in the Down syndrome group. While initially reading levels for children with Down syndrome were predicated by vocabulary knowledge, by the second testing period neither vocabulary nor phonemic awareness were predictive of reading ability. Furthermore, children in the Down syndrome group, who demonstrated a higher a phonemic awareness aptitude on assessments, also achieved higher scores for vocabulary knowledge and reading. These authors hypothesized that early deficits in language development are associated with deficits in vocabulary development and are a consequence of poor phonemic awareness and reading abilities later in the child's development. The researchers intimated that vocabulary might more fully predict reading ability for children with Down syndrome. These findings add support to the work completed by Naess et al. (2012), who found a similar connection between vocabulary development and reading ability for children with Down syndrome.

In a recent study, Burgoyne, Duff et al. (2013) instructed teaching assistants to use a 6-week intervention to support phoneme blending with ten children with Down syndrome. Children were their own controls. Using a six-step intervention, teaching assistants instructed the children to use visual blending with pictures, visual blending without pictures, oral blending with pictures, oral blending without pictures, non-word reading, and sentence reading. The thirty teaching sessions delivered instruction in daily 10-15 minute sessions with individual children. Each session followed a prescribed format and covered all six steps. The goal of the research was to 1) determine if a targeted teaching program improve blending skills for children with Down syndrome, and 2) determine if the program lead to gains in reading and spelling.

Results from the study showed that most children improved his or her blending and word reading skills for real words in a short period of time. However, results for non-word reading showed no significant effect. Similarly, although some children made modest gains in spelling, no significant effects were realized. Although the gains were positive, there was a high degree of variability. Coincidently, children who did not perform well during the intervention also had the lowest scores for word reading scores and lowest vocabulary scores at time 1. Lemons and Fuchs (2010a) showed that poor scores on initial word reading tasks are a significant predictor for growth in decoding. Hence, the authors of this study suggest that the blending intervention might be better suited for students who have some sight-word reading ability.

Section summary. The nine intervention studies reviewed for this section ranged in duration from ten weeks to two-years and involved over two hundred children with Down syndrome. Although results were highly variable, all the studies clearly demonstrated that children with mild intellectual disabilities, who also have Down syndrome, like most children, are likely to make gains in decoding ability when they are presented with explicit and direct phonics instruction. Not surprising, studies with longer intervention cycle showed more significant gains (e.g., Allor et al., 2010; Bryne et al., 2002; Burgoyne et al., 2012). The majority of the studies found success by simultaneously combining phonemic awareness instruction with decoding instruction (e.g., Allor et al., 2010; Al Otaiba & Hosp, 2004; Burgoyne et al., 2012; Burgoyne et al., 2013), which is an important factor to consider when developing future instructional strategies for children with Down syndrome. Finally, several studies showed conflicting results with respect to how children with Down syndrome generalize decoding skills from reading known words to reading new words composed of a similar letter and sound structure. These findings are important to consider when planning instruction for children with Down syndrome and other children with intellectual disabilities in general, since it appears that they can benefit from similar reading focuses as other children.

General summary. In spite of the conclusions made in Cossu et al. (1990) and Cossu et al. (1993) that children with Down syndrome can read in the absence of phonics-based skills, researchers have provided strong contrary evidence to this earlier work by demonstrating that children with intellectual disabilities who also are identified with Down syndrome can perform many, if not all tasks, related to phonics-based instruction including: the ability to (a) rhyme (Cupples & Iacono, 2000); (b) segment, delete, and count phonemes (Cupples & Iacono, 2000; Gombert, 2002); (c) oral blending and letter-sound correspondence (Conners et al., 2001, 2006;

Goetz et al., 2008); (d) alliteration (Kennedy & Flynn, 2002); (e) blend sounds together to read words (Cohen et al., 2008); and (f) benefit from phonetic instruction (e.g., Browder et al., 2008; Conners et al., 2006; Cupples & Iacono, 2000; Kennedy & Flynn, 2002; see Joseph & Seery, 2004 for a review). In addition, research as clearly demonstrated that the combination of explicit and direct instruction with an appropriate amount of instructional time, will allow children with intellectual disabilities including children with Down syndrome make sizeable gains in their ability to read (e.g., Allor et al., 2010; Baylis & Snowling, 2011 Burgoyne et al., 2012).

III. METHODS

Single-Subject Research

It is critically important in today's standards-based learning environment that practices used to educate children are based on evidence from experimental research. Single-subject research provides a comprehensive protocol for securing such evidence (Horner et al., 2005; Cohen et al., 2008). For over 70 years, single-subject research has been a scientifically rigorous methodology utilized in the fields of medicine (for a review, see Portney & Watkins, 2007), clinical psychology (Kazdin, 1975), and special education (for a review, see Horner et al., 2005). Unlike case studies, which are based on correlations of events or larger studies that provide data on mean performance, single-subject methodology provides for a unique focus on the individual through a methodical degree of experimental control (Zhan & Ottenbacher, 2001). The rigor of single-subject methods is supported by a number of key features including (a) within-subject or between-subject replications of a treatment; (b) a systematic and quantitative assessment of the dependent variable; (c) maintenance of the treatment effect across time; (d) generalizations of treatment effects across people, settings, or behaviors; and (e) the importance of determining social validity (Odom & Strain, 2002).

In the field of special education, single-subject designs have provided educators with important instructional strategies including phonics-based reading instruction, systematic instruction, and inclusive education. Children have benefited from the individualized interventions that single-subject research provides (e.g., Cihak, Kessler, & Alberto, 2008; Horner et al., 2005; Kennedy & Flynn, 2002; Cohen et al., 2008) and teachers and parents have benefited from the knowledge and immediacy of practical procedures that can be used to positively affect instruction (e.g., Kuhn, Bodkin, Devlin & Doggett, 2008; Odom & Strain, 2002).

Single-subject methodology is a means of establishing experimental control between a dependent variable (A) and an independent variable (B) (Lane, Wolery, Reichow, & Rogers, 2007). To establish experimental control, the researcher must demonstrate that a functional relation exists between the dependent and independent variables. A ship establishes the scientific evidence that the introduction of the independent variable has changed or otherwise effected the dependent variable. The dependent variable is often regarded as “estimates of the behaviors being analyzed” (Kennedy, 2005, p. 29), while the independent variable is typically the intervention employed to alter the behaviors of the dependent variable. If the researcher is successful at showing that the participant’s behavior (A) changed due to the introduction of the independent variable (B), then there is reason to suspect that the intervention may have influenced the dependent variable. Over time, through a series of introductions and withdrawals of the independent variable, a measurable pattern of behavior change emerges (Lane et al., 2007). By documenting these patterns, researchers can determine how behaviors function and use this information to develop new theories and instructional protocols. One pattern of behavior change alone, however, does not establish a functional relation. At least one additional replication that mirrors the results of the first experimental cycle is required to establish a functional relation (Kennedy, 2005). By virtue of replication, the researcher increases the study’s internal validity by demonstrating that extraneous variables did not play a part in affecting the behavior change. Banded together, multiple single-subject studies have the potential to affect a larger scale change by producing a body of reliable, persuasive evidence that can be used to guide the initiatives of larger, more costly studies (Horner et al., 2005; Kennedy, 2005).

Single-subject Multiple Baseline Research Design

The multiple-baseline design is a series of two or more separate intervention phases occurring over the same time span where the switch from baseline to intervention occurs at different points in time for the different intervention phases (Kennedy, 2005). The logic of the design requires researchers to stagger the intervention between multiple subjects, steadily increasing each subject's time in the baseline phase as the experiment progresses from the first subject to the last subject. Participants in the later phases of the experiment function as a test of the extended effects of baseline. In so doing, researchers are able to show a functional relation between baseline and intervention, demonstrate increased validity and reliability across multiple subjects, and remove any ill effects that returning to the original baseline may cause the subject. The multiple baseline design does not require the removal of the intervention. Thus, the potential problem of returning a subject to an "unfavorable" baseline condition is removed. Traditionally, multiple baseline designs have been used across behaviors, people, settings, stimuli, or times (Cihak et al., 2008; Jones, Carr, & Feeley, 2006; Reason & Morfidi, 2001; Tien, 2008), and can be either concurrent or non-concurrent (Kennedy, 2005).

Non-concurrent multiple baseline design. Watson and Workman (1981) originally wrote about the advantages of using non-concurrent multiple baseline design across individuals as an alternative to the traditional (concurrent) baseline technique. Concurrent and non-concurrent multiple baseline designs are similar in so much as both designs examine the relationship between the independent and dependent variables across people, behaviors or settings. However, whereas concurrent multiple baseline data are collected contemporaneously, non-concurrent multiple design allows for data to be collected over an asynchronous span of time (Harvey, May & Kennedy, 2004). For the non-concurrent multiple baseline design, the researcher pre-determines 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. Assuming stable data points, baseline is carried out for the designated number of trials followed by implementation of the treatment. 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). In the present study, participants were recruited from multiple sources. The non-concurrent design allowed participants who met the study's qualifying criterion early on during the recruitment process to begin the study while recruitment for additional participants continued. In so doing, early participants did not have to wait to begin the study until all the subsequent participants were identified. This allowed for a more expeditious use of time while still providing an environment that allowed the researcher to examine the functional relation between the dependent and independent variables.

In terms of threats to internal validity, Campbell and Stanley (1963) identified 8 threats to internal validity: history, maturation, testing, instrumentation, statistical regression, mortality, and interactions between of these various threats. Of these, mortality and history are often cited as the largest threats to research with a non-concurrent single subject design (Carr, 2005; Christ, 2007; Watson & Workman, 1981). Mortality occurs when a participant is excluded from the study because the researcher has observed problematic baseline data (Christ, 2007). Unlike the concurrent multiple-baseline design, which can extend a baseline while waiting for data to become stable, the non-concurrent design is not afforded this same allowance. Instead participants are randomly assigned, a priori, to a baseline for a specific duration of time (i.e., 3-trails, 6-trails, or 9-trails). If the participant's baseline data becomes problematic (i.e., excessive variability in the dependent variable), he or she is removed from the study and replaced with the next waiting individual. However, the systematic removal of individuals from a study is difficult to justify and may have a deleterious effect on internal validity. The threat of history occurs when events outside the scope of the research have the potential to influence the participant's behaviors (i.e., curriculum or personnel changes in a child's classroom) (Kennedy, 2005). This is a particular concern for participants in non-concurrent multiple baseline studies because they have more opportunity for exposure to outside influences given that their entrance into study begins at different times. However, several researchers have down played this threat noting that it would be highly unlikely that an extraneous event would affect each participant at three different randomly appointed times (Christ, 2007; Skinner, Watson & Workman, 1981). Hence it is possible for participant to be affected by history, but it is not probable.

Participants

Three children (Ben, Anna, and Eddie) ages 9 to 11 and their parents agreed to participate in this study (see Appendix A for Office for the Protection of Research Subjects approval letter; see Table 1 and 2 for child demographic data and assessment scores). Each child was given a pseudonym to protect his or her identity. Each child has a documented genotype for Down syndrome with mild intellectual disabilities. The criteria for intellectual disabilities for this study follow the IDEA (2004) Sec. 300.8(c)(6) definition, which defines intellectual disability (currently also known as mental retardation) 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." Intellectual disability as a condition of Down syndrome was the primary descriptor for participation. Participants with a diagnosis of other intellectual etiologies such as

Williams syndrome, fragile X syndrome, PKU, or a non-genetic form of intellectual disabilities including traumatic brain injury (TBI) were excluded from this study.

All three children met the following criteria for participation in the study: (a) an age range between 9-11 years; (b) enrollment in a public or private elementary school; (c) a documented medical diagnosis for the genotype for Down syndrome; (d) assessment data showing IQ scores ranging between 69-55, indicating mild intellectual disability; (e) minimal hearing and visual difficulties; (f) English-only speaker; (g) demonstrated good receptive language (i.e., child is able to answer a simple question); (h) demonstrated good expressive language (i.e., others able to understand the child when he or she speaks); (i) ability to follow a simple one-step, oral direction (i.e., respond to directions to sit, to stand, and attend to an object); (j) demonstrate imitative skills to orally repeat phonemes and words; (k) met the minimum criterion on the *WRMT-III;* (l) met the minimum criterion of the *PPVT-IV*; and (m) demonstrated knowledge of a minimum of ten different letter-sound correspondences including at least one vowel sound (see Appendix B for flow chart of participant inclusion criterion).

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

Table 2

Child Profiles from Comprehensive Test of Phonological Processing-2 (CTOPP-2)

	Ben		Anna		Eddie	
	Percentile	Scaled Score	Percentile	Scaled Score	Percentile	Scaled Score
PACS[a]	<1	7	9	20	35	27
PMCS[b]	3	11	3	11	75	23
APACS[c]	<1	3	<1	7	<1	1

Note: [a] Phonological Awareness Composite Score
[b] Phonological Memory Composite Score
[c] Alternate Phological Awareness Composite Score

Recruitment Process

A total of 11 parent support groups including *Dads for Downs*, *UP for Downs*, and *Special Connections* were identified from the Illinois Special Education website (www.illinoisspecialed.com), which is designed to assist families of children with disabilities. A main contact from each group was sent a letter of introduction written by the researcher along with research study information. Upon receipt of these documents, four groups contacted the researcher requesting permission to advertise the study in electronic newsletters. In addition, the researcher contacted Gigi's Playhouse, a national non-for profit Down syndrome awareness center, to request permission to recruit individuals associated with their organization. The researcher was granted permission to post recruitment flyers in five Chicagoland locations. Due to these recruitment efforts, a total of 32 parents contacted the researcher to obtain additional information about the study over the course of seven weeks. Twenty-seven parents emailed the researcher and five parents called the researcher. From this inquiry group, 15 parents removed themselves from further consideration due to concerns over the potential length of the study. The remaining 17 families agreed to move forward to determine their child's eligibility for the study.

Parent screening survey. Parents interested in having their child participate in the study were given a 12-question phone survey, which was used to confirm the child's initial eligibility to participate (see Appendix C for screening survey). The survey took less than five minutes to complete. From this group of 17 potential participants, 11 were removed from further consideration because the children did not meet the minimum criterion for inclusion in the study (i.e., most were excluded on the basis of age or IQ level). In the end, six children met initial eligibility criteria. The children from the first three families to contact the researcher became eligible to move to the next stage of eligibility (assessment process) with the remaining three children put on a waiting list. One of the initial three children chosen to participate in the study had to exit the study, because he did not meet the minimum performance criterion on the *PPVT-IV*. A parent of the next child on the waiting list was contacted and that child took his place. Parents of the remaining two children on the waiting list were informed that they would be contacted if another place became available.

Assessment Process

Prior to beginning the assessment process, the researcher met with the parents and the child at the child's home. During this visit, introductions were made and parent consent and child assent forms were signed (see Appendix D and Appendix E). The child assent process began with a brief overview of the study between the child, the child's parents, and the researcher. The researcher routinely stopped and asked the child questions to ensure they understood what he or she were being asked to do. The researcher also reassured the child that he or she did not have to participate in the study even if their parent said it was okay. Once the child agreed to participate, the assent form was signed. In all cases, a parent aided the child in signing the form. Parents were requested to and did provide documentation supporting a clinical diagnosis for Down syndrome along with written documentation of the child's IQ level. Based on these documents, all three children were eligible to participate in the study. Out of the three children, Anna's mother was the only one to indicate a specific problem with articulation. About a year ago, Anna was observed having a difficult time making the /l/ sound and developed a habit of skipping over words that contain the letter "l". However, through speech therapy Anna's problem was able to successfully overcome this problem. However, according to her mom, Anna still tries to skip over words that contain the letter "l". Her mom indicated that Anna needs to be reminded that she can make the sound correctly. The researcher used this corrective prompt twice during the intervention.

The assessment process occurred over six days in each child's home. On the first day, each child began with three short assessments used to verify his or her ability to respond to the researcher's oral directions (see Appendix F for child assessment schedule). These assessments were designed to mimic the routines required for the intervention in three areas: a) instructional control, b) word repetition, and c) word blending. Following these assessments, additional assessments were administered to determine the child's: a) reading level, b) alphabet knowledge, and c) expressive language abilities. One child scored below the minimum criterion on the *PPVT-IV*. Given his low score, he did not meet the minimum eligibility criteria to participate. He was replaced with the next child on the waiting list who did meet all eligibility criteria. Assessments on the second day were administered to determine the child's: a) phonological awareness abilities, b) level of phonological memory, and c) short vowel knowledge. Assessments on the third, fourth and fifth days, were administered to determine the child's word knowledge within the five short vowel word families The entire assessment process occurred over a two-week period with each session lasting about 15 minutes.

Assessment Instruments

Three short assessments were used to verify the child's ability to respond to the researcher's oral directions. The assessments were 1) Instructional Control, 2) Word Repetition, and 3) Word Blending. The criterion for each assessment was 100 percent accuracy.

Instructional Control. The Instructional Control assessment required the child to demonstrate instructional control when given a directive to complete a task (e.g., sit on a chair, respond to a verbal instruction, or attend to a word written on an index card). The researcher stated, "We are going to play a game like Simon Says." "Do you know how to play Simon Says?" "Great!" "I'm going to ask you to do a few very easy things and then at the end you will get a prize." "Ready?" *"(Child's name*), sit in this chair (researcher pointing to chair)." "Now touch your finger to your nose." And finally, "Touch the word on this card" (*researcher showing card*). Can you tell me what the names of the letters are?" " Great job (*child's name)*!"

Word Repetition. The Word Repetition assessment required the child to (a) repeat ten words, (e.g., "man", "run", and "sad"); (b) repeat five short sounds (e.g., /d/ and /t/); and (c) repeat and hold five continuous sounds (e.g., repeating /m/ and /n/).

Word Blending. The Word Blending assessment required the child to blend compound words together while learning a cuing system similar to one that is used during the intervention. The process began with the researcher showing the child a pair of demonstration pictures - one of a "foot" and one of a "ball." The researcher then modeled the technique by saying each word individually, (e.g., saying, "foot" and "ball"). The researcher then modeled blending the words together to form one word (e.g., saying, "football"). The child was asked to repeat these two steps on his or her own. Following the demonstration, the child was shown five pairs of pictures. For each pair, the researcher asked, "What is this?" (*Pointing to picture A*); "What is this?" (*Pointing to picture B*), followed by, "Now say the words together without stopping."

Peabody Picture Vocabulary Test *(PPVT-IV: Dunn & Dunn, 2007).* The *PPVT-IV* was administered to each child. The *PPVT-IV* measures the receptive word processing of examinees from two to over 90 years. The assessment was used to get a sense of each child's verbal ability and vocabulary knowledge and took approximately 15 minutes to complete. The assessment has a test-retest reliability factor between .91 to .94 (median .92). Mastery of this assessment was not required, but a cut-off score of no more than two standard deviations below the norm was established to ensure the child could successfully move through the intervention.

Woodcock Reading Mastery Test-III (*WRMT-III; Woodcock, 2011).* All the children were given four subtests (*Letter Identification*, *Phonological Awareness*, *Rapid Naming*, and *Word Attack)* of the *WRMT-III.* The *WRMT-III* is designed to assess the reading levels of test takers within an age range from four to 75 years and over. The *WRMT-III* total reading full-scale reliability coefficient for *Form A is* .98 The *Letter Identification* subtest is comprised of 17-items of upper and lower case letters printed in a uniform font. Children were asked to name or provide the most common sound for each letter presented. The *Phonological Awareness* subtest is comprised of 33-items and was used to measure the child's awareness of the phonological components of language. The *Rapid Automatic Naming* subtest is comprised of 144-items and measures the child's speed and accuracy in naming objects, colors, numbers, and letters. The *Word Attack* subtest is comprised of 26-items and is used to assess the child's ability to use phonics and structural analysis skills to read nonsense words of increasing difficulty. Children scoring at the two standard deviations or higher on this subtest were considered to have decoding abilities that were too advanced for this study.

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 upper and lower case letter was typed using a 72-point Futura Lt BT font and presented on white 5x8 inch index card. Each letter was presented once. 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. This assessment was repeated at the end of the study to assess changes in the participant's performance.

Comprehensive Test of Phonological Processing-2 (*CTOPP-2;* Wagner et al., 1999). The *CTOPP-2* is a measure of phonological coding, which consists of the analysis and synthesis of phonemes (Lennon & Slesinski, 2002). All the children were given seven subtests (*Elision*; *Blending Words*; *Blending Nonwords*; and *Segmenting Nonwords)* of the *CTOPP-2* to assess phonological awareness, phonological memory, and rapid naming. The *CTOPP-2* was normed on over 1,600 individuals ranging in age from five through twenty-four in 30 states. More than half of the norming sample came from elementary school children (grades K-5). Reliability for the *CTOPP-2* was investigated using estimates of content sampling, time sampling, and scorer differences (Wagner et al., 1999). Average internal consistency exceeds .80, with test/retest reliability coefficients ranging from .70 to .92 (Wagner et al., 1999). The administration guide does not indicate that children with disabilities were part of the norming sample.

Elision. The *Elision* subtest contains 20-items and required the child to a) omit a component of a compound word (e.g., "airplane", omitting "air" Correct answer: "plane"; b) omission of a syllable (e.g., "running", omitting the /ing/ Correct answer: "run"); and c) omission of a phoneme (e.g., cat, omitting /c/; Correct answer: /at/) (Treiman, Pennington, Shriberg, & Boada, 2008).

Blending Words. The *Blending Word* subtest contains 20-items and required the child to listen to sound units, via a CD, and combine them to make words (e.g., "What word do these sounds make: /c/ /a/ /t/?" Correct answer: "cat"). Additional items require the participant to blend syllables, onsets and rhymes, and phonemes to form real words (Treiman et al., 2008).

Phoneme Isolation. The *Phoneme Isolation* subtest contains 32-items and required the child to identify the beginning, middle, and ending sounds in words.

Memory for Digits. The *Memory for Digits* subtest contains 28-items and measures the child ability to repeat a series of numbers ranging in length from two to eight digits.

Nonword Repetition. The *Nonword Repetition* subtest contains 30-items and is presented to the child via audio recording. The child is tasked with repeating back nonsense words. For example, if the child hears the recorded sounds "lignog" to which the correct response is "lignog."

Blending Non-Words. The *Blending Non-words* subtest contains 18-items and requires the child to listen to a CD of individually spoken sounds, and to combine the sounds together to form and say a nonsense word (e.g., "What word do these sounds make /s/ /oo/ /p/?" Correct answer: "soop") (Frechtling, Zhang, & Silverstein, 2006).

Segmenting Non-Words. The *Segmenting Nonword* subtest contains 18-items and requires the child to listen to a CD and to orally segment a spoken nonsense word into individual sounds (e.g., "What sounds do you hear in the word "sem?" Correct answer: /s/ /e/ /m/) (Hecht, 2003).

From these subtests, three cluster scores are provided. The *Phonological Awareness Composite Score* (*PACS*) is comprised of the *Elision*, Blending Words, and *Phoneme Isolation* subtests. The *Phonological Memory Composite Score* (*PMCS*) is comprised of the *Rapid Digit* and *Nonword Repetition* subtests. Finally, the *Alternate Phonological Awareness Composite Score* (*APACS*) is comprised by adding the scaled scored from the *Blending Nonwords* and *Segmenting Nonwords* subtests.

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.

Short vowel word patterns. The purpose for this assessment was to determine which short vowel sounds and short vowel word patterns were difficult for the child to decode. To begin, the researcher constructed five word lists, one list for each short vowel sound (e.g., /a/, /e/, /i/, /o/, /u/). 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 (e.g., /c/ /a/ /t/). 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”. Consistent with the protocols established by Cohen et al. (2008), all words were typed in 72-point Futura Lt BT font and presented on white 5x8 inch index cards. The researcher held up each 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 for the researcher was to determine the short vowels and short vowel word patterns the child had difficulty decoding.

Targeted word families. The purpose of this assessment was to construct at least seven pairs of rhyming words to use during the intervention phase. The 14 words required for the study needed to include words the child could not read consistently. Thus, 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. In addition, the child did not need to know the meaning of the word for the word to be included. To accomplish this, the researcher started with a list of 35 words that was uniquely crafted 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 (2 out of 6 times) or more, the word was excluded from the intervention phase of the study. To counter the effects of a child simply guessing sounds correctly, if a child accurately decoded two adjacent sounds correctly while still misreading the word 33 percent or more times (e.g., twice reading “map” as “tap”) the word was eliminated from the intervention phase, as well. Through a process of elimination, the researcher reduced the list of 35 words to a smaller list of words the child could not read or got incorrect 33 percent of the time (2 out of 6 trials) or more. In the end, each child’s list contained between 14-18 words. Ben’s list contained 16 words, Anna’s list contained 14 words, and Eddie’s list contained 18 words. From this smaller list, 14 words were chosen for each child to use in the study (see Table 3 for each child’s word list) six words were used during the first intervention phase and six words were used during the second intervention phase. The remaining two words were used for training purposes. Each word was composed so that it had a corresponding rhyme. For example, if the word "sat" was used during the first intervention phase, then the word "mat" was used during the second intervention phase.

Table 3

Word Selection Data

Intervention Phase I Words	Percentage of Time Word Read Correctly	Intervention Phase II Words	Percentage of Time Word Read Correctly	Demonstration Words
		Ben		
rub	0%	sub	0%	mit
jet	0%	set	0%	rip
fit	0%	hit	17%	
hip	0%	nip	0%	
sob	0%	lob	0%	
net	0%	met	0%	
		Anna		
Intervention Phase I Words	Percentage of Time Word Read Correctly	Intervention Phase II Words	Percentage of Time Word Read Correctly	Demonstration Words
fed	0%	wed	0%	mag
mum	0%	hum	0%	mug
mat	0%	rat	17%	
rag	0%	lag	0%	
lot	17%	rot	0%	
wag	17%	sag	0%	
		Eddie		
Intervention Phase I Words	Percentage of Time Word Read Correctly	Intervention Phase II Words	Percentage of Time Word Read Correctly	Demonstration Words
wed	17%	led	0%	sod
set	0%	met	0%	nod
yen	0%	hen	17%	
let	0%	wet	17%	
rot	17%	lot	17%	
rim	17%	vim	0%	

Procedures

Once the assessment period was completed, the researcher made arrangements to meet with each child two to three times per week in the child's home. Sessions were always scheduled at the discretion of the parents and generally occurred on weekdays. The research was conducted over a period of five months (see Table 4 for number of sessions and time frame). Each session generally lasted less than ten minutes. Every effort was made to keep the testing 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 told that they would be given the opportunity to learn the intervention at the conclusion of the study. All three sets of parents expressed interest in learning the decoding technique; however only one mother at the end decided to learn how to administer the decoding technique.

Table 4

Number of Sessions and Time Frame

	Baseline	Intervention Phase I[a]	Probe	Intervention Phase II[b]	Duration
Ben	3	8	1	7	11 weeks
Anna	6	5	1	4	7 weeks
Eddie	9	10	1	4	11 weeks

Note. [a]Criterion equals two consecutive sessions at 92% or greater accuracy with one session at 100%
[b]Criterion equals two consecutive sessions at 92% or greater accuracy

Baseline. Children were randomly assigned to one of three baselines with each trial consisting of two presentations of words from the WS-A list. Ben was assigned to three baseline sessions, Anna to six baseline sessions, and Eddie to nine baseline sessions. Baseline sessions occurred no more than three times a week. Each session took less than five minutes to complete. Baseline scores were collected and graphed.

Training Phase. Before each intervention session, the researcher modeled and trained the children to use the 3-SDS with the 0-second CTD procedure (see Table 7 for training procedure). The purpose of this training 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). In their final analysis, Cohen et al. (2008) recommended that replications of their study might do well to add additional training trials focused on letter-sound blending. The researcher began each intervention session with a demonstration trial in which the child was guided through the decoding process using his or her training words. Consistent with the protocols established in Cohen et al. (2008), all words were typed using a 72-point Futura Lt BT font and presented on white 5x8 inch index cards. The same two words were used for training throughout the course of the study. All three children caught on to the decoding strategy very quickly and by the second intervention session they were able to execute the strategy without hesitation. Overtime, Anna and Ben stopped waiting for the researcher's instructions and proceeded to decode and read the word as soon as the word card was presented.

Instructional strategy: 3-SDS with a 0-CTD procedure. The three steps in the decoding strategy are: (a) Step 1 (Attention Getting); (b) Step 2 (Decoding); and (c) Step 3 (Reading the Word) (see Table 5 for training phase procedure). Because the child had an immediate model of the behavior to be performed, only minor errors were experienced during the teaching phase and results were not graphed.

Step 1 (Attention Getting). Using a 0-second CTD procedure, 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."

Step 2 (Decoding). Using a 0-second CTD procedure and 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."

Step 3 (Reading the Word). Using a 0-second CTD and the same sample word used previously, 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

Table 5

Training Phase: 3-SDS with a 0-CTD Procedure

	Step 1: Attention Getting	Step 2: Decoding	Step 3: Word Reading
Instruction Delivered by Researcher	"Point to the word and lets look at it."	"Slowly point to each letter while you say each letter-sound in the word."	"Now say the sounds together without stopping while you run your finger along the bottom of the card."
Simultaneous Action taken by Researcher and Child	Both point to the card	Both look at word printed on card and point to each letter while saying each letter-sound	Both read the word on the card while running their fingers along the bottom of the card.

Intervention Phase I. Once the training trials were completed, 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 training trials (see Table 6 for intervention procedures).

Two presentations of all six words from the WS-A list made up one complete session. Each child completed a session in less than five minutes. 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.

Probe. 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 WS-B list 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. Each child completed the probe in approximately two minutes. Probe data were recorded and graphed.

Table 6

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

Intervention Phase II. The second intervention phase was a replication of the first intervention phase. During the second intervention phase, words from the WS-B list 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. On average, it took less than 3 minutes for each child to complete one session.

Parent Questionnaire

At the conclusion of the last intervention phase, each child's parent was interviewed. The 12-question interview was used to construct a more in-depth profile for each child (e.g., child's attitude about reading, reading curriculum used in school, IEP goals). The interview took approximately ten minutes to complete. During this time the research also instructed the parent on how to continue using the 3-SDS and the 4-CTD procedure with their child. The researcher also offered to come back to the child's home and work with the parent to help them to develop great proficiency in using the strategy with their child (see Appendix G for parent questionnaire).

Summary

In the present study a 3-SDS with a 4-CTD procedure was used to teach blending skills to three children with Down syndrome and mild intellectual disabilities. A non-concurrent multiple baseline design with two intervention phases was used to assess decoding efficiency with words composed of a similar phonemic structure. A probe was administered between the phases to assess generalization of decoding skills from taught words to untaught words. Children were tested with a battery of assessments to determine each child's ability to respond to the researcher's oral direction, verbal ability, phonemic awareness abilities, reading level, and alphabet knowledge (letter naming and letter-sound). In addition, each child was assessed on his or her knowledge of short vowel word families. Based on the results of these assessments, target-words were constructed for use during the intervention. Criterion for reading master for the first intervention phase was to consecutive sessions at 92% or greater accuracy with one session at 100%. Criterion for the second intervention session was two consecutive sessions at 92% or better accuracy. Parents were interviewed to determine additional background information on each child (i.e., attitudes towards reading, reading curriculum used in the school, IEP goals).

Data Analysis

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 relation between the dependent and the independent variables (Kennedy, 2002). 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. Student 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. Results from the parent interviews were analyzed to obtain additional descriptive information for each child. This information was included to give the researcher a better sense of each child's experiences and attitude towards reading and school.

Procedural Fidelity

All sessions were videotaped and audio recorded using two separate recording devices and reviewed for procedural fidelity and interobserver reliability. Procedural fidelity was conducted by a trained observer who is a doctoral candidate in special education. The researcher trained the observer by introducing and discussing the 3-SDS and 4-CTD procedure, reviewing tapes, and role-playing with the researcher. Using a checklist, the observer scored the researcher's procedural fidelity for delivering the instructional cue for each step of the decoding strategy, as well as delivering the corrective prompt within the 4-seconds time periodical (see Appendix H for fidelity checklist). Thirty percent of the intervention sessions were reviewed for procedural fidelity. No script deviations were observed during the 18 sessions indicating a high procedural fidelity. The observer was not blind to the intervention/baseline sessions she was observing. The researcher also trained the observer identify any unintentional cueing or prompting during the sessions (i.e., repeating the instructional cue more than once, or providing the child with the first letter-sound in the word). The observer found no occurrence of unintended cuing or prompting on the part of the researcher.

Interobserver agreement (reliability) was conduct by a second trained observer who is a professor in special education. The researcher trained the observer by introducing and discussing the 3-SDS and 4-CTD procedure, reviewing tapes, and role-playing with the researcher. Using a checklist, the observer scored the researcher's accuracy for scoring each letter-sound the child produced and for each word the child read (see Appendix I for scoring checklist). The observer reviewed 21 randomly selected sessions to collect reliability data: 30% of baseline sessions, 30% of intervention phases one and two, and 100% of the probe sessions. Interobserver agreement was calculated by dividing the number of agreements of occurrence of the target sounds and words by the number of agreements plus disagreements and multiplying by 100. Interobserver agreement ranged from 93% to 100% with a mean of 96%. The observer was blind to whether she was checking a baseline or intervention session.

IV. RESULTS

The study used a 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 intellectual disabilities who were identified with Down syndrome. 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. In the following section, findings are reported by child and include all the data points collected from baseline to the second intervention phase. In addition each child's parent was interviewed to provide additional descriptive information on the child's attitude towards reading.

Ben

Ben is an 11-year old Caucasian male 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.

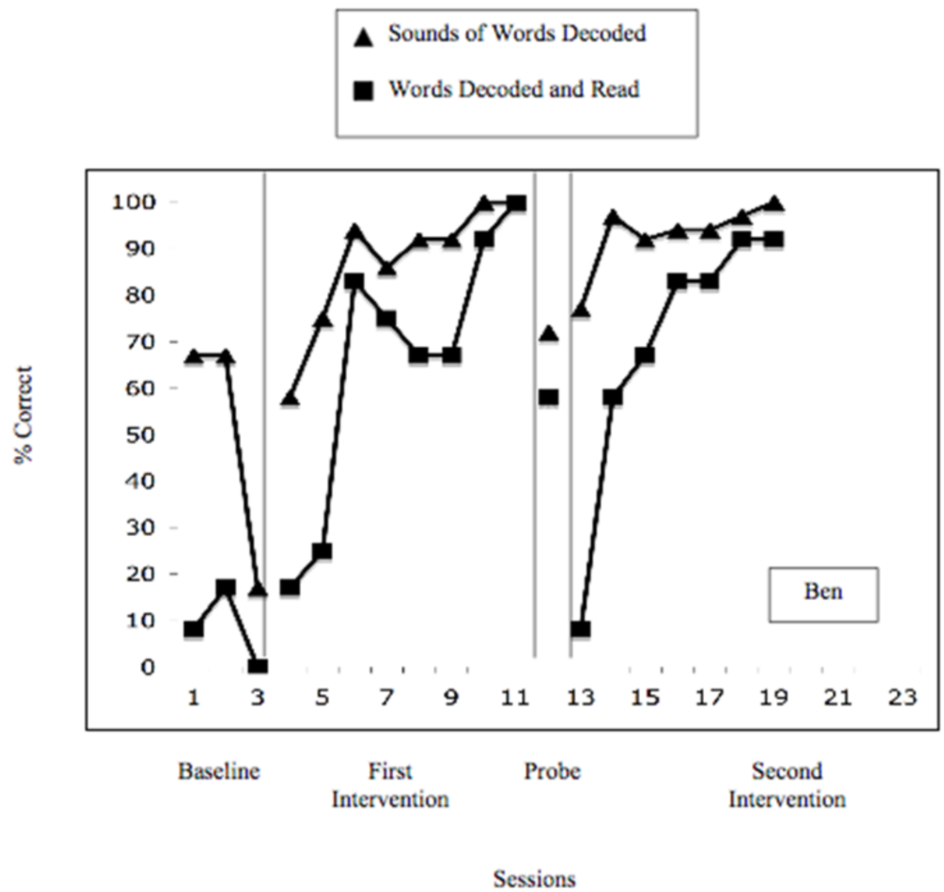
Based on parent report, Ben generally likes school and likes to read, but often needs to be motivated. Results from his last reading evaluation show Ben reading at a low second grade level. According to his mom, Ben's greatest difficulty reading is remembering the short vowel sounds. This difficulty was also demonstrated during the study. Generally, his mother describes him as a good learner. However, she is very concerned about his poor short-term memory, which she sees as not improving. According to his mom, many of Ben's academic problems stem from his inability to simply remember the task at hand. His mom has been working with his special education teacher on activities to develop his short-term memory.

During the study, Ben demonstrated excellent social skills and appeared to be a kind, loving child. Throughout Ben's participation in the study he was always eager to participate, upbeat, funny, and positive. Before we would begin a session, Ben usually had a story to tell that involved him triumphing at some type of sports activity.

Baseline. During Ben's three baseline sessions (see Figure 1), he was presented with 36 letter-sounds to decode and 12-words to read for each session. For each session, 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) (see Figure 1). Ben's lowest overall score occurred during his third session, when his letter-sound decoding accuracy fell to 17% and his combined letter-sound decoding and word reading was null. No apparent reason for this decline was noted during the session.

The majority of Ben's decoding errors during baseline involved vowel substitutions in words such as "fit" and "hip" (e.g., substituting the short "a" sound for the short "i" sound in "fit" and substituting the short "e" sound for the short "i" sound in "hip"). The errors he made

Figure 1. Ben's Data



decoding consonant sounds did not show as consistent a pattern and were as varied as substituting a short vowel sound for a consonant sound, mumbling through the final constant sound, and substituting beginning consonant sounds (e.g., /b/ for /d/ in the word “sob” and /t/ for /p/ in the word “hip”).

Intervention Phase I. During the first intervention phase in a single session, Ben was presented with 36 letter-sounds to decode and 12-words to read from his first set of target-words (WS-A). Across all sessions he was presented with 288 letter-sounds to decode and 96-words. Ben made consistent progress accurately decoding 17% (2-words) of his WS-A target-words during his first session and reaching criterion by the eighth session (crerion for completing the first intervention phase session is two consecutive sessions at 92% or greater accuracy with one session at 100% accuracy for combined letter-sound decoding and word reading). 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). Throughout all sessions, Ben’s accuracy for decoding letter-sounds ranged from 58% (167 letter-sounds) to 100% while his combined accuracy for decoding letter-sounds and word reading ranged from 17% (2-words) to 100% (all words). Analogous to his performance during baseline, Ben’s most frequent mistakes involved vowel substitution errors (e.g., substituting the short “e” sound for the short “i” sound and the short “i” sound for the short “o” sound) and phonetically based errors with the final consonant sounds (e.g., /rd/ for /b/).

Probe. On the probe Ben was presented with 36 letter-sounds to decode and 12 target-words to read using new target-words from his second word set (WS-B). Ben decoded 72% (26 letter-sounds) accurately and read and decoded 58% (7-words) of his words and correctly. Ben’s errors during the probe were responses centered on the short “o” sound (e.g., “sob” for “sub” and “lob” and /op/ for “nip”).

Intervention Phase II. During the second intervention phase in a single session, Ben was presented with 36 letter-sounds to decode and 12-words to read from his second set of target-words (WS-B). Across all sessions he was presented with 252 letter-sounds to decode and 84-words to read. Ben reached criterion after the seventh session showing a 12% increase in efficiency in learning words from WS-B (criterion for completing intervention phase two was two consecutive sessions at 92% accuracy of better). Overall Ben’s letter-sound accuracy remained consistently higher than his combined decoding and word reading accuracy. Across all seven sessions, Ben’s accuracy for decoding letter-sounds ranged from 77% (194 letter-sounds) to 100% (all letter-sounds), while his accuracy for combined letter-sound decoding and word reading ranged from 8% (1-word) to 92% (77-words). Similar to his performance during baseline and the first intervention phase, Ben’s most frequent errors involved vowel substitution errors (e.g., substituting the short ”o” sound for the short “u” sound in “sub” and the short ”a” sound for the short “i” sound in “nip”). During his seven sessions, Ben made no errors decoding final consonant sounds, but made four errors decoding beginning consonant sounds (e.g., /n/ for /m/ in “met”, /h/ for /n/ in “hip”, /r/ for /l/ in “rob” and /wh/ for /n/ in “nip”).

Anna

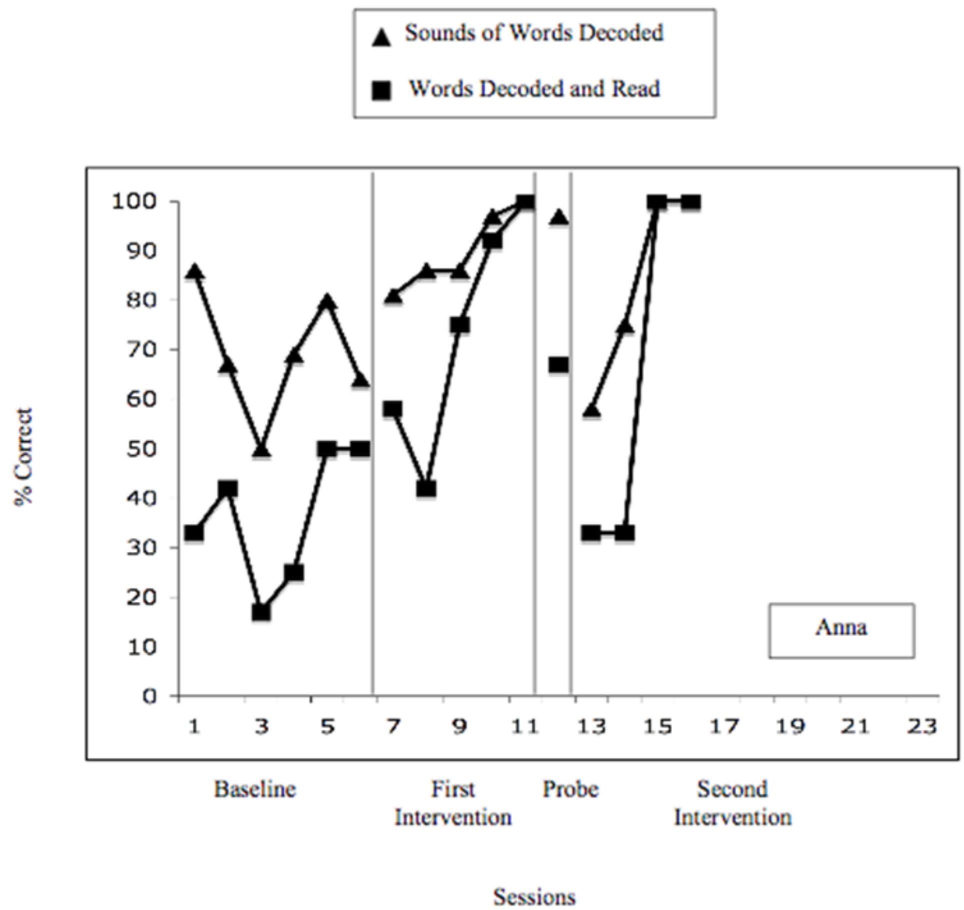
Anna is an 11-year old Caucasian female in the fifth grade with an IQ of 59. She is one of four female children in her family and is the second oldest child. Anna attends a public elementary school in the suburbs of a major city in the Midwest. Her time is split evenly between resource room and general 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.

Results from her last reading evaluation show that Anna is reading at a low second grade level, which is on target for the goals established on her IEP. Anna's reading curriculum includes a reading program called *Reading Milestones,* which is primarily used to teach sight-words. Anna's parents are moderately pleased with this curriculum, but would like to see Anna exposed to a curriculum that includes more phonics-based activities. Generally, Anna demonstrates a fondness for reading in school and at home. To help motivate her to read at home, Anna's parents have set-up a reward system that allows her to earn time on an iPad for time-spent reading. On average, Anna's parents read with her for two to three hours a week. In addition, Anna's mom reads to her every night before bedtime. Throughout Anna's participation in the study, she was always very enthusiastic and consistently maintained a positive upbeat attitude.

Baseline. During Anna's six baseline sessions (see Figure 2), she was presented with 36 letter-sounds to decode and 12-words to read for each session. For each session, her letter-sound decoding accuracy ranged from 64% (23 letter-sounds) to 86% (31 letter-sounds) and consistently remained higher than her combined letter-sound decoding and word reading accuracy, which ranged from 33% (4-words) to 50% (6-words) correct (see Figure 2). Anna's lowest overall score occurred during her third session, when her letter-sound decoding accuracy fell to 50% (18 letter-sounds) and her combined letter-sound decoding and word reading declined to 17% (2-words).

Of the errors Anna did make, her most frequent decoding mistakes involved vowel substitution errors (e.g., substituting the short "u" sound for the short "a" sound). In addition, several times she omitted voicing an initial consonant sound (e.g., /l/ in "lot"), and was often

Figure 2. Anna's Data



preservative on certain words. For example, when asked to decode words as random as “wag”, “mat”, and “fed” she frequently said “rug.”

Intervention Phase I. During the first intervention phase in a single session Anna was presented with 36 letter-sounds to decode and 12-words to read from her first set if target-words (WS-A). Across all sessions she was presented with 180 letter-sounds to decode and 60-words to read. She made steady progress accurately decoding 58% (7-words) of her WS-A target-words during the first session and reaching criterion by the fifth session (criterion for completing the first intervention phase session is two consecutive sessions at 92% or greater accuracy with one session at 100 % accuracy for combined letter-sound decoding and word reading). 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 (see Figure 2). Throughout all sessions, Anna’s accuracy for decoding letter sounds ranged from 81% (146 letter-sounds) to 100% while her combined accuracy for decoding letter-sounds and word reading ranged from 42% (25-words) to 100% (all words).

Mirroring her performance during baseline, Anna made frequent vowel substitution errors (e.g., substituting the short “a” sound for the short “u” sound), and continued perseverating on specific words (e.g., repeatedly substituting the word “rug” for several target-words). There was not one instance during this phase when Anna failed to voice an initial consonant sound.

Probe. On the probe Anna was presented with 36 letter-sounds to decode and 12 target-words to read using new target-words from her second word set (WS-B). Anna decoded 97% (35 letter sounds) accurately and read and decoded 67% (8-words) of her words correctly. Anna did not demonstrate a consistent pattern of letter-sound decoding or word reading errors on the probe.

Intervention Phase II. During the second intervention phase in a single session Anna was presented with 36 letter-sounds to decode and 12-words to read from WS-B. Across all sessions she was presented 144 letter-sounds to decode and 48-words to read. Anna reached criterion after the fourth session showing a 20% increase in efficiency in learning the words from WS-B (criterion for completing intervention phase two was two consecutive sessions at 92% accuracy of better). 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. Across all four sessions, Anna’s accuracy for decoding letter-sounds ranged from 58% (83 letter-sounds) to 100% while her accuracy for combined letter-sound decoding and word reading ranged from 33% (16-words) to 100% (all words). Similar to her performance during the first intervention phase, Anna obtained her lowest score during the second session but recovered during her third session making her most significant gains in combined letter-sound decoding and word reading.

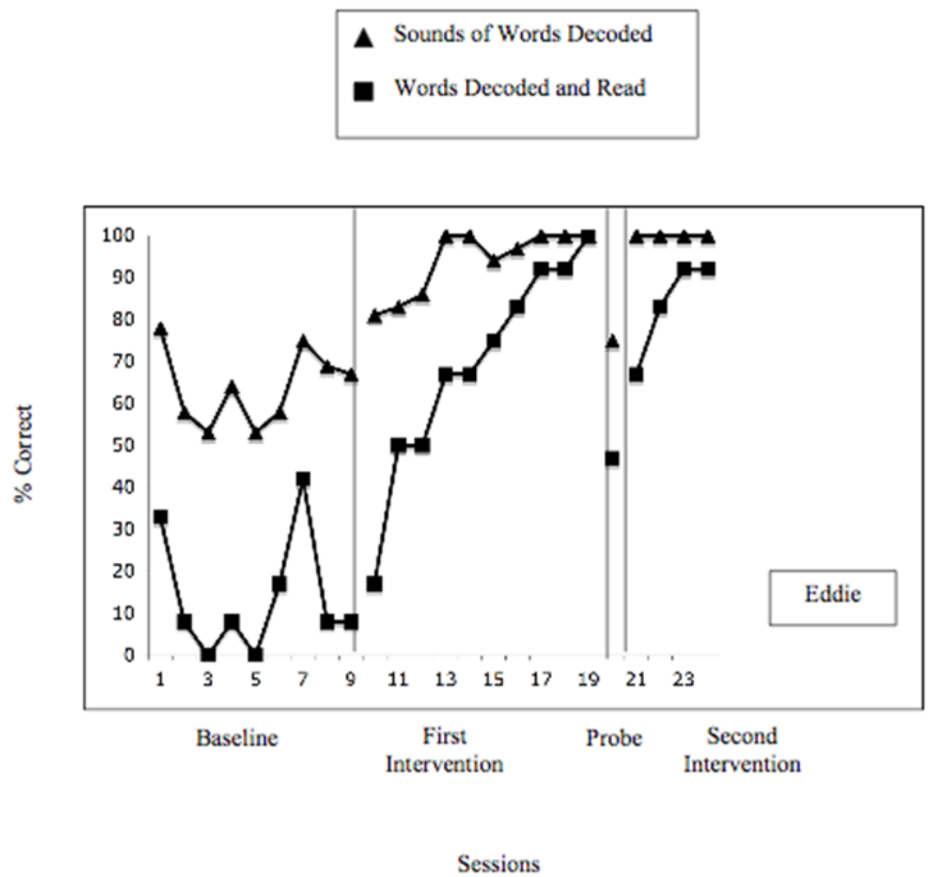
During the first intervention phase, Anna responded to her cue within the allotted 4-seconds 100 percent of the time. In contrast, during the first two sessions of the second intervention phase, Anna amassed ten errors related to not responding to her cue within the allotted 4-seconds. In sum, these errors represented 48% of all errors made for this phase. When the investigator delivered the corrective prompt, Anna talked over him to provide the correct answer. Nonetheless, Anna did not receive any points for correct responses she gave beyond the 4-second periodical. In addition to the timing errors, Anna continued to perseverate on specific words (e.g., substituting the word “rug” for “rot” and “sag”).

Eddie

Eddie is a 10-year old Caucasian male in the fourth grade with an IQ of 59. He is the younger of two boys in his family. He is instructed in a regular education classroom and his assisted by a full-time instructional aide. Early in Eddie's schooling, his parents fought for months with the local school board to have Eddie fully included in all classes. The school board, however, wanted Eddie to attend a special school for children with intellectual disabilities. Eddie's parents won the fight, but keep a watchful eye on Eddie's curriculum. 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. Eddie's latest assessment data show him reading at a low second grade level. His mom works with Eddie on reading and math activities at home for about five hours a week. Eddie likes to read but resist reading books that are not related to his favorite cartoons (i.e., *Batman* and *Scooby-Do*). 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.

Baseline. During Eddie's nine baseline sessions (see Figure 3), he was presented with 36 letter-sounds to decode and 12-words to read for each session. His letter-sound decoding accuracy ranged from 53% (19 letter-sounds) to 78% (28 letter-sounds) and consistently remained higher than his combined letter-sound and word reading accuracy, which ranged from 0% to 42% (5-words) (see Figure 3). In six out of nine sessions, Eddie achieved less than ten percent correct for combined letter-sound decoding and word reading accuracy, scoring at a null level on two sessions.

Figure 3. Eddie's Data



The majority of Eddie's decoding mistakes involved vowel substitutions errors (e.g., substituting the short "i" sound for the short "e" sound) and confusion over the final consonant sound (e.g., /d/ for /t/ in the word "rot"). Eddie's decoding errors frequently aligned very closely with his word reading errors (e.g., decoding the word "yen" as /y/- short "i" sound - /n/, and reading the word as "yin"). This pattern was observed in all the children.

Intervention Phase I. During the second intervention phase in a single session, Eddie was presented with 36 letter-sounds to decode and 12-words to read from his first set of target-word (WS-A). Across all sessions he was presented with 360 letter-sounds to decode and 120-words to read. Eddie made steady progress increasing his combined letter-sound and word reading accuracy from 17% (2-words) during the first session to reaching criterion by the tenth session (criterion for completing the first intervention phase session is two consecutive sessions at 92% or greater accuracy with one session at 100 % accuracy for combined letter-sound decoding and word reading). 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 (see Figure 3). Throughout all sessions, Eddie's accuracy for decoding letter-sounds ranged from 81% (292 letter-sounds) to 100% while his combined accuracy for decoding letter-sounds and word reading ranged from 17% (20-words) to 100% (all words). Similar to his performance during baseline, Eddie's most frequent mistakes involved vowel substitution errors (e.g., substituting the short "i" sound for the short "e" sound and the short "o" sound for the short "i" sound). However by the fourth session, he had almost perfect accuracy decoding all letter-sounds.

Probe. On the probe Eddie was presented with 36 letter-sounds to decode and 12 target-words to read using new target-words from his second word set (WS-B). Eddie decoded 47% (17 letters-sounds) of the letter-sounds accurately and read and decoded 75% (9-words) of his words and correctly. Eddie's most frequent errors on the probe involved mistakes decoding the final constant sound (e.g., /d/ for /t/ in "wed" and "let" and /g/ for /t/ in "lot").

Intervention Phase II. During the second intervention phase for a single session, Eddie was presented with 36 letter-sounds to decode and 12-words to read from WS-B. Across all sessions he was presented with 144 letter-sounds to decode and 48-words to read. Eddie reached criterion after four sessions showing a 60% increase in efficiency in learning the words from WS-B (criterion for completing intervention phase two was two consecutive sessions at 92%). accuracy of better. Eddie's letter-sound accuracy remained consistently higher than his combined decoding and word reading accuracy. Across his four sessions, Eddie's accuracy for decoding letter-sounds was 100% while his accuracy for combined letter-sound decoding and word reading ranged from 67% (32-words) to 92% (44-words). Eddie's most frequent mistake centered on the word "wed", which he misread as "wit", "what", and "wid".

Visual Analysis of Data

Within-Phase Patterns. Three variables are used to analysis graphical data of within-phase patterns: level (determines the estimation of central tendency), trend (determines if the data is moving in a positive or negative direction and by what degree), and variability (determines the degree to which individual data points deviate from the trend) (Kennedy, 2005). Across all three children, the level increased significantly over baseline demonstrating that the intervention positively affected each child's ability to decode words. In addition, Eddie and Ben also increased their decoding accuracy between intervention phases. In both cases, the levels for their decoding accuracy increased between 3 to 14 percent, respectively from the first to the second intervention phase. Anna did not show a similar gain because her overall average was lowered due to scoring poorly during the first two sessions of the second intervention phase. The trend of the data across all three children demonstrated a positive (upward) slope in each intervention phase. Ben and Eddie demonstrated a low magnitude (gradual increase in word reading) with Anna demonstrating a high magnitude especially during the second intervention phase. In terms of variability, all the children demonstrated low variability with the exception of Ben, who demonstrated medium to high variability during the first intervention phase.

Between-Phase Patterns. Two variables are used to analysis graphical data of between-phase patterns: immediacy of effect and overlap (Kennedy, 2005). The first, immediacy of effect refers to the change that occurs from the last data point in baseline to the first data point in the first intervention phase. For all three children, the introduction of the 3-SDS during the first intervention made a small but immediate change in each child's word reading accuracy. The second term, overlap refers to the percentage of baseline sessions that overlap with sessions in the first intervention phase. In terms of overlap, Ben demonstrated some overlap at 12.5 percent and Anna demonstrated an overlap of 20 percent. Eddie had no overlap across adjacent phases. These results suggest that Eddie may have benefited from the intervention immediately while Anna and Ben needed more time for the intervention to become effective. It should also be noted that there was a ceiling effect, as data collection stopped during each intervention phase once word reading mastery was reached. The data suggests that based on the increase in word reading accuracy after the 3-SDS was introduced a functional relation existed between the dependent variable and the independent variable for all three children.

Pre-and Posttest Scores: Word Attack and Letter Checklist

Pre-intervention and post-intervention data were collected using the *WRMT-III*. Because the study focused on teaching the children to decode, results from the Word Attack subtest were of particular interest. Pre-intervention, none of the children were able to decode any of the items. Post-intervention all three children made gains. Ben and Anna were able to accurately decode one item each and Eddie was able to decode two items. Post-intervention results on the Letter Checklist assessment showed just a slight improvement for each child over pre-intervention results. Anna made the most noticeable improvement mastering all the letter-names and letter-sounds (see Table 7 for letter check list assessment results).

Table 7

Letter Checklist Scores

	Upper Case Letter Substituions	Lower Case Letter Substituions	Upper Case Missed Letter-Sounds and Letter-Sound Substitutions	Lower Case Letter-Sound Substitutions
Pre-Interventon				
Ben	G for C Z for X Z for C J for T M for V M for U	x for z a for c i for a q for p u for w	/L/	/w/ for /r/ /e/ for /d/ /p/ for /q/ /w/ for /u/
Anna	"Mom" for M J for U		/Q/	
Eddie	B for P	d for p b for q	/B/ for /P/ /G/ for /C/ /G/ for /K/	
Post-Intervention				
Ben	G for C Z for X Z for C J for T M for V	x for z a for c i for a q for p u for w		/w/ for /r/ /e/ for /d/ /p/ for /q/ /w/ for /u/
Anna				
Eddie	B for P	d for p b for q	/B/ for /P/ /G/ for /C/	

Note. Letters presented on flashcards

V. 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 intellectual disabilities, including children with Down syndrome (Burgoyne et al., 2013; Steele et al., 2013). The 3-SDS used in the present study has been successfully used to teach children with mild to moderate intellectual disabilities to read words (Cohen et al., 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 intellectual disabilities who have Down syndrome, thus expanding the number of children who can benefit from this type on instruction. 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 Down syndrome and mild intellectual disabilities to read words. The 3-SDS approached demonstrated a degree of effectiveness and efficiency for all three children. During the intervention, each child improved his or her accuracy for letter-sound decoding and word reading over baseline. Furthermore, during the second intervention, all children demonstrated gains in learning efficiency for letter-sound decoding and word reading. However, none of the children were adequately able to generalize reading untaught words during the probe.

Letter-Sound Decoding

Phonics-based reading instruction gives children the tools to decode the sound features of language (Burgoyne et al., 2012). Through this process the child learns to recognize semantic patterns in words and to develop the skills required to generalize this knowledge to read previously unknown words (Flores et al., 2004). Thus, the first research question in this study asked if the process of decoding words into their requisite letter-sounds and then blending the sounds together using a constant time delay procedure would be effective at teaching children with Down syndrome to read words. Graphic analysis and error examination clearly indicate that the decoding strategy was 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. During the first intervention phase, Anna's decoding accuracy was never less than 80% for any session and by the fifth session she could say all the letter-sounds correctly. Her performance was not surprising given that she also had the highest score for word reading during baseline. Research has shown that initial word reading is a significant predictor for growth in decoding (Lemons and Fuchs, 2010a). Eddie was the most accurate decoder and was able to say all the sounds correctly by the fourth session. Once mastering letter-sounds however, he took an additional six sessions to successfully learn to blend the sounds together to read his target words. Ben, the child with the highest IQ, mastered his letter-sounds by the fifth session, but it took him three more sessions to master blending the sounds together to read his target words.

The second research question asked whether these children were able to generalize their decoding skills from known words to untaught words from analogous word families. To find the answer, each child was given a probe between interventions. The results from the probe showed increases for all three children's letter-sound decoding and word reading abilities over baseline. Anna had the most significant increase in letter-sound decoding. Scoring 97%, she was the only child to generalize her letter-sound decoding from known words to untaught words in a short period of time (generalization was inferred when a child achieved 92% correct or greater for decoding letter-sounds and word reading). Eddie and Ben scored 75% and 72% respectively on the probe for letter-sound decoding, which showed impressive gains over baseline. These gains, however, were not sufficient to infer generalization. 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 (Tyang, Hanneke, & Carbonell, 2013).

In summary, all three children demonstrated good letter-sound decoding skills prior and during the intervention. This may not be too surprising given that schools typically emphasize teaching letter-sound correspondence until proficiency (Steele et al., 2013). Graphical analysis shows that this is very much the case for these three children. However, their strong letter-sound decoding ability belies a much larger difficulty. Throughout the study, letter-sound decoding skills significantly out-paced word reading ability. These results corroborate the findings of Steele et al. (2013), who found that all too often reading instruction for children with Down syndrome begins and ends with letter-sound correspondence instruction and does not adequately teach to higher order processes such as understanding the alphabet principle and blending sounds together to read words. The students in Cohen et al. (2008) demonstrated similar results.

Word Reading

In the present study, the children were tasked with learning to decode 3-letter words in c-v-c pattern with each child's word list composed of 12-13 letter-sounds. It took the children anywhere between five to ten sessions to learn to read their words during the first intervention. Anna learned her target words most rapidly, reaching mastery in five sessions, even though her scores on the phonological assessments were among the lowest in the group. Although Eddie took the longest to reach mastery, he demonstrated very steady progress and made consistent gains from session to session. More so than the other children, Eddie's word reading progress closely matched his progress for decoding letter-sounds.

All children demonstrated strength in their ability to learn to read words during the first intervention phase over baseline. However, after mastering word reading of the target words, all children had difficulties generalizing their ability to read analogous words from the same word families on the probe. They, did however, demonstrate increased efficiency for word reading over their baseline results. The results of the probe indicate that while letter-sound correspondence was significantly strengthened, blending was still difficult. Perhaps the children needed additional practice to help them generalize their skills to read analogous words on the probe.

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. Although Ben took the longest to reach word reading mastery during the second intervention phase, his letter-sound decoding was almost consistently above 90% correct. Eddie had the greatest improvement over the first intervention phase, accurately decoding 100% of his letter-sounds across four sessions.

Error Analysis. Unequivocally, the most frequent type of error made during the early stages of both intervention phases and the probe were vowel substitution errors (e.g., substituting the short "a" sound with a short "i" sound in the word "sat", or the short "a" sound with a short "i" sound in the word "mat"). Errors made with vowels over consonants are theorized to be part of the child with Down syndrome's auditory dysfunction, which inhibits the child's ability to keep and recognize the sounds associated with vowels (see Purser & Jarrod, 2013 for a review). Viewed in isolation, these types of errors were not unexpected and may be a result of word guessing. However, when these errors are reviewed in relation to the errors made during word reading, an interesting pattern emerged across the children. For example, when Ben was presented with the word “sat”, and asked to decode the letter-sounds, he decoded the word as /s/-/short “i” sound/-/t/. However, when asked to blend the sounds together to read the word (even after correction) he said, “sit” and not “sat.” Across all three children there were fifty examples of this type of error. This pattern demonstrates that each child was able to keep and blend three discreet sounds in their short-term memory, even if they misidentified them initially. These vowel substitution errors suggest that decoding letter-sounds within a word may be problematic.

Effectiveness of Intervention and Child Characteristics

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 auditory short-term memory deficits that are greater than in children with unspecified causes for intellectual disability who are of equivalent chronological age and IQ level (e.g., Baddeley & Jarrold, 2007; Marcell, Ridgeway, Sewell & Whaeln, 1995; Marcell & Weeks, 1998; Marcell, Harvey & Cothran, 1998). Deficits in auditory 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). In the present study, all three children were of similar age, IQ levels, and reading levels. Anna and Ben’s scores on the subtests for phonological memory on the *CTOPP-2* were in the “poor” and “very poor” range, respectively, and Eddie’s scores were in the “average” range.

Anna learned her first word set in the fewest number of sessions and was one of the quickest to reach criterion during the second intervention session, increasing her word reading efficiency by 20%. Her quick ascent however belies her rather unremarkable scores on the *CTOPP-2*, where she scored in the "below average" range on the PACS and in the "poor" range on the PMCS. Her score on the *Memory for Digits* subtest was in the "very poor" range. Although Anna made the quickest acquisition during both intervention phases and scored the highest on the probe, she demonstrated some of the weakest skills for phonological memory. These results stand in contrast to others (Cohen et al., 2008 & Conners et al., 2001) who found that the strongest decoders had stronger phonological memory. Anna's findings represent a conundrum: "whereas many children with Down syndrome can learn to read to some level of mastery… the foundation skills that underpin reading are not secure." (Baylis and Snowling, 2011 p. 39). Perhaps as some have suggested for children with Down syndrome, Anna might be an example of a child whose reading abilities develop on a path that is atypical from other children with and without disabilities (Boudreau et al., 2002: Gombert, 2002; Snowling et al., 2002).

Eddie spent the longest amount of time in the first intervention phase; however, during the second phase he reached mastery quickly, demonstrating a 60% increase in learning to read his target words. Although Eddie was the youngest of the three children, he was also the strongest at verbally expressing himself. More telling however, were his scores on the *CTOPP-2*. He was the only child to score in the average range on both the PACS and PMCS. He also scored the highest on the *Memory for Digits* subtest. His phonemic awareness and memory skills appeared to have aided him to increase his word reading efficiency during the second phase. His assessment performance is a strong indication that in time and with practice, Eddie has a strong potential to become a successful reader (Conners, et al., 2001; Gombert, 2002; Lemons and Fuchs 2010a).

Ben took the longest to master his words during the second intervention phase, and only increased his efficiency from the first intervention phase by 12%. Although he took the longest to reach criterion and made the smallest overall improvements in word reading, his trajectory throughout was consistently positive. One explanation for Ben's performance might be related to deficits in phonological processing. Ben's composite scores on the PACS placed him in the "very poor" range (the lowest out of the three children) and his PMCS scores placed him in the "poor" range. Ben's deficits in both these areas may have affected his ability to make stronger gains during the second phase. In addition, maintaining a more consistent intervention schedule might have been more advantageous for Ben, helping him to recall the letter-sounds from session to session.

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 intellectual disabilities can learn to blend phonemes in words when provided with targeted instruction in a short period of time (Burgoyne et al., 2013). This study may add further evidence of the efficacy of phonics-based reading programs for children with intellectual disabilities, and in the case of the present study, children with Down syndrome (Baylis & Snowling, 2012; Burgoyne et al., 2010a; Goetz et al., 2008; Lemons and Fuchs, 2010b).

Three-step Decoding Strategy

It is well established that effective interventions for decoding deficits involve work on letter-sound knowledge and blending (see Lemons & Fuchs, 2010a, 2010b for a review). Research has shown that the most effective method of teaching phonics skills is through explicit, systematic and multi-sensory instruction (e.g., Cologon et al., 2007; Goetz et al., 2008; Kennedy & Flynn, 2002). In terms of reading strategies, Naess et al. (2012) found that the best strategies for children with Down syndrome are those that incorporate expressive and receptive language skills and that are highly structured, minimize demand on auditory memory and occur in a predictable learning environment. The decoding strategy, 3-SDS, used in the present study integrates many of these suggestions.

In terms of the 3-SDS as a strategy, the children had the most difficulty with the third step, 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. 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 students and cause confusion. The children in the present study did not have a problem understanding the "blending concept" used in the strategy, but students in the Cohen et al. (2008) study did demonstrate some consternation during the blending assessment. New 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 students. Students are better able to engage with the letters, as some applications respond to the student's touch. These types of applications are now becoming more accessible through niche companies specializing in applications and software for education.

In addition, the strategy may be equally effective working with children who are not special needs students, but still, nevertheless, struggle with learning phonics skills. Students in the second and third tiers of an intervention cycle, who need direct and implicit instruction in learning to read may benefit from the direct and explicit instruction the strategy offers.

Constant Time Delay

This study adds further support to the work of Wolery et al. (1992) and Cohen et al. (2008) for the use of constant time delay as an instructional procedure to teach phonics skills. The procedure has been used widely to teach sight-word instruction to children with intellectual disabilities and less frequently to teach phonics skills (e.g., Browder & Xin, 1998; Conners, 1992; Hoogeveen, Birkhoff, et al., 1989; Singh & Singh, 1985; 1988). 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 Anna, 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 the graphs indicate, as time went on, more errors were 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.

Summary

In summary, the results from the present study demonstrated all three children had strong letter-sound decoding skills compared to word reading skills, and that good letter-sound decoding skills do not necessarily equate to efficient word reading skills. Clearly, this was the case for Ben and Eddie, who took a significant amount of time to master word reading after mastering letter-sound decoding during the first and second intervention phases. Results from the probe showed that although all three children increased their word reading accuracy, none of the children were able to successfully increase their word reading accuracy to infer generalizability. However, the study clearly shows that in time and with targeted reading instruction children with mild intellectual disabilities might be successful at increasing their accuracy for letter-sound decoding and word reading. With respect to phonological memory the results were mixed. Anna, who obtained some of the lowest scores on the assessments for phonological memory performed the best during the intervention phases and the probe. In contrast Eddie attained the highest scores on assessments for phonological memory but took the longest to reach mastery during the first intervention phase. However, his significant increases for word reading accuracy during the second intervention phase may suggest that his memory may have assisted him in efficiently mastering his new words. Finally, results from the pre- and post-word attack assessment demonstrated that all three children increased their performance, which may suggest that the 3-SDS used simultaneously with the 4-seconds CTD procedure may be effective at helping children read nonsense words. It is important to note that the children in the present study had a variety of resources available to them including strong parent support, strong teachers and access to technology. These types of resources may have enhanced the results. Results for children that do not have these same or similar types of supports may be different.

Limitations

Although the researcher made every effort to standardize all procedures, there are always trade-off between threats to internal and external validity. In terms of internal validity, history posed the most apparent threat (Kazdin, 1984; Kennedy, 2005). 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 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. The parent interview revealed that it was commonplace for parents to spend several hours a week working on reading activities with their children. Parents also reported their children regularly spent several hours a week using computers and tablet devices to work on didactic reading activities that included skill development in comprehension, vocabulary and phonics. 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 (i.e., *N*=3) 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) (Horner et al., 2005). 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. Horner and colleagues (2005) suggest that external validity is improved when a study is replicated at least five times by three different researchers, from different geographical locations with at least 20 participants. With respect to generalizing these findings to children with different genotypes for intellectual disability, more research is needed.

Future Considerations

Although the 3-SDS and the CTD procedure were both used to advance the efficiency of word reading for all three children, additional studies are needed to further investigate the effects of this intervention with a more diverse sample of children, especially children with lower IQs and children with a different form of intellectual disability to discover if the intervention is equally effective with these populations.

This study contributes to the limited research using a time delay procedure to teach phonics skills to children. Although the 4-CTD procedure was used effectively in the present study to teach students how to blend sounds together to read words, future researchers may also want to consider the efficiency of using a progressive time delay (PTD) to teach decoding skills to children. A PTD procedure with a 2- or 3-second delay would allow the corrective prompt to be provided sooner, allowing participants to experience more errorless learning during the intervention. In the present study, the majority of time-delay related errors occurred because the child responded incorrectly before the 4-second interval expired (non-wait error). Cohen and colleagues (2008) came to a similar conclusion with the participants in their study.

The role of phonological memory and how it affects a child's ability to decode needs further investigation. Conners et al. (2001) and Cohen et al. (2008) found that participants who performed better on tasks for phonological memory also performed better on decoding tasks.

Results from this study do not align with this conclusion. One child had relatively high scores on his phonological memory assessments, but was among the weakest decoders. Conversely, another child scored in the “poor” range on her phonological memory assessments, but was a relatively strong decoder compared to the other children. Hence, more investigation needs to be done on the correlation between phonological memory and decoding.

Maintaining consistent schedule intervention schedule is important to achieve optimal results in a study (Gresham, MacMillian, Beebe-Franenberger, & Bocian, 2000). In the present study the intervention took place after school in each child’s home. Although this structure allowed the child’s parents a great deal of scheduling flexibility, it also created an impermanent intervention schedule from week to week for some children. Future researchers should consider working with children in a setting where attendance is not in flux and more highly regulated, such as in a school setting.

Future studies may want to expand on these findings and include other variables. Generalization of newly acquired decoding abilities can be expanded to include reading-acquired words in different settings and context (Van Bysterveldt et al., 2006; Roch, Florit &, Levorate, 2013). Van Bysterveldt and colleagues (2006) accomplished this by first teaching children phonics-based skills using plastic letters and storybooks. Once the children became familiar with the letter-sounds they were directed to words composed from these same letters in storybooks. The present study could be augmented to include a second probe that assesses the child’s efficiency to read newly mastered letter-sound knowledge in the context of a story.

The present study investigated a child’s ability to learn how to decode letter-sounds and to generalize this knowledge to read unknown words. Future research in this area may want to augment this study to include a comprehension component to investigate if knowledge of word meaning increases decoding efficiency for this population. For example, it is has been shown that if a word is in a child's listening/speaking vocabulary prior to experiencing the word in print for the first time the child will have an easier time decoding the word (Chard, Pikulski, & Templton, 2000). Future researchers may want to investigate the effects of introducing new words into a child's listening/speaking vocabulary prior to presenting the word in print in order to discover if decoding efficiency is increased.

Finally, the nature of the 3-SDS is such that the child experience each target-word in the same order multiple times during the course of an intervention cycle. This combined with the number of corrective prompts provided by the researcher may promote word memorization on the part of some children. This may explain why the children were able to successfully read a word during the third intervention step, but were not able to successfully decode each letter-sound in the word accurately during the second intervention step. To prevent the possible effects of word order contributing to word memorization, future researchers may want to consider periodically changing the order in which the words are presented.

Implications for Schools, Teachers, and Parents

The decoding strategy and time delay procedures may 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 all students, with or without disabilities. In addition to training para-professionals on how to use this strategy with students, other modifications 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.

Implementing the time delay procedure in a classroom setting is a bit more challenging. Although the procedure has been used successfully in a classroom setting to teach phonics-based skills (i.e., Cohen et al., 2008), the procedure requires a strict adherence to time management, which may prove difficult for teachers to implement successfully in their classrooms. Para-professionals however can be taught the procedure to work one-on-one with students. Implementing the procedure in a small group format would be difficult to manage with or without the aid of a para-professional, as managing the features of the time delay procedure for each student would most like become overly burdensome.

Finally, parents and siblings can be instructed how to use the 3-SDS and time delay procedure at home. Using the strategy at home as a supplement to school-based reading instruction may provide children with additional support and practice in both letter-sound decoding and word reading.

Conclusion

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 students are endowed with the knowledge of learning how to read. This mission is especially important for teachers who instruct special populations of students. Of these populations, children with Down syndrome make the largest class of students with intellectual disabilities in our schools.

Historically, children with Down syndrome were instructed to read using a sight-word curriculum. Although effective, it does little to inform decoding, which is fundamental to becoming a successful reader. “Decoding skills need to build on a foundation of oral language and phonemic and orthographic awareness in children.” (Chard, Pikulski, & Templeton, 2000, p. 10). Simply memorizing words does not provide this level awareness. Today, thankfully, research has demonstrated that in time children with Down syndrome can become successful, accomplished readers through a phonic-based curriculum (see Lemons and Fuchs, 2010a for a review). However, what is less clear is how specific phonemic awareness skills (i.e., rhyming) 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 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.

REFERENCES

Allor, J. H., Mathes, P. G., Jones. F. G., & Roberts, J. K. (2010). Teaching children with moderate intellectual disability to read: An experimental examination of a comprehensive reading intervention. *Education and Training in Autism and Developmental Disabilities, 45*(1), 3-22.

Al Otaiba, S., & Hosp, M. (2004). Providing effective literacy instruction to children with Down syndrome. *Teaching Exceptional Children*, *36*(4), 28-35.

American Pregnancy Association. (2010). *Down syndrome: Trisomy 21*. Retrieved from www.americanpregnancy.org/birthdefects/downsyndrome.html

Baddeley, A., & Jarrold, C. (2007). Working memory and Down syndrome. *Journal of Intellectual Disability Research*, *51*(12), 925-931. doi:10.1111/j.1365-2788.2007.00979.x

Ballin, L., & Balandin, S. (2007). An exploration of loneliness: Communication and the social networks of older people with cerebral palsy. *Journal of Intellectual & Developmental Disability, 32*(4), 315-327. doi:10.1080/13668250701689256

Barudin, S., & Hourcade, J. (1990). Relative effectiveness of three methods of reading instruction in developing specific recall and transfer skills in learners with moderate to severe mental retardation. *Education and Training in Mental Retardation and Developmental Disabilities, 25*(3), 286-291.

Basil, C., & Reyes, S. (2003). Acquisition of literacy skills by children with severe disability. *Child Language and Teaching Therapy*, *19*(1), 27-48. doi:10.1191/0265659003ct242oa

Baylis, P., & Snowling, J., M. (2012). Evaluation of phonological reading programme for children with Down syndrome. *Child Language Teaching and Therapy*, *28*(1), 39-56. doi:10.1177/0265659011414277

Bertelson, P. (1993). Reading acquisition and phonemic awareness testing: How conclusive are data from Down's syndrome? (Remarks on Cossu, Rossini, and Marshall, 1993). *Cognition*, *48*(3), 281-283. doi:10.1016/0010-0277(93)90043-U

Bishop, M. (1983). The Test for Reception of Grammar [TROG]. Manchester, England.

Black, R., Waller, A., Pullin, G., & Abel, E. (2008). Introducing the PhonicStick: Preliminary evaluation with seven children. Dundee: School of Computing, University of Dundee. Retrieved from http://phonicstick.computing.dundee.ac.uk/ download/ISAAC2008_PS_Black et al.pdf

Boudreau, D. (2002). Literacy skills in children and adolescents with Down syndrome. *Reading and Writing: An Interdisciplinary Journal*, *15*(5/6), 497-522. doi:10.1023/A:1016389317827

Bower A, Cuskelly M, Jobling A. (2005, June). *Fathers' experiences of parenting a child with Down syndrome*. Paper presented at the 1st Asia-Pacific Regional Congress of International Association for the Scientific Study of Intellectual Disabilities. Taipei, Taiwan. Retrieved from: http://www.down-syndrome.org/reviews/2079/

Bower, A., & Hayes, A. (1994). Short-term memory deficits and Down syndrome: A comparative study. *Down Syndrome Research and Practice*, *2*(2), 47-50. doi:10.3104/reports.29

Browder, D., & Xin, Y. (1998). A meta-analysis and review of sight word research and its implications for teaching functional reading to individuals with moderate and severe disabilities. *The Journal of Special Education*, *32*(3), 130-153. doi:10.1177/002246699803200301

Browder, D. (2001). *Curriculum and assessment for children with moderate and severe disabilities.* New York: The Guilford Press.

Browder, D., Ahlgrim-Delzell, L., Courtade-Little, G., & Snell, M. (2006). General curriculum access. In M. Snell & F. Brown (Eds.), *Instruction of children with severe disabilities* (6th ed., pp. 489-523). Upper Saddle River, NJ: Merrill/Prentice Hall.

Browder, D., Wakeman, S., Spooner, F., Ahlgrim-Delzell, L., & Algozzine, B. (2006). Research on reading instruction for individuals with significant cognitive disabilities. *Exceptional Children, 72*(4), 392-408.

Browder, D., et al. (2008). Literacy for children with severe developmental disabilities. *Remedial and Special Education*, *20*(10), 1-14. doi:10.1177/0741932508315054

Browder, D., Ahlgrim-Delzell, L, Courtade, G., Gibbs, L., S., & Flowers, C. (2008). Evaluation of the effectiveness of an early literacy program for students with significant developmental disabilities. *Exceptional Children*, *75*(1), 33-52.

Browder, D., Flowers, C., & Wakeman, S. (2008). Facilitating participation in assessments and the general curriculum level of symbolic communication classification for children with significant cognitive disabilities. *Assessment in Education: Principles, Policy & Practice, 15*(2), 137-151. doi:10.1080/09695940802164176

Browder, D. (2009). Literacy for students with severe developmental disabilities: What should we teach and what should we hope to achieve? *Remedial and Special Education, 30*(5), 269-282. Doi: 10.1177/0741932508315054

Browder, D., Ahlgrim-Delzell, L., Flowers, C., & Baker, J. (2012). An evaluation of a multicomponent early literacy program for students with severe developmental disabilities. *Remedial and Special Education*, *33*(4), 237-246. doi:10.1177/07411932510387305

Buckley, S. J. (1995). Attaining basic educational skills: reading, writing and number. In Lane, D. and Stratford, B. (Eds.). *Current approaches to Down syndrome*. Holt, Rinehart, Winston.

Buckley, S., Bird, G., & Byrne, A. (1996). Reading acquisition by young children. In Stratford B. and Gunn, B. (Eds.). *New approaches to Down syndrome*. (pp. 268-279). London: Cassell.

Buckley, S. J. (2000). Speech, language and communication for individuals with Down syndrome: An overview. *Down Syndrome Issues and Information*, *1*(4), 1-4. doi:10.3104/9781903806005

Buckley, S. J. (2005). Specificity in Down syndrome. *Down Syndrome News and Update*, *4*(3), 81-86.

Buckley, S. J., Bird, G., Sacks, B., Archer, T. (2006). A comparison of mainstream and special education for teenagers with Down syndrome: Implications for parents and teachers. *Down's syndrome, Research and Practice. 9*(3), 54-67. doi: 10.3104/reports.295

Burgoyne, K. (2009). Reading interventions for children with Down syndrome. *Down Syndrome Research & Practice*. 1-16. doi: 10.3104/reviews.2128

Burgoyne, K., Duff, F. J., Clarke, P. J., Buckley, S., Snowling, M. J., & Hulme, C. (2012). Efficacy of a reading and language intervention for children with Down syndrome: A randomized controlled trial. *The Journal of Child Psychology and Psychiatry*, *53*(10), 1044-1053. doi:10.111/j.1469-7610.2012.02557.x

Burgoyne, K., Duff, F., Snowling, M., Buckley, S., & Hulme, C. (2013). Training phoneme blending skills in children with Down syndrome. *Child Language Teaching and Therapy, 29*(2), 1-18. doi:10.1177/0265659012474674

Bursuck, W. D., & Damer, M. (2007). *Reading instruction for children who are at risk or have disabilities.* New York, NY: Pearson Education, Inc.

Byrne, B. (1993). Learning to read in the absence of phonemic awareness? A comment on Cossu, Rosini, and Marshall (1993). *Cognition*, *48*(3), 94-98. doi:10.1037/0022-0663.85.1.104

Byrne, A., MacDonald, J., Buckley, S. (2002). Reading, language and memory skills: A comparative longitudinal study of children with Down syndrome and their mainstream peers. *British Journal of Educational Psychology*, *72*(4), 513-529. doi:10.1348/00070990260377497

Calhoon, J. A. (2001). Factors affecting the reading if rimes in words and non-words in beginning readers with cognitive disabilities and typical developing readers: Exploration in similarity and differences in word recognition cue use. *Journal of Autism and Developmental Disorders, 31*(5)*,* 491-505. doi:10.1023/A:1012268909286

Campbell, T., D & Stanley C., J. (1963). *Experimental and quasi-experimental designs for research.* Boston, MA: Houghton Mifflin Company.

Cardoso-Martins, C., & Frith, U. (2001a & 2001b). Can individuals with Down syndrome acquire alphabetic literacy skills in the absence of phoneme awareness? *Reading and Writing: An Interdisciplinary Journal, 14*(3/4), 361-375. doi:10.1023/A:1011132124630

Cardoso-Martins, C, Michalick, M. F., & Pollo, T. C. (2002). Is sensitivity to rhyme a developmental precursor to sensitivity to phoneme? Evidence from individuals with Down syndrome. *Reading and Writing: An Interdisciplinary Journal*, *15*(5/6), 439-454. doi:10.1023/A:1016330313939

Cardoso-Martins, C., Peterson, R., Olson, R., & Pennington, B. (2009). Component reading skills in Down syndrome. *Reading and Writing*, *22*(3), 277-292. doi:10.1007/s11145-007-9114-6

Carr, E., J. (2005). Recommendations for reporting multiple-baseline designs across participants. *Behavioral Interventions*, *20*(3), 219-224. doi: 10.1002/bin.191

Catts, H. W. (1993). The relationship between speech-language impairments and reading disabilities. *Journal of Speech and Hearing Research*, *36*(5), 948–958.

Catts, H. W., & Kamhi, A. G. (Eds.). (1999). *Language and reading disabilities*. Needham Heights, MA: Allyn & Bacon.

Center for Disease Control. (2010). *FMRI and Down syndrome*. Retrieved from http://www.cdc.gov/hugenet/factsheets/DS

Chall, J.S. (1967). *Learning to read: The great debate.* New York: McGraw-Hill.

Chall, J.S. (1996). *Learning to read: The great debate*. Fort Worth: Harcourt Brace College Publishers.

Chapman, S. R., & Hesketh, J. L. (2001). Language, cognition, and short-term memory in individuals with Down syndrome. *Down Syndrome Research and Practice, 7*(1), 1-7.

Christ, J., T. (2007). Experimental control and threats to internal validity of concurrent and nonconcurrent multiple baseline designs. *Psychology in the Schools*, *44*(5), 451-459. doi: 10.1002/pits.20237

Cihak, F. D., Kessler, K., & Alberto, A. P. (2008). Use of a handheld prompting system to transition independently through vocational tasks for children with moderate to severe intellectual disabilities. *Education and Training in Developmental Disabilities*, *43*(1), 102-110.

Cohen, E., Wolff Heller, K., Alberto, P., & Fredrick, D. L. (2008). Using a three-step decoding strategy with constant time delay to teach word reading to children with mild and moderate mental retardation. *Focus on Autism and Other Developmental Disabilities*, *23*(2), 67-77. doi:10.1177/1088357608314899

Cologon, K., Cupples, L., & Wyver, S. (2011). Effects of targeted reading instruction on phonological awareness and phonics decoding in children with Down syndrome. *American Association on Intellectual and Developmental Disabilities*, *116*(2), 111-129. doi:10.1352/1944-7558-116.2.111

Conners, F. (1992). Reading instruction for children with moderate mental retardation. Review and analysis of research. *American Journal on Mental Retardation, 96*(6), 577-597.

Conners, A., F. (2003). Language and communication in mental retardation reading skills and cognitive abilities of individuals with mental retardation. *International Review of Research in Mental Retardation*, *27*, 191-129. doi: 10.1016/S0074-7750(03)27006-3

Conners, F., Atwell, J., Rosenquist, C., & Sligh, A. (2001). Abilities underlying decoding differences in children with intellectual disability. *Journal of Intellectual Disability Research, 45*(4)*,* 292-299. doi:10.1046/j.1365-2788.2001.00319.x

Conners, F., Rosenquist, C., Sligh, A., Atwell, J., & Kiser, T. (2006). Phonological reading skills acquisition by children with mental retardation. *Research in Developmental Disabilities, 27*(2)*,*121-137. doi:10.1016/j.ridd.2004.11.015

Cossu, G., & Marshall, J. C. (1990). Are cognitive skills a prerequisite for learning to read and write? *Cognitive Neuropsychology*, *7*(1), 21-40. doi:10.1080/02643299008253433

Cossu, G., Rossini, F., & Marshall, J. C. (1993). When reading is acquired but phonemic awareness is not: A study of literacy in Down's syndrome, *Cognition*, *46*(2), 129-138. doi:10.1016/0010-0277(93)90016-O

Cupples, L., & Iacono, T. (2000). Phonological awareness and oral reading skills in children with Down syndrome. *Journal of Speech, Language, and Hearing Research, 43*(3), 595-608. doi:10.92-4388/00/4303-0595

Cupples, L., & Iacono, T. (2002). The efficacy whole word versus analytic reading instruction for children with Down syndrome. *Reading and Writing: An Interdisciplinary Journal*, *15*(5/6)*,* 549-574. doi:10.1023/A:1016385114848

Cuskelly, M., Jobling, M.A., Chant, D., Bower, A. and Hayes, A. (2002). Multiple perspectives of family life. In M. Cuskelly, A. Jobling and S. Buckley (Eds.), *Down syndrome across the life span* (pp. 159-173) London: Whurr.

Cuskelly, M., Hauser-Cram, P., & Van Riper, M. (2008). Families of children with Down syndrome: What we know and what we need to know. *Down Syndrome Research and Practice,*105-113. doi:10.3104/reviews.2079

Dunn, M. L., Dunn, M., D., Whetton, C. W., & Burley, J. (1997). The British picture vocabulary scales, 2nd edition. Windsor, UK: NFER Nelson.

Dunn, M., L., & Dunn, M., D. (2007). Peabody Picture Vocabulary Test, 4th Edition. San Antonio, US: Pearson Publishing.

Ehri, K., & Masataka, N. (2001). Co-occurrence of pre-verbal vocal behavior and motor action in early infancy. *Developmental Science, 4*(2), 40-48. doi:10.1017/S095457940707006X

Evans, R. (1994). Phonological awareness in children with Down syndrome*, Down's Syndrome Research & Practice, 2*(3), 102-107. doi:10.3104/reports.38

Fidler, D. J. (2005). The emerging Down syndrome behavioral phenotype in early childhood *Infants & Young Children, 18*(2), 86-103.

Fidler, D. J., Most, D. E., & Guiberson, M. M. (2005), Neuropsychological correlates of word identification in Downs syndrome. *Research in Developmental Disabilities*, *26*(5), 487-501. doi:10.1016/j.ridd.2004.11.007

Fletcher, H., & Buckley, S. (2002). Phonological awareness in children with Down syndrome. *Down Syndrome Research and Practices, 8*(1), 11-18. doi:10.3104/reports.123

Flores, M. M., Shippen, E. M., & Alberto, P. (2004). Teaching letter-sound correspondence to children with moderate intellectual disabilities. *Journal of Direct Instruction*, *4*(2), 173-188.

Fowler, A. E., Doherty, B. J., & Boyton, L. (1995). The basis of reading skill in young adults with Down syndrome. L. Nadel & D. Rosenthal (Eds.). *Down Syndrome: Living and learning in the community,*182-196. New York, NY: Wiley-Liss.

Frechtling, J. A., Zhang, X., & Silverstein, G. (2006). The voyager universal literacy system: Results from a study of kindergarten children in inner-city schools. *Journal of Education for Childs Placed At-Risk, 11*(1), 75-95. doi:10.1207/s15327671espr1101_5

Fredrick, L. D., Davis, D. H., Alberto, P. A., Waugh, R. E. (2013). From initial phonics to functional phonics: Teaching word-analysis skills to students with moderate intellectual Disabilities. *Education and Training in Autism and Developmental Disabilities*, *48*(1), 49-66.

Gerber, J., P. (2012). The impact of learning disabilities on adulthood: A review of the evidence-based literature for research and practice in adult education. *Journal of Learning Disabilities*, *45*(31), 31-46. doi:10.1177/0022219411426858

Gersten, R., & Maggs, A. (1982). Teaching the general case to moderately retarded children: Evaluation of a five-year project. *Analysis and Intervention in Developmental Disabilities*, *2*(4), 29-334.

Gilles, C. (2006). An invitation for a special issue on whole language. *International Journal of Progressive Education*, *2*(2), 1-16.

Goetz, K., Hulme, C., Brigstock, S., Carroll, J. M., & Nasir, L. (2008). Training reading and phoneme awareness skills in children with Down syndrome. *Reading and Writing, 21*(4), 395-412. doi:10.1007/s11145-007-9089-

Gombert, J. (2002). Children with Down syndrome use phonological knowledge in reading. *Reading and Writing: An Interdisciplinary Journal*, *15*(5/6), 455-469. doi:10.1023/A:1016324016485

Goodman, K. (1982). *Language and Literacy*. Boston, MA: Routledge & Kegan.

Gove, M. K. (1983). Clarifying teachers' beliefs about reading. *The Reading Teacher, 37*(3), 261–268.

Groen, M. L., Laws, G., Nation, K., & Bishop, D., V.M. (2006). A case of exceptional reading accuracy in a child with Down syndrome: Underlying skills and the relation to reading comprehension. *Cognitive Neuropsychology*, *23*(8), 1190-12114. doi:10.1080/02643290600787721

Hannah, M., Midlarsky, E., & MacLean E., W. (2005). Helping by siblings of children with mental retardation. *American Journal on Mental Retardation*, *110*(2), 87-99.

Harste, C. J. (1990). What do we mean by literacy now? *Voices from the Middle*, *10*(3), 8-12. doi:10.1.204.232.153.98

Harvey, T., M., May, E., M., & Kennedy, H., C. (2004). Nonconcurrent multiple baseline design and the evaluation of educational systems. *Journal of Behavioral Education*, *13*(4), 267-276. doi: 10.1023/B:JOBE.0000044735.51022.5d

Hatcher, P. J., Hulme, C., & Ellis, A. W. (1994). Ameliorating early reading failure by integrating the teaching of reading and phonological skills-the phonological linkage hypothesis. *Child Development*, *65*(1), 41-57. doi:10.1111/j.1467-8624.1994.tb00733.x

Hecht, S. A. (2003). A study between Voyager and control schools in Orange County, Florida 2002-2003. Retrieved from http://www.voyagerlearning.com/docs/difference/report_studies/ocps_2002_03.pdf

Hedov, G., Anneren, G., & Wikblad, K. (2002). Swedish parents of children with Down syndrome. *Scandinavian Journal of Caring Sciences*, *16*(4), 424-430. doi: 10.1046/j.1471-6712.00109x

Hedov, G. (2006). Sickness absence in Swedish parents of children with Down syndrome: relation to self-perceived health, stress and sense of coherence. *Journal of Intellectual Disability Research*, *50*(7), 546-552. doi: 10.1111/j. 1365-2788.2006.00810.x

Hedrick, W., Katims, D., & Carr, N. (1999). Implementing a multi-method, multilevel literacy program for children with mental retardation. *Focus on Autism and Other Developmental Disabilities*, *14*(4)*,* 231-240. doi:10.1177/108835769901400405

Hodapp R.M, Glidden, L., & Kaiser, P. A. (2005). Siblings of persons with disabilities: Toward a research agenda. *Mental Retardation*, *43*(5), 334-338.

Hoogeveen, F. R., Smeets, P. M., & Van der Houven, J. E. (1987). Establishing letter-sound correspondence in children classified as trainable mentally retarded. *Educational and Training in Mental Retardation and Developmental Disabilities, 22*(2), 77-84.

Hoogeveen, F. R., Smeets, P. M., & Lancioni, G. E. (1989). Teaching moderately retarded children basic reading skills. *Research in Developmental Disabilities, 10*(1), 1-18. doi:10.1016/0891-4222(89)90025-5

Horner, R. H., et al. (2005). The use of single-subject research to identify evidence-based practices in special education. *Exceptional Children*, *71*(2), 165-179.

Hughes, A. T., Fredrick, D. L., & Keel, C. M. (2002). Learning to effectively implement constant time delay procedures to teach spelling. *Learning Disability Quarterly*, *25*(3), 209-222.

Hulme, C., Goetz, K., Brigstocke, S., Nash, H. M., Lervag, A., & Snowling, J. M. (2012). The growth of reading skills in children with Down syndrome. *Developmental Science*, *15*(3), 320-329. doi:10.1111/j.1467-7687.2011.01129.x

Individuals for Disabilities Education Act of 2004: U. S. Department of Education Federal Register; 2005, Washington, DC: General Printing Office Vol. 70.

Jameson, M. J., McDonnell, J., Polychronis, S., & Riesen, T. (2005). Embedded, constant time delay instructions by peers without disabilities in general education classrooms. *Intellectual and Developmental Disabilities*, *46*(5), 346-363. doi:10.1352/2008.46:346-363

Jones, E. A., Carr, E. G., & Feeley, K. M. (2006). Multiple effects of joint attention intervention for children with autism. *Behavior Modification*, *30*(6), 782-834. doi:10.1177/0145445506289392

Joseph, L. M., & Seery, M. (2004). Where is the phonics? *Remedial and Special Education, 25*(2), 88-94. doi:10.1177/07419325040250020301

Katims, D. (2000). Literacy instruction for people with mental retardation: Historical highlights and contemporary analysis. *Education and Training of Mentally Retarded, 35*(1), 3-15.

Kay-Raining Bird, E., Cleave, P. L., & McConnell, L. (2000). Reading and phonological awareness in children with Down syndrome: A longitudinal study. *American Journal of Speech-Language Pathology, 9*, 319-330.

Kazdin, A. E. (1975). Characteristics and trends in applied behavior analysis. *Journal of Applied Behavior Analysis, 8*(3), 332-356. doi:10.1901/jaba.1975.8-332

Kennedy, E., & Flynn, M. (2003). Training phonological awareness skills in children with Downs syndrome. *Research in Developmental Disabilities, 24*(1)*,* 44-57. doi:10.1016/S0891-4222(02)00168-3

Kennedy, C. (2005). *Single-case designs for educational research*. New York: Allyn and Bacon.

Kliewer, C., Biklen, C., & Kasa-Hendrickson, C. (2006). Who may be literate? Disability and resistance to the cultural denial of competence, *American Educational Research Journal*, *43*(2), 163-192. doi:10.3102/00028312043002163

Koppenhaver, A. D., Coleman, P. P., Kalman, L. S., & Yoder, E. D. (1991). The implications of emergent literacy for children with developmental disabilities. *American Journal of Speech-Language Pathology*, *1*(1)*,* 38-44.

Koppenhaver, D., & Yoder, D. E. (1993). Classroom literacy instruction for children with severe speech and physical impairments (SSPI): What is and what might be. *Topics in Language Disorders, 13*(2), 1-15.

Kuhn, R. L., Bodkin, E., Devlin, D. S., & Doggett, A. R. (2008). Using pivotal response training with peers in special education to facilitate play in two children with Autism. *Education and Training in Developmental Disabilities, 43*(1), 37-45.

Laing, A. (2002). Investigating reading in atypical participants: The case of Williams syndrome. *Reading and Writing: An Interdisciplinary Journal*, 15(5/6), 575-587. doi: 10.1023/A:1016344519890

Lane, S., & Critchfield, T. (1998). Classification of vowels and consonants by individuals with moderate mental retardation. Development of arbitrary relations via match-to sample training with compound stimuli. *Journal of Applied Behavior Analysis, 31*(1), 21-41. doi:10.1901/jaba.1998.31-21

Lane, K., Wolery, M., Reichow, B., & Rogers, L. (2007). Describing baseline conditions: Suggestions for study reports. *Journal of Behavior and Education*, *16*(3), 224-234. doi:10.1023/A:101636412681710.1007/s10864-006-9036-4

Laws, G., & Gunn, D. (2002). Relationships between reading, phonological awareness and language development in individuals with Down syndrome: A five year follow-up study. *Reading and Writing: An Interdisciplinary Journal*, *15*(5/6), 527-548. doi:10.1023/A:1016364126817

Lemons, C. J., & Fuchs, D. (2010a). Modeling response to reading intervention in children with down syndrome: An examination of predictors of differential growth. *Reading Research Quarterly*, *45*(2), 134-168. doi:10.1598/RRQ.45.2.1

Lemons, C. J., & Fuchs, D. (2010b). Phonological awareness of children with Down syndrome: It's role in learning to read and the effectiveness of related interventions. *Research in Developmental Disabilities*, *31*(2), 316-330. doi: 10.1016/j.ridd.2009.11.002

Lemons, C. J., Mrachko, A. A., Kostewicz, D. E., & Paterra, M. F. (2012). Effectiveness of decoding and phonological awareness interventions for children with Down syndrome. *Exceptional Children*, *79*(1), 67-90.

Lennon, E. J., & Slesinski, C. (2002). Comprehensive Test of Phonological Processing Cognitive-linguistic assessment of severe reading problems. Retrieved from http://alpha.fdu.edu/psychology/comprehensive_test_of_phonologic.htm

Liberman, I. Y., Shankweiler, D., & Fischer, F.W. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Exceptional Children Psychology*, *18*(2), 201-212. doi:10.1017/S0142716400000424

Mayo Clinic Staff. (2012, May 5). Re: Down syndrome. Retrieved from: http://www.mayoclinic.com/health/down-syndrome/DS00182

Mengoni, S., E., Nash, H., & Hulme, C. (2013). The benefits of orthographic support for oral vocabulary learning in children with Down syndrome. *Journal of Child Language*, *40*(1), 221-243. doi: 10.1017/S0305000912000396

Magnussen, E., & Naucler, K. (1990). Reading and spelling in language-disordered children-linguistic and metalinguistic prerequisites: Report on a longitudinal study. *Clinical Linguistics & Phonetics*, *4*(1), 49-61.

McLaughlin, M. E., Bell, M. P., & Stringer, D.Y. (2004). Stigma and acceptance of persons with disabilities: Understudied aspects of workforce diversity. *Group & Organization Management*, *29*(3), 302-333. doi:10.1177/1059601103257410

Miller, J. F., & Leddy, M. (1998). Down syndrome: The impact of speech production on language. R. Paul, (Ed.). *Exploring the speech-language connection* (pp.28-29). Baltimore, MD: Brookes.

Naess, K. B., Melby-Lervag, M., Hulme, C., Lyster, S. H. (2012). Reading skills in children with Down syndrome: A meta-analytic review. *Research in Developmental Disability*, *33*(2), 734-747. doi:10.1016/j.ridd.2011.09.019

National Center for Educational Statistics [NCES]. (2003). The national assessment of adult literacy. Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2003495rev

National Center for Educational Statistics [NCES]. (2008). *Digest of Education Statistics, 2007.* Washington, DC: Author.

National Down Syndrome Society [NDSS]. (2011). *Down syndrome fact sheet*. Retrieved from www.ndss.org

National Governors Association Center for Best Practices, Council of Chief State School Officers Title: Common Core State Standards. Publisher: National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington D.C. Copyright Date: 2010. Retrieved from: www.corestandards.org/

National Institute of Child Health and Human Development [NICHD]. (2000). *Report of the National Reading Panel. Teaching children to read: An evidence-based-assessment of the scientific research literature on reading and its implications for reading instruction*: *Reports of the subgroups* (NIH Publication. No. 00-4754), Washington, DC: U.S. Government Printing Office. Retrieved from http://www.nichd.nih.gov/research/supported/nrp.cfm

National Institute of Child Health and Human Development [NICHD]. (2003). *Developing early literacy: Report of the national early literacy panel,* Washington, DC: U.S. Government Printing Office. Retrieved from www.nichd.nih.gov/publications/pubs/upload/NELPSummary.pdf

National Institute of Child Health and Human Development [NICHD]. (2010). *Down syndrome,* Washington, DC: U.S. Government Printing Office. Retrieved from http://www.nichd.nih.gov/health/topics/Down_Syndrome.cfm

National Institute for Reading the Partnership for Reading. (2001). *Put reading first.* Retrieved from http://lincs.ed.gov/publications/pdf/PRFbooklet.pdf

National Literacy Trust. (2011). *Phonics: Methods of teaching*. Retrieved from www.literacytrust.org.uk/phonics

No Child Left Behind [NCLB] Act of 2001, 20 U.S.C.A. § 6301 et seq.

Odom, L. S., & Strain, S. P. (2002). Evidence-based practices in early intervention/early childhood special education: Single-subject design research. *Journal of Early Intervention*, *25*(2), 151-160. doi:10.1177/105381510202500212

Paulesu, E., Demonet, J. F., Fazio, F., & McCrory, E. (2001). Dyslexia-cultural diversity and biological unity. *Science, 291*(5511), 2165–2167. doi:10.1126/science.1057179

Pisu, E. (2007). A comparative study of stress profiles in mothers of children with autism and those of children with Down syndrome. *Journal of Applied Research in Intellectual Disabilities*, *20*(3), 274-278. doi: 10.1111/j.1468-3148-.2006.00342x

Portney, G. L., & Watkins, P. M. (2007). *Foundations of clinical research: Applications for practice*. New York, NY: Pearson.

Purser, H. R. M., & Jarrold, C. (2013). Poor phonemic discrimination does not underlie poor verbal short-term memory in Down syndrome. *Journal of Experimental Child Psychology*, *115*(1), 1-15. doi: 10.1016/j.jecp.2012.12.010

Reason, R., & Morfidi, E. (2001). Literacy difficulties and single-case experimental design. *Educational Psychology in Practice*, *17*(3), 227-244. doi:10.1080/02667360120072756

Ricci, L., A. (2003). Fathers of children with Down syndrome versus other types of intellectual disabilities: Perceptions, stress and involvement. *Journal of Intellectual Disability Research*, *47*(4-5), 273-284. doi: 10.1046/j. 1365-2788.2033.00489.x

Roberts, J. E, Price, J., & Malkin, C. (2007). Language and communication development in Down syndrome. *Mental Retardation and Developmental Disabilities, 13*(1), 26-35. doi:10.1002/mrdd.20136

Roberts, G., Torgesen, K. J., Boardman, A., & Scammacca, N. (2008). Evidence-based strategies for reading instruction of older children with learning disabilities. *Learning Disabilities Research & Practice, 23*(2), 63-69. doi:10.1111/j.1540-5826.2008.00264.x

Roch, M., & Jarrold, C. (2008). A comparison between word and non-word in Down syndrome: The role of phonological awareness. *Journal of Communication Disorders*, *41*(4), 305-318. doi:10.1016/j.jcomdis.2008.01.001

Roch, M., & Jarrold, C. (2012). A follow-up study on word and non-word reading skills in Down syndrome. *Journal of Communication Disorders*, *45*(2), 121-128. doi:10.1016/j.jcomdis.2011.11.001

Roch, M., Florit, E., & Levorato, C. (2013). The role of linguistic context in deriving word meanings in individuals with Down syndrome. *Research in Developmental Disabilities: A Multidisciplinary Journal*, *34*(1), 605-615. doi: 10.1016/j.ridd.2012.09.014

Roizen, J. (2007). Down syndrome. In Batshaw, M. L; Pellegrino, L; Roizen, J. (Eds.). *Children with disabilities,* 263-273. Baltimore, MD: Brookes.

Rose, J. (2006). Independent review of the teaching of early reading. Nottingham: DFES Publications.

Ryder, F. J., Tunmer, E. W., & Greaney, T. K. (2008). Explicit instruction in phonemic awareness and phonemically based decoding skills as an intervention strategy for struggling readers in whole language classrooms. *Reading & Writing*, *21*(4), 349-356. doi:10.1007/s11145-007-9080-z

Scerif, G., & Steele, A. (2011). Neurocognitive development of attention across genetic syndromes: Inspecting a disorder's dynamics through the lens of others. *Progress in Brain Research*, *189*, 285–301.

Schillinger, D., Piette, K., Grumbach, K., & Wang, F. (2003). Closing the loop. *Intern Medicine, 163*(1), 294-305. doi:10.1001/archinte.163.1.83

Singh, J., & Singh, N. N. (1986). Reading acquisition and remediation in the mentally retarded. *International Review of Research in Mental Retardation*, *14*, 165-199. doi:10.1016/S0074-7750(08)60078-6

Singh, N. N., & Singh, J. (1988). Increasing oral reading proficiency through overcorrection and phonetic analysis. *American Journal on Mental Retardation*, *93*(3), 312-319. doi:10.1177/01454455860103006

Skinner, H., C. (2004). Single-Subject Designs: Procedures that allow school psychologists to contribute to the intervention evaluation and validation process. *Journal of Applied School Psychology*, *20*(2), 1-10. doi: 10.1300/J370v20n02_01

Skotko, G., B. (2006). What the other children are thinking: brothers and sisters of persons with Down syndrome. *American Journal of Medical Genetics. Part C, Seminars in Medical Genetics*, *142C*(3), 180-186. doi: 10.1002/ajmg.c.30101

Skudiene, V. (2002). A comparison of reading models, their application to the classroom and their impact on comprehension. *Studies About Language*, *2*, 124-136.

Smith, K., S., Nutbeam, D., McCaffery, J., K. (2013). Insights into the concept and measurement of health literacy from a study of shared decision-making in a low literacy population. *Journal of Health Psychology*, *18*(8), 1011-1022. doi:10.1177/1359105312468192

Snowling, M. J., Hulme, C., & Mercer, R. C. (2002). A deficit in rhyme awareness in children with Down syndrome. *Reading Writing Interdisciplinary Journal, 15*(5/6*)*, 471-495. doi:10.1023/A:1016333021708

Stahl, S. A., Duffy-Hester, A. M., & Stahl, K. (1998). Everything you wanted to know about phonics (but were afraid to ask). *Reading Research Quarterly, 33*(3), 338-355. doi:10.1598/RRQ.33.3.5

Steel, A., Scerif, G., Cornish, K., & Karmiloff-Smith, A. (2013). Learning to read in Williams syndrome and Down syndrome: Syndrome-specific precursors and developmental trajectories. *The Journal of Child Psychology and Psychiatry*, *54*(7), 754-762. doi:10.1111/jcpp.12070

Steele, A., Karmiloff-Smith, A., Cornish, K. M., & Scerif, G. (2012). The multiple sub-functions of attention: Differential developmental gateways to literacy and numeracy. *Child Development*, *83*(7), 2028–2041. doi: 10.1111/j.1467-8624.2012.01809.x

Stevens, B. K., & Lingo, S. A. (2005). Constant time delay: One-way to provide positive behavioral support for children with emotional and behavioral disorders. *Beyond Behavior*, *15*(2), 10-15.

Stoel-Gammon, C. (1997). Down syndrome phonology: Development patterns and intervention strategies. *Down syndrome Research and Practice, 7*(3), 93-100.

The National Center for Educational Statistics, (2007). *The 2003 national assessment of adult literacy (NAAL)*. Retrieved from: http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2007480

Tien, K. (2008). Effectiveness of the picture exchange communication system as a functional communication intervention for individuals with autism spectrum disorders: A practice-based research synthesis. *Education and Training in Developmental Disabilities*, *43*(1), 61-76.

Tracey, D. H., & Morrow, L. M. (2006). *Lenses on reading: An introduction to theories and models*. New York, NY: Guilford Press.

Treiman, R., Pennington, B. F., Shriberg, L. D., & Boada, R. (2008). Which children benefit from letter names in learning letter sounds? *Cognition*, *106*(3), 1322-1338. doi:10.1016/j.cognition.2007.06.00

Torgesen, J. K., & Mathes, P. G. (1999). *A resource manual for assessment and instruction in phonological awareness* (Monograph). Florida Department of Education.

U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics (2003). *The national assessment of adult literacy*. Washington, DC: U.S. Government Printing Office. Retrieved from http://nces.ed.gov

Van Bysterveldt, K. A., Gillion, T. G., & Moran, C. (2006). Enhancing phonological awareness and letter knowledge in preschool children with Down syndrome. *International Journal of Disability, Development, and Education*, *53*(3), 301-329. doi:10.1080/10349120600847706

Van Riper, M. (2000). Family variables associated with well-being in siblings of children with Down syndrome. *Journal of Family Nursing*, *6*(3), 267-286. doi: 10.1177/107484070000600305

Venail, F., Gardiner, Q., & Mondain, M. (2004). ENT and speech disorders in children with Down syndrome: An overview of pathophysiology, clinical features, treatments, and current management. *Clinical Pediatrics*, *43*(9), 783-791. doi:10.1177/000992280404300902

Verucci, L., Menghini, D., & Vicari, S. (2006). Reading skills and phonological awareness acquisition in Down syndrome. *Journal of Intellectual Disability Research*, *50*(7), 477-491. doi:10.1111/j.1365-2788.2006.00793.x

Wagner, R. K., Torgesen, J. R., & Rashotte, C. A. (1999). *Comprehensive test of phonological processing*. Austin, TX: Pro-Ed.

Watson , P., J. & Workman, E., A. (1981). The non-concurrent multiple baseline across-individuals design: An extension of the traditional multiple baseline design. *Journal of Behavior Therapy and Experimental Psychiatry*, *12*(3), 257-259. doi: 10.1016/0005-7916(81)90055-0

Wood, M. (2005). The development of the Down syndrome phenotype. *Down syndrome News and Updates, 4*(4), 135-139.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2011). *Woodcock-Johnson III Tests of achievement*. Itasca, IL: The Riverside Publishing Company.

Yamaki, K., & Fujiura T. G. (2002). Employment and income status of adults with developmental disabilities in the community. *Mental Retardation*, *40*(2), 132-141. doi:10.1352/0047-6765(2002)040<0132:EAISOA>2.0.CO;2

Yopp, K. H., & Yopp, H. R. (2000). Supporting phonological awareness in the classroom. *The Reading Teacher, 54*(2), 1-14. doi:10.1598/RT.54.2.2

Zhan, S., & Ottenbacher, J. K. (2001). Single subject research designs for disability research. *Disability and Rehabilitation*, *23*(1), 1-8.

Appendix A

Office for the Protection of Research Subjects Approval Letter

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice
Initial Review (Response to Modifications)

August 27, 2012

Michael Maiorano, M.Ed.
Special Education
1040 W Harrison St
M/C 147
Chicago, IL 60612
Phone: (312) 355-4317 / Fax: (312) 996-1427

RE: Protocol # 2012-0532
"Using a Three-Step Decoding Strategy with Constant Time Delay to Teach Word Reading to Children with Down Syndrome"

Dear Mr. Maiorano:

Your Initial Review (Response to Modifications) was reviewed and approved by the Expedited review process on August 27, 2012. You may now begin your research

Please note the following information about your approved research protocol:

Protocol Approval Period: August 27, 2012 - August 27, 2013
Approved Subject Enrollment #: 10
Additional Determinations for Research Involving Minors: The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk. Therefore, in accordance with 45CFR46.408, the IRB determined that only one parent's/legal guardian's permission/signature is needed. Wards of the State may not be enrolled unless the IRB grants specific approval and assures inclusion of additional protections in the research required under 45CFR46.409. If you wish to enroll Wards of the State contact OPRS and refer to the tip sheet.
Performance Sites: UIC
Sponsor: None
PAF#: Not Applicable
Research Protocol(s):

a) Using a Three-Step Decoding Strategy with Constant Time Delay to Teach Word Reading to Children with Down Syndrome

Recruitment Material(s):

a) Flyer; Version 2; 08/21/2012
b) Parent Phone Screening; Version 2; 08/21/2012
c) Parent Phone Screening Questions; Version 2; 08/21/2012
d) Recruitment Letter; Version 2; 08/21/2012

Phone: 312-996-1711 http://www.uic.edu/depts/ovcr/oprs/ FAX: 312-413-2929

Informed Consent(s):

a) Waiver of Signed Consent Document granted under 45 CFR 46.117 for recruitment and screening purposes

b) Alteration of Informed Consent granted for screening purposes

Assent(s):

a) Child Assent Form; Version 3; 08/21/2012

Parental Permission(s):

a) Permission/Consent Form; Version 3; 08/21/2012

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
06/18/2012	Initial Review	Expedited	06/22/2012	Modifications Required
08/14/2012	Response to Modifications	Expedited	08/16/2012	Modifications Required
08/24/2012	Response to Modifications	Expedited	08/27/2012	Approved

Please remember to:

→ Use your **research protocol number** (2012-0532) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,
"UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-9299. Please send any

Informed Consent(s):

a) Waiver of Signed Consent Document granted under 45 CFR 46.117 for recruitment and screening purposes
b) Alteration of Informed Consent granted for screening purposes

Assent(s):

a) Child Assent Form; Version 3; 08/21/2012

Parental Permission(s):

a) Permission/Consent Form; Version 3; 08/21/2012

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

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06/18/2012	Initial Review	Expedited	06/22/2012	Modifications Required
08/14/2012	Response to Modifications	Expedited	08/16/2012	Modifications Required
08/24/2012	Response to Modifications	Expedited	08/27/2012	Approved

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We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-9299. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Marissa Benni, M.S.
IRB Coordinator, IRB # 2
Office for the Protection of Research Subjects

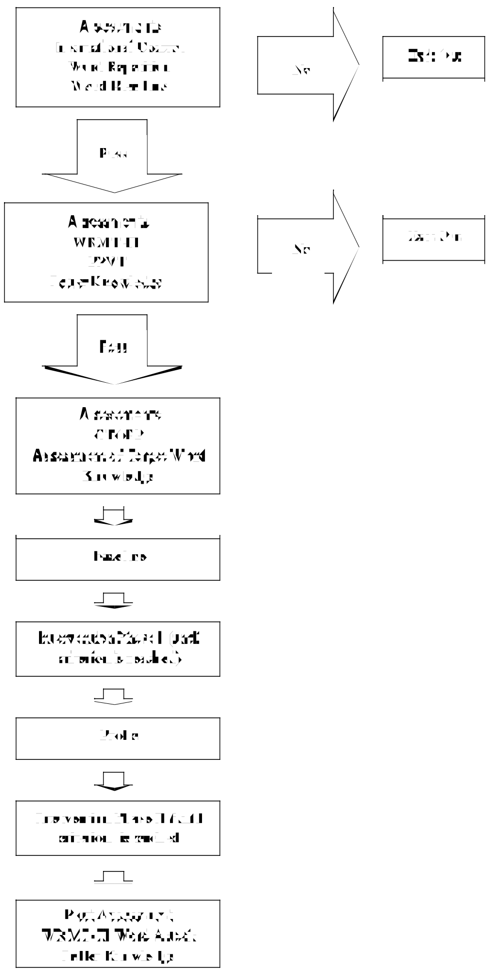
Enclosure(s):

1. **UIC Investigator Responsibilities, Protection of Human Research Subjects**
2. **Assent Document(s):**
   a) Child Assent Form; Version 3; 08/21/2012
3. **Parental Permission(s):**
   a) Permission/Consent Form; Version 3; 08/21/2012
4. **Recruiting Material(s):**
   a) Flyer; Version 2; 08/21/2012
   b) Parent Phone Screening; Version 2; 08/21/2012
   c) Parent Phone Screening Questions; Version 2; 08/21/2012
   d) Recruitment Letter; Version 2; 08/21/2012

cc: Elizabeth Talbott, Special Education, M/C 147
Marie Tejero Hughes, Special Education, M/C 147

Appendix B

Participant Inclusion Criterion Flow Chart



Appendix C

Parent Phone Screening

MIKE: Thank you for taking the time to contact me to discuss my study. Just to confirm what you may already know… I am a doctoral student in the Dept of Special Education at the University of Illinois at Chicago. I am interested to learn how children with Down syndrome learn to read. I have designed a study that I hope will benefit children with Down syndrome and contribute to the research on reading instruction and children with Down syndrome.

MIKE: If your child is selected to participate, he/she will be taught how to decode letter-sounds and to apply this skill to read words. The study will involve a screening, and identification phase, which includes assessing your child's reading ability, and an intervention phase, which includes one-on-one, in-home instruction with your child. There is a modest time commitment on your and your child's part to be involved in the study. For example, the screening will take about 25 minutes, the identification phase will take about 2.5 hours over 3 days, and the intervention phase can take up to 8 weeks or 22 sessions with each session lasting about 20 minutes.

MIKE: If you would like to see if your child is eligible, I need to ask you a few screening questions to determine his/her eligibility. Before we begin, do you have any questions for me?

Go to Screening

<u>If the child does not meet eligibility</u>
MIKE: Based on the information you provided, unfortunately your child is not eligible to participate in this study, but I do appreciate the time you took to contact me. Do you have any questions for me?

<u>If the child does meet eligibility</u>
MIKE: Based on the information you provided, it appears that your child might be eligible to participate in the study. The next step is for us to meet, so that I can review the parent consent/permission form and the child's assent form. The meeting may take about an hour, so is there a good time when the three us can meet to review these forms?
During this time, I will also explain the study in more detail and talk about the next steps.

Parent's name:

Child's name:

Child's age:

	Y	N
Is your child enrolled in public school?		
Is your child enrolled in private school?		
Is your child home schooled?		

	Y	N
Does your child have a medical diagnosis for Down syndrome?		
Does your child have assessment data showing an IQ level between 69-55 (mild intellectual disabilities)?		

	Y	N
Does your child have significant hearing problems?		
Does your child require an augmentative device to communicate?		
Does you child have significant vision problems?		

	Y	N
Is your child's first language English?		
Does your child have good receptive language (i.e., Can the child understand simple directions?)		
Does your child good expressive language? (i.e., Can others generally understand the child?)		

	Y	N
Is your child able to follow simple one-step, oral directions?		
Is your child able to respond to a prompt?		
Is your child able to orally repeat a sound?		
Is your child able to orally repeat a word?		

	Y	N
Does your child have some letter-sound knowledge?		
Does your child regularly substitute one sound for another (i.e. say /d/ for the /b/?)		

Appendix D

Parent Consent

Leave box empty - For office use only

STARTS APPROVAL EXPIRES

AUG 2 7 2012 TO AUG 2 7 2013

UNIVERSITY OF ILLINOIS AT CHICAGO
INSTITUTIONAL REVIEW BOARD

University of Illinois at Chicago
Research Information and Permission and Consent for Participation in Social Behavioral Research

Using a Three-Step Decoding Strategy with Constant Time Delay to Teach Word Reading to Children with Down syndrome

You are being asked to participate in a research study and give consent for your child to participate in a research study. Researchers are required to provide a form such as this one to tell you about the research, to explain that taking part is voluntary, to describe the risks and benefits of participation, and to help you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Principal Investigator Name and Title: Michael J. Maiorano, M.Ed., Doctoral Candidate
Department and Institution: Department of Special Education, University of Illinois at Chicago (UIC)
Address and Contact Information: 1640 W. Roosevelt Road, Chicago, IL 60608
Phone: 312-355-4317 **Email**: mmaior1@uic.edu

Why am I being asked?

As a parent of a child with Down syndrome, you are being asked to participate in a research study and to give permission for your child to participate in a research study that will examine the use of a phonics-based reading strategy to teach children with Down syndrome how to read words. You and your child are being asked to participate in this research study because you indicated that you are a parent of a child with Down syndrome (ages 9-11) and that you and your child may be eligible to take part.

Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future dealings with the University of Illinois at Chicago or Gigi's Playhouse. **If you decide to participate, you are free to withdraw at any time without affecting that relationship.**

Ten child participants and parent participants will be recruited for this study. From this group three child participants will complete the intervention and three parent participants will complete a Parent Questionnaire.

Permission/Consent Form; Decoding and Children with Down syndrome, v3, 8/21/12 Page 1 of 6

DECODING AND CHILDREN WITH DOWN SYNDROME

What is the purpose of this research?
The purpose of the study is to determine if: 1) a decoding reading strategy is effective in teaching children with Down syndrome how to read words, and 2) the decoding strategy leads to generalization or increased decoding efficiency.

What procedures are involved?
This research will be performed at your home or another mutually agreed upon location. All sessions will be video taped. In addition to the Child Screening, there are two phases to the study: the Identification Phase and the Intervention Phase. Not all parents and children who participate in Screening and/or Identification Phase will be eligible to participate in the Intervention Phase.

The Child Screening will take approximately 25 minutes to complete. The Identification Phase requires your child to meet with the researcher up to three times in a one week period. Each day's session will not be more than 60 minutes long. The total time your child will participate in Identification Phase activities will be no more than 2.5 hours. The Intervention Phase will require your child to meet with the researcher up to 22 times in an 8 week period (approximately 3 times a week). Each session will last for approximately 20 minutes. Parent participants will be required to complete a short Parent Questionnaire pertaining to your child's educational experiences. The Questionnaire will take about 15 minutes to complete.

Child Screening
Your child's participation in the study will consist of completing three short assessments. The total time to complete these three assessments is estimated to be 25 minutes. The first assessment will require your child to complete a task or respond to a request (e.g., sit in a chair or respond to a verbal instruction), repeat ten words (e.g., "man, "run", and "sad"), and five short sounds (e.g., /d/ and /t/), and blend words together (e.g., "foot" and "ball" to read "football").

Identification Phase
The identification phase will begin with the administration of the (1) the *Peabody Picture Vocabulary Test-IV*, which measures verbal skills, and (2) the *Woodcock Reading Mastery Test*, which measures phonics skills. The total time to administer these two assessments is estimated to be 35 minutes.

After the *Peabody Picture Vocabulary Test-IV* and the *Woodcock Reading Mastery Test-III* are completed, the child's results will be reviewed. If a child's score is too low on the *Peabody Picture Vocabulary Test-IV,* he or she will not be eligible to continue. Likewise, if the child does not demonstrate knowledge of 10 different letter-sound correspondences including at least one vowel sound on the *Woodcock Reading*

DECODING AND CHILDREN WITH DOWN SYNDROME

Mastery Test-R, he or she will not be eligible to continue. Conversely, if the child's score is too high on the *Woodcock Reading Mastery Test-R,* he or she will not be eligible to continue. If the child meets the above criteria he or she will take three additional assessments to measure their ability to orally manipulate sounds.

1. *Comprehensive Test of Phonological Processing* will measure your child's ability to remember, manipulate, and repeat sounds. This assessment is estimated to take 20 minutes to complete.

1. *Assessment of Short Vowels and Word Patterns* will assess your child's knowledge of short vowel sounds. This assessment is estimated to take 20 minutes to complete.

2. *Assessment of Word Families* will be used to determine which letter combinations your child can or cannot decode. This assessment is estimated to take 1-2 hours to complete over a couple days.

Study Protocols

The first three children to meet the screening and identification criteria will be eligible to participate in the study. The first three children to successfully complete the Identification Phase, will begin the Intervention Phase. The Intervention Phase begins with the researcher gathering initial or baseline data. Baseline data is simply a gage of your child's ability to read the words used during the intervention prior to receiving instruction. During this phase, the researcher will present words printed on index cards to your child and ask the child to read them. The data gathered during baseline will be compared to the data gathered during the intervention. After the processes of gathering baseline data is completed, your child will begin the intervention. The intervention will consist of teaching the child to read words using a decoding strategy within a structured time frame. Each child will complete two phases of the intervention and a probe given between the intervention phases. A probe is a very short assessment used at the end of the first intervention phase and the beginning of the second intervention phase to determine if your child is able to decode the words in the second intervention phase without any prior instruction. Both intervention phases will consist of teaching the child to decode words. Six words will be used to teach the decoding strategy during the first intervention phase and six words will be used to teach the decoding strategy during the second intervention phase.

The strategy used to teach the child to read words has three steps. The first step called *Attention Getting* will teach the child to touch the card. This step is designed to help the child focus on the study activities. The second step called *Decoding* will teach the child to say each letter-sound in the word. The final step called *Reading the Word* will teach the child to blend the individual letter-sounds together to read the word.

DECODING AND CHILDREN WITH DOWN SYNDROME

Your child will be randomly assigned to one of three intervention types. The first intervention type will require the child to complete 3 baseline sessions before beginning the intervention. The second intervention type will require the child to complete 6 baseline sessions before beginning the intervention, and the third intervention type requiring the child to complete 9 baseline sessions before beginning the intervention. Each baseline session will take approximately 5 minutes to complete. The intervention phase will require your researcher up to 22 times in an 8 week period (approximately 3 times a week). Each session will last for approximately 20 minutes.

You will be asked to complete a short Parent Questionnaire pertaining to your child's educational experiences at the end of the identification phase. The Questionnaire will take about 15 minutes to complete.

What are the potential risks and discomforts?
There are minimal risks associated with the study. There is a risk that a breach of privacy (others will know the subject is participating in research) and confidentiality (accidental disclosure of identifiable data) may occur. All data is confidential and no identifying data will be shared with others. However, some children may feel uncomfortable participating in a structured learning environment, which may cause them to feel anxious. However, the instructional practices used during study are similar to the instructional practices used in a typical school setting. Thus, child participants may already be used to working in a structured learning environment. Additionally, all sessions with child will be video tapped. Some children may feel uncomfortable with a camera in the room. Parent participants will be interviewed to provide additional descriptive information on each child's towards reading. Parents will not be video recorded. If parents are uncomfortable answering questions during the interview, they will have the option to stop the interview. The research will make them aware of this option in advance of starting the interview.

Are there benefits to taking part in the research?
Your child may directly benefit from this study by learning to apply a decoding strategy to read words they previously were unable to decode on their own. However, no benefits are assured. There are no direct benefits for parent participants. However, parents may indirectly benefit from the knowledge that their child has learned a new skill. The research community may benefit from this study because it may contribute to the body of research on phonics-based reading instruction for children with Down syndrome.

What other options are there?
You and your child have the option to not participate in this study. Your participation and your child's participation in the study are completely voluntary. You and your child can choose to remove yourselves from the study at anytime without penalty.

DECODING AND CHILDREN WITH DOWN SYNDROME

What about privacy and confidentiality?
The people who will know that you are a research participant are members of the research team. Otherwise information about you will only be disclosed to others with your written permission, or if necessary to protect your rights or welfare or if required by law (i.e. when the UIC Institutional Review Board and the State of Illinois auditors monitors the research and consent process). The research team consists of doctoral candidate, Michael Maiorano, and his doctorial advisor, Dr. Marie Tejero Hughes. Also, when the results of the research are published or discussed in conferences, no information will be included that would reveal your identity or your child's identity.
To preserve confidentiality, each participant will be assigned an ID number. A master list containing the name and ID number of each participant will be stored in a locked file cabinet away from any hard or electronic documentation pertaining to the study. Only Michael Maiorano will have access to the master list. All information pertaining to, but not limited to recruitment, assessment, and data collection including ancillary notes taken by the researcher will be coded with an ID number. Your child's name will NOT appear on any documentation. All electronic data (including electronic images) will be stored in a password-protected computer. Additionally, all hard copy information will be stored in a locked file cabinet in a separate location from that of the computer.

What are the costs for participating in this research?
There are no costs for your participation in this research.

Can I withdraw or be removed from the study?
If you decide to participate and have your child participate, you and your child are free to withdraw your consent and discontinue participation at any time. There are no consequences for withdrawing. The researcher also has the right to stop your participation or your child's participation in this study without your consent if he believes it is in the best interest of you and your child (e.g., the child fails to show up for scheduled sessions or the child appears to become upset). You will be notified if this occurs.

Who should I contact if I have questions?
Michael Maiorano is conducting the research under the guidance of his advisor, Dr. Marie Tejero Hughes. You are free to contact them if you have any questions or concerns about the study. Michael Maiorano can be reached at 773-934-3724 or by email at mmaior1@uic.edu Dr.Tejero Hughes can be reached at 312-413-1623 or by email at marieth@uic.edu

What are my rights as a research subject?
If you feel you have not been treated according to the descriptions in this form, or if you have any questions about your rights as a research subject, including questions, concerns, complaints, or to offer input, you may call the Office for the Protection of

DECODING AND CHILDREN WITH DOWN SYNDROME

Research Subjects (OPRS) at 312-996-1711 or 1-866-789-6215 (toll-free) or e-mail OPRS at uicirb@uic.edu.

Compensation
Twenty-five dollar gift cards from a national bookstore retailer will given to each child participant in compensation for their time during the course of the study. Gift cards will be given out at the conclusion of the study.

Remember:
Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Illinois at Chicago or Gigi's Playhouse. If you decide to participate, you are free to withdraw at any time without affecting that relationship.

Signature of Subject or Legally Authorized Representative
I have read (or someone has read to me) the above information. I have been given an opportunity to ask questions and my questions have been answered to my satisfaction. I agree to participate in this research and give permission for my child to participate. I will be given a copy of this signed and dated form.

__________________________ __________
Signature Date

____
Printed Name

__________________________ __________
Signature of Person Obtaining Consent Date (must be same as subject's)

____
Printed Name of Person Obtaining Consent

____
Name of Child Participant

Appendix E

Child Assent

Leave Box Empty – For office use
STARTS APPROVAL EXPIRES
AUG 2 7 2012 TO AUG 2 7 2013
UNIVERSITY OF ILLINOIS AT CHICAGO
INSTITUTIONAL REVIEW BOARD

University of Illinois at Chicago

ASSENT TO PARTICIPATE IN RESEARCH

Using a Three-Step Decoding Strategy with Constant Time Delay to Teach Word Reading to Children with Down syndrome

This project will have three parts and I will need the help of several children. All the children will get to complete the first part (Screening), but only some children will get to complete the second part (Identification Phase) and/or the third part (Intervention Phase). But your participation on any of the parts is important, and it is perfectly okay if you don't get to complete all the parts.

Part 1: The Screeening

- I am going to ask you to do activities like read words and play a game like "Simon Says". These activities will help us to get to know each other better.
- This part will take about 25 minutes to complete.
- Do you have any questions?

Part 2: The Identification Phase

- I am going to test you to find out more about your abilty to read.
- We will meet 3 times a week for an hour less each time.
- Do you have any questions?

Part 3: The Intervention Phase

- I will teach you a new skill that you will use to read words.
- We will meet 3 times per week for a half hour or less for about 8 weeks or 22 sessions.
- When we are all done, you may be able to read new words without any help from me, your parents, or your teacher.
- Do you have any questions?

Questions/Concerns

- Do you understand that you may not have to complete all the parts of this study?
- Do you have any questions about what you will be asked to do?

Recording

- I also want to let you know that you might be recorded on video tape during the times we work together. I will not share the video with others.
- Do you think you will be okay being recorded and having a camera in the room?

Feeling Tired

- During the times we meet you may get tired or feel like you don't want to do anymore, which is fine. I will ask you if you want to continue for a couple of more minutes or if you would rather stop and continue the next time we meet.

Questions/Concerns

- Do you have any questions about what you should do if you feel tired or you feel like you don't want to continue working on a given day? Remember it will be okay to tell me to stop if you feel tired or you just don't want to do any more. I also want to remind you that you might be video taped during the times we work together.

Please talk this over with your parents before you decide whether or not to participate. Your parents already gave permission for you to take part in this study. But even though your parents said "yes", you can still decide not to participate.

Questions/Conerns

- Do you have any questions or thoughts right now? Do you understand that even though your parents agreed that you could participate, you can still tell me "no" and no one will be upset with you?
- Remember it will be okay to tell me stop if you feel tired or you just don't want to do any more. I also want to remind you that you will be video taped during the times we work together.
- **If you don't want to be in this study, you don't have to participate. Remember, being in this study is up to you and no one will be upset if you don't want to participate or if you change your mind later and want to stop.**

You can ask me any questions that you have about the study at any time. If you have a question, you can call me at (773) 934-3724, email me at mmaior1@uic.edu, or ask me next time we meet. Do you have any questions now?

During the study, as a "thank you" for your time you will receive a gift card from national bookstore for each of the three phases you complete as follows:

- Children completing the Screening Phase will receive a $5.00 gift card
- Children completing Identification Phase will receive a $5.00 gift card
- Children completing the entire study will receive a $25.00 gift card

Signing your name at the bottom means that you agree to be in this study. You and your parents will be given a copy of this form after you have signed it.

Name of Subject ______________________ Date ______________

Signature ______________________ Age ______ Grade in School ______________

Appendix F

Child Assessment Schedule

Assessment Schedule

Assessment Type	Day	Estimated Time to Complete
Instructional Control	1	3min
Word Repetition	1	3min
Word Blending	1	4min
Peabody Picture Vocabulary	1	15min
Woodcock Reading Mastery Test-3rd Edition Word Attack (Pre)	1	20min
Letter Checklist: (Pre and Post) Upper Case Letters; Lower Case Letters	1, 5	5min
Comprehensive Test of Phonological Processing-2	2	20min
Word List Assessment of Target Words Subtest: Short Vowels Word Families	2	15min
Word List Assessment of Target Words Subtest: Word Families	3, 4, 5	20min
Word Attack (Post)	6	5min

Appendix G

Parent Questionnaire

1. Generally, how does your son/daughter feel about being in school? About reading?
2. Has he/she experienced any significant academic or behavioral problems during the past school year?
3. Does your child receive special services from the school they attend or an outside agency, such as speech therapy?
4. With respect to your child's IEP, do you know what your child's reading goals are for the 2012-2013 school year?
5. To the best of your knowledge, what reading curriculum or program is used in your child's classroom?
6. Do you know at what grade level your child is currently reading?
7. Does your child's teacher do any phonics-based activities in the classroom? About what percent of the time? Can you provide me some examples of these activities?
8. Does your child's teacher do any sight-word based activities in their classroom? About what percent of the time? Can you provide me some examples of these activities?
9. In your opinion, over the past two years, would you say your child's reading ability has improved, stayed the same, or decreased? Why do you feel this (examples)?
10. Do you or someone else in your family read to your child at home? If yes, about how many hours a week?

Appendix H

Fidelity Checklist

Child's name: Date: Session:	**Did the researcher deliver the cue to the child correctly?**	**Did the researcher wait 4-seconds before delivering the corrective prompt?**	**If the corrective prompt was delivered, was it delivered correctly?**
Step 1 "Touch the Card"	Yes No	Yes No	Yes No
Step 2 "Slowly point to each letter while you say each letter sound"	Yes No	Yes No	Yes No
Step 3 "Now say the sounds together without stopping while you run your finger along the bottom card."	Yes No	Yes No	Yes No

Comments:

Appendix I

Scoring Checklist

Date: Session: Accuracy for Session:	Credit for Decoding Sounds of Word (Y/N)	Individual Sounds Missed (circle)	Number Indivdual Sounds Decoded Correctly (out of a possilbe 18 sounds)	Credit for Reading Corectly (Y/N)	Word Read As	Counts Towards Criterion (Y/N)
Trial 1						
fed		/f/ /e/ /d/				
mum		/m/ /u/ /m/				
mat		/m/ /a/ /t/				
rag		/r/ /a/ /g/				
lot		/l/ /o/ /t/				
wag		/w/ /a/ /g/				
			% Correct ____	**% Correct ___**		
Trial 2						
fed		/f/ /e/ /d/				
mum		/m/ /u/ /m/				
mat		/m/ /a/ /t/				
rag		/r/ /a/ /g/				
lot		/l/ /o/ /t/				
wag		/w/ /a/ /g/				
			% Correct ___	**% Correct ___**		
						Accuracy for Session (X/12)___

VITA

Michael J. Maiorano, Ph.D.
4608 N. Leavitt, Apt 2
Chicago, IL 60625
mmaior1@uic.edu
773-934-3727

EDUCATION:

Degree	**Name of Institution**	**Year**
Ph.D., Special Education	University of Illinois at Chicago	2013
M.Ed., Special Education	University of Illinois at Chicago	2005
BA, Political Science	Loyola University of Chicago	1987

Dissertation Title: Using a Decoding Strategy with Constant Time Delay to Teach Word Reading to Children with Down Syndrome

CERTIFICATION:
License Behavioral Specialist I (LBS I)

AWARDS:
John & Balaban Special Education Fellowship Award, University of Illinois at Chicago, (2011). Cash award of $2,500

Albin and Young Special Education Doctorial Fellowship, University of Illinois at Chicago, (2010). Cash award of $1,000

PROFESSIONAL EXPERINCE:
Grant Coordinator, (2003-Present)
The Monarch Center (The National Outreach and Technical Assistance Center for Discretionary Awards for Minority Institutions, The US Department of Education Office of Special Education Programs (Grant # H325R080002), Department of Special Education, University of Illinois at Chicago, Chicago, IL

- Support an extensive client base of special education professors in all areas pertaining to the development and completion of federal personnel preparation grants through the U.S. Department of Education Office of Special Education Programs (OSEP) including assistance in developing, drafting, and managing personnel preparation grants
- Facilitate and manage all aspects of grant development training workshops
- Negotiate and manage all aspects of contractual obligations with vendors and contractors
- Represent the Monarch Center in bi-yearly conferences with the University's Office of Business and Financial Services
- Supervise day-to-day office operations
- Collaborate with colleagues to conceptualize, produce, and market 13 web-based training modules

- Interview all new hires including graduate assistants and academic professionals
- Co-supervise all graduate assistants

Adjunct Lecturer, (2007-2014)
Department of Special Education, University of Illinois at Chicago, Chicago, IL
Graduate Course: SPED 463 Instructional Adaptations in Reading and Writing I

- Designed evidence-based graduate coursework in all areas of early literacy development including contrasting the major theories of literacy development.

Guest Lecturer, (2009-2012)
Department of Special Education, University of Illinois at Chicago, Chicago, IL

- Graduate Course: SPED 577 Field Teaching Internship, 2009, 2010, 2011
- Graduate Course: SPED 564 Single Subject Research Design, 2012

Clinical Teaching, (2005)
John C. Haines Elementary School, 247 West 23rd Place Chicago, IL 60616

- Field Internship (Self-contained/Resource grades 2-5), September 2005-December 2005
- Student Teaching (Self-contained/Resource grades 2-5), January 2005-April 2005

Substitute Teacher, (2001-2002)
Chicago Public Schools, Chicago, IL, 2001-2002

EARLY CAREER:
Reid Psychological Systems Human Resources Consulting, Chicago, IL, (1987-2003)
Executive Director, Background Investigations, (2001-2003)

- Managed a staff of 24, including interview, selection, retention and training
- Managed all aspects of employment/applicant background investigative processes including: product development, front-end client presentations and interpretation of results
- Developed and implemented project plans to assess user requirements, *improve performance and increase client retention*
- *I*dentified opportunities to improve service and expand utilization of product line
- Designed, delivered and evaluated comprehensive internal/external sales training plans that include maintenance of manuals and creation of ad hoc user tips
- Developed standard operating procedures necessary to support the end user's needs
- Developed and maintained quality control process*es* to ensure integrity and accurac*y of* data *analysis* and reporting

PUBLICATIONS:

- Lopez-Reyna, N. A, Snowden, P. A., Stuart, N., Baumgartner, D., & Maiorano, M. J. (2012). Critical Features of Program Improvement: Lessons From Five Minority Serving Universities. *Interdisciplinary Journal of Teaching and Learning*. *2*(3), 143-156.
- Baumgartner, D., Bay, M., Snowden, P. A., & Maiorano, M. J. (2013). Culturally

Responsive Practice in a Teacher Educator's Classroom. Manuscript submitted for publication.
- Maiorano, M. J., & Tejero Hughes, M. (2014). Using a Three-step Decoding Strategy with Constant Time Delay to Teach Word Reading to Children with Down Syndrome. Manuscript in preparation.

PRESENTATIONS:
- "Using a Three-Step Decoding Strategy with Constant Time Delay to Teach Word Reading to Children with Down Syndrome", University of Illinois at Chicago, 2012, 2013
- "How to Draft an Effective Literature Review: Narrowing Your Topic" University of Illinois at Chicago, 2011, 2012

PROFESSIONAL AFFILATIONS:
- Council for Exceptional Children
- National Down Syndrome Congress
- National Down Syndrome Society
- Special Education Consultants, Law, Policy and Practice

SERVICE:
- Editor, *Interdisciplinary Journal of Teaching and Learning*, College of Education Southern University A & M College, Baton Rouge, LA
- Interviewer, Project Step-UP, University of Illinois at Chicago
- Member of the Graduate Search Committee for New University Faculty, University of Illinois at Chicago

VOLUNTEER:
- Volunteer Tutor, John C. Haines Elementary School, 2006