CHAPTER SIXTEEN

Fluency Training as an Alternative Intervention for Reading-Disabled and Poor Readers

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The major contribution of the article to follow is the demonstration that fluency training in single word reading can be an effective intervention for some readers who have not responded well to more conventional intervention techniques. Understanding this contribution though will require the presentation of some background information on the origins of reading difficulty and on conventional intervention techniques and their effectiveness.

ORIGINS OF READING DIFFICULTY

It is generally assumed among reading researchers and professional educators that the large majority of students with reading difficulties have difficulties at the level of reading individual words (e.g., Seidenberg, 1992; Shaywitz, 2003, Snow, Burns & Griffin, 1998; Wang, 1996). Slow and/or inaccurate word reading uses valuable cognitive resources (e.g., working memory capacity) necessary for higher level reading activities such as activation of meaning and the comprehension of connected text. Word reading difficulty does not account for all reading problems, but it certainly is a characteristic shared by many readers who fall behind their peers in reading performance.

The prevailing view is that the central cause of word reading difficulties is a core phonological processing deficit. Poor phonological processing is thought to inhibit the accurate encoding of the constituent sounds of speech (phonemes),

and this in turn has consequences for both the acquisition of speech and the subsequent development of reading ability. For instance, individuals who develop reading difficulties often exhibit delays in learning to speak, and they often display articulation difficulties when they do speak (Shaywitz, 2003). Shaywitz (2003) describes poor phonological processing as resulting in the storage of "fuzzy phonemes," which subsequently inhibit normal language development and the acquisition of reading skill. More formally, Harm and Seidenberg (1999) have presented a connectionist model that shows how a phonological processing deficit can negatively impact both speech acquisition and reading acquisition.

One lingering question regarding phonological processing deficits is where they come from. One answer is that they are in part constitutional in origin. There is a large body of research showing that reading difficulties have genetic components (e.g., Olson, 2004, Shaywitz, 2003) and that FMRI research has shown that the brains of individuals with dyslexia process written information differently than the brains of unimpaired readers (e.g., Salmelin & Helenius, 2004). There is also, however, evidence that phonological processing difficulties can also have environmental origins (e.g., Vellutino, Scanlon & Sipay, 1997). At this point it is not possible to sort out the unique contributions of environmental and biological factors in poor reading performance but it is apparent that both can play a role.

As an aside, a particularly striking example of phonological processing difficulties arising from environmental origins comes from the first author's research with adult neoliterates (adults who have little or no formal schooling) in Burkina Faso (Royer, Abadzi & Kinda, 2004). Royer et al's (2004) sample of over 100 adolescents and adults who had never been to school did not include a single individual who initially could identify whether two words rhymed, started with the same phoneme, or ended with the same phoneme when the tasks were presented in the participant's mother tongue. However, exactly the same tasks were readily accomplished when administered to 3rd grade Burkina Faso children who were native speakers of the same language as spoken by the adult neoliterates. The Royer et al (2004) study showed that training in phonological awareness and training in rapid word recognition (in the students' mother tongue) significantly improved end of course literacy performance.

CONVENTIONAL INTERVENTIONS FOR READING DIFFICULTIES

Two general approaches have dominated attempts to improve word reading performance. The first is to directly tackle the source of the difficulty: poor phonological processing. One commonly used indicator of phonological processing is phonological awareness which can be defined as the ability to attend explicitly to the phonological structure of spoken words. Individuals who have phonological awareness can readily identify words that rhyme, and that start and end with the same phoneme. They can also perform phoneme manipulation tasks such as indicating what the word "cat" would sound like if the c were removed.

Many studies have attempted to improve word reading performance by explicitly teaching phonological awareness skills. Brady, Fowler, Stone and Winbury (1994)

for example showed that phonological awareness skills could be readily taught to inner-city children who were at risk for developing reading difficulties and Lundberg and her colleagues (Lundberg, 1994; Lundberg Frost and Peterson, 1988) reported research indicating that children taught phonological awareness skills prior to receiving formal reading instruction were stronger word readers that untaught controls at the end of grade 2. Moreover, Lundberg (1994) showed that the improvement in word reading skills was greatest in children whose initial phonological awareness skills were lowest. The positive impact of phonological awareness training on subsequent reading performance has been shown for studies conducted in Germany (Schneider, 1997), Norway (Lie, 1991), Australia (Byrne & Fielding-Barnsley, 1991, 1995), Burkina Faso (Royer et al, 2004) and the United States (e.g., Cunningham, 1990).

Another common approach to improving single word reading is the explicit teaching of decoding strategies. Typically, explicit decoding instruction (also commonly called phonics based instruction) involves the systematic teaching of letter-sound correspondences, and sounding out and blending strategies. Foorman, Francis, Fletcher, Schatschneider and Mehta (1998), for example, implemented an intervention they called embedded phonics with grade 1 and 2 students in a school district serving a high proportion of students who were at risk for reading difficulty. They showed that students exposed to embedded phonics were better word readers than their control counterparts receiving regular instruction, and that phonics instructed students made measurable gains in reading performance over the school year whereas control students showed an essentially flat reading performance trajectory.

A third approach, perhaps more common than the previous two, is to combine aspects of phonological awareness training and decoding instruction into the same intervention package. Henceforth, this kind of intervention will be referred to as conventional intervention. One example of such an approach (Vellutino and others, 1996) involved presenting kindergarten and grade 1 children with daily tutoring sessions that were individually tailored to the instructional needs of the child. There was, however, a common core of each instructional session that included exposure to phoneme awareness training, training in letter sound correspondences, instruction in using phonics based work attack strategies, and instruction in writing. Vellutino et al. (1996) showed that their intervention procedures had a positive impact on the reading performance of most, but not all, of the students who had been identified early in the study as being at risk for reading failure. The issue of not all of the readers benefiting from what should be a particularly potent blend of intervention procedures is the starting point for the intervention strategy described later in this chapter. However, before describing that strategy, several other examples of an intervention attempts that did not work for everyone should be mentioned.

Torgesen, Wagner, Rashotte, Rose, Lindamood and Conway (1999) screened approximately 1400 kindergarten students with letter naming and phonological awareness tasks and selected the 180 lowest scorers who had an IQ of at least 75. All students received approximately 80 hours of specialized reading instruction over a 2 ½ year period beginning in the second half of their kindergarten year. Students were divided between three intervention conditions. Two of the intervention conditions

varied in the intensity of their phonics based approach, and a third was designed to provide support for regular classroom reading instruction. The intervention approach that provided the most phonemically explicit instruction produced the strongest growth in word reading performance, but interestingly, the groups did not differ in reading comprehension performance at the end of the study. Also of interest was the fact that even the most successful of the intervention approaches did not produce gains in all of the students. Using a criterion which said that students scoring one standard deviation or more below the mean in word reading performance were impaired, Torgesen et al. (1999) reported that 21% of the students in their best intervention condition remained impaired at the end of the study.

Olson, Wise, Johnson, and Ring (1997) also provide evidence that interventions targeted at students lacking in phonological processing skills may not be uniformly effective. They reviewed a number of studies and concluded that some students do demonstrate improved reading performance (particularly word reading performance), but may not show consistent benefits. This latter group of students, that is, those who do not show a positive response to phonological awareness and/or systematic decoding instruction, have been referred to as "treatment resistors" (e.g., Blachman, 1997).

A meta-analysis of intervention studies (Swanson, 1999) indicated that the most effective interventions for students with reading difficulties was one that combined direct instruction (typically phonics based) with strategy instruction designed to enhance reading comprehension performance. Swanson's research showed that the combined interventions produced better learning outcomes than did interventions that used either direct instruction of strategy instruction alone, or that used procedures not including either direct instruction or strategy instruction. However, Swanson's (1999) review did not consider the issue of treatment resistors so one cannot estimate the percentage of students who did not show gains as a consequence of exposure to combined interventions.

A WORKING HYPOTHESIS OF INTERVENTION EFFECTIVENESS

As described in the above mentioned research, intervention efforts have typically targeted young children who are slow in developing letter recognition abilities, who have poor phonological awareness abilities, and who display little understanding of letter-sound correspondences. Studies have shown that some of these children respond well to interventions that train phonological awareness and/or word decoding, and others do not. The working hypothesis adopted by the authors of this chapter for why conventional intervention effectiveness is problematic for some students was alluded to earlier. The speculation is that there are two kinds of readers in the mix of students who display properties that predict reading difficulty: students whose difficulties are largely biological in origin, and students whose difficulties are largely environmental in origin. The hypothesis is that students who have biological difficulties are likely to be resistant to conventional interventions, whereas students whose difficulties are environmental in origin are likely to respond positively to conventional interventions.

The way these two explanations play out is as follows. Students who have biological problems are those who have early difficulty in identifying and separating the phonemic properties of speech (Shaywitz's fuzzy phoneme students). This may produce difficulties in early speech acquisition and the development of phonological awareness, and it delays the discovery of the alphabetic principle which allows a child to attach speech sounds to orthographic characters. This, in turn, delays reading acquisition and makes it difficult for the child to utilize sounding out strategies to assist in the word recognition process.

Students whose problems are environmental in origin are likely to come from family circumstances where there is little exposure to print materials and where the child has little practice in activities such as rhyming exposure (as in nursery rhymes), letter identification, and practice in attaching sounds to letters. This lack of exposure can produce a child who behaviorally looks very much like the child whose difficulties are biological in origin. That is, the child has difficulty in acquiring letter names upon entering school, has difficulty in successfully completing phonological awareness tasks, and who has difficulty in acquiring and using the alphabetic principle.

Cisero and Royer (1995) reported two studies with kindergarten and grade 1 students that showed the possible impact of environmental factors in the development of phonological awareness. Their studies were conducted in two Western Massachusetts communities that differed in SES status and language status. The students in the higher SES communities were all native English speakers and the students in the lower SES community were mainstream English speakers and Spanish speaking students enrolled in a transitional bilingual education program (TBE). All students were administered phonological awareness tasks (detection of rhyme, initial phoneme, ending phoneme) in both English and Spanish. The overall performance of the three groups showed that the higher SES students performed best followed by the lower SES mainstream students with the lower SES Spanish speaking student performing the lowest. One striking aspect of the results was that the higher SES English speaking students performed better on the Spanish phonological awareness tasks than did the lower SES Spanish speaking students. In fact, the general trend in the data was that if a student could do well on the phonological awareness tasks in one language, they could also perform the tasks in the second language, even if they did not speak the language.

After the study was completed the authors surveyed stores in the community surrounding the schools enrolling the lower SES Spanish speaking students. They could not find a single alphabet book or young child's story book in Spanish.

The idea that some readers have difficulties of biological origin whereas others have difficulties that can be traced to environmental experience can perhaps be traced to a paper by Clay (1987) who argued that the only way to identify readers who were truly disabled (i.e., dyslexic) was to examine their responsiveness to effective reading instruction. Readers who appeared to be at risk for reading failure but who did respond to effective instruction were judged by Clay to not be truly disabled, but rather, she suggested that they had difficulties that could be traced to lack of early experiences necessary for the development of reading ability. In contrast, readers

who did not respond to effective instruction were those that were truly disabled. As we will see later in the chapter, Clay's idea that disabled readers should be identified by responsiveness to intervention is currently at the forefront of the debate about how best to identify reading disabled students (e.g., Fuchs, Mock, Morgan, & Young, 2003).

Vellutino and his colleagues (Vellutino et al.. 1996; 1997) have also written about two types of readers among those at risk for reading failure. They described readers as having difficulties attributable to "experiential" deficits or to "cognitive" deficits. They described the cognitive deficits group as likely having problems that were constitutional in nature. Vellutino and his colleagues also suggested that students with experiential deficits were likely to benefit from intervention, whereas those having cognitive deficits were likely to be resistant to interventions. A similar theme about intervention effectiveness being problematic can be found in the article by Olson et al. (1997), though Olson does not make the dichotomy made by Clay and Vellutino.

ANECDOTAL EVIDENCE REGARDING INTERVENTION EFFECTIVENESS

The first author became acutely aware of the problematic nature of reading interventions when he founded a laboratory studying reading disabilities at the University of Massachusetts in the 1980s. Initially, the laboratory, called the Laboratory for the Assessment and Training of Academic Skills (LATAS), was devoted to developing a computer-based reading diagnostic system, but it soon also began conducting research on interventions for students who were experiencing reading difficulties. LATAS is located in a building adjacent to the Psychology building at the University of Massachusetts and is staffed by the first author and by graduate students in the Department of Psychology. LATAS charges a small fee for assessment and intervention services that is used for graduate student support. All of the students participating the LATAS research were referred by professional diagnosticians, school personnel, or by parent to parent recommendations.

The impetus for moving from a sole focus on diagnostics to a focus on both diagnostics and remediation came from parents and educators who urged the first author to try and develop intervention procedures for children who had not responded well to the educational experiences they received at school and/or from tutors. The intervention experiences they had received involved a mix of the type of interventions described earlier. Some of the LATAS children who were identified in kindergarten and the first grade as being at risk for reading difficultly received training in phonological analysis followed by various forms of phonics based instruction. Other children who were identified at the third grade or later received only phonics based interventions that were often accompanied by other instructional treatments designed to improve strategic reading practices and to encourage frequent reading.

The common characteristic exhibited by all of the LATAS children with a reading disability, regardless of grade, was that they were slow and halting when they read aloud. Many of them were very successful at word identification in the sense that they could accurately identify words. However, they were slow at doing so and often had to reread several times in order to comprehend what they were reading.

Over time the first author developed the idea that there was a sense in which the instruction these children had received turned out to be as harmful as it was helpful. Children who were in the 6th grade and older may have received as much as 4 years of fairly intensive phonics based instruction as prescribed by their IEPs (Individualized Education Plans). The schools frequently touted their improved accuracy of word recognition as evidence of reading progress. However the author viewed it in many cases as evidence of increased impairment. The problem was that the students had developed sounding out of words as the strategy of first choice when reading. They sounded out virtually every word they read. As will be seen in the data to follow, this resulted in long word reading times, often accompanied by impaired comprehension of sentence and paragraph length material. Some children did not exhibit impaired comprehension if given unlimited reading time. They were willing to "grind out" the meaning of text through a laborious process of continuous rereading. But there was no sense in which their successful comprehension was a product of skilled reading.

INTERVENTION EFFECTIVENESS AND THE IDENTIFICATION OF READING DISABILITY

For many years reading disabilities were defined using a discrepancy procedure that involved administering intelligence tests and reading tests. If the child had an average or above average IQ, but below average reading performance, then the student was identified as having a reading disability. Over time evidence accumulated that there were many problems with discrepancy procedures and a number of writers called for alternatives that were more viable (e.g., Aaron, 1997).

One currently popular alternative to discrepancy formulas as a way of identifying reading disability is to implement Clay's (1987) idea of using responsiveness to intervention (RTI) as a means of identifying truly disabled students. The idea is that students who are not truly disabled will be responsive to best practice interventions but students who are truly disabled will not (e.g., Fuchs et al, 2003).

RTI as a means of identifying reading disability does, however, present an interesting paradox. Students who have a reading disability are identified by their failure to respond to effective instruction. Effective instruction is most often defined as the conventional instruction (described in an earlier section) that has proven to be effective in many previous studies. If children are unresponsive to conventional instruction, what can we offer them that will be effective? The sections to follow describe one alternative and evidence regarding the effectiveness of that alternative.

FLUENCY TRAINING AS AN ALTERNATIVE TO PHONICS BASED INTERVENTIONS

If there is a population of students for whom phonological awareness training and the teaching of systematic phonics is not successful, what might be successful for them? The answer the first author decided to try with the clinical population at LATAS was to attempt to improve the accuracy and fluency of word recognition by continuously practicing rapid word recognition.

Fluency training is an old idea in the reading research community. Wolf and Katzir-Cohen (2001) trace the history of the idea that reading problems were associated with reading fluency and they provide a review of intervention studies designed to enhance reading fluency. Wolf and Katzir-Cohen (2001) reported the characteristics of the students that were provided fluency interventions, the length of the interventions, the nature of the interventions, the impact of the interventions on the intervention materials themselves, and the extent to which the interventions transferred to untrained passages.

Most of the studies involved a relatively short intervention of several sessions, with the longest intervention period being 21 sessions over 7 days. Most of the interventions consisted of a mix of intervention procedures with the most popular of the procedures involving repeated re-readings of the same passage. In addition, most of the interventions were targeted at multiple levels of reading (e.g., orthographic patterns, words, passages) with the exceptions generally involving a sole focus on improving the fluency of passage reading. Many of the interventions showed improved fluency on the intervention material with a lesser or no impact on transfer materials.

An article not reviewed by Wolfe and Katzir-Cohen (2001) involved a longer intervention period and a primary focus on improving the fluency of word recognition. (Johnson & Layng, 1992). Johnson and Layng showed that indicating that word recognition could be greatly improved in both efficiency and accuracy by practicing the rapid identification of words, and they provided some evidence that improved word recognition fluency improved overall reading performance as reflected in standardized test scores. However, it was uncertain whether this procedure would work with the type of disabled readers referred to LATAS.

The fluency training that is currently in use as LATAS has evolved as a function of trial and error. Many of the early students referred to LATAS were adolescents who had been diagnosed with an attentional disorder. Initially, the LATAS intervention consisted of training in the rapid identification of nonwords (e.g., plok). This intervention was based on the idea that the fundamental problem LATAS readers were having involved the rapid analysis of letter-sound correspondences and one way to isolate and strengthen this ability was through practice sounding out nonwords. This intervention was soon abandoned because readers were resistant to repeatedly practicing the pronunciation of nonwords, and because we saw little evidence that improvements in nonword identification was transferring to naming of real words. This failure may be attributable in part to the general resistance many attentional disorder adolescents display to academic activities and should not be taken to mean that the procedure will not work. However, our subjective impression was that the students saw little utility to practicing the recognition of nonwords, and without their buy-in to an intervention activity, whatever we did was doomed to failure.

Another aborted procedure, predicated on the same idea that led to practicing the pronunciation of nonwords, was to have readers practice the rapid naming of words that were unfamiliar to them. For instance, students in grade 3 and 4 might practice words that were at the grade 8 or 9 level, and students in grade 8 or 10 might practice vocabulary words likely to be encountered on SAT exams. This

procedure turned out to be even less successful—in terms of student resistance and lack of transfer—than the practicing of nonwords. In retrospect, having students with reading difficulties practice the rapid recognition of difficult to recognize words seems like a very silly idea.

Eventually LATAS settled on the procedures to be described in the section below.

METHOD

Participants

The research described in this section took place over a period of years beginning in the mid 1990s and continuing until 2004. Since LATAS served a referred population students varied in age, grade, time of referral, and length of intervention period. In addition, LATAS students varied in terms of the academic difficulty they were experiencing. Some had relatively mild impairments and others had very severe impairments.

The way the LATAS referral process worked was as follows. A parent would contact LATAS indicating the source of the referral. At that point or shortly thereafter they generally talked to the first author to ascertain the suitability of the child for LATAS services. On occasion the student was deemed not appropriate for LATAS and was referred elsewhere. For instance, LATAS services were seen as not being appropriate for retarded students, for autistic students and for students with emotional disturbances. Upon establishing suitability for services, the parent made three appointments. On the first appointment the child completed listening and reading comprehension assessments and the first author completed an in-take interview that collected information about birth history, early language development, incidence of learning difficulties in the family, and educational history. The parent was also instructed to bring to the first meeting copies of psych-educational evaluations and IEPs. On the second meeting the child completed the CAAS computer tasks described below. On the third meeting the first author met with the child and parent and presented a report detailing the assessment findings and suggestions for intervention activities. If the child chose to continue with intervention services, we provided a set of intervention materials (to be described) that were to be practiced at least five times per week. Most children returned to LATAS on a weekly basis to be reassessed and to receive new practice materials if they had mastered the first set.

One group referred to LATAS that will be described in this chapter was not formally diagnosed as having a learning disability. This group consisted of readers (henceforth referred to as poor readers) who were referred to LATAS because a parent, a teacher, or a clinical diagnostician believed they were not reading as well as they should have. A few of the students in this poor reading group had been through a formal diagnostic process, conducted either by a school's child study team or by a licensed diagnostician outside of the school system, and were found not to have a disability that would qualify them for special education services.

The second group of students that will be described in the chapter are students who had formally been diagnosed as having a specific reading disability (reading

disabled group). On most occasions the diagnosis of reading disability was made by an outside diagnostician, but in some of the cases the diagnosis was also made by a school-based evaluation team. All of the children in the reading disabled group were either receiving or had received special education services in their schools and all had IEPs. Since we will focus our analyses on students who were in the third grade or beyond, the majority of the students in the reading disabled group had been receiving school-based intervention services for multiple years. Sometimes these school-based interventions were supplemented by private tutoring.

The nature of the special education services provided to students of varying ages is interesting. Typically the pattern is that students up to grade 5 or 6 will receive services that are designed to improve their reading skill. These services involve some variant of conventional interventions. Beyond grade 5 most schools in the LATAS area begin to substitute accommodations for intervention services. Students are given extra time for assignments and tests, they are provided with readers or books on tape, and the nature of the assignments they are expected to complete is watered down relative to assignments completed by peers. Schools seemed to have made the tacit assumption that at grade 6 or so they should give up on trying to improve reading skills and they should concentrate instead on creating an environment where students can function without reading.

WISC III Scores and Wide Range Achievement Test Scores

We will report our data in two ways. First, we will report data for students who have a WISC III (Weschler Individual Scale for Children) score sometime accompanied by reading, math and spelling scores on the WRAT (Wide Range Achievement Test). The WISC III is an individually administered test that consists of six verbal and five performance subtests. Children receive three scores: Performance IQ, Verbal IQ, and Full Scale IQ. This standardized test is used to identify learning disabled individuals as well as gifted children. The WRAT is short, individually administered achievement test that measures performance in the areas of reading, spelling, and math. It is often used to assess the presence of a learning disability, though it can also be used to compare student performance and to aid in the design of educational programs. Like the WISC III, scores are standardized with a mean of 100 and a standard deviation of 15.

The second way that we will report our data is to report available data for all students who were either poor or disabled readers. We report the data in multiple ways to give the reader a complete picture of intervention outcomes.

CAAS Assessments

When students first begin participating in the LATAS program they are administered a battery of assessments that is contained on the Cognitive Aptitude Assessment System (CAAS). This is a computer-based assessment system that has been developed at LATAS and that has been described in a number of publications (e.g., Cisero, Royer, Marchant & Jackson, 1997; Royer, 1997; Sinatra & Royer, 1993). This system

measures the speed and accuracy of performance on both reading and math tasks. The CAAS system is based on the assumption that reading can be conceptualized as involving a number of component skills that develop in sequence. If one moves from very simple skills to complicated skills it should be possible to identify the skill that is deficient relative to peer performance. That skill could then be targeted for direct intervention. The rationale for conceptualizing reading as involving component skills that have diagnostic utility is presented in Royer and Sinatra (1994). The selection of the particular skills to be evaluated in the CAAS system was based on a review of the literature on developmental reading patterns reported in Greene and Royer (1994).

The CAAS system exists in an elementary version (grades 2-5), a middle school version (grades 6-9) and an adult version (high school and adult). The data described in this report all came from the elementary version of the system. This was true even though the oldest students participating in the study were 9th graders.

In the sections to follow grade level percentiles will be reported as well as data on accuracy and speed of performance on CAAS tasks. Grade level percentiles are calculated by combining speed and accuracy into a combined index (contact the senior author for how this is done). The percentile performances are based on data from at least 20-30 students at each grade level. This data was collected by administering the CAAS battery to every student at a particular grade except for students who had an IEP. Data collection for normative purposes was completed at a school in Western Massachusetts, at several schools in the Cleveland Ohio region, and at several schools in central Connecticut. The students contributing normative data were largely Caucasian students from middle to upper middle income groups, though the Cleveland sample did come from lower income and minority households. No claim is made about the grade level percentiles of LATAS students being representative of a larger group. Rather, the percentile data is presented to simply give a rough indication of how the students in the study performed relative to other students who are comparable in background and enrolled in the same grade as study students.

All of the tasks in the CAAS system, with the exception of the listening and reading comprehension tasks, are administered by having a stimulus appear on the computer screen and the examinee then makes a response into a microphone. When the stimulus appears on the screen a clock starts in the computer and when the examinee makes a response, the clock stops. An examiner then scores the response for accuracy.

CAAS assessments provide three scores. First, overall accuracy in terms of percent correct responses is reported. Second, average response time is reported. Average response time is actually a trimmed average that is computed by first computing average response time for all items, trimming times that are either impossibly fast (below .25 seconds) or 2 standard deviations above the mean, and then recalculating mean time and standard deviations using the trimmed times. The third score that is reported for each task is a grade level percentile that is based on an index that combines speed and accuracy into a single metric. A description of each of the CAAS tasks is listed below. Examples of each of the CAAS tasks, plus examples of assessment

outcomes and assessment reports can be found at WWW.readingsuccesslab.com. A trial version of the CAAS system can also be downloaded from the site.

DESCRIPTION OF CAAS ASSESSMENT TASKS

Simple Perception; The examinee sees 3 stars (***) or three plusses (+++) on the screen and says star or plus into the microphone and accuracy of the response is scored by a human examiner. The participant responds to 20 items that are varied randomly during each assessment. This task provides a baseline measure of student's ability to respond to simple stimuli presented via computer.

Letter Recognition: Twenty randomly selected upper or lower case letters appear on the screen and the student says the name of the letter into a microphone whereupon the examiner scores it for accuracy.

Word Naming : Forty 3, 4, 5, or 6 letter words (10 at each length) appear on the screen and the student says the name of the word into a microphone and it is then scored for accuracy. The words have been specifically chosen so that the difficulty of the words ranges from grade 2 to grade 5.

Pseudoword Naming: Pseudowords were created by changing one or two letters (typically vowels) in a word in the word task. The task is administered just like the word task. This task, in conjunction with the word task has proven to be very valuable in identifying students with a specific reading disability.

Concept Activation: The student is given a number of category names (e.g., animals, modes of transportation, furniture names) and told that two words will appear on the screen. The student is to respond "yes" if the two words belong to the same category and "no" if they belong to different categories. Twenty randomly selected items are presented during each assessment.

Sentence Understanding: Twenty cloze sentences appear on the screen (e.g., "Jill patted the cat's fur/claws") and the student says the name of the word into the microphone that best completes the sentence.

Listening comprehension. Students listen to 3 tape recorded passages that vary in difficulty. One passage is at a level below their current grade, one is at their current grade level, and one is above their grade level. After listening to a passage they complete a comprehension test that is based on Royer's SVT procedure (see Royer, Carlo & Cisero, 1992, for a review).

Reading comprehension. Students read 3 passages that are based on the same content as used in the listening comprehension tests. Again there are 3 passages varying in difficulty and the student reads a passage and then completes an SVT test that assesses the extent to which the passage was comprehended. The test is untimed, meaning that students could take as much time as they wanted to complete the three passages.

With the exception of the reading and listening comprehension tests, all of the tasks in the CAAS battery contain a large number of potential items that are randomly sampled for presentation on any given assessment. For example, the elementary version of the CAAS word assessment used in the reported research involves presenting 10 three letter words, 10 four letter words, 10 five letter words, and 10 six letter words during an assessment. These 40 presented words are randomly sampled from a pool of 60 words of each letter length (240 words total). This sampling process means that repeated assessments are different from one another and it allows for the tracking of progress without worrying about whether the examinee remembers items from a previous assessment.[1]

Characteristics of Participants and Discussion of Those Characteristics

Over the years data was collected from over 100 students referred to LATAS. Some of the referred students were diagnosed with attentional disorders or dyscalculia and their data will not be considered in this chapter. Given the nature of the referring process, many of the students had incomplete testing records and others participated only briefly in prescribed interventions. Our primary analyses will be conducted with data from poor and disabled readers for whom we at least have IQ scores and relatively complete intervention data. Students that are listed as reading disabled had a diagnosis in the files that were collected upon entry to the LATAS program. However, some of the students did not have complete reports listing IQ scores, achievement tests scores, or other testing data. Both reading disabled students and poor readers who had at least an IQ score and CAAS assessment information are listed as having complete data in the tables to follow. Students who had a diagnosis as reading disabled but did not have test data available upon entry to the LATAS program will be added to the data set for students with incomplete data.

The poor readers with incomplete data are readers who had a diagnosis that said they were *not* disabled readers or they had never gone through a diagnostic process but were referred to LATAS because of a parent, teacher or diagnostician thought they might benefit from the program. All of the referred students were Caucasian and almost all of them were from middle or upper middle class households with many parents having postgraduate educational degrees.

Grade Breakdown. The breakdown of our total sample in terms of grade enrollment is presented in Table 16-1. As can be seen in the table, students who are in the poor reader group tend to be referred to LATAS at a somewhat younger age than students in the reading disabled group. This probably reflects the fact that many schools often do not initiate formal diagnostic procedures for reading delayed children until the 3rd grade. Some students in lower grades could not complete CAAS assessments beyond the letter and word level. Hence, the analyses to be reported in the sections below will focus on students in grade 3 or above.

[1]A commercial version of the CAAS assessment system and a version of the intervention system described in this chapter is available at: www.readingsuccesslab.com

TABLE 16.1
Number of Students Per Grade by Diagnosis and Complete versus Incomplete Data

	Grade								
Diagnosis	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Poor reader complete	3	3	2	4	3				
Reading disabled complete		4	4	4	3	4	1	1	3
Poor reader incomplete	3	9	3	5	4	2	1	3	
Reading disabled incomplete	1	8	8	8	10	6	2	4	

IQ and Achievement Test Performance

The mean WISC scores for the 3rd grade and beyond poor and disabled readers are presented in Figure 16-1, along with WRAT scores, when available. As per our definition in the preceding section, all of the data in Figure 16-1 comes from students who have taken the WISC III test and they have completed CAAS assessments. In several cases WISC verbal and performance scores were reported but the full scale score was not. As can be seen, the average student in both the poor reader group and the disabled reader group was above average in WISC performance (mean of WISC = 100, SD = 15). Note also that the average student in both the reading disabled and the poor reader group scored below the mean on all of the WRAT tests (mean of WRAT = 100, SD = 15). However, students in the poor reader group are only scoring slightly below the mean on all of the WRAT tests. This contrasts to the performance of the reading disabled group where there was a discrepancy of over one SD between performance on the WISC and performance on the reading and spelling sections of the WRAT. Also noteworthy is the fact that the reading disabled group scores noticeably better on the math subtest of the WRAT than they did on the spelling and reading subtest.

Patterns of Performance. The patterns of performance displayed in Figure 16-1 are consistent with what would be expected based on diagnostic classifications. The reading disabled group displays a large gap between reading and spelling WRAT performance and IQ performance, whereas the gap between IQ and

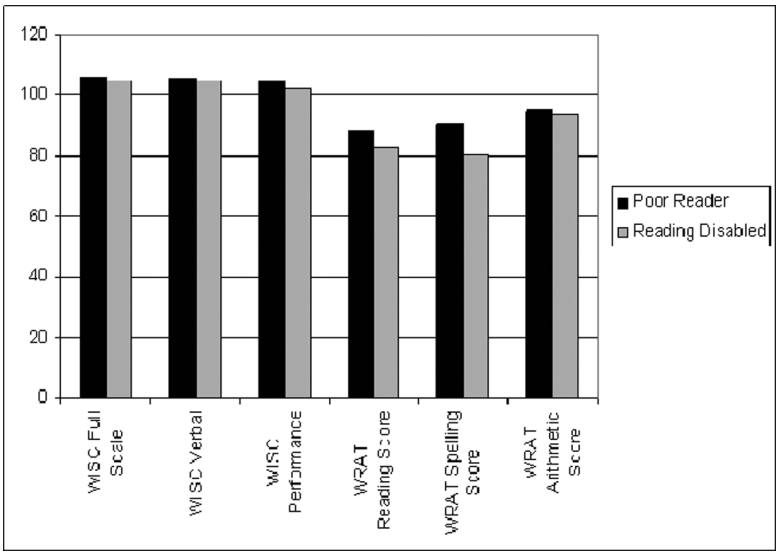

FIGURE 16.1 Mean Performance on the WISC and WRAT as a Function of Diagnosis

math WRAT performance was much smaller. In contrast, the poor reader group has much less of a gap between reading, spelling and IQ, and there is little difference in reading and math WRAT performance.

Performance on the CAAS Assessments

The grade level percentile performance on the CAAS tasks is presented in Table 16-2. The table breaks the data down in two ways. The data for poor readers and reading disabled readers labeled "complete" is for students who have WISC III data. That is, the data is from the same students who contributed data to Figure 16-1. The data from students labeled "incomplete" comes from all the students who have gone through at least four weeks of the fluency intervention. This includes students for whom WISC III scores were available plus some additional students who participated in the intervention but did not have WISC scores available upon entry to the LATAS program.

An important point to remember about percentile performance is that it has an artificial floor of one. That is, even if a student scores 3 or more standard deviations below the mean, the lowest score they can get is 1. This makes the percentiles listed in Table 16-2 deceptive. In fact, many of the students in the reading disabled group score more than 3 standard deviations below the mean on the CAAS tasks. For example, the student with the greatest disability (at least test performance wise) in the reading disabled group was a 9th grade male whose average word naming time

TABLE 16.2
Percentile Performance on the CAAS Tasks as a Function of Diagnostic Category

Diagnosis		*Simple*	*Letter*	*Word*	*Nonword*	*Category*	*Sentence*	*Listening Comprehension*	*Reading Comprehension*
Poor	**Mean**	**67.12**	**65.11**	**28.88**	**31.55**	**26.37**	**22.62**	**53.14**	**42.98**
reader	*N*	8	8	9	9	8	8	7	7
complete	*SD*	27.33	23.01	27.75	31.97	27.42	28.81	36.63	37.49
Reading	**Mean**	**68.92**	**58.08**	**11.16**	**9.57**	**17.10**	**9.99**	**40.87**	**23.54**
disabled	*N*	21	21	21	21	20	20	21	20
complete	*SD*	24.50	30.88	17.89	17.83	16.14	18.61	26.69	24.56
Poor	**Mean**	**63.85**	**50.74**	**20.00**	**24.90**	**32.00**	**24.50**	**51.33**	**43.22**
reader	*N*	10	10	11	11	10	10	9	9
incomplete	SD	30.52	33.57	19.44	28.63	28.47	22.22	33.14	30.87
Reading	**Mean**	**65.62**	**51.75**	**9.89**	**7.17**	**20.28**	**8.73**	**44.80**	**21.96**
disabled	*N*	33	33	34	34	32	31	33	32
incomplete	*SD*	24.23	29.42	13.79	12.29	23.08	15.55	28.96	21.89

was over 10 seconds per word. Given his age peers named words on average at .6 seconds per word with a standard deviation of .11, this student was performing at a level of over 90 standard deviations below the mean in word naming performance. This student was deleted from the intervention data to be reported. However, it should me mentioned that this student more than halved his negative Z score as a function of the fluency interventions.

Patterns of Performance. As can be seen, there is very little difference between the two data sets. In both the incomplete and complete data sets there is little difference between poor readers and reading disabled readers on the simple perception and letter naming tasks. Moreover, in both cases the students are performing at the average level or the slightly above average level on the tasks. As an aside, the average or above average performance for both of these groups speaks to a hypothesis that would suggest that disabled readers are deficient on all speeded naming tasks. Neither the disabled readers nor the poor readers showed a hint of deficiency on the simple perception and letter naming tasks.

Beyond the letter naming tasks there was clear evidence that the patterns of performance differed for the two groups. The poor reader group hovered between the 20th and 30th percentile on the word, nonword, category and sentence task. This indicates that these students were deficient in low-level reading performance relative to comparable grade peers. It is noteworthy that there was little difference between word and nonword performance for either the complete or incomplete readers. In fact, nonword performance was slightly better than word performance.

The profile of performance is different for the reading disabled group. First, they have considerably lower performance on the word, nonword, category and sentence task than does the poor reader group. Second, the pattern is different. Notice that the reading disabled group has lower performance on the nonword task than they do on the word task. As noted in the paragraph above, this pattern is reversed in the poor reader group.

Turning now to the comprehension tasks, the poor reading group has a grade percentile almost at the mean for the listening comprehension task, and slightly below the mean on the reading comprehension task. The reading disabled group is slightly below the mean on the listening comprehension task and well below the mean on the reading comprehension task. The patterns on the comprehension tests, along with the patterns on the simple perception and letter naming tasks, are consistent with the idea that the readers in the both groups have deficiencies that are specific to reading. It should also be remembered that the reading comprehension tests were administered untimed. It is likely that the performance of both the poor reading group and the reading disabled group would have been lower if the reading comprehension tests were timed.

Taken overall, the patterns of performance on the CAAS tasks are again what would be expected based on diagnostic categories. Specifically, both the poor readers and the disabled readers do not display deficiencies in perceptual responding (the simple and letter tasks) and in listening comprehension, though the disabled

readers are slightly below average in listening comprehension. The groups do display deficiencies in reading with particularly striking deficiencies in the reading disabled group. In addition, the poor readers do not display a disassociation in their ability to recognize words and nonwords. In contrast, as would be expected among individuals with a phonological processing problem, the disabled readers have more difficulty with nonwords than they do with words.

THE READING INTERVENTION

Prior to describing the intervention process it should be indicated that the words that students practice during intervention and the words that are contained in the CAAS assessments are different. This was deliberately done so that CAAS assessments would provide an assessment of the degree to which word practice transfers to unpracticed words.

The LATAS intervention consisted of speeded practice at naming words for at least five days per week. The typical word practice set consists of 160 words divided into pages of 4 pages with 40 words per page. A practice session would consist of having the student look at a practice page and ask to have any word on the page pronounced if the word was not recognized. When the student was ready to be timed, he/she would name the words on a page as rapidly as possible while trying to maintain accuracy. During this naming period a parent, teacher, or peer would record time in seconds per page and would record on a separate sheet any words that were named incorrectly. The student was encouraged to guess a word if the word was not immediately recognized. After the student completed naming the words on a page the person working with the student would go back and point out words where errors occurred and indicate the error the student made and would then correctly pronounce the word. Words that were repeatedly missed over practice sessions would be isolated and would be subject to added practice before and after regular practice sessions. Practice of the remaining three pages followed the same procedure as used for the first page.

After practicing naming the four pages of words the mean time per page would be calculated and plotted on a graph. This graph was completed for each practice session so that the student would have immediate feedback on the time taken to name the words on each practice session.

Every student that participated in the LATAS process lowered average time per page within three practice sessions. Time would continue to decrease over practice sessions until it reached a low asymptote of somewhere between 30 and 40 seconds per page. There was considerable variability in the number of sessions it would take to reach low asymptote, but there was relatively little variability between students in the low asymptote point.

When time per page reached a low asymptote for four practice sessions with near perfect accuracy, the student was given a new set of 160 words and repeated the process. Practice words were divided into 4 practice sets at each grade level ranging from grade 1 to grade 8. When the 4 practice sets at a given grade were completed the student moved to practice materials at the next grade level. In addition to the

graded practice sets, practice sets of words were developed from textbooks the students were currently using. These materials were often used with students in grade 6 and beyond who indicated they were having difficulty keeping up with assigned reading.

The assignment of the right set of practice materials was an important part of the intervention process. The idea was to assign practice materials that were at a level where the student could show improvement, but not so difficult so as to create frustration. The process of assigning materials at the right level involved consideration of multiple sources of information. The first source was the intake interview which involved collection of a psychological and educational history. The second source of information was records the students brought to LATAS including diagnostic reports, testing data, and copies of IEPs and school reports of progress. Finally, the CAAS assessment data also contributed to the process of material assignment.

Another practical aspect of the intervention that proved to be important was varying the order in which students named the words. It quickly became obvious that if one allowed student to name the words in the same order on every practice occasion they would memorize sequences as long as 10 words. In order to prevent responding from memory we varied the order of word naming, sometimes going from top to bottom, left to right, then varying other orders so as to prevent responding from memory.

While interventions were occurring the student returned to LATAS either once per week or once every other week. When they returned the students completed one of two versions of a CAAS reassessment consisting of the word task, the nonword task, the category task and the sentence understanding task. One version was completed upon admission to LATAS and was then repeated at 4 week intervals. This is the CAAS transfer version that was described in the earlier section of the chapter and it is the one that will provide the data to be described in the next section. A second set of CAAS materials that included some of the words the students were practicing during intervention was administered on the weeks the student was not scheduled to complete the regular CAAS assessment.

When students returned for reassessment they brought their home/school practice graphs. These graphs, along with the results of the CAAS reassessments, provided the information needed to decide if it was time to assign a new set of practice words.[2] The home graphs also provided a check on whether students were engaging in assigned practice.

Another component of the intervention process was a reward system. When students were reassessed, if they made improvements in speed and accuracy of performance on the majority of tasks (3 of the 4) without declining in either speed or accuracy, they were allowed to draw a slip from a grab bag where they could win a monetary reward ranging from 25 cents to 10 dollars. This reward system was

[2]All of the intervention procedures described in this section are now implemented in the commercial version of the CAAS system. Also available are all of the practice words including many sets of words drawn from subject matter textbooks at varying grade levels.

popular, but in the opinion of the authors a far more important reinforcement for continuing practice was watching the time line decrease on the practice graphs.

Finally, both parents and students were told that practice in naming words was only one part of the process of becoming a skilled reader. Another very important part was practicing their developing skills on a nightly basis by reading books, magazines or any other material they were interested in.

RESULTS OF THE READING INTERVENTION

The results of the interventions are reported in the form of changing performance on the CAAS reassessments. As indicated earlier, performance on the word, nonword, category and sentence understanding tasks was measured on the regular CAAS system at four week intervals. The speed and accuracy of performance for reading disabled and poor readers will be reported for week 0 (the week the students were initially assessed) and then at weeks 4 and 12. This data will be reported for both reading disabled (RD) and poor reading (PR) groups.

These intervention results provide indications of two kinds of transfer. First, since the words in the regular CAAS system are different than the words the students are practicing, any improvement in performance on the CAAS words represents general improvement in word naming performance. Second, the measurement of performance on the nonword, category, and sentence understanding tasks provide an indication of the extent to which word naming practice transfers to other reading tasks.

The results of the interventions are presented in Figures 16-2 and 16-3. Since students in both the reading disabled and poor reading groups vary in grade, performance for each student was converted into a grade level Z score and then Z scores were averaged across students. The means and standard deviations for grade levels were obtained from the norm groups that were mentioned previously in the chapter.

As can be seen in the figures, both the reading disabled and the poor readers improve on the CAAS tasks during the 12 weeks of interventions. The change in the reading disabled group is particularly striking with improvement of as much as four standard deviations over the intervention period.

DISCUSSION

The results reported in the above section show differential effectiveness of the fluency intervention as a function of treatment group. Looking first at accuracy, the poor reading group made little change in word performance and an initial decline in nonword accuracy followed by a subsequent improvement at the 12 week point. There was some evidence of negative change for the poor reading group in their performance on the category and sentence task in that they start at the beginning of intervention around the mean in accuracy performance and then decline to below accuracy during the intervention period. The pattern is quite different for the disabled reading group where the students made steady improvement in accuracy of performance during the intervention period.

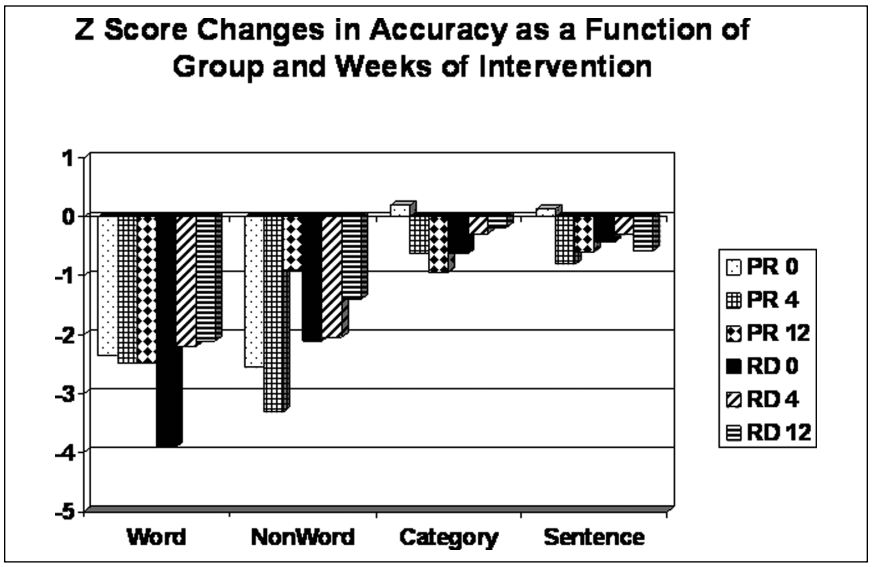

FIGURE 16.2 Z Score Changes in Accuracy as a Function of Group and Weeks of Intervention

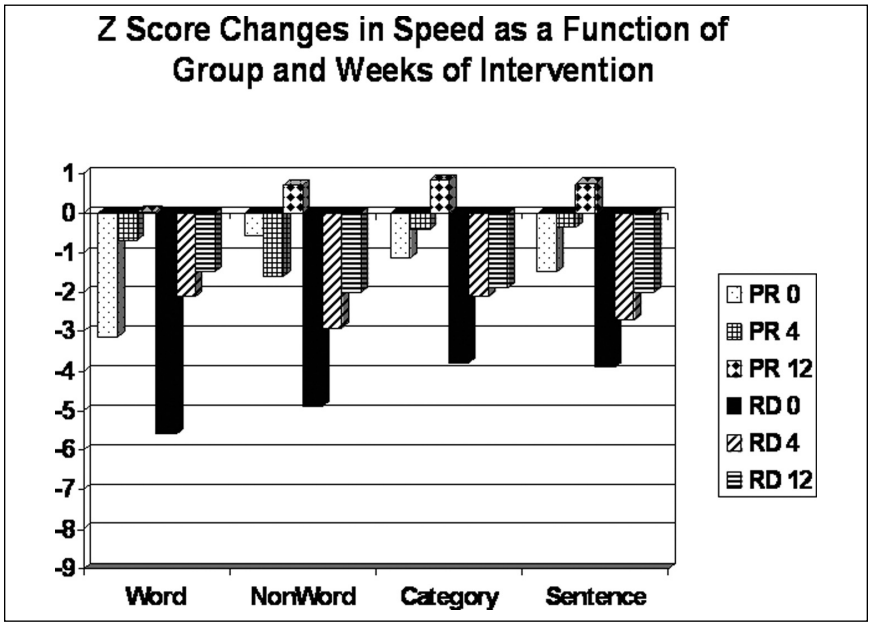

FIGURE 16.3 Z Score Changes in Speed as a Function of Group and Weeks of Intervention.

The patterns for both groups were more consistent for speed of performance. There was clear evidence in both the poor reading group and the reading disabled group that performance improved on all of the tasks during the intervention period. The only exception to this generalization occurs in the poor reading nonword task where performance declined slightly at the 4 week interval but then showed gain by the 12 week interval.

Sources of Improvement

Our sense in watching students improve their performance was that there were two factors at play. First, there was a strategy shift that occurred, particularly in the reading disabled group. Most of the reading disabled group used sounding out excessively when reading. They seemed to use sounding out as the strategy of first choice for most of the words they read. From observation we developed the sense that over time the speeded practice brought about a strategy shift where the preferred strategy was to go into the head for the word rather than sound it out. You could almost see this happen on a word by word basis. As practice with the same list continued, the student would drop out words that were immediately recognized and this group of words became larger as practice continued, ultimately creating a situation where all of the words were recognized without sounding them out.

We believe that the second source of improvement was cognitive in nature. Our thinking about cognitive improvement is influenced by Perfetti's (1992) description of the word representation that is developed in skilled readers. Perfetti argued that over time skilled readers develop cognitive representations for individual words that "bind" together orthography and phonology. The skilled reader's representation is activated by the visual form of the word and upon activation the readers hears with his or her "mind's ear" the word being pronounced. We believe that one consequence of word fluency training is the development of bound representations for words that were being practiced.

We believe that a corollary that follows from Perfetti's perspective on word representations in skilled readers is that bound representations are unlikely to be developed in readers who consistently sound out words when reading. Our perspective is that representations that bind orthography and phonology will only develop when the sound of a correctly pronounced word and visual representation of a word are in working memory simultaneously. The reader who consistently sounds out words when trying to recognize them will have a difficult time binding together orthography and phonology because the correct pronunciation of the word is only a part of sound pattern that is available in working memory.

Transfer of Fluency Training to Other Reading Activities

There is evidence for two kinds of positive transfer in our data. One kind of positive transfer involves improvements in the recognition of words that were not practiced, and a second kind of positive transfer involves improvements in reading tasks other than word recognition. Evidence for improvements in the recognition of

unpracticed words is apparent in that improvements in the speed and accuracy of the recognition of practiced words was accompanied by changes in speed and accuracy of unpracticed word recognition as evidenced by the CAAS system assessments. These changes are depicted in the word recognition performance in Figures 16-2 and 16-3.

Evidence for improvements of reading performance in general can also be seen in Figures 16-2 and 16-3. The graphs in the figures show that most students made improvements in the recognition of nonwords, improvements in the ability to activate the meaning of words as indicated by performance on the category task, and in improvements in the ability to accurately and rapidly interpret sentences as evidenced by performance on the sentence comprehension task. These gains were particularly noteworthy in the reading disabled group.

Again we believe that there are two factors that are interacting to produce these improvements. First, we believe that as the efficiency of word recognition improved, more cognitive resources were available to activate meaning and to devote to comprehension processes. Students who struggle to sound out words have relatively few resources to devote to comprehension The extreme of this situation is reflected in the student who took an average of 10 seconds to decode a word, but even students who decode in ranges of 2 to 3 times slower than peers have a distinct disadvantage with respect to comprehension, particularly when comprehension is indexed by both the speed and the accuracy of performance.

The second factor is more complicated and provides a possible explanation for the curious finding that word fluency training not only positively transferred to the recognition of other words, it also positively transferred to the recognition on nonwords. We believe the explanation for this kind of transfer was proposed in an early paper by LaBerge and Samuels (1974). LaBerge and Samuels proposed that automatic word recognition is enabled by the development of a series of cognitive representations that with practice become automatically activated. The lower levels of their representation system included letters, letter sound connections, spelling patterns and words. Our hypothesis is that word fluency training produces two types of "bound representations." The end product is bound representations that bind orthography and phonology for whole words, but underneath these representations are spelling pattern representations for regular spelling patterns in English. Figure 16-4 illustrates our hypothesis. A reader who practices the rapid recognition of a word like "prepare" is forming two kinds of representations. First, the reader is forming a representation that binds the visual form and the phonology of the complete word. Second the reader is forming a spelling pattern representation corresponding to the "pre" and "pare" parts of the word. These are frequently occurring spelling and pronunciation patterns in English and the spelling pattern representations map onto words that the reader has not practiced that contain the same patterns. So, for example, the reader's ability to recognize the words "prevent" and "compare" will be facilitated due to the existence of the underlying spelling pattern representations. These spelling patterns will also facilitate the reading of nonwords that contain the patterns. Most of the nonwords in the CAAS system are created by altering the spelling of regularly pronounced words, hence a facilitation of nonword

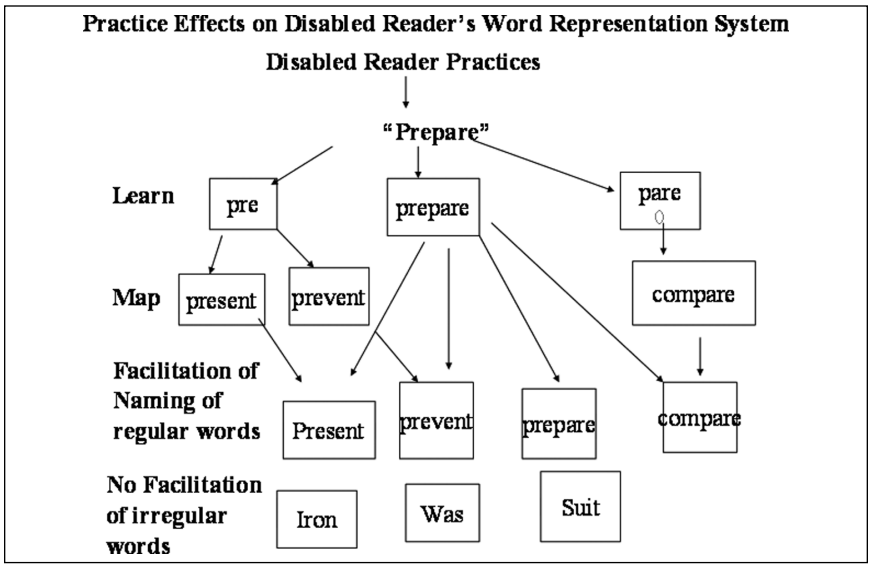

FIGURE 16.4 Practice Effects on Disabled Reader's Word Representation System.

recognition as a function of fluency training. Notice also that our hypothesis would predict that one would not get facilitation on irregularly pronounced words and nonwords. We have not systematically tested this hypothesis but we do believe we have seen evidence supporting it in our observations of reading performance.

Limitations of Our Research

There are two major limitations of our research. The first stems from the fact that it is based on a referred population in a clinical setting. We are not able to control important factors like nature of disability, comparability of students and length and adherence to an intervention process. We are also not able to offer concrete evidence that our disabled readers are treatment resistant. The evidence we have suggests that they have not optimally benefited from the instruction they have received. However, this evidence is not systematic and we are not able to document the exact interventions students received nor are we able to document the failure to benefit from those interventions. We believe the fact that our disabled readers in particular are poor readers as evidenced by our objective measures indicate that they have not made substantial gains from the interventions they have received. But an examination of their current status is not a substitute for careful experimentation that controls intervention procedures and monitors outcomes associated with those procedures.

A second major limitation of our study is that our data is based on a relatively small number of participants. We have data from more participants than we have

reported but chose to only present data for the subset of participants for whom we had relatively complete data sets. The majority of students receiving the intervention who did not contribute data to this article showed gains comparable to those reported.

We also chose to limit our data reporting to students who only had reading problems. This means that we did not report data for students who had attentional disorders, or who had some combination of dyslexia, dyscalculia, attentional disorders or emotional disorders. It should be noted though that our reading intervention procedures have been successful with students who have both attentional disorders and reading problems (Royer, Rath & Tronsky, 2001). We have also reported a study showing that fluency training procedures produce math gains in students with attentional disorders (Royer & Tronsky, 1998).

This said, the reader should still be cautious about assuming the generalizability of our findings for the effectiveness of word fluency training. Additional research needs to be conducted before one can be confident that it provides an alternative to better established procedures.

Even given these cautionary notes, we believe that our research offers hope of intervention possibilities for students who seem not to have benefited from traditional interventions. Our students do improve in reading performance and some of our disabled readers improve to the point where they are reading at the level of their peers. We hope that our report encourages further research into the procedure and in so doing develops an alternative reading intervention procedure that may help readers that are not responding to conventional interventions.

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