Running Head: Comprehensive Reading Intervention

Teaching Students with Moderate Intellectual Disabilities to Read: An Experimental Examination of a Comprehensive Reading Intervention

Jill Allor

Patricia Mathes

Kyle Roberts

Francesca Jones

Tammi Champlin

Southern Methodist University

Manuscript to be published in *Education and Training in Developmental Disabilities*

Author Contact Information:
Jill H. Allor
Department of Teaching and Learning
Simmons School of Education and Human Development
Southern Methodist University
P.O. Box 750381
Dallas, TX 75275-0381

Acknowledgments: The work presented in this article was supported by Grant No. H324K040011-05 from the Institute of Education Sciences. This article does not necessarily reflect the positions or policies of this funding agency and no official endorsement should be inferred. We thank the teachers and students who participated in this research.

Abstract

The primary purpose of our research was to determine if a comprehensive, phonics-based, direct instruction reading program would be effective in teaching early reading and language skills to students with moderate intellectual disabilities (ID). Participants were 28 elementary students from 10 public schools in an urban school district and one urban private school who were randomly placed into treatment and contrast groups. Students in the treatment condition received daily, comprehensive reading instruction in small groups of 1-4 students for approximately 40 minutes per session. A broad array of measures was studied, including phonemic awareness, phonics, word recognition, comprehension, and oral language. Means favored the intervention group on all measures, with moderate to strong effect sizes. Statistically significant differences were found on most measures, including phonemic awareness, phonics, vocabulary, and comprehension. These findings demonstrated that students with moderate ID can learn basic reading skills given consistent, explicit, and comprehensive reading instruction across an extended period of time.

Teaching Students with Moderate Intellectual Disabilities to Read: An Experimental Examination of a Comprehensive Reading Intervention

In recent years, there has been growing national recognition that literacy is a civil right. The national rhetoric suggests that *all* children have the right to scientifically-based reading instruction and that it is not acceptable for any child to leave school with low literacy skills (No Child Left Behind Act, 2002). However, within the rhetoric about all children, references to students with intellectual disabilities (ID), or mental retardation, are typically vague or absent. One might question how one set of children could be overlooked in discussions about all children. In our experience, the answer appears to be that *all* has really referred to all children who are believed to be capable of learning to read (Katims, 2000). We define reading as the ability to process individual words in connected text resulting in understanding the author's intended meaning. With this definition in mind, many educators assume that children with ID are not capable of learning to read (Katims). The expectation has been that, at best, students with ID, particularly those with moderate ID, can learn to identify a specific list of words memorized by sight. The result is that typically little effort is made to teach these students to become fully literate and only 1 in 5 children with mild or moderate ID achieves even minimal literacy skills (Katims, 2001).

Research on Reading and Intellectual Disabilities

Although much progress has been made in recent years regarding the education of students with ID, to date, very little reading research has been conducted with these students. What research has been done has focused primarily on students with mild ID (see Browder, Wakeman, Spooner, Ahlgrim-Delzell, & Algozzine, 2006) and has focused only on isolated subskills of reading, rather than on comprehensive reading interventions that integrate all essential components of reading (defined below). Currently, no research has been conducted to determine whether students with ID can learn to read by fully processing the print and meaning of connected text, as is consistent with current theories of reading development (see reviews Browder & Xin, 1998; Browder et al., 2006; Conners, 2003; Joseph & Seery, 2004).

In spite of the paucity of research, the research that does exist is promising, suggesting that students with ID are capable of learning various aspects of reading. Sight word recognition has received the greatest attention from researchers and the preponderance of evidence demonstrates that students with even moderate and severe levels of ID can learn to automatically recognize a fairly large corpus of words with systematic instruction (Browder et al., 2006). Even so, these students have little ability to generalize their learning beyond the specific words included in instruction, and thus, are far from achieving even basic literacy (Browder et al.). Research on the effectiveness of phonics instruction is primarily limited to students with mild ID, but that research is also promising. Conners (1992) and Joseph and Seery (2004) found fourteen studies that examined phonics instruction for students with ID and these studies lend preliminary support to the effectiveness of phonics interventions. Unfortunately, these studies were all relatively brief, providing at most a few months of instruction, and they focused on isolated subskills of phonics, rather than a comprehensive, systematic approach that might result in skilled decoding. Further, none of these studies focused specifically on phonemic awareness (PA). In 1996, O'Connor, Notari-Syverson, and Vadasy, described the progress of several students with mild ID who participated in a PA intervention study. Of the nine students with ID who participated in the six-month PA intervention, three made substantial progress. In a recent study, students with ID receiving instruction for approximately 10 weeks made significantly more progress on sounding out activities than a similar control group (Conners, Rosenquist, Sligh, Atwell, & Kiser, 2006). Studies on vocabulary and comprehension are even more limited, only including demonstrations of very basic skills, such as using a sight word in the context of a functional activity or matching a word to a picture (Browder et al.).

Taken in its totality, the research base on teaching students with ID to read is sparse and inadequate. At the present time, there are no studies that have examined the effectiveness of a comprehensive reading intervention delivered over a sustained period of time. Without this type of research, we cannot determine whether “all” as described in No Child Left Behind should or should not include students with ID. In short, we simply do not know what is possible for students with ID. The mission of the research reported here is to take important steps toward addressing this question. Specifically, we seek to determine what is possible for teaching children with moderate levels of ID to read.

Conceptual Framework

While there is little research on reading to guide decision making for children with moderate ID, much research has been conducted with other populations who also find learning to read very difficult, and thus, should inform research on teaching students with ID to read. This research provides the conceptual framework for our study. As is consistent with current research, we see reading as an integrated process, rather than a set of isolated skills. In a relatively simple view of reading, good readers effortlessly recognize words and build mental representations of the message of the text (Ehri, 2005; Perfetti, Landi, & Oakhill, 2005). Studies examining the underlying processes of word recognition are clear. Good readers fully process print, attending to the inner structure of each word that is read (Adams, 1990; Ehri, 2005; Ehri & McCormick, 1998; Torgesen, 2002). They do this quickly and effortlessly. Researchers believe good readers are able to focus attention on the meaning of print because word recognition processes are automatized. The underlying processes of comprehension are arguably more complex, depending on a variety of factors including listening comprehension, linguistic abilities, relevant knowledge, and general intelligence (Perfetti et al.). Specific to written language understanding are factors including sensitivity to story structure, inference making, and comprehension monitoring (Perfetti et al.). We know that students progress through predictable stages as their word recognition and comprehension skills develop (Chall, 1996; Ehri; Ehri & McCormick, 1998). In early stages students develop phonological awareness and print awareness, along with expressive and receptive oral language skills. In later stages decoding and morphographic knowledge increases, eventually leading to the quick and effortless retrieval of words from long-term memory, enabling students to read fluently and, most importantly, focus on making sense of the message of text. Good readers make inferences and monitor their own comprehension, ensuring that stories and information are cohesive (Perfetti et al.).

Research on Early Reading Interventions

Over the past 30 years numerous studies focused on the prevention and correction of reading problems with students who struggle to learn to read who do not have ID. A primary finding from this research is that intervention provided to small groups of children in the primary grades can be highly effective in preventing reading problems for most children and greatly reducing the depth of reading problems for those who continue to experience difficulty, (e.g., Foorman & Torgesen, 2001; Mathes et al., 2005; Mathes & Denton, 2002; Denton & Mathes, 2003; National Reading Panel, 2000; Snow, Burns, & Griffin, 1998). Likewise, we now understand the critical content students must acquire if they are to become competent readers. Effective interventions in early reading target multiple components of the reading process in an integrated and comprehensive manner, including concepts of print, oral language, phonological and phonemic awareness (PA), letter knowledge, word recognition, fluency, and comprehension (see Foorman & Torgesen, 2001; National Reading Panel, 2000; Pressley, 1998; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001; Snow et al., 1998). Many experimental studies demonstrate that teaching PA results in improved reading and spelling outcomes (see Ehri et al., 2001). Letter knowledge, including letter naming and letter-sound recognition, is also an important predictor of reading achievement (Share, Jorm, Maclean, & Matthews, 1984; Adams, 1990), and these skills influence other key early literacy skills, such as PA and phonemic decoding (Blaiklock, 2004; Evans, Bell, Shaw, Moretti, & Page, 2006; Foy & Mann, 2006; Roberts, 2003; Treiman, Tincoff, & Richmond-Welty, 1996; Treiman, Tincoff, Rodriguez, Mouzaki, & Francis, 1998). Many children who have difficulty learning to read also struggle with the development of good oral language skills (Perfetti et al., 2005). One method demonstrated to be effective for students with language delays is interactive storybook reading (Arnold & Whitehurst, 1994; Dickinson & Smith, 1994; Karweit & Wasik, 1996; Valdez-Menchaca & Whitehurst, 1992). Explicit instruction in basic comprehension strategies is also a critical component of successful early reading interventions (Mathes et al., 2005).

As we approach the task of intervening with children with moderate ID, it is important that we provide instruction that not only teaches the critical content of reading, but also synthesizes what is known to be effective in teaching students with ID. For these students, a behavioral approach appears to be most appropriate (Adams & Engelmann, 1996; Browder et al., 2006; Joseph & Seery, 2004). The role of the teacher in a behaviorist model is to explicitly teach content and model skills, providing systematic review of skills and reinforcement for mastery.

Purpose of the Study

The purpose of this study was to analyze the effectiveness of a carefully crafted, comprehensive reading intervention built on behavioral principles in teaching primary-grade students with moderate ID to read. Students in this study participated in our intervention for one to one and a half years. Specifically, we implemented and expanded an explicit, systematic reading intervention that had been empirically validated with students at-risk for learning disabilities (Mathes et al., 2005) and with students who are both struggling readers and English Language Learners (Vaughn, Mathes et al., 2006). This intervention, now published as *Early Interventions in Reading* (Mathes & Torgesen, 2005a), was (a) rooted in behavioral theory, (b) comprised of all of the content demonstrated to be critical for struggling readers without ID, and (c) supplemented with additional language development support.

This study adds to the literature in several ways. First, the reading intervention is comprehensive in nature, with instruction targeting oral language, phonemic awareness, alphabetic knowledge, phonemic decoding, and basic comprehension strategies. Second, the intervention in this study includes many components that have been previously validated with students at-risk for reading failure who have IQs in the average range, thus extending that research to the population of students with moderate ID. Third, the study extends these techniques with the addition of oral language activities and modified teaching techniques. Fourth, the study employs a longitudinal, randomized trial design. In this article, we report data collected after the students had been in the study for at least one full academic year. Future reports will follow the students for approximately four academic years. Finally, phonemic awareness and phonemic decoding were measured repeatedly allowing for the use of advanced statistical techniques. We addressed the following specific research question: Does a comprehensive reading program taught to primary-grade students who have moderate ID (IQs ranging from 40-55) result in better reading outcomes than typical special education instruction on measures of (a) phonemic awareness, (b) alphabetic knowledge, (c) word recognition/phonemic decoding, and (d) oral language/comprehension?

Previously Validated Intervention Components

The intervention included components previously validated for students without ID. The first, and most comprehensive, is *Early Interventions in Reading* (Mathes & Torgesen, 2005a; Mathes et al., 2005; Vaughn, Mathes et al., 2006). We also built upon oral language storybook techniques successfully used with English Language Learners (Vaughn, Cirino et al., 2006; Vaughn, Linan-Thompson, Mathes, Duradola, & Cárdenas-Hagan, 2007). Finally, we used a simple game to provide students with extensive modeling, practice, and feedback in phonemic awareness segmentation and blending, as well as the application of those skills to print (Allor, Gansle, & Denny, 2006). (See Method section for further details about the intervention.)

Method

Research Design

This study focused on students with moderate intellectual disabilities (i.e. IQs ranging from 40-55) who were participants in a larger, longitudinal study examining the effectiveness of a comprehensive reading program for students with low IQs (ranging from 40-79: Allor, Roberts, Mathes, Roid, & Cheatham, 2009). Students were randomly assigned within each school to either (a) an intervention group that participated in daily, small group reading instruction delivered by research teachers or (b) a contrast group receiving typical special education.

Participants

Schools

The study took place in 10 elementary schools in a large, southwestern urban school district and one private school for students with special needs. District personnel worked with the researchers to select schools with a relatively large number of students with ID and that would provide a balanced sample, racially and economically. An urban, private school that served students with special needs was added to increase the size of our sample of students with moderate ID.

Teachers

Six certified special education teachers were hired to provide instruction to students in the research study. The highest degree held by five of the teachers was a bachelor's degree, while one teacher also held a master's degree. Five were female and one was male. Five were Caucasian and one was African American. Five were jointly hired and supervised by district personnel and researchers, teaching at two or three different schools each day. One taught exclusively at the private school. At the outset of the study, two were new to teaching and the others had 5, 9, 12, and 35 years of teaching experience, respectively. Three of the teachers had prior experience working with students with reading difficulties, one had prior experience with students with behavioral disorders, one was bilingual, and one had prior experience teaching students with ID.

Students

At the outset of the study, researchers and school district personnel identified all students in each of the schools with moderate ID (IQ scores between 40 and 55) and who were in grades 1 to 4. All students in this IQ range were included regardless of the cause or comorbid conditions (i.e., Down Syndrome, autism, William's Syndrome, physical disability, etc.). Students were randomly assigned within each school into either the intervention group or the contrast group.

Due to the small number of students within each school, students were not matched on other variables. Twenty-four students began the study in the first year and another seven students joined the study at the beginning of the second year (these seven were also randomly assigned to the treatment or contrast group). Of these 31 students, two moved during the study and one was removed from the sample due to misidentification, resulting in a sample of 28 students (treatment, $n = 16$; contrast, $n = 12$). The mean age of the participants was 9.46 ($SD = 1.19$) for the treatment group and 9.25 ($SD = 1.76$) for the contrast group. This difference was not significant ($t = -.106$). Other demographic information is presented in Table 1. Chi-square analyses revealed no significant differences on any demographic variables, including race, gender, socioeconomic status, and educational placement.

Measures

We employed two types of measurement schemes. First, we assessed at pretest and posttest. Second, we collected continuous progress monitoring data every four weeks during the first year of the intervention and every six weeks during the second year.

Pre-post

All students were assessed prior to the intervention and at the end of the Spring semester of the second year. Pretesting during the first year occurred between October and February on a staggered schedule with students in the treatment and contrast groups tested at approximately the same time. The 7 students who entered the study in the second year were pretested in August or September of that year. The following measures comprised the comprehensive battery:

Peabody Picture Vocabulary Test-III (PPVT-III; Dunn & Dunn, 1997). The PPVT-III measures receptive vocabulary. The technical manual reports reliability coefficients ranging from .91 to .98 and adequate content, criterion, and construct validity.

The Expressive Vocabulary Test (EVT; Williams, 1997). The EVT measures expressive vocabulary. The technical manual reports internal reliability alphas ranging from .90 to .98 with a median of .95 and test-retest reliability coefficients range from .77 to .90. Data on content, criterion, clinical and construct validity are reported in the technical manual.

The Woodcock Language Proficiency Battery- Revised. (WLPB-R; Woodcock, 1991). We included memory for sentences and listening comprehension from the language composite. We included the letter-word identification (real word reading), word attack (nonsense word reading), and passage comprehension from the reading composite. The WLPB-R has good reliability (internal consistency ranged from .81-.92; test-retest ranged from.75 to .95). Adequate content, concurrent, predictive, and construct validity data are also reported in its technical manual.

The Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999). Five subtests of the CTOPP were used: Blending Words, Blending Non Words, Segmenting Words, Sound Matching (first sound and last sound), and Rapid Letter Naming. The CTOPP has good reliability (internal consistency ranged from .83 to .95; test-retest ranged from .70 to .92). Adequate content, concurrent, predictive, and construct validity data are also reported in its technical manual.

Test of Word Reading Efficiency (TOWRE: Torgesen, Wagner, & Rashotte, 1999). Both subtests were administered: phonemic decoding efficiency and sight word efficiency. Reliability coefficients are .95 and .96, respectively. Data on content-description, concurrent, construct identification, and item validity are reported in its technical manual.

Continuous Progress Monitoring

In order to assess progress continuously across a school year, we used *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS; Good & Kaminski, 2002). DIBELS measures are commonly used for collecting continuous progress monitoring data. We administered 4 subtests: Initial Sound Fluency (ISF), Phoneme Segmentation Fluency (PSF), and Nonsense Word Fluency (NWF). ISF, PSF, and NWF reliability coefficients range from .72 to .92 on single probes and .91 to .98 on the means of multiple probes (3 to 5 probes). Concurrent and predictive validity with a variety of reading tests ranges from .36 to .82. In addition, the Letter Naming Fluency (LNF) test was given at pre and posttest. The alternative form reliability coefficient for LNF was .88. Validity coefficients for this measure ranged from .65 to .71.

Intervention

Overview

Students in the intervention condition received approximately 40 to 50 minutes of instruction daily in small groups of one to four from one of our six highly trained and supported intervention teachers across the duration of the study. The intervention was comprehensive, including systematic and explicit instruction in multiple content strands (i.e. concepts of print, phonological and phonemic awareness, oral language, letter knowledge, word recognition, vocabulary, fluency, and comprehension) woven together so skills and strategies were integrated and applied in context.

The intervention built on a curriculum previously validated with students without ID, *Early Interventions in Reading* (Mathes & Torgesen, 2005a, 2005b), which was comprised of 240 lessons split evenly into two levels. However, students in the current research did not possess the prerequisite skills necessary to profit from this curriculum. Thus, we created an additional 60 lessons we called the *Foundation Level* (Allor, Mathes, & Jones, in press). An oral language component was also developed and included in both the *Foundation Level* and *Level One*. In total, 300 lessons have been designed to take students from being nonreaders with very little or no letter knowledge or phonological awareness to reading at approximately an ending 3rd grade reading level. Since no students had yet begun *Level Two* at the time of the article, only details about the *Foundation Level* and *Level One* are provided here.

Based on pre-test DIBELS scores, 13 students began the intervention in the *Foundation Level* and three began in *Level One*. The three students beginning in *Level One* were among the older students in the study (2 third graders and 1 fourth grader). Groups were determined by DIBELS pretest scores as well as other practical considerations. Thus, two of the 16 students were taught individually, while others were taught in groups of two to four. Grouping arrangements changed as needed, based on rate of progress.

Instructional Design and Features

All of the lessons in the program were fully-specified and employed the principles of Direct Instruction (Carnine, Silbert, Kame’enui, & Tarver, 2004; Coyne, Kame’enui, & Simmons, 2001; Englemann, 1997; Englemann & Carnine, 1982; Kame’enui & Simmons, 1990). We chose this model of instruction because of its long standing record of success with various populations at-risk for school failure (Adams & Engelmann, 1996; Borman, Hewes, Overman, & Brown, 2003; Carlson & Francis, 2002; Ligas, 2002). Instructional content was carefully analyzed and organized into a systematic scope and sequence intended to reduce student confusion and target big ideas and key strategies. Errors were reduced through integration of new learning with previous learning, ongoing review, and opportunities for group and individual responding. The goal was to integrate skills and strategies over time, resulting in a set of daily lesson plans with overlapping content strands and extensive cumulative review and application (i.e., concepts of print, phonological and phonemic awareness, letter knowledge, word recognition, connected text fluency, comprehension strategies, vocabulary, and oral language development). Following a behavioral approach, lessons provided for (a) frequent reinforcement on both an interval and intermittent schedule, (b) carefully orchestrated time delay techniques between stimuli presentation and student responses, and (c) multiple opportunities to practice each item of content.

Each lesson plan was highly detailed, providing exact wording to ensure teacher language was clear and kept to a minimum. By following these plans, teachers delivered explicit instruction in integrated instructional strands, responding to individual student learning needs by scaffolding instruction when necessary. Thus, while lesson plans were prescribed, the way in which lessons were actually delivered required teachers to make on the spot decisions and minor adjustments in the plans in order to focus on specific target areas needed by students within a group. Accompanying these lesson plans, teachers were provided storybooks for read-alouds, pictures for vocabulary support, student activity books, magnetic pictures (*Foundation Level* only), daily reading books using decodable stories (*Level One* only), a puppet with a fully articulated mouth, letter-sound picture cards, “automatic” word cards, and lesson mastery tracking forms. Additionally, the *Foundation Level* included a game designed to provide students with opportunities to practice the PA skills of blending, segmenting, and letter-sound correspondence (See Allor et al., 2006 for details).

Instructional Strands

Concepts of print. During the *Foundation Level*, students developed various concepts of print. These included pointing to the title and author of a book, tracking from left to right, and pointing to individual words while repeating a sentence.

Phonological and phonemic awareness. Activities in this strand span the *Foundation Level* and *Level One* and addressed skills along the continuum of phonological and phonemic awareness, including clapping words in sentences, clapping syllables within a multi-syllabic word, initial sound isolation, phoneme segmentation, phoneme blending, and phoneme discrimination. Over time the complexity of words included in segmentation and blending activities increased.

Letter knowledge. In this strand, students learned letter names and the sounds of individual letters and letter combinations, as well as worked on speeded retrieval (i.e., rapid automatic naming tasks). Starting in the 21st lesson of the *Foundation Level*, students were taught to map phonemes to letters, with new letter-sound correspondences introduced every few days and followed by daily cumulative review.

Word recognition. This strand included both phonetically regular and irregular words. Toward the end of the *Foundation Level*, students were taught a small number of sight words; these words were high-frequency, phonetically irregular words presented as tricky words to be recognized automatically. Students were also taught to decode very simple phonetically regular words (i.e. closed syllable, consonant-vowel-consonant: CVC) by blending the sounds represented by the letters. As students progressed through *Level One*, additional sight words were taught and the time allowed to sound out the words was reduced, while the complexity of the words was increased (i.e. variant spelling patterns, blends, additional syllable types, and multisyllabic words). Students were also taught to be flexible decoders.

Fluency with connected text. Beginning very early in *Level One*, word recognition strategies were applied as students read decodable stories. As students acquired greater mastery of more elements, as well as the ability to decode more difficult words, this text became more challenging. To promote fluency, repeated reading of these stories was built into daily lessons. Typically students read a story in unison on the first reading, followed by reading a page or two individually on the second reading. The third reading was typically read in pairs, with the teacher timing the reading rate of one student.

Comprehension strategies. A major objective was for children to read strategically to increase understanding. Thus, prior to reading a story, students "browsed the story" looking at the pictures and predicting story content. Students then read to find out if their predictions were true. With expository text, teachers activated prior knowledge by asking students to tell what they already knew about the topic and to read to learn more. After reading the story, students then engaged in a number of activities depending on the students' competence and text structure. Initially, students were only asked to tell about what they read. Information in any order was accepted. Over time, students sequenced information until they were able to sequence only the most important information. In later lessons, students identified story grammar elements for narrative text and new information learned in expository text.

Vocabulary and oral language development. Language goals were addressed through storybook read-alouds, with direct teaching of spoken vocabulary and key background knowledge, as well as extensive discussion. In the *Foundation Level*, teachers explicitly taught vocabulary and engaged students in conversation using open-ended questions and building on student language (Arnold & Whitehurst, 1994). When students began *Level One*, the Storybook routine became more complex, with books organized into themes to facilitate vocabulary and concept review. One book was read from and discussed for 3 to 5 days, with two to three new vocabulary words taught each day. Students listened for and discussed the "target words" during the reading of the story. After the passage was read aloud, students provided an oral retell and discussed the story with the teacher who employed feedback and scaffolding to encourage the use of complete sentences and new vocabulary terms.

Staff Development

During the first year of the intervention, the teachers attended a total of six days of training on the intervention, four at the beginning of the school year and two later in the school year. Teachers were visited by two experienced reading coaches every other month to address their individual needs and the needs of their students. The coaches were former teachers who had previously taught the *Early Interventions in Reading* (Mathes & Torgesen, 2005a) curriculum under similar research conditions. Teachers also attended three meetings with the entire research team, including the coaches and lead research investigators who had created the curriculum.

During the second year, teachers participated in three days of training, two days at the beginning of the school year and one day in the middle of the school year. The number of coaching visits was reduced to two per semester. Research team meetings with the teachers were increased in frequency to once per month and focused on using student data to make instructional decisions, including both academic and behavioral modifications.

Implementation Fidelity and Intensity

Three fidelity observations were conducted each year to measure the degree to which the intervention was implemented. After each observation, the research assistants shared feedback with teachers. A 3-point rating scale was used to evaluate the fidelity of implementation across several categories including teaching to mastery, maintaining a good pace, maintaining student attention, and providing error correction and scaffolding. A score of 3 indicated that the teacher implemented the category exactly as intended. A score of 2 indicated that the category was implemented acceptably but with some error. A score of 1 indicated that the category was poorly represented. A score of 0 indicated that the behavior was expected but not observed. The measure included a global checklist for readiness of materials, appropriate seating arrangement, and instructor warmth and enthusiasm. Interrater agreement was calculated and exceeded 85%. Averaged across six fidelity observations, teachers' scores ranged from 2.29 to 2.96 out of 3 with a mean of 2.75 (*SD* = 0.25). The mean, calculated as a percentage score, was 90.9% (*SD* = 8.63).

Total instructional time for each student varied depending on when they began the intervention and attendance. As a result, instruction for the students varied from 30 to 53 weeks, with a mean of 42.8 weeks (*SD* = 10.34). The average length of an instructional session was 40 minutes (*SD* = 6). Students participated in an average of 119 (*SD* = 11) instructional sessions during the study.

Results

Pretest Equivalence

Pretest data were analyzed using independent *t*-tests. These indicated no statistically significant differences between the treatment and contrast groups on any pretest measure. Pretest equivalency data are presented in Table 2.

Growth from Pretest to Posttest

Independent *t*-tests on difference scores of the pretest and posttest measures were conducted to determine whether students in the treatment condition made greater gains than students in the contrast condition. Because of positive results in previous studies with *Early Interventions in Reading*, we anticipated the directionality of any differences (Mathes et al., 2005) and, therefore, we analyzed the data using a one-tailed test of the null hypothesis (Gall, Gall, & Borg, 2007). *T*-test and effect size results are presented in Table 3. Statistically significant results were found on the following measures: CTOPP Blending Nonwords, CTOPP

Segmenting Words, CTOPP Sound Matching, PPVT, TOWRE Sight Word Efficiency, TOWRE Phonemic Decoding Efficiency, WLPB-R Letter-Word Identification, WLPB-R Passage Comprehension, and WLPB-R Word Attack. No statistically significant differences were found on CTOPP Blending Words, EVT, WLPB-R memory for sentences, and WLPB-R listening comprehension, although all means favored the treatment group and effect sizes were moderate to strong.

We also applied the Bonferroni correction procedure because we employed multiple, related measures of various reading constructs. This adjustment was made to help control for Type I error (Dunn, 1961). We adjusted our critical *p* value by dividing .05 by the number of measures in a given construct, i.e. phonemic awareness, phonemic decoding, real word recognition, reading comprehension, and oral language measures. After making this correction, differences on PPVT, TOWRE Sight Word Efficiency, and WLPB-R Passage Comprehension were no longer statistically significant. Other findings remained the same. Additionally, Analysis of Covariance tests were conducted on the gain scores using pretest measures as covariates. However, results were very similar to the t-test analyses, including significant findings on all of the same measures, as well as significant findings on CTOPP Blending Words, CTOPP Sound Matching, and WLPB-R Memory for Sentences. Therefore, these results were not included.

Growth on Continuous Progress Monitoring Measures

We used a hierarchical linear modeling (HLM) approach to examine student gains on the three DIBELS measures: initial sound fluency (ISF), phoneme sound fluency (PSF), and nonsense word fluency (NWF). The advantage of HLM over simple regression, ANOVA, or repeated measures ANOVA is that it allows the researcher to look at hierarchically structured data and interpret results without ignoring these structures. This is accomplished by including a complex random part that can appropriately account for complex covariance structure in the data (Roberts, 2004). In the present analysis, a two-level model was examined with measurement occasions at level-1 and students at level-2. Previously, only *t*-tests were conducted on gain scores to note differences between the treatment and contrast groups. These initial analyses were not performed in a HLM environment because of a lack of power in the HLM design. Therefore, independent samples *t*-tests were used because they were more appropriate and more parsimonious. With the continuous progress monitoring data, HLM growth curve analysis is more appropriate as it can model complex covariance structures and effectively model explanatory variables that are able to mediate the changes in growth from student to student.

The HLM model investigated differences among the success of the intervention for students with moderate ID (IQ scores between 40 and 55). HLM combines the strength of simple ANOVA (mean difference analysis) and regression (correlational analysis) to build a model that both considers differences across students (the second-level or student-level) and incorporates a correlational component for each of these students (the time covariate). This assumption is fundamental to our analysis since we are hypothesizing that belonging to the intervention group and the cross-level interaction between time and intervention (a student-level variable) will have an impact on growth.

For each of the three dependent variables, PSF, ISF, and NWF, two models were tested. Because these models included interaction effects, it was important to code time with a meaningful zero (Hox, 2002). Therefore, time was centered with zero being the day that a student began the program and increasing numbers representing the number of weeks the student was involved in the intervention. The first model included only the time covariate with random effects for the intercept and for the time variable and was presented as:

$$y_{ti} = \gamma_{00} + \gamma_{10} * time + u_{0i} + u_{1i} * time + e_{ti} \quad , \tag{1}$$

where y_{ti} is the dependent variable for that model, γ_{00} is the average fluency at time = 0, γ_{10} is the average student increase in fluency for each week since the program began, u_{0i} is the random effect of γ_{00}, u_{1i} is the random effect for γ_{10}, and e_{ti} is the random effect of the measurement occasions within individual students.

The second model included a student-level (level-2) effect to identify whether or not the student was in the intervention or control group. In this model, the intercept γ_{00} has a slightly different interpretation than in the first model as it now represents the average fluency for a student in the control group at time=0 (the intervention group receives a "1" for the level-2 grouping variable). This new model is:

$$y_{ti} = \gamma_{00} + \gamma_{10} * time + \gamma_{01} * group + \gamma_{11} * time * group + u_{0i} + u_{1i} * time + e_{ti} \quad , \tag{2}$$

where γ_{01} is the effect of a student belonging to the intervention group at time = 0 and γ_{11} represents the cross-level interaction between time and the intervention effect.

Hox (2002) has noted that it is typical to include both of the main effects in a model in the presence of a statistically significant interaction effect. As can be seen from the results of our three models in Tables 4-6, the model structures are the same across all four analyses. The only change between each analysis was the dependent variable.

The analysis in Table 4 represents the effect of the intervention on ISF across time for students. There was no statistical difference between the intervention and contrast groups at the initial time-point (-1.026, $p = 0.711$). The interaction effect tested to see whether or not the amount of difference between the intervention group and contrast group changed over time. For example, a large positive value for γ_{11} would mean that students involved in the intervention tended to have larger gains in ISF over the contrast group students the longer they were involved in the intervention. In this analysis, however, the value for this interaction (0.167) was not statistically significant over time ($p = 0.058$) indicating that students in the intervention and control groups tended to have the same rate of change over time.

Table 5 shows the effect of the intervention on PSF across time for students. As can be seen from this analysis, there was no statistical difference between the intervention and contrast groups at the initial time-point (-0.199, $p = 0.927$), thus indicating that they were statistically equivalent in terms of PSF when the program began. Also in model M1, the value for the interaction effect (0.417) was statistically significant over time ($p < .001$) thus indicating that students in the intervention group tended to have a larger rate of growth in PSF over time than did the students in the contrast group.

Table 6 shows the effect of the intervention on students' NWF across time. Again, there was no statistical difference between the intervention and contrast groups at the initial time-point (-3.725, $p = 0.309$), thus indicating that they were statistically equivalent in terms of NWF when the program began. Also in model M1, the value for the interaction effect (0.337) was statistically significant over time ($p = .003$) thus indicating that students in the intervention group tended to have a larger rate of growth in NWF over time than did the students in the contrast group. It should be noted that one student in the treatment group was excluded from this analysis because the student began the study above benchmark and maintained scores above benchmark.

Graphs of scores for individual students on PSF and NWF are presented in Figures 1 and 2. The graphs on the left show the scores for the 12 students in the contrast group; the graphs on the right show the scores for the 16 students in the treatment group.

Discussion

In this article, we report the results from a longitudinal study examining the effectiveness of a comprehensive early literacy intervention for students with moderate intellectual disabilities (ID). This article reports on student progress after participating in the intervention, or typical special education instruction, for one to one and a half years. The purpose of the study is to determine if students participating in the intervention make significantly more progress on a variety of reading and language measures than similar students participating in typical special education. Our outcomes strongly support the effectiveness of the intervention with students with moderate ID. These findings are discussed in detail below.

Research Question : Does a comprehensive reading program taught to primary-grade students who have moderate ID (IQs ranging from 40-55) result in better early reading outcomes than typical special education instruction on measures of (a) phonemic awareness (PA), (b) phonics, (c) word recognition, and (d) oral language/comprehension?

The answer to this question is clearly yes. On all outcome measures, means favored the intervention group, with moderate to strong *ES*s on all measures. Despite low statistical power due to the small sample size (16 in the intervention and 12 in the contrast group), statistically significant differences were found on multiple measures, including measures of phonemic awareness, phonics, word recognition, vocabulary, and comprehension.

The clearest, and arguably one of the most important findings in the study were on measures of phonemic awareness (PA). Students participating in the intervention consistently outperformed students in the contrast group on measures of PA. Effect sizes on the four CTOPP subtests (gains from pretest to posttest) ranged from a medium effect of .57 to a strong effect of .88. The differences on both Blending Nonwords and Segmenting Words were statistically significant (See Table 3). Additionally, these differences remained significant after the

Bonferroni correction. Although differences on CTOPP Blending Words and Sound Matching were not statistically significant, effect sizes were strong (.57 and .68, respectively). Results from the HLM analysis also revealed that the students in the intervention group tended to have a higher rate of growth on DIBELS-PSF over time, with this interaction statistically significant ($p < .001$; see Table 5 and Figure 1). This finding is particularly compelling because it indicates that students in the intervention group consistently outperformed students in the contrast group over a long period of time. Unexpectedly, the same pattern of results was not evident on DIBELS-ISF, but this was likely because students with ID found the language and cognitive demands of the task challenging, preventing them from demonstrating their ability to isolate phonemes.

Consistent differences in favor of the treatment group were also evident on multiple measures of alphabetic decoding. Effect sizes on nonsense word reading measures, TOWRE phonemic decoding and WLPB word attack, were 1.0 and .66, respectively, with statistically significant differences on the former measure. These differences remained significant after the Bonferroni correction procedure. Additionally, HLM analyses of NWF measures across time revealed a statistically significant interaction in favor of the treatment group ($p = .003$; See Table 6 and Figure 2).

Data also indicate that students in the treatment group consistently made more growth on word recognition (i.e., real word reading) than students in the contrast group. Two measures directly assessed this skill, TOWRE Sight Word Efficiency and WLPB-R Letter-Word Identification. Differences on these measures were statistically significant and ESs were strong (.72 on TOWRE-word reading efficiency and .99 on WLPB-R Letter-Word Identification).

Outcomes for oral language and comprehension were also positive. Effect sizes were moderate to strong on language measures, ranging from .36 to .71, with significant differences on receptive vocabulary (PPVT). Differences on passage comprehension were statistically significant. (See Table 3.)

Conclusions

This study provides clear support for raising expectations related to reading for students with moderate ID. Students with moderate ID should not be left behind; they should be provided with scientifically-based reading instruction. The findings of this study strongly support the conclusion that students with moderate IDs can make important gains in reading and language skills when provided with intensive and comprehensive instruction over an extended period of time. A broad array of measures was studied, including PA, phonics, word recognition, comprehension, and oral language. *ES*s on all measures were moderate to strong, with means consistently favoring the intervention group. Statistically significant differences were found on multiple measures, including phonemic awareness, phonics, word recognition, and comprehension. These findings are consistent with existing research and extend that research in several ways.

First, explicit, systematic instruction in PA and phonics that has proven to be effective for students with IQs in the average range (Ehri et al., 2001; Mathes et al., 2005) is also effective for students with moderate ID. Prior research on teaching PA and phonics to students with ID focused on those with mild ID and was limited to relatively brief instructional periods targeting isolated skills (Joseph & Seery, 2004; O’Connor et al., 1996). The current study demonstrates that with an integrated and systematic approach, students with moderate ID can successfully combine isolated skills in PA and phonics to decode unfamiliar words.

Second, this study is consistent with previous research demonstrating the effectiveness of systematic approaches in improving sight word recognition (Browder et al., 2006). In this study sight word instruction was one component of the comprehensive reading program implemented. Effect sizes on measures of sight word recognition were high and differences between the treatment and contrast groups were statistically significant.

Third, we found that a comprehensive reading intervention can positively impact oral language and comprehension. With moderate *ES*s on oral language measures and strong, statistically significant differences on reading comprehension and receptive vocabulary, the current study extends previous research that had demonstrated only very basic, isolated comprehension skills (Browder, 2006). As is similar in research with students without ID, it is likely that gains in comprehension are strongly influenced by gains in word recognition. It appeared that the students in the treatment group were able to identify more words than the students in the contrast group, enabling them to answer a few basic comprehension items on the standardized measure.

Fourth, the longitudinal design of this study provides information about the level of reading performance that can be expected after one to one and a half years of consistent instruction in a comprehensive reading program. Eight of the 16 students in the treatment group were approximately halfway through *Level One* or further. At this level, students were able to identify the most common sound for all individual letters and read words made up of those letters. For example, students were able to successfully say the sounds in words such as *last*, *mom*, *slip*, and *step*, as well as blend those sounds together to form the word. Further, students at this level were working on basic comprehension strategies, such as retelling stories, sequencing main events, and story grammar. Generally, students in this study took approximately twice the amount of time to successfully complete lessons than struggling readers in previous studies. Further, a closer look at the graphs in Figures 1 and 2 reveals that gains on DIBELS measures of

PA and phonics (PSF and NWF) were typically not evident until students had been participating in the intervention for approximately 15 to 20 weeks of instruction. The time needed to evidence gain was much longer in duration than is typical of struggling readers without ID. Thus, while the content of instruction for both groups is the same, what differentiates them is the persistence needed on the part of schools to provide this instruction.

Practical Implications

The findings of this study have important practical implications for educators in the field of intellectual disabilities. First, and most importantly, our findings support educators who choose to provide reading instruction that is comprehensive and not limited to sight word memorization, even with students with IQs in the moderate range. Second, reading programs should be selected that are consistent with the techniques of the intervention described in this study, including (a) systematic, explicit instruction in all components of reading; (b) repetitive, routine activities implemented with consistent instructional language; and (c) fast-paced, short activities that are highly motivating. Third, to be effective with students with ID, programs must be implemented with extremely high degrees of fidelity. This requires initial and ongoing professional development. Fourth, practitioners need to make data-based decisions about how to modify instruction and provide positive behavioral support. In addition to using existing progress monitoring measures, such as DIBELS, observation of student performance during lessons and other informal measures is key to making appropriate decisions.

Limitations and Future Research

One limitation of the current study is the variability of student performance on outcome measures, as is common among students with IDs. We met the challenge of eliciting optimal performance from our students on study measures by ensuring familiarity of examiners and discontinuing testing when necessary. We also addressed this issue by including repeated measures across time, when possible. This enabled us to employ data analytic techniques (i.e., HLM) that analyzed trends across time and minimized the impact of variability of the data. Due to this limitation, findings related to measures only administered at pretest and posttest should be interpreted cautiously. Further research is needed to develop reading and language tests that use repeated measures of progress, especially untimed measures as existing repeated measures are usually timed.

Another limitation of the study is the small sample size. This is a common problem when studying low-incidence populations because it is logistically challenging and resource-intensive to increase sample size with a low-incidence population. Even after carefully selecting schools with as many students with moderate IDs as possible and with the addition of a school that focuses on students with IDs, our sample remained quite small for a group design study. This is problematic because it increases the probability of Type II error and it is possible that significant differences between the groups on some measures were not detected simply because of the small sample size. A competing limitation is that by conducting multiple *t*-tests on related measures we increased the possibility of Type I error. We addressed this limitation by applying the Bonferroni correction procedure. Our findings held up under the scrutiny of this conservative procedure.

Further research is needed to address multiple questions related to teaching students with ID to read. One need is further exploration of the relationship between IQ and response to reading instruction. Currently, we are examining this issue with our larger study in which we are following the progress of students with IQs ranging from 40 to 79 over four academic years. In that study, we are also addressing the question of the level of reading competence that can be achieved by students with low IQs. In this article, language measures were administered only at pretest and posttest. Further analyses of language measures, especially measures across time, are also needed. Given the variability of student performance, language measures that can be administered frequently would be useful for research and for teachers to use in their classrooms for ongoing progress monitoring. Finally, further research is needed to determine progress over a longer period of time, especially on measures of advanced reading, including fluency and comprehension.

Summary

In summary, students with moderate IDs can learn basic reading skills given consistent, explicit, and comprehensive reading instruction across a long period of time. Success requires that we apply key instructional features that have been demonstrated to be effective with struggling readers with average IQs, as well as techniques known to be effective for students with IDs. Teachers must be provided with up-to-date materials and extensive professional development and continued support in order to implement research-based instruction with high degrees of fidelity. Additionally, teachers must monitor student progress in order to make academic and behavioral modifications needed to ensure success. Teachers also need access to coaches with expertise in reading. Although we hope this study raises expectations for students with IDs, particularly moderate IDs, we also wish to emphasize that providing effective reading instruction to students with IDs is extremely challenging. Finally, we need to continue to explore what is possible for students with ID if they are provided consistent, comprehensive reading instruction for an extended period of time.

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Table 1
Student Demographic Data by Group

Variable	Treatment (*n*=16) *n*(%)	Contrast (*n*=12) *n*(%)	X^2 (df)[a]
Gender			1.77 (1)
M	14(88%)	8(66%)	
F	2(12%)	4(31%)	
Race			.58 (3)
Caucasian	4(25%)	4(33%)	
African American	9(56%)	5(42%)	
Hispanic	2(12%)	2(17%)	
Other	1(6%)	1(8%)	
Free Lunch Program Participation			
Free	5(31%)	3(25%)	.15 (2)
None	10(63%)	8(67%)	
Unknown	1(6%)	1(8%)	
Special Education Placement			1.39 (2)
Self contained class for students with ID	12(75%)	11(92%)	
Self contained class for students with autism	1(6%)	0(0%)	
General education w/ resource	3(19%)	1(8%)	

[a]No differences were statistically significant.

Table 2

Pretest Equivalencies

	Treatment (*n* = 16)		Contrast (*n* = 12)		
Measure	*M*	*SD*	*M*	*SD*	*t* (1, 27)[ns]
CTOPP					
Blending Words	2.00	3.50	.92	1.98	-.96
Blending Nonwords	.88	1.78	.83	1.64	-.86
Segmenting Words	.37	1.50	.00	.00	-.86
Sound Matching	2.00	2.45	1.50	4.30	-.36
EVT	34.94	13.28	30.08	13.85	-.94
PPVT	40.81	21.70	33.92	19.52	-.87
TOWRE					
Sight Word Efficiency	2.69	5.65	6.08	16.26	.78
Phonemic Decoding Efficiency	.38	1.50	2.42	8.37	.84
WLPB					
Memory for Sentences	23.44	10.02	21.17	8.27	-.64
Listening Comprehension	2.81	3.25	1.25	1.55	-1.54
Letter-Word Identification	12.25	7.61	11.25	7.42	-.35
Passage Comprehension	2.62	3.30	1.58	2.28	-.94
Word Attack	1.00	2.85	.75	2.30	-.25

[ns]No significant differences found at .05 level on any measure

Table 3

Growth on Pretest to Posttest Measures

	Treatment *n* = 16						Contrast *n* = 12							
	Pretest		Posttest		Difference		Pretest		Posttest		Difference			
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*t*	Effect Size
CTOPP														
Blending Words	2.00	3.50	4.44	4.94	2.44	4.66	.92	1.98	1.25	1.87	.33	1.61	-1.68	.57
Blending Nonwords	.88	1.78	2.31	2.94	1.44	2.75	.83	1.64	.33	.89	-.50	1.24	-2.49	.87*
Segmenting Words	.37	1.50	3.06	3.87	2.69	3.75	.00	.00	.17	.58	.17	.58	-2.64	.88*
Sound Matching	2.00	2.45	4.69	3.93	2.69	2.91	1.50	4.30	2.33	2.81	.83	2.44	-1.78	.68
EVT	34.94	13.28	42.38	11.51	7.44	9.31	30.08	13.85	34.42	11.84	4.33	7.70	-.94	.36
PPVT	40.81	21.70	50.81	25.38	10.00	10.22	33.92	19.52	33.25	14.18	-.67	19.64	-1.87	.71*
TOWRE														
Sight Word Efficiency	2.69	5.65	11.38	11.12	8.69	9.45	6.08	16.26	8.33	16.38	2.25	8.35	-1.87	.72*
Phonemic Decoding Efficiency	.38	1.50	5.00	6.53	4.63	5.38	2.42	8.37	1.75	4.07	-.67	5.23	-2.61	1.00*
WLPB-R														
Memory for Sentences	23.44	10.02	27.88	7.22	4.44	7.66	21.17	3.27	22.00	7.99	.83	5.87	-1.36	.52
Listening Comprehension	2.81	3.25	5.44	6.11	2.63	4.24	1.25	1.55	2.17	2.89	.92	2.35	-1.25	.48
Letter-Word Identification	12.25	7.61	18.75	7.72	6.50	4.05	11.25	7.42	14.00	8.11	2.75	3.38	-2.60	.99*
Passage Comprehension	2.62	3.30	5.31	3.93	2.69	2.63	1.58	2.28	2.67	2.93	1.08	1.83	-1.81	.69*
Word Attack	1.00	2.85	2.94	2.82	1.94	2.49	.75	2.30	1.08	2.94	.33	.78	-2.15	.82*

*$p < .05$

Table 4

Model Fit Estimates for Initial Sound Fluency with Students with IQs in the Moderate Range

	M_0: Null model			M_1 : + group & interaction		
Fixed Effects:	estimate	s.e.	*p*-value	estimate	s. e.	*p*-value
Intercept γ_{00}	5.000	1.326	< 0.001	5.579	2.060	0.007
Time γ_{10}	0.238	0.046	< 0.001	0.142	0.066	0.033
Group γ_{01}				-1.026	2.735	0.711
Time*Group γ_{11}				0.167	0.088	0.058
Random Effects:						
σ^2_e	30.706			30.746		
σ^2_{u0}	38.957			41.130		
σ^2_{u1}	0.040			0.034		
$COV\ (u_0.u_1)$	0.017			0.041		
Fit:						
AIC	1678.826			1678.642		
BIC	1699.882			1706.652		
X^2	1666.826			1662.642		

Table 5
Model Fit Estimates for Phoneme Segmentation Fluency with Students with IQs in the Moderate Range

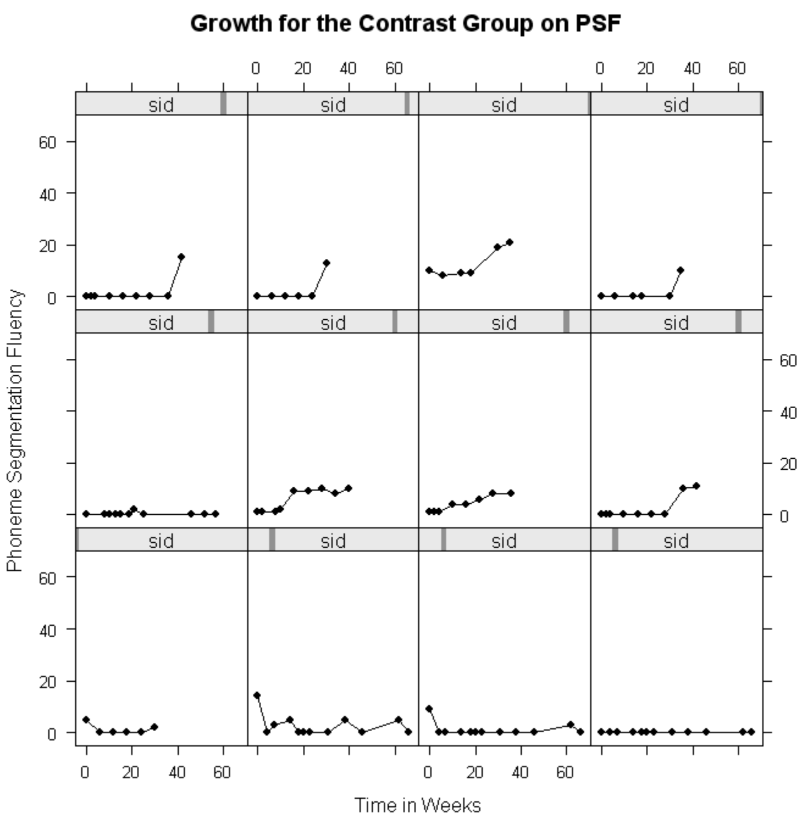
	M_0: Null model			M_1 : + group & interaction		
Fixed Effects:	estimate	s.e.	*p*-value	estimate	s. e.	*p*-value
Intercept γ_{00}	0.681	1.032	0.509	0.883	1.608	0.584
Time γ_{10}	0.369	0.066	$< .001$	0.124	0.081	0.130
Group γ_{01}				-0.199	2.139	0.927
Time*Group γ_{11}				0.417	0.108	$< .001$
Random Effects:						
σ^2_e	27.819			27.832		
σ^2_{u0}	20.332			22.102		
σ^2_{u1}	0.107			0.062		
$COV\ (u_0.u_1)$	0.231			0.247		
Fit:						
AIC	1666.922			1657.986		
BIC	1687.979			1685.996		
X^2	1654.922			1641.986		

Table 6

Model Fit Estimates for Nonsense Word Fluency with Students with IQs in the Moderate Range

	M_0: Null model			M_1 : + group & interaction		
Fixed Effects:	estimate	s.e.	*p*-value	estimate	s. e.	*p*-value
Intercept γ_{00}	2.786	1.794	0.122	4.845	2.668	0.071
Time γ_{10}	0.327	0.065	<0.001	0.140	0.085	0.102
Group γ_{01}				-3.725	3.586	0.309
Time*Group γ_{11}				0.337	0.114	0.003
Random Effects:						
σ^2_e	37.252			37.266		
σ^2_{u0}	73.907			73.004		
σ^2_{u1}	0.088			0.064		
$COV\ (u_0.u_1)$	0.455			0.828		
Fit:						
AIC	1673.274			1666.205		
BIC	1694.057			1693.847		
X^2	1661.274			1650.205		

Figure 1 Individual Graphs on Phoneme Segmentation Fluency


Growth for the Contrast Group on PSF
sid
Phoneme Segmentation Fluency
Time in Weeks
0
20
40
60

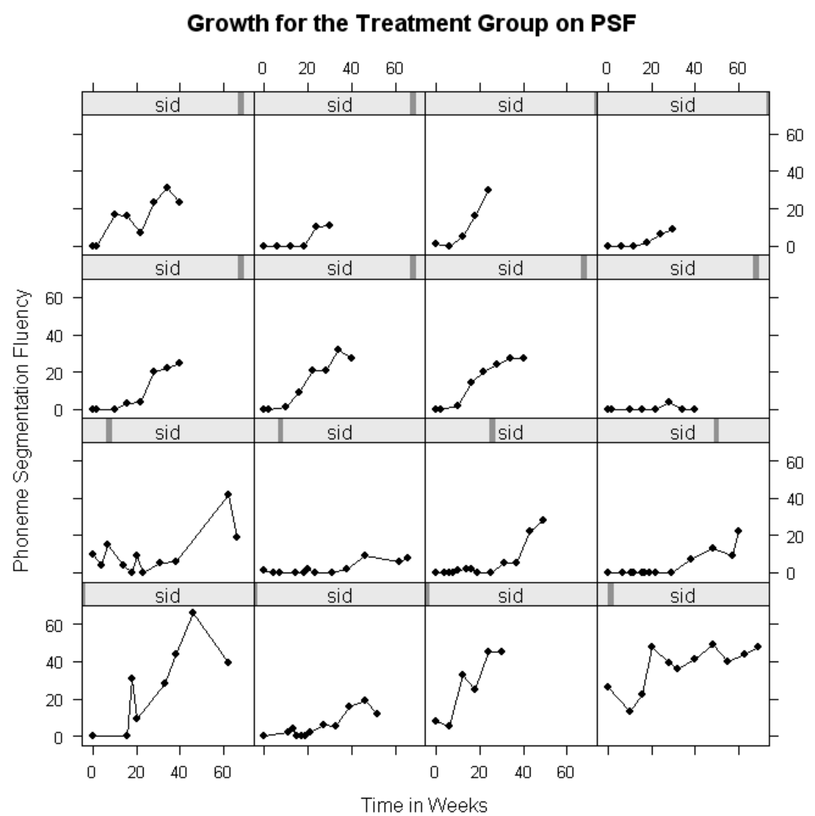
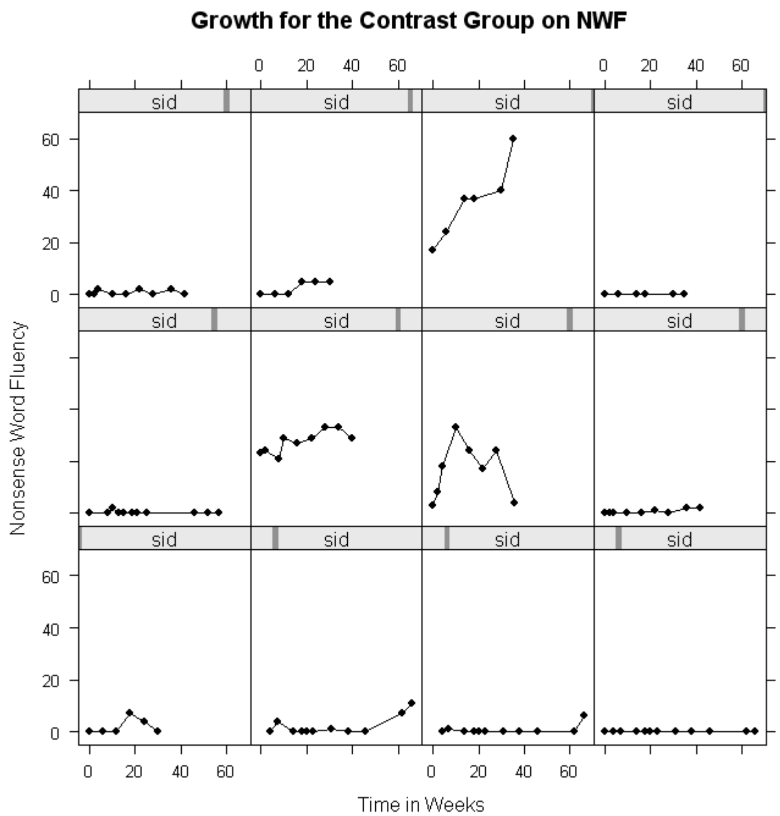
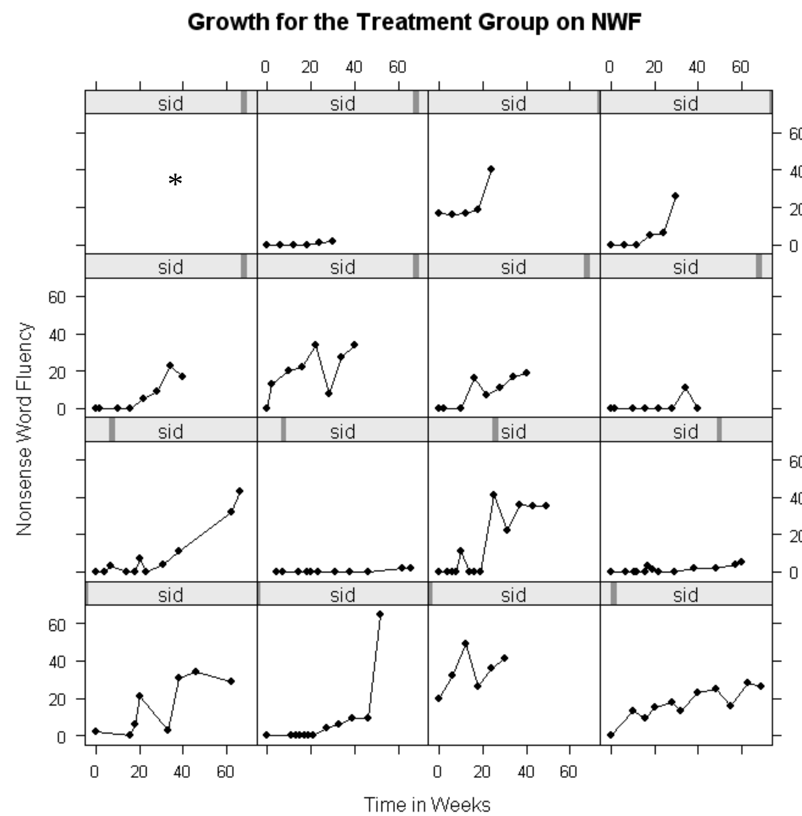

Growth for the Treatment Group on PSF
sid
Phoneme Segmentation Fluency
Time in Weeks
0
20
40
60

Figure 2 Individual Graphs on Nonsense Word Fluency





*This student's scores are not included because the student began the study above the benchmark of 50 and maintained scores above 50.