DYSLEXIA

Theory & Practice

of

Remedial Instruction

Diana Brewster Clark

Joanna Kellogg Uhry

Selected Excerpts

Required Book Report

Intro Training

DYSLEXIA

Theory & Practice of Remedial Instruction

DIANA BREWSTER CLARK
JOANNA KELLOGG UHRY

2

The Nature of Dyslexia

DEFINING DYSLEXIA

The term *dyslexia* is derived from the Greek *dys* (difficult) and *lexicos* (pertaining to words) and was first used by Berlin in 1887 to describe extreme difficulty reading and spelling words. The World Federation of Neurology defines dyslexia as follows.

> *Specific developmental dyslexia* is a disorder manifested by difficulty learning to read despite conventional instruction, adequate intelligence, and adequate sociocultural opportunity. It is dependent upon fundamental cognitive disabilities which are frequently of constitutional origin (1968; cited in Critchley 1970).

The qualifier *developmental* refers to a disorder of suspected congenital or hereditary origin, in contrast to acquired dyslexia, a disorder resulting from brain injury after the onset of reading (Frith 1986). It is important to state that the word *developmental* does not mean that the disorder will disappear with maturity. A distinguishing characteristic of dyslexia is, in fact, its persistence, although appropriate remedial treatment and the development of compensatory strategies may moderate its effects.

The qualifier *specific* is intended to connote a disorder limited specifically to reading rather than involving a general learning problem. As Keith Stanovich describes this notion,

> Simply put, it is the idea that a dyslexic child has a brain/cognitive deficit that is reasonably specific to the reading task. That is, the concept of a specific reading

disability requires that the deficit displayed by the disabled reader not extend too far into other domains of cognitive functioning (Stanovich 1988a, p. 155).

Stanovich refers to poor readers who are poor in cognitive ability as well as in all academic areas as *garden variety poor readers* (Stanovich 1988b). Reading is not discrepant from IQ in these children as it is in children with dyslexia.

There is even evidence that dyslexia is limited not just to reading, but to very specific aspects of reading. Philip Gough's theoretical *simple view of reading* (see chapter 1) holds that there are two contributors necessary to skilled reading comprehension: 1) decoding and 2) listening comprehension (Gough and Tunmer 1986). That is, children with reading problems could be having difficulty at either the word reading level or with understanding what they have read once they have decoded or deciphered written words into spoken words. Wesley Hoover has tested Gough's model using data from 900 children on the Iowa Test of Basic Skills. He analyzed subtest results for listening comprehension, decoding, and reading comprehension to confirm Gough's two independent contributors to reading comprehension and found that each is necessary but not sufficient for reading success (Hoover 1994). Dyslexia is conceptualized as difficulty at the word-reading level. Reading comprehension is affected, but it is decoding, and not listening comprehension, that causes the difficulty.

Dyslexia is considered a learning disability in the Federal Register under Public Law 94-142 (see Kavanagh and Truss 1988). As with other learning disabilities covered under this law, dyslexia involves what is called an *exclusionary* diagnosis. That is, instead of describing characteristics directly, the definition describes all the conditions that must be ruled out (e.g., low IQ, physical handicaps, environmental factors, etc.) before making a diagnosis.

The term *learning disabilities* is actually a political label coined by Samuel Kirk (see Farnham-Diggory 1992). The term was adapted to secure special services for students with mild learning handicaps. Some of these children had not previously qualified for placement in already-established special education categories — mentally handicapped, emotionally handicapped, physically handicapped. Others' parents did not want their children classified with those more-severely handicapped. Although the majority of students who are classified as *learning disabled* have reading difficulties, in many cases these difficulties can be attributed to mild handicapping factors or conditions other than dyslexia, such as low average intelligence. These children, in terms of Gough's *simple view of reading* are poor at both decoding and listening comprehension. They are considered *garden variety poor readers*. Much of the research on reading disorder has been muddied by failure to distinguish between children who are dyslexic and those who are classified for school instruction as learning disabled, with poor reading as part of a more extensive set of difficulties (e.g., borderline IQ, poor mathematics skills, poor listening, etc.).

Stanovich and Gough base their models on a very specific language deficit in the area of phonological processing, a deficit that will be discussed later on in this chapter in great detail. The idea of a specific deficit distinguishes dyslexia from other, less specific learning disorders.

HISTORICAL AND CURRENT VIEWS ON ETIOLOGY

While the term *dyslexia* has been used consistently since 1887 to indicate reading disorder at the word-reading level, theories about the exact etiology or causes of dyslexia have changed over time. Much of the very early thinking about possible causes grew out of work with brain injured adults who had lost the ability to read. James Hinshelwood, an ophthalmologist practicing in Scotland at the turn of the Century, was one of the first scientists to describe clinical studies of children who failed to read (e.g., 1896; 1917). He surmised that his patients with reading disorder, which he called *congenital word blindness*, must have had either birth injuries to the brain or brain defects. Hinshelwood believed that these defects were in the left hemisphere of the brain in areas related to the storage of visual memory because these children seemed to have difficulty remembering the names of letters and words.

Samuel Orton, an American neurologist, also published theoretical work in which visual processes were implicated. According to Orton, reading reversals (e.g., *b* for *d* and *saw* for *was*) were caused by problems with cerebral dominance in the early stages of reading. He theorized that both right and left visual fields received visual input and relayed this as mirror images to the visual cortices. While in most people one side of the brain becomes dominant over the other and suppresses the image from the non-dominant hemisphere, he believed that dominance was poorly established in people with dyslexia and that the backwards image was often perceived rather than inhibited or suppressed, resulting in what he called *strephosymbolia*, or twisted symbols (1928). Thus, children with dyslexia would see the word *saw* but perceive its mirror image, the word *was*. Orton's model is often misinterpreted, however, as a deficit at the sensory input level involving actually seeing mirror images. This was never his intention.

Orton was also one of the first to associate dyslexia with language disorders (Geschwind 1982), and this constituted the major thrust of his work. Orton's work on language formed a basis for many of the remedial programs that are currently in use. However, it is his visually based mirror-image explanation that caught on in the popular literature and that continues to be a widely held misconception.

Visual Explanations of Dyslexia

The Visual-Perceptual Deficit Hypothesis

Orton's mirror-image theory had been discredited by the 1970s on several grounds, one being that reversal and sequencing errors did not appear to account for a greater proportion of the total reading errors made by readers with dyslexia than by normal readers (Stanovich 1986a). In other words, while children with dyslexia may make more oral reading errors than do children who are good readers, the ratio of reversal errors to other errors is the same; most readers make occasional reversals.

Another reason to question the visual-perceptual deficit hypothesis is that readers with dyslexia were not found to differ from average readers in their performance on nonlinguistic tasks, such as the ability to distinguish visual designs or faces (Liberman and Shankweiler 1979). In studies performed by Frank Vellutino and his colleagues, poor readers had no more difficulty than good readers in copying or recognizing letters or words from a novel alphabet, which were essentially nonverbal stimuli (Vellutino et al. 1975; Vellutino, Steger, and Kandel 1972). Furthermore, Vellutino (1978, 1983) demonstrates that poor readers are almost as adept as good readers at copying visually confusable letters and words from memory, although they are significantly less good at naming or pronouncing these items on second exposure. He attributes the naming problems of poor readers to less well established verbal codes for letter or word forms rather than to visual-perception deficits. Vellutino (1987) suggests that the mirror writing exhibited by some dyslexics (as well as some normally developing readers) reflects their incomplete grasp of letter-sound relationships rather than a visual-perception deficit. That is, it is not the case that they confuse the look of the letters; rather, they cannot remember which name goes with which letter.

In a recent review of the literature, however, Dale Willows and Megan Terepocki suggest that there is some evidence for non-linguistic directional confusions in children with reading disorder. While the look-alike and sound-alike properties of *b* and *d* could indeed result in a naming-based reversal problem consistent with Vellutino's model, we ought to continue to refine research methods for examining directional confusions in children with reading disorder (Willows and Terepocki 1993).

Probably the most compelling arguments against attempting to correct dyslexia through correcting visual-perception come from two additional lines of research. First, there is little evidence of a significant correlation between early visuo-spatial or visuo-motor problems and later reading ability (e.g., Robinson and Schwartz 1973). Consistent with this, a second line of research from the 1970s indicates that visual-perception training is generally ineffective in improving reading skills in individuals with dyslexia (Bateman 1979; Bryant 1979). This training was once quite popular. For example, during the 1960s Marianne Frostig developed a test for visual perception and a remedial training program involving tracing, and copying shapes and patterns (Frostig 1967; Frostig, Lefever, and Whittlesey 1964). While Frostig apparently meant these materials to supplement rather than replace reading training, many training programs were misguidedly based on her materials alone. There simply were no studies from that period indicating that this training had any positive affect on reading ability.

Optometric training for visual-perception deficits is another historical trend. As Larry Silver points out, optometric training programs that proliferated in the 1960s and 70s have been both controversial and generally unsuccessful in promoting reading acquisition (Keogh and Pelland 1985; Metzger and Werner 1984). Optometric training alone is not sufficient to improve reading. This point of view grows out of a compelling body of research in the mid- to late-1970s suggesting that *diagnostic-prescriptive teaching* or *process training* (remediation of weak processes, usually visual-perception processes) did not produce gains in reading (e.g., Arter and Jenkins 1979). The most effective remedial therapy for children with reading problems involves direct instruction in reading (Silver 1987).

The Intersensory Deficit Hypothesis

Another hypothesized explanation for dyslexia involves difficulty integrating information that must be processed simultaneously in two or more modalities (Birch 1962). This seemed logical, for in reading, both auditory and visual systems are involved. Herbert Birch, who first proposed the intersensory deficit hypothesis, developed a test of auditory-visual integration that requires children to match rhythmic patterns with dot patterns, and found that some poor readers were markedly less proficient than good readers at this task (Birch and Belmont 1964). However, subsequent efforts by Birch and his associates to substantiate this theory have been criticized for failing to control for deficiencies within, rather than between, sensory channels (Bryant 1968). Other researchers, such as Naomi Zigmond (1966), find that disabled readers are inferior to readers of normal ability when processing in a single modality, as on auditory tasks; therefore, their inferior performance on intersensory tasks can be expected.

In a further challenge to the intersensory or cross-modal deficit hypothesis, Frank Vellutino and his colleagues (Vellutino, Steger, and Pruzek 1973) find no significant differences between poor and adequate readers on nonverbal paired-associate matching tasks that measure both within and between modality functioning (visual-visual; auditory-auditory; visual-auditory). By contrast, similar studies carried out with verbal stimuli, such as words and letters, reveal notable differences for poor and adequate readers. These investigators conclude that verbal, rather than intersensory, deficits distinguish dyslexics from normal readers.

Erratic Eye Movements

The above research has centered on misperception or failure to integrate stationary visual forms. Other work has focused on the temporal aspects of vision. One such line of research involves questions about eye movements. According to Alexander Pollatsek (1993) when the eyes view letters and words, or any other stationary visual stimuli, they fixate briefly (for roughly 200 to 300 ms) while constructing an image to be perceived by the brain before performing a *saccade* or eye movement (for roughly 10 to 40 ms) to the next fixation. Visual information from the saccade is suppressed. This *saccadic suppression* insures a series of discrete rather than overlapping images. In reading, most movements are from left-to-right but there are also right-to-left movements when we go back to confirm a letter or word.

Because erratic eye-movement patterns have been observed in children who are poor readers, it has been hypothesized that this is a cause of dyslexia (Pavlidis 1985; Punnet and Steinhauer 1984). However, it seems likely that erratic eye movement is the result rather than the cause of reading problems; in most cases it is not observed when poor readers are reading at their independent reading levels, but rather when they read text that is too hard for them. Consistent with this explanation, Richard Olson and his colleagues compared younger good readers with older poor readers in a reading-age-match study (Olson, Conners, and Rack 1991) and found similar eye movement for the two groups during the reading of similar text.

At the same time, some researchers continue to suggest that there may be a small percentage of children who are dyslexic and whose abnormal fixation patterns reflect a primary visual-spatial disorder (Benton 1985; Eden et al. 1995; Keogh and Pelland 1985; Raynor 1985). For example, there is recent research suggesting that both language and visual skills contribute to reading ability and that this is true for good as well as poor readers (Eden et al. 1995). Guinevere Eden administered visuospatial and oculomotor measures to subjects who were already participants in a longitudinal study of reading disability conducted by Frank Wood and his colleagues at Bowman Gray Medical School (see below). These children were discrepantly poor readers, with IQs significantly stronger than reading ability, and with deficits in phonological skills. In comparison with normal readers of comparable IQ they were poor at several visuospatial skills (i.e., vertical tracking and fixation stability with the left eye, which is ordinarily used as the lead eye during movement). Note that they were no poorer at these visual tasks than a third group of garden variety poor readers. Eden states that her results are consistent with the sort of temporal visual deficits in poor readers reported by Lovegrove and his colleagues (see below).

Deficits in Timing in the Visual Pathways

Another, more complex visual explanation for reading disorder in some children has emerged recently. In this model, there is a deficit in regard to *saccadic suppression* (see above) involving one of the two systems that transmit information from the eye to the brain. The sustained or *parvocellular* system operates during fixations and the transient or *magnocellular* system operates during saccades or movements to the next fixation. Keep in mind that it is information from the fixation rather than the saccade that is perceived. During the saccade, in normal readers the image from the first fixation is suppressed before the next fixation.

A number of researchers have demonstrated that the transient system operates somewhat sluggishly in some poor readers in comparison with normal readers (e.g., Livingstone 1993; Lovegrove 1992; Lovegrove and Williams 1993), and fails to suppress the initial fixation as efficiently as is the case for good readers. Note that this body of research is based on tasks designed to measure identification of images under both quickly and slowly changing conditions, but that the tasks are not reading tasks. However, it has been hypothesized that during reading, failure of the transient system to suppress one fixation before moving on to the next would result in perception of two overlapping sets of letters, which would gradually fade to a single set. Children with *saccadic-suppression deficits* should be able to read words in lists more easily than in connected text (Breitmeyer 1993; Lovegrove and Williams 1993). However, as Charles Hulme points out, this is not the case (Hulme 1988).

If Livingston and Lovegrove are correct, some forms of dyslexia involve a neural deficit that cannot be corrected and that causes a perceptual deficit (Breitmeyer 1993). The implications for instruction have not been addressed fully, but Breitmeyer and others suggest that reading may be improved by using colored lenses (i.e., Irlen lenses) or transparent colored overlays to cover text. This has been a highly controversial treatment for reading problems (e.g., Blaskey et al 1990; O'Connor et al 1990; Robinson and Conway 1990; Solan 1990). Up until this point there has been no theoretical model or research to explain why some individuals report increased ease in reading with these lenses. Breitmeyer suggests that while certain complex properties of red light would exacerbate the deficit, blue lenses could actually help to counteract the effects of the sluggish transient system. Note that there is insubstantial evidence to draw conclusions about either the model or the treatment.

Keith Raynor, an important figure in the development of research on eye movement, makes several important points in his concluding chapter to a recent book that reviews research on visual processes in reading (Raynor 1993). He points out that with the publication of Frank Vellutino's *Dyslexia* in 1979, the field began to shift away from a notion of dyslexia as a visual problem and toward the unitary view that dyslexia was caused by a language deficit involving phonological processing (Vellutino 1979). Raynor suggests that we need to be careful not to assume that dyslexia has a unitary cause. He advocates continuing examination of the most current models of skilled reading (e.g., Seidenberg and McClelland 1989) with attention to the various points at which reading might break down. At this time, though, there is no persuasive and comprehensive body of research pointing to a visual-deficit explanation for dyslexia.

Dyslexia as a Language-Based Deficit

The more prevalent view for the past 15-20 years involves language problems (e.g., Catts 1986, 1989; Liberman 1973, 1984; Stanovich 1986a; Vellutino 1979). Language is a highly complex function, however, and not all aspects of language appear to be implicated as primary causes in developmental dyslexia.

Early Language Difficulties and Dyslexia

Research substantiates a significant relationship between early language processing and/or production problems and later reading problems. Follow-up studies of children diagnosed with early specific language impairment (SLI) have shown the incidence of later reading disability to be 90 percent or greater (e.g., Stark et al. 1984; Strominger and Bashir 1977). While the incidence of later reading difficulties for children with early language impairment is very high, the reverse is not always the case. Not all children with dyslexia have histories involving early language disorder. For example, in a prediction study, Natalie Badian used a screening tool that included a number of language measures with four-year-olds to predict sixth-grade reading (Badian 1988). Almost all of the four-year-olds with low screening scores developed later reading problems, but only a little more than half of the children with later reading problems had scored below the screening cut-off as four-year-olds. There are two groups of children here, those whose global language impairment causes later reading impairment, and those whose dyslexia affects only a specific area of language development (see Catts 1989).

Specific Linguistic Deficits in Phonological Processing

Speech Perception Deficits. One recurring question in the field is whether or not difficulty with the phonological aspects of reading is caused by difficulty with auditory perception. No differences have been found between children with and without dyslexia in perception of nonverbal environmental sounds (Brady, Shankweiler, and Mann 1983; Godfrey et al. 1981). Possible difficulties appear related to speech sounds alone. Susan Brady and her colleagues at Haskins Laboratories have carried out a series of experiments comparing good and poor readers in ability to listen to words and repeat them back. In an early study there were no differences except when stimuli were presented under conditions of background noise (Brady, Shankweiler, and Mann 1983). In this study the words were all a single syllable in length. In a later study differences were found in listening and repeating back nonsense words and multi-syllable words even in the absence of background noise. Brady hypothesizes that the difficulty is not at the perceptual level but at the level of phonological representation. This results in poor ability to encode phonological information. That is, under less than optimal conditions (unfamiliar words, long words, and under noisy conditions), children with this reading-related deficit have difficulty remembering sounds and encoding them into spoken reproductions (Brady, Poggie, and Rapala 1989).

Paula Tallal, who works with children with language deficits, observed a group of reading impaired children, not diagnosed as language impaired, who were deficient in discriminating tone sequences presented at rapid rates (Tallal 1980). Tallal and her colleague Rachel Stark suggest that there may be a subgroup of individuals with dyslexia who have a subtle auditory perceptual deficit characterized by difficulty in perceiving and analyzing rapidly presented speech sounds. They believe that this problem interferes with the ability to detect fine discriminations between phonemes in words and, consequently, with the ability to make connections between graphemes and phonemes in attempting to read (Tallal and Stark 1982). Tallal has recently suggested that there may be links between this impairment in rapid auditory processing and difficulties in the rapid processing of visual information (see above). Consistent with Tallal's argument, Stein (1993) reports an association between unstable binocular control, indicative of a deficient transient visual system, and deficits in phonological processing. Like Tallal, he indicates that both may be affected by a deficit at the neural level involving ability to process rapidly changing information.

Verbal Short-term Memory. Measures of ability to listen, remember, and repeat auditory stimuli have also been used to assess verbal short-term memory, but the stimuli tend to be longer than the single words used above in the auditory perception tasks. Individuals with dyslexia have been found to perform less well than same-age normal readers on tasks requiring them to repeat information verbatim (e.g., Mann, Liberman, and Shankweiler 1980). A number of studies comparing children of equivalent IQ, but of both high and low reading ability report deficits on the Digit Span subtest of the Wechsler Scales for the poor readers (see Jorm 1983). The idea here is that verbal information is held in memory more efficiently when it is stored in a phonological code. Individuals with impaired phonological processing have difficulty doing this. Holding meaningless material in short-term memory involves heavier demands on phonological coding than does memory for materials that are meaningful. For example, in a group of 6- and 7-year-olds referred for reading disorder, there was a significant discrepancy between ability to repeat sentences, the easier task for this group, and unrelated word strings, which was more difficult (Shepherd and Uhry 1993).

As Peter Bryant and Lynette Bradley point out, verbal short-term memory is another area in which one can question the causal role in reading. (Bryant and Bradley 1985). Does the pre-reading level of facility in remembering oral linguistic material drive later reading ability? Or is verbal short-term memory exercised during reading through needing to remember strings of words until the end of a sentence is reached? Bryant and Bradley make a strong case for this practice effect, and thus for the effect of reading on verbal memory. To test their hypothesis, they measured memory in 368 children over a period of four years. They found that verbal short-term memory at age 4 was not a very good predictor of reading at age 6, but that reading at age 6 was a good predictor of verbal short-term memory at age 8. Contradictory results are reported by Virginia Mann and Isabelle Liberman who found that memory for word strings in kindergarten predicted some of the variance in first-grade reading (Mann and Liberman 1984).

Speech Articulation Rate. It can be argued that at least some of the variance in verbal short-term memory tasks may be accounted for by motoric elements affecting articulation rate. That is, as a child prepares to repeat lists or sentences, they are retained in an *articulatory loop* in which material is rehearsed subvocally in order to retain it in short-term memory. Slowness in vocalization can cause the phonological impression to deteriorate and can interfere with accuracy of reproduction. This could be caused by speech-motor deficits. Peter Wolff and his colleagues at the Children's Hospital in Boston report evidence that both children and adults with dyslexia are slow and dysrhythmic when asked to repeat the same sequence of syllables (e.g., *pa-ta-ka*) over and over to the rhythm of a metronome. Furthermore, these speech motor deficits are correlated with deficits in reading (Wolff, Michel, and Ovrut 1990b). Hugh Catts reports similar findings. He found children with reading disorder to be significantly slower in repeating multisyllabic words when compared to normal readers (Catts 1986).

Rapid Naming. The length of time it takes to look at a visual stimulus and say its name is a good predictor of reading ability. Inability to retrieve the names of objects previously known is symptomatic of adult acquired aphasia. Early studies of children with anomia or word-finding problems have grown out of the literature on adult aphasia. One of the two formats commonly used for testing retrieval rate involves what is called *discrete trial* or *confrontational* naming in which objects are presented for naming one at a time. Earlier studies found that this format did not appear to be linked with dyslexia. For example, Maryanne Wolf found that confrontational naming using the Boston Naming Test (Kaplan, Goodglass, and Weintraub 1983) in kindergarten was correlated with later comprehension but not with decoding ability (Wolf and Goodglass 1986). In other studies, poor readers named colors, digits, and pictures as quickly as did good readers. It was only when naming written words (i.e., reading but not name finding) that poor readers did less well (Perfetti, Finger, and Hogaboam 1978; Stanovich 1981). However, recent studies suggest that this is a highly complex issue worth reexamining (see Wolf 1991 for a fuller description of the tasks and their link with dyslexia).

The second format, *continuous* or *serial naming*, involves a number of stimuli presented in linear format, and named in a series, one after the other. This form of retrieval difficulty appears to be unequivocally linked with dyslexia. Seminal work with an instrument for measuring the dyslexia-related second form, continuous or rapid serial naming, has been carried out by Martha Denckla and Rita Rudel. Called the Rapid Automatized Naming Test (RAN; Denckla and Rudel 1974, 1976a, 1976b), the instrument uses matrixes of the same five colors (and then numerals, pictured objects, and letters) repeated over and over in random serial order. Denckla and Rudel found that the length of time it took to name these stimuli varied with age; older children were quicker than younger children. It also varied with reading ability; good readers were quicker than poor readers at any given age (Denckla and Rudel 1974). This has been confirmed through more recent studies (e.g., Wolf 1986; Wolff, Michel, and Ovrut 1990a).

This task is similar to the act of reading. In both cases a child looks at a visual stimulus and speaks a response. It could be argued that good readers, in effect, practice for the RAN test when they practice reading, whereas poor readers, who read far fewer words in a day or a week, practice less and thus are slower on the RAN. The Oxford psychologist Peter Bryant and his research colleague Lynette Bradley have criticized the methods used in the Denckla and Rudel studies. As in the case of verbal short-term memory, they make the point that only through reading-age-match studies can rapid automatized naming be linked specifically with dyslexia, rather than with the early stages of reading. That is, if older dyslexics and younger normal readers who read at the same level were compared, and the dyslexics were still poorer than the normal readers, then slow retrieval rate could be linked to dyslexia with more confidence (Bryant and Bradley 1985). On the other hand, there are a number of studies in which retrieval rate in prereaders has been found to be an accurate predictor of later decoding ability (e.g., Wolf 1986). That is, slow retrieval rate is a precursor to, rather than result of, poor reading.

Phonological awareness. The term phonological awareness refers to the metacognitive understanding that spoken language is made up of a series of sounds and that these sounds occupy a particular sequential order . Keep in mind that this is quite different from skills in phonics knowledge, a low-level paired-associate form of learning that relates letters and sounds on an automatic or rote level. The seminal work on phonological awareness in the United States involves a tapping task used by Isabelle Liberman together with her students at the University of Connecticut and her colleagues at Haskins Laboratories (Liberman, 1973; Liberman et al. 1974; Liberman et al. 1977). Liberman asked children to use a wooden dowel to tap the number of sounds they could hear in spoken sentences and then in words. She found that there was a developmental hierarchy with words in sentences easier to segment than syllables in words, which in turn were easier to tap than phonemes in single syllables. Virtually none of the children could represent phonemes accurately at age four, a few at age five, and most by age six. Liberman's work suggests that these tasks develop in a sequence, and that they develop late in children with reading disorder.

Several British researchers have provided evidence of a link between deficits in phonological awareness and deficits in reading. In a series of often cited case histories, Maggie Snowling and her colleagues document the pervasive phonological deficits of children with dyslexia seen over a period of time in a clinical setting (e.g., Snowling and Hulme 1989). While it has been argued that phonological awareness may be an effect of mature reading rather than its cause (Morais et al. 1979), it has also been demonstrated that the degree to which phonological awareness is developed prior to reading instruction plays a powerful role in determining reading outcomes (e.g., Bradley and Bryant 1983). In a reading-age match study, Snowling (1980) found that older poor readers matched on reading level with normal younger readers were much poorer at phonological tasks. This suggests that the deficit has a cause beyond lack of exposure to reading. It is likely that the relationship is reciprocal; phonological awareness drives reading in the early stages and then exposure to print increases phonological awareness once reading catches on.

Keith Stanovich has suggested that the entire range of difficulties often attributed to dyslexia may stem from what he calls the *phonological core deficit*. He argues that failure to learn to decode words because of phonological processing problems causes subsequent deficits in reading comprehension, vocabulary development, and even IQ through lack of access to print experiences. Stanovich calls this the *Matthew effect* from Bible verses in which the rich get richer and the poor get poorer. There is evidence that this phonological core deficit is of organic origin. There is also evidence that its symptoms are responsive to remediation.

Historically, overt neurological problems have been difficult to identify among children with dyslexia (Rutter 1978). Therefore, investigative efforts to understand the neurological underpinnings of dyslexia were focused historically on individual behavioral differences, thought to indicate neurological differences, with much of the exploration in the area of divergences in hemispheric specialization. The basic assumption behind this research has been that language processing in dyslexics may not be controlled by the same areas of the brain as in individuals without dyslexia. For the majority of the population, these areas lie in the left cerebral hemisphere. Much of this research examined *laterality differences* which were presumed to reflect *lateralization differences*. *Laterality* refers to the choice of hand, eye, or foot in performing everyday activities. *Lateralization* refers to "the involuntary brain functioning of the left and/ or right cerebral hemispheres" (Obrzut and Boliek 1986), otherwise called *hemispheric specialization*.

The relationship between left-handedness and reading disability has received considerable attention. Within the general population, the incidence of left-handedness has been estimated to be 8 to 10 percent (Kinsbourne and Hiscock 1981); lateralization indices are not as easily determined. Drake Duane, a neurologist, reported in 1983 that 98 percent of right-handed people and 70 percent of left-handed people have language lateralized in the left hemisphere (Duane 1983b). An interesting finding from one study (Hardyck and Petrinovich 1977) is that left-handers with a family history of left-handedness appear to have less hemispheric specialization than right-handers, whereas left-handers with no family history of left-handedness seem to process language in the left hemisphere like most right-handers. Confounding the issue is the possibility that some cases of left-handedness may be the result of early brain injury (Satz, Saslow, and Henry 1985). Clinical investigations of reading disorder may involve such *pathological left-handers* and cognitive deficits in such cases would more likely be due to cerebral insult than to deviant cerebral lateralization (Hiscock and Kinsbourne 1982). Any data pertaining to the connection between left-handedness and dyslexia, therefore, would be falsely skewed.

Among educators, psychologists, and neuropsychologists, opinions on the theorized association between handedness patterns and reading disability vary considerably. Finding left-handedness to be more common in males than females, the late Norman Geschwind, a neurologist who pioneered neurological research on the etiology of dyslexia, proposed a theory, based on epidemiological research, that links male sex, left-handedness, and autoimmune diseases to dyslexia (Geschwind 1983; Geschwind and Behan 1982). Further exploration of this hypothesized association has been carried out by Geschwind's colleagues at Beth Israel Hospital in Boston, principally Albert Galaburda (Galaburda 1985). The majority opinion among respected professionals exploring the link between left-handedness and dyslexia, however, is that we lack enough substantial data to draw definitive conclusions (Hiscock and Kinsbourne 1982).

In contrast to the unresolved issues related to handedness and dyslexia, the research indicates quite firmly that there is no significant link between eye preference and reading disability (Hiscock and Kinsbourne 1982; Obrzut and Boliek 1986; Rutter 1978).

Lateralization

Several measures of central language processing have been devised that are now considered to be better indices of cerebral lateralization than handedness. One of these measures is dichotic listening, where paired stimuli are presented simultaneously to each ear and the subject's response pattern, favoring one or the other ear, is thought to indicate the dominant hemisphere for that particular stimulus type: a right-ear advantage (REA) reflecting left-hemispheric processing and vice versa. Another measure, visual half-field (VHF) technique, involves presenting verbal or nonverbal stimuli tachistoscopically to either the left or right visual fields, or to both fields simultaneously in bilateral presentations. Response performance comparisons are considered to reflect degree of lateralization to one or the other hemisphere.

Cerebral Anomalies

A few postmortem anatomical studies have been conducted on the brains of persons previously diagnosed as dyslexic (e.g., Galaburda 1983, 1985; Galaburda and Kemper 1979). Although biological anomalies were indicated, the number of cases has not been sufficient to draw any definitive conclusions about the occurrence of cerebral abnormalities in dyslexics (Geschwind 1986). However, in the opinion of the investigators, one finding is considered particularly significant. Whereas in most individuals the left hemisphere is larger than the right, the dyslexic brains examined by Galaburda "showed deviation from the standard asymmetry pattern of the language regions, i.e., instead of a larger size of the left temporal language region there was symmetry" (Galaburda 1985). The symmetry appears due to a larger-than-normal right hemisphere in the brains of individuals with dyslexia. This finding has led Albert Galaburda to postulate that the etiology of dyslexia lies in abnormal migration of neural cells during fetal development (Galaburda, Rosen, and Sherman 1989).

Early efforts to look for possible cerebral abnormalities in dyslexic individuals involved a number of noninvasive techniques, such as *electroencephalography* (EEG), an electrical scanning procedure, and *computerized tomography* (CT), a radiological scanning technique. Neither of these brain scanning methods has been effective in identifying dyslexia (Connors 1978; Denckla 1978; Denckla, LeMay, and Chapman 1985; Duane 1983b). In a literature review on a more recent technique, *magnetic resonance imaging* (MRI), the above-mentioned earlier devices are described as somewhat imprecise (Filipek and Kennedy 1991). Even the CT scan, which provided an image of the brain, failed to do this with much clarity.

Until recently, studies of blood flow in the brain involved the radioactive isotopes used in *positron emission tomography* (PET) scans, which limited experimental use with children. Experiments with *magnetic resonance imaging* (MRI) are far less invasive and provide the sort of detailed picture available prior to MRI only through postmortem studies. Work with MRI indicates that there are physiological differences between individuals who read normally and those who are dyslexic. For example, Lubs and his colleagues found differences in patterns of asymmetry in the two hemispheres; whereas normal readers tend to be asymmetrical in the angular gyrus area of the parietal lobe, with left side larger than right, the pattern is reversed with individuals who are dyslexic (Lubs et al. 1991). In another example of imaging techniques, Frank Wood and his colleagues at Bowman Gray Medical Center have carried out studies indicating that blood flow differences involving Wernicke's area of the left hemisphere are present in adults diagnosed with dyslexia as children, in comparison with those without a history of reading disorder. These studies were carried out during performance of an auditory-to-orthography task; subjects were asked to indicate whether a word they heard had four letters (Flowers 1993; Wood et al. 1991).

The value of this recent ability to form an image of the brain of a living person engaged in a specific linguistic task lies not so much in diagnostic benefit for individuals, as in its ability to confirm that dyslexia is an organic disorder.

Attention Deficit Disorder and Dyslexia

Up until fairly recently the distinction between children with dyslexia, and those classified as learning disabled who read poorly and also had behavior problems, was not made clear in much of the research literature. One important recent step has involved isolating *attention deficit disorder* with and without *hyperactivity disorder* (ADD/ADHD) as distinct from other learning disorders.

During the 1960s and 70s, the term *minimal brain dysfunction* (MBD) was used to describe children assumed to have subtle neurological problems causing both learning and behavior problems (e.g., Clements and Peters 1962). Neurological *soft signs* such as reflexes or borderline performance on the EEG were used diagnostically by the medical community. These children were often assumed to have suffered birth the two sets of twins. However, this was not the case. In 70 percent of the identical pairs, when one twin had a reading disorder, the other did as well, while in the fraternal twins the concordance rate was only 48 percent (DeFries et al. 1991). These rates confirm findings from earlier, smaller studies from other researchers, in suggesting the heritability of dyslexia.

An interesting additional finding from the Twin Study involved analysis of phonological processing data. While there was a strong genetic influence on phonological skills, this was not the case with orthographic skills. That is, when subjects were poor at reading and weak phonological processing skills, there was a genetic link. This was not so when orthographic processing was considered. These findings are consistent with those of a British twin study in which the genetic component of spelling disorder appears to influence phonology but not orthography (Stevenson 1991).

Using a different model but asking a similar question, Herbert Lubs and his colleagues also find a familial predisposition to dyslexia. Eleven families with dyslexic members were traced for three generations in an attempt to locate a gene leading to dyslexia. The pattern of inheritance that emerges from this and other studies is called *autosomal dominant inheritance* (Lubs et al. 1993). Some unaffected members appear to carry the gene but remained asymptomatic, while others appear to have recovered or compensated. The latter are more apt to be women than men.

A number of recent studies have tried to identify a gene for dyslexia. For example, Shelley Smith and her colleagues have worked on gene localization using a technique called *sib pairs*, in which DNA samples are analyzed in pairs of siblings. The argument for this technique is that pairs of siblings who are both dyslexic will have similar DNA in regard to the dyslexia gene, while this will not be the case in disconcordant pairs. Smith found encouraging results for both chromosome 6 and chromosome 15 (Smith, Kimberling, and Pennington 1991). A more recent study favors chromosome 6 (Cardon et al. 1994). This work is in the very early stages and caution should be exercised in interpreting results.

While there is much still to be learned about the genetic characteristics of dyslexia, it does seem clear at this time that it can be inherited. Bruce Pennington, one of the principal researchers in the Colorado Reading Study, cites evidence that dyslexia is both "familial (about 35%-40% of first degree relatives are affected),", and "heritable (with a transmission rate of about 50%)" (Pennington 1991, p. 48).

Gender

The stereotype of the male dyslexic grew out of statistical descriptions based on children referred to clinics and to special school placements.

Using these samples, it looked as though there were roughly four times as many boys as girls with dyslexia or severe reading disorder (Vogel 1990). Recent re-evaluation of these ratios has been carried out in projects involving, for example, the Connecticut Longitudinal Studies (Shaywitz et al. 1990), Bowman Gray Medical Center (Wood et al. 1991), and the Colorado Reading Project (DeFries et al. 1991). Instead of figuring ratios of boys to girls in samples of referred children, these studies tested large numbers of children within school districts. When tallies were kept of the number of children whose reading was lower than expectations based on IQ, there were close to as many girls as boys with reading deficits. One possible explanation of the discrepancy is that boys are referred more often than girls because they are more apt to have attentional and behavioral problems (Vogel 1990) and thus their reading problems are more visible than those of girls.

ACADEMIC MANIFESTATIONS OF DYSLEXIA

Dyslexia is generally perceived first and foremost as a word-reading disorder. At the time of the first edition of this book there was fairly general agreement in the field that along with this word-level reading disorder there might be a wide range of other disorders including persistent difficulty in spelling, phonological processing, reading rate, comprehension, expressive writing, and handwriting. The picture has shifted toward primary deficits in phonologically driven word-level reading as the area of deficit in dyslexia as several large-scale federally funded studies have provided better control in terms of careful description of the samples of children examined.

Oral Reading

Word Attack Skills

The most pronounced among the reading difficulties that individuals with dyslexia experience is the inability to decode unfamiliar words (e.g., Olson et al. 1985; Siegel 1985; Vellutino 1983). This problem appears to be the common denominator in all cases of dyslexia (Gough and Tunmer 1986).

The basis for the decoding deficiencies among dyslexic readers is believed to be a deficit in phonological processing that affects ability to make use of letter-sound associations (i.e., phonics knowledge) possibly as an effect of rapid retrieval problems. Deficits in understanding the sound structure of speech (phonological awareness) confound mastery of the relationship between sounds in speech and letters in words. In short, children with dyslexia have extraordinary difficulty in using word attack skills to read words they have not committed to memory. These children have trouble breaking down spoken words in order to identify their component parts when they spell, and in blending together these parts into words when they read. Sound sequencing errors (articulating letter sounds in the wrong order), as well as letter-sound confusions (producing the wrong sound for a given letter or letters), are often observed in their oral reading. Word attack skills have proven to be the most sensitive identifier of disabled readers (Read and Ruyter 1985; Richardson, DiBenedetto, and Adler 1982; Ryan, Miller, and Witt 1984; Siegel 1985).

Nonsense words are widely used to measure ability to use word attack skills to read unfamiliar words. This task seems artificial, especially to advocates of a meaning-based approach, but keep in mind that many syllables in long words are nonsense words until the full word has been decoded. For example, the syllable *lan* has no meaning until all of the word *Atlantic* has been decoded.

Studies documenting the nonsense-word-reading deficit are often carried out through matching dyslexic and normal readers by word recognition level. The question here is, do the older children with dyslexia, matched on real-word reading level with younger normal readers, have more difficulty in reading nonwords? Maggie Snowling provided early documentation of the nonword reading deficit in a *reading-age-match* (RAM) comparison in which children were asked to respond to words using pairs of modalities (visual-visual, auditory-auditory, visual-auditory) and say whether the words were the same or not. Children with dyslexia were as competent as normal readers in making same-different judgements in pairs such as *torp* and *trop* in the visual-visual and auditory-auditory modes. Only when they needed to see one word in print and listen to the other did they have substantially more difficulty than normal readers (Snowling 1980).

In another often-cited study, Richard Olson and his colleagues made a similar comparison of 15-year-olds with dyslexia and 10-year-old normal readers. They were asked which of a pair of written words (e.g., caik-dake) sounded like a real word. The older readers were poorer than the younger normal readers, despite the match in real word reading level (Olson et al. 1985). In a more recent study with much larger numbers of students, including twin pairs from the Colorado Twin Study, this phonological coding deficit was confirmed, as was its heritability (Olson et al. 1989).

Word Recognition

If individuals with dyslexia are not facile at decoding unfamiliar words, how do they read? One argument is that they compensate by using an area of strength to make up for their phonological weakness and that this strength involves visual memory for letter strings, which is considered an orthographic skill. Richard Olson tested this theory in an experiment using the same 15 year-old-dyslexic and 10-year-old-normal readers tested for phonological ability above. This time he asked them to choose between two phonologically similar written words, one real and the other its pseudohomophone (e.g., *street-streat*). The task here is essentially one of proof reading. Which word looks right? Here the two groups did not differ. Keep in mind, however, that the children with dyslexia were five years older than the normal readers. These children's strength in orthography is a relative one in comparison with their weakness in phonological skills. Compared to normal readers of their own age, they read far fewer words (Olson et al. 1989).

Dyslexia is most evident when words are presented in isolation (Perfetti 1984; Stanovich 1980). This is logical because children with dyslexia are relatively strong in comprehension. Understanding a paragraph can help in understanding an unknown word. Once enough words have been learned to enable at least some degree of comprehension, then comprehension enables decoding of unfamiliar words.

Reading Rate

Word recognition skills improve with remediation, and there is even evidence that word attack skills can be improved through intensive training in phonological awareness, but individuals with dyslexia continue to read more slowly than normal readers. That is, accuracy can be remediated more effectively than rate. Much of the recent research on reading rate has been carried out through the Colorado Reading Project in the laboratories of Richard Olson. He and his colleagues have found significant differences between readers with and without dyslexia in vocal response latencies — the time between presentation of a stimulus and a subject's response — when single words are presented on a computer screen.

Another way of looking at rate is to time entire passages of text. P. G. Aaron and Scott Phillips examined the academic skills of college students with dyslexia and found their reading comprehension scores to be well above these students' own scores for reading rate (Aaron and Phillips 1986).

Spelling Problems

For individuals with dyslexia, spelling presents even greater challenges than reading. While reading is remediable to some degree, spelling deficits appear to persist through adulthood (Aaron and Phillips 1986; Cone et al. 1985; Ganschow 1984; Rutter 1978).

Roderick Barron (1980) observes that poor readers are more likely to use a visual-orthographic strategy in reading and to apply a phonological strategy to spelling. Lynette Bradley and Peter Bryant find this same strategy differential in young normal readers (Bradley 1985; Bradley and Bryant 1979). They believe that the independence of reading and spelling behaviors is a natural developmental phenomenon; young children who have not yet learned to read often spell words on the basis of sound. Are children with dyslexia simply behind on a developmental continuum, or do they spell differently from children without dyslexia?

In a recent analysis of the spelling errors of children who are dyslexic but have received intensive remediation, Mary Kibel and T. R. Miles found persistent difficulty with a type of errors not found in spelling-age matched controls. The errors involved both cluster reduction (e.g., spelling *blend* as "bend") and substitution of phonologically confusable pairs (e.g., *e/a*, *b/d*, *r/l*). These errors are consistent with Tallal's theory that individuals with dyslexia experience difficulty processing rapid acoustic information (Kibel and Miles 1994). These findings are consistent with several other studies. A similar analysis by Louisa Moats produced evidence of cluster reductions and unstressed syllable reductions in the spelling errors of third and fifth grade children with dyslexia, again in comparison with spelling-age matched controls (Moats 1993). Maggie Bruck and Rebecca Treiman have also found consonant clusters to be particularly troublesome for spellers with dyslexia (Bruck and Treiman 1990). These studies are more sophisticated than earlier ones that attempted to categorize errors as either phonological or orthographic, in that highly specific phonological processing deficits are the focus here, rather than a wider array of phonetic errors.

The unanswered question here is why individuals with dyslexia appear better able to compensate for phonological processing deficits in reading than in spelling. If orthographic spelling develops over time through exposure to print, this should fall into place eventually, after remediation of reading. It may be that orthographic processing in spelling is particularly dependent on successful phonological processing and subsequent representations of the sound structure of words.

Reading Comprehension

Children with dyslexia have been found to be poorer at reading comprehension than good readers, which is consistent with Philip Gough and William Tunmer's simple view of reading (1986). If decoding is poor, even in the presence of well developed listening comprehension, then reading comprehension will be poor. This is also consistent with Keith Stanovich's Matthew effect (1986b). Reading comprehension is a skill that needs development over time; it is difficult to practice comprehension if decoding is undeveloped.

Lack of reading accuracy and automatic recognition at the word level appear to place limitations on the comprehension of text, as well as on reading fluency (Stanovich, Cunningham, and Feeman 1984). David La Berge and S. Jay Samuels (1974) attempted to explain this apparent trade off in attentional resources by hypothesizing a limited capacity mechanism in working memory. In the same vein, Charles Perfetti (1984, 1985b) proposes a verbal efficiency mechanism to account for the strong relationship between speed and accuracy of word identification and reading comprehension shown in correlational studies.

Tests of the simple view of reading indicate that reading comprehension cannot surpass its two components, word decoding and listening comprehension (Hoover 1994). However, this data comes from very large numbers of readers drawn from the general population of school children. In examining the relationship between decoding and comprehension in readers with dyslexia in the Colorado Twin Study, Richard Olson and his colleagues provide a different story. When children with dyslexia were matched with controls in regard to timed word recognition ability, their comprehension levels were significantly higher on several measures. Keep several things in mind. The match was on *timed* word reading. Had accuracy been the matching criterion the match would have been with higher functioning controls. Also, the children with dyslexia were older and thus had an intellectual advantage.

Maggie Bruck reports similar data from a study of college-age students with dyslexia. Some of these subjects comprehended very well despite poor decoding skills. Bruck proposes the possibility of what she calls a *minimum threshold level* for word recognition, saying, "Once critical levels of word-recognition skill have been achieved, variation in comprehension levels may be best accounted for by higher level component processes" (Bruck 1990, p. 450). That is, bright individuals with dyslexia use their oral language strengths (e.g., vocabulary, general knowledge, interpretation of context) to compensate for weak decoding skills.

Listening Comprehension

Counter to current definitions provided by research, historically, children described as dyslexic were found to have deficits in a range of oral language skills including listening comprehension (Smiley et al. 1977), understanding complex sentences in speech as well as reading (Byrne 1981; Vogel 1975), and in grammatical understanding and morphological knowledge (Byrne 1981; Menynuk and Flood 1981). Keep in mind that attention deficit disorder is associated with deficits in both listening and reading comprehension, but not with decoding deficits. Until recently, control for this factor has not been a systematic part of research studies on reading comprehension. It may account for some of the variation in listening comprehension in many individuals who are also dyslexic.

While the research is both clear and clearly articulated on this point, the term *dyslexia* continues to be used with many children who appear to have language deficits beyond the phonological domain. While The Orton Dyslexia Society has adapted a phonologically oriented definition of dyslexia for research purposes, it uses a second, broader definition in order to be able to procure special dyslexia-oriented services for children with a range of language-related problems. Their definition is not limited to phonological difficulties, but includes more global deficits in expressive and receptive language (The Orton Dyslexia Society 1994).

Keith Stanovich is an advocate of limiting the term *dyslexia* to individuals with a discrepancy between listening and reading comprehension (Stanovich 1988a, 1988b), which makes it strictly a reading problem. Hugh Catts calls it a language problem but limits it to those aspects of language that are phonological (Catts 1989). Catts' model is consistent with that of Isabelle Liberman and her colleagues, who have led this line of research. Liberman maintained that as we read or listen we must hold incoming linguistic information in working memory in phonological form while we process sentences (e.g., Liberman and Shankweiler 1985; Mann, Shankweiler, and Smith 1984). Thus, the deficit that affects reading also affects listening. Support for this view can be found in a recent study carried out in Australia by Gail Gillon and Barbara Dodd. They tested poor readers, ages 8-10 years, matched on reading level with younger good readers, using a number of measures of phonological processing as well as measures of syntax and semantics. While the poor readers were weaker than reading-age-match controls in all oral language areas, they were particularly poor in phonological processing (Gillon and Dodd 1994).

Another explanation of weak listening skills in older students with dyslexia is linked to Stanovich's Matthew effect. Because of their general lack of reading experience some dyslexic individuals may fail to develop a strong knowledge base, which further limits their ability to comprehend and remember text material (Stanovich 1986b; Torgesen 1985). Insufficient background knowledge can be considered a second-order comprehension problem. It is most likely that both phonological processing deficiencies and lack of reading experience contribute to lowered levels of listening comprehension when this occurs.

Maggie Bruck has not found diminished levels of either listening comprehension or verbal IQ in adults with dyslexia (1990). Her data suggest a hierarchy of skills in both high- and average-IQ adults with dyslexia, in which low-level, phonologically driven skills such as nonsense-word reading are less developed than high-level skills such as reading and listening comprehension. Whether or not listening has been diminished by phonological processing deficits, there is agreement that decoding is poorer than reading comprehension, which, in turn, is poorer than oral language skills.

Expressive Writing Problems

While poor spelling is a well documented characteristic of dyslexia, little research exists on the written expression problems associated with dyslexia. When we consider the three potential areas of writing difficulties for individuals with dyslexia — composition, spelling, and handwriting (Cicci 1983) — spelling stands out as by far the most prevalent area of deficit (Ganschow 1984; Poplin et al. 1980). Other types of deficiencies can also be found in the writing samples of dyslexic students — for example, poor punctuation, word omissions, lack of subject/predicate number agreement, and lower percentages of compound and/or complex sentences — but there is little consistent documentation of their prevalence. In a study in which students with learning disabilities were asked to dictate stories to an examiner and then to write stories by hand or on a word processor, the dictated stories were significantly longer, of better quality, and contained fewer grammatical errors. These findings suggest that "...mechanical and conventional demands of producing text appear to interfere with the fluency and quality of written expression" (MacArthur and Graham 1988). It can be argued that deficits in spelling absorb so much energy and attention that all other aspects of writing are diminished in quality (Uhry and Shepherd 1993b).

Perhaps the most serious writing problem among individuals who are dyslexic is a general resistance to writing. As Diana King (1985), who works with adolescents, affirms, without remedial intervention this resistance tends to build throughout the school years.

Handwriting Problems

Research on handwriting is minimal, and there is no reliable standardized measurement instrument to evaluate letter and word formations (Cicci 1983). Visual memory deficits, fine motor problems, or slow rate of execution may all interfere with handwriting, but these are not deficits specifically associated with dyslexia. It is not far-fetched to suggest that emotional factors may also contribute to poor handwriting, given the lack of confidence most individuals with dyslexia have in their spelling abilities. No systematic analysis of these difficulties or of their relationship to dyslexia has been made.

RECURRING QUESTIONS

Subtypes or Unitary Disorder?

A question that has provoked specialists and researchers for some time is whether dyslexia is a unique syndrome or whether it comprises a number of identifiable subcategories. The question has led to studies aimed at classifying dyslexia into discrete subtypes based on patterns of symptoms.

Subtyping research began many years ago with M. Kinsbourne and E. K. Warrington (1963). They distinguish two groups of poor readers having more than a 20 point discrepancy between verbal and performance IQ on the Wechsler Intelligence Scale (Duane 1983a):

children with lower verbal IQ scores appear to have language related deficits whereas those with lower performance IQ scores demonstrate perceptual and visual-motor impairments. Note, however, that while low Verbal scale IQ is associated with language disorder, it is not a characteristic of dyslexia.

Some researchers have based subtypes on spelling errors. Elena Boder (1971), for example, claims to find three distinct spelling patterns among individuals with dyslexia. She terms these error patterns *dysphonetic* (reflecting deficits in sound-symbol association), *dyseidetic* (representing difficulty remembering visual aspects of words with nonphonetic spellings), and *dysphonetic-dyseidetic* (a combination of both problems). Attempts to validate Boder's subtypes, however, have not been successful (Carpenter 1983; Moats 1983; Nockleby and Galbraith 1984). In a recent study, Dale Willows and Gillian Jackson found Boder's categorization measures to be unreliable in terms of consistency between examiners (Willows and Jackson 1992).

Rebecca Treiman and Jonathan Baron (1983) examine spelling behaviors in dyslexia from the perspective of rule application. They find evidence of individuals with dyslexia who are overly reliant on spelling-sound rules, whom they have labeled *Phoenecians,* and a group who depend on word-specific associations, whom they call *Chinese*. These investigators allege that the Phoenician is able to spell nonsense words but tends to over-generalize phonics rules to exception words.

Another approach to the subtyping of dyslexia involves a dichotomy between what is called *surface dyslexia*, or failure on an orthographic level to move directly from print to meaning, and *deep dyslexia*, or failure in using phonological processes to decode unfamiliar words. This dichotomy is consistent with the dual route theory of processing in which either the direct lexical route or the phonological route is used. The terminology comes from studies of adults who were once normal readers and who lost either one ability or the other following brain damage (Patterson, Marshall, and Coltheart 1985). When used with children these terms are altered to *developmental surface dyslexia* and *developmental deep dyslexia*.

In a review of the literature on nonsense word reading John Rack, Maggie Snowling, and Richard Olson make the point that while studies using large numbers of subjects generally fail to distribute all subjects into distinct subtypes, not all individuals with dyslexia have the same profiles (Rack, Snowling, and Olson 1992). Snowling and her colleagues have documented a number of case histories of children with average or higher IQ scores and extraordinary difficulty with word reading and these profiles fall into two types, children with phonological deficits and those with visual memory deficits (Goulandris and Snowling 1991; Snowling, Goulandris, and Stackhouse 1994; Snowling and Hulme 1989).

At this point there is no single subtype classification system that is supported by a comprehensive body of research or that is useful in choosing remedial programs for children with dyslexia. While 25 years ago practitioners tried to match children with instruction depending on whether they were considered to be *auditory learners* or *visual learners*, there is no research base to support this dichotomy as a construct. The best practice involves teaching children to coordinate these two systems because both are crucial to skilled reading.

How Distinct is Dyslexia from "Normal" Reading?

Another argument in the field involves the conceptualization of dyslexia as an *either-or* condition. Is it, like pregnancy, a condition that one either has or does not have? Or, like blood pressure, is it on a scale ranging from normal to abnormal by degrees? In an often cited study, Rutter and Yule (1975) tested a large number of children in reading and demonstrated a statistical hump toward the low end of the bell curve, creating a bimodal distribution. That is, in addition to the distribution of readers, ranging from poor, to average, to strong along a normal curve, clustered around the mean, there was a second, smaller cluster of poor readers at the low end of the curve. These readers, they argue, represent a group of disabled readers distinct from the normal distribution.

In a recent study that challenges this finding, Sally Shaywitz and her colleagues tested children participating in the Connecticut Longitudinal Study on a number of measures over several years. Twenty-four intact kindergarten classes in twelve schools were randomly chosen from the state of Connecticut to participate in the study. The sample is reported by the study to be 84 percent non-Hispanic white, 11 percent Black, 2 percent Hispanic, and .9 percent Asian. Data on the 445 children were collected over a number of years. Children with dyslexia were identified through discrepancies between IQ and reading scores in first grade and then tested again in grades three and five. The Rutter and Yule model of dyslexia as a discrete condition would predict that once children were classified as dyslexic they would remain in this category, but this did not turn out to be the case. There were substantial shifts, both into and out of the dyslexia category, with each new testing period (Shaywitz et al. 1992).

Is There Recovery from Dyslexia?

There was some initial criticism of the Shaywitz study, centered on the claim that the results were misleadingly optimistic in terms of the prognosis for individuals with dyslexia (e.g., Duane 1992). Other research leads us to believe that children do not spontaneously recover from dyslexia. Furthermore, symptoms such as slow reading rate and difficulty with nonsense-word reading often persist into adulthood, even in individuals with dyslexia who have become successful academically (e.g., Bruck 1990).

Symptoms persist on an organic level as well. Frank Wood and his colleague Lynn Flowers have examined adults first diagnosed by Samuel Orton. Many of these individuals with dyslexia were tutored as children by Orton's wife, June Lyday Orton. Brain differences in regard to blood flow were found in these individuals as adults even in cases where reading had been successfully remediated during childhood (Flowers 1993; Wood 1993). When these same adults were examined for neuropsychological residue of dyslexia, they were found to have deficits in nonword reading, phonological awareness and rapid automatized naming (Felton, Naylor, and Wood 1990). Of the three symptoms, rapid automatized naming seems to be the most pervasive and to determine the degree to which recovery from dyslexia is possible (Wood and Felton 1994). There is evidence, by contrast, that phonological awareness and nonsense word reading are remediable to some degree (e.g., Alexander et al. 1991; Kibel and Miles 1994; Shepherd and Uhry 1993; Uhry 1994; Wise et al. 1989). Put in terms of word-reading, accuracy can be improved over time, but reading rate remains slow.

Recovery-rate research is hard to interpret because of inconsistent documentation of the characteristics of subjects and instruction across studies. Are there some symptoms of dyslexia that are easier to remediate than others? Is it important to begin early? What methods work best? At present, two large-scale longitudinal treatment studies are being carried out by research teams in Florida (Torgesen 1985) and Texas (Foorman, Francis, and Fletcher 1995). Results should clarify the extent to which recovery from dyslexia is possible.

SUMMARY

Dyslexia, then, is a reading disability at the word-reading level. It runs in families and is of fairly certain organic origin. Historically, dyslexia has been associated with both visual deficits and phonological processing deficits but not with global language deficits. At this time, the most compelling body of evidence points to phonological processing as the predominant cause. A number of reading-related treatments have been found to be effective in remediating phonological awareness deficits, but low-level cognitive skills such as spelling and timed oral reading never develop as fully as reading comprehension, which is a high-level cognitive skill.

The following chapter presents a conceptual plan and practical suggestions for the educational assessment of individuals with dyslexia based on the research discussed above.

4

Principles and Techniques of Remedial Instruction for Dyslexic Students

Although we should not minimize the importance of understanding the nature of dyslexia, reading disabilities research has been justifiably criticized for focusing disproportionately on the search for causality and all but neglecting inquiry on correction or prevention of the problem (Bryant et al. 1980; Chall 1978; Lipson and Wixson 1986). The reading disabilities field has in fact been referred to as *deficit driven* (Poplin 1983). Rachel Gittelman, a psychologist at the College of Physicians and Surgeons, Columbia University, reviewing the research on the remediation of reading disorders, states "The literature on the treatment of children with reading retardation is full of opinionated practices devoid of even barely adequately controlled treatment research." (Gittelman 1983).

There are several plausible explanations for the relative lack of treatment research on dyslexia, the first being the effort and cost involved; the need for a remedy is usually urgent, therefore taking precedence over the need to plan for later evaluation. A second explanation is that many remedial programs began in the private sector where formal evaluation is not required for implementation as it is in many public school systems. Still another reason is that few of the more popular programs or techniques have been affiliated with a college or university where research is routinely conducted. Moreover, much of the research that does exist is methodologically flawed, as a task force of the Research Institute for the Study of Learning Disabilities at Columbia University Teachers College discovered in surveying the research literature (Peister et al. 1978-1980). Gittelman points out that small numbers of subjects in the sample population, lack of control groups, and failure to assign subjects randomly to treatment and control groups, are some of the design problems in the studies to date (Gittelman 1983).

Random assignment to treatment groups is particularly difficult to achieve, since dyslexic subjects are often already in treatment. The length of time needed to produce significant gains from remedial instruction, which is usually two years or more (Peister et al. 1978-1980), also tends to discourage practitioners from carrying out effective studies. Furthermore, as Gittelman notes, neither the duration nor the intensity of treatment is spelled out, calling into question any conclusions that may be drawn.

The Teachers College task force (Peister et al. 1978-1980) has drawn attention to the fact that even where control or comparison groups exist, the instruction applied in these groups often is not adequately described, making it difficult to determine which instructional components are actually being compared. The nature of choice of outcome measures frequently is not given adequate consideration in planning program evaluation or in interpreting findings from studies that have been carried out. As Gittelman (1983) points out, most standardized tests are not designed to pick up small gains over short periods of time; thus, with short-term or *one shot* studies the possibility of failure to detect treatment effects statistically where they exist is greatly increased.

DIRECT INSTRUCTION

Despite the lack of empirical support, there is remarkable consensus on the major principles to be applied in remedial treatment for dyslexic students (Bryant et al. 1980). One of the most often acknowledged principles is direct instruction. N. G. Haring and B. Bateman in their book, *Teaching the Learning Disabled Child* (1977), make the point that dyslexic children do not learn *by osmosis*, as other children seem to do. Rather, they need direct, intensive, and systematic input from, and interaction with, the teacher.

Three different models of direct instruction have been applied to dyslexic children: the tutoring model (Traub 1982), the small group model (Cox 1985; Enfield and Greene 1981), and the whole class model (Wolf 1985). Determining which of these models is most effective and most economically efficient is one of the critical challenges in the field of reading disabilities.

Nancy Karweit of Johns Hopkins University suggests that we judge the relative value of the different models of adaptive instruction in terms of *student use of instructional time* (Karweit 1985). This concept has been referred to alternatively as *academic learning time* (Berliner 1981), *academic engaged time* (Ysseldyke and Algozzine 1983), and *time on task*

(Otto, Wolf, and Eldridge 1984). In reviewing the drawbacks and advantages of different educational settings, Karweit adopts J. B. Carroll's definition of learning time as the ratio of time spent to time needed (when the two factors are equivalent, learning is maximized) (Carroll 1963). In the whole-class model, Karweit notes that the amount of active learning time varies widely with the size and heterogeneity of the class and the procedural demands on the teacher. However, in this model all teaching time can be devoted to direct instruction.

In the within-class grouping approach, instructional time for each group is divided between direct instruction and independent seat work. While reducing the amount of direct instruction for each student, this approach can place an excessive burden on a teacher, because he or she must monitor seat work in addition to working directly with each group. Looking at individualized instruction only within a classroom setting (a model, she notes, that is considerably less popular today), Karweit emphasizes the formidable management problems involved in distributing teacher time and the often large amount of time wasted in students' waiting for the teacher's attention. Although she does not attempt to confirm the superiority of one instructional model over another, Karweit provides an important perspective on classroom management.

Students with dyslexia need more time to learn than students without reading disabilities (Haring and Bateman 1977), and special educators have given considerable thought to the issue of academic engaged time. For example, Wayne Otto and his colleagues (1984) have concluded that this variable is the best predictor of academic achievement; James Ysseldyke and Bob Algozzine (1983) suggest that reading diagnosis should begin with an examination of student time on task. Ethna Reid (1986), in designing an instructional program to be used in classrooms to prevent reading failure, makes provisions for minimizing the length of teacher questions and student response latencies in order to maximize learning time. Unison oral response is incorporated in several programs (for example, DISTAR and Slingerland) to ensure that each student is fully involved in the lesson at hand. The use of teacher scripts (Calfee 1981-1984; Engelmann and Bruner 1983; Reid 1986) can be viewed as another approach to time management. These scripts are written formats provided to teachers to help structure their lessons. Scripts may be more or less specific; in the DISTAR program (see Chapter 18), for example, the scripts tell teachers exactly what to say and do during each lesson, when to call for responses, when to repeat statements for emphasis or correction, and so on, thereby controlling the pace of instruction.

Careful pacing of instruction is an essential feature of effective teaching for dyslexic students in order to prevent information overload, which occurs when the amount of information to be processed within a given time span exceeds the individual's capacity (Bryant et al. 1980).

N. D. Bryant and his associates (1980) have identified four processing problems that contribute to overloading: 1) slow speed of processing, 2) difficulty automatizing information learned, 3) failure to apply strategies, and 4) distractibility. The successful teacher or practitioner working with dyslexic students, regardless of instructional setting, must provide for this contingency in planning each lesson (Cox 1992; Gillingham and Stillman 1960; Slingerland 1976). Most established remedial methods and programs utilize a structured, hierarchical approach to learning, breaking down tasks into small units taught in order of difficulty (Bryant et al. 1980).

LEARNING TO MASTERY

Mastery is an extremely important factor in remedial or preventive instruction for disabled learners. Barak Rosenshine, who supports direct teaching, states that, to insure retention, mastery needs to reach levels of 70 to 80 percent when new reading skills are acquired; in independent practice, mastery should be 100 percent, especially for learners with disabilities (Rosenshine 1983). David Berliner, another strong advocate of direct instruction, maintains that younger and less able students need to achieve almost errorless performance on early learning tasks in order for later learning to be successful (Berliner 1981).

Gaining automaticity is a critical component of mastery learning in remedial reading instruction. Automatic processing at the word level frees up working memory to allow for more efficient processing at the sentence and passage levels of text (LaBerge and Samuels 1974; Perfetti 1985a; Stanovich 1984). As mentioned earlier, dyslexic readers in general are markedly slower at word recognition than good readers (Perfetti 1984; Stanovich 1980). Most of the established remedial programs for students with dyslexia, therefore, make ample provision for extended practice to attain automaticity beginning at the letter-sound level. Barbara Bateman in particular stresses the need for repetition with all new learning, a concept termed *overlearning* (Bateman 1979). However, as N. D. Bryant and his associates at Teachers College point out, practice needs to be carefully distributed over time, rather than massed. They suggest that massed practice reinforces short-term memory at the expense of long-term memory (Bryant et al. 1980). The majority of remedial programs for dyslexic students provide for systematic review of previously learned material at the beginning and end of each lesson.

Prompting techniques are often utilized in treatment approaches to decrease the possibility of errors and to help students to respond without overcontrolling their behavior (DeCecco 1968). Although there has not been much research on the subject, Bryant and his associates (1980) report on two studies that support the value of prompting in remedial instruction, which usually involves using picture or object cues as memory aids.

For example, remedial programs derived from the Orton-Gillingham approach (see Chapters 13 and 15) provide pictures to promote letter-sound associations. A picture of a pig, for example, could be considered a prompt for the sound of the letter *p*.

Academic feedback is another essential instructional component of learning to mastery (Berliner 1981). B. Rosenshine and R. Stevens (1984) cite immediate feedback from the teacher as one of the five most important contributive factors to academic achievement. They subdivide the feedback process into four instructional components: demonstration, guided practice, feedback, and independent practice. Although little research has specifically investigated the effects of this variable on students with dyslexia, some provision for feedback is incorporated in all established programs. It is not necessarily teacher driven, however, as in the classic Direct Instruction model exemplified by the DISTAR program (see Chapter 18; Engelmann and Bruner 1983). In some programs a *discovery* or *Socratic* method is used (Cox 1992; Lindamood and Lindamood 1975), albeit under careful teacher supervision to ensure correct responses. When working with older students, frequent performance assessment offers a way to inform them of their progress, thereby increasing motivation (Zigmond and Miller 1986). Providing standards against which to measure their performance also helps students to become self-monitors and take on more responsibility for their own progress (Bandura 1982).

Gaining pupil attention is particularly important in teaching children who are prone to distraction (Bryant et al. 1980) and often lack motivation due to previous failure (King 1985). Techniques to promote attending behavior have been incorporated into many instructional programs for these students. For example, the Alphabetic Phonics and Slingerland programs (see Chapters 13 and 15) require specific sitting positions to be assumed before reading and writing activities begin. Hand signals used to cue group response, as in the DISTAR program and Enfield and Greene's Project Read (see Chapter 17), also serve as attentional devices.

Monitoring and evaluating student progress is an essential component of successful academic treatment, although not all treatment methods for students with dyslexia include evaluation procedures. Naomi Zigmond and Sandra Miller (1986) report on studies that showed significantly greater academic gains for students whose teachers monitored student progress, as compared to students whose teachers collected no ongoing progress data. However, these reviewers emphasize that to be effective, progress evaluation must be frequent and systematic and teachers must use the data constructively to modify instruction when needed. Furthermore, a data-based approach has been found to be more effective in improving pupil achievement than informal observational procedures, though the data analysis need not be elaborate to provide adequate information on student progress. Note the daily record taking in Reading

Recovery (see Chapter 22) and the frequent curriculum-based evaluation in Alphabetic Phonics (see Chapter 13).

MULTISENSORY TECHNIQUES

The use of multisensory techniques in remedial intervention with children who are dyslexic is widespread and dates back to the 1920s with Grace Fernald who instructed students with reading impairment to trace letters or words while saying the names aloud (Fernald and Keller 1921). This procedure came to be known as the VAKT approach (visual, auditory, kinesthetic, tactile). Fernald maintained that VAKT reinforcement would help to produce a memory schema for the stimulus information. Samuel Orton's hypothesis that dyslexia is caused by incomplete cerebral dominance, resulting in reversal and sequencing problems, led to the adoption of multisensory teaching methods by his many disciples (Cox 1992; Gillingham and Stillman 1960; Slingerland 1971; Traub and Bloom 1975). The prototype of multisensory instruction for children with dyslexia was developed by Orton's colleague, Anna Gillingham, a psychologist, and is most often referred to as the *Orton-Gillingham approach*. Gillingham collaborated with Bessie Stillman, a remedial reading teacher, in writing a manual that describes this method (Gillingham and Stillman 1960).

Among these practitioners, the assumed rationale for multisensory remedial training has been that kinesthetic activities help to establish visual-auditory associations in learning grapheme-phoneme correspondences, as well as to establish left-to-right letter progression (Orton 1966). Aylett Cox, author of Alphabetic Phonics (see Chapter 13), a program derived from the Orton-Gillingham approach, refers to this learning procedure as *intersensory elaboration*. Other proposed benefits of VAKT or VAK techniques are that they encourage attention to details within letters or words (Gates 1927) and that they help in retrieving words from long-term memory (Slingerland 1971).

As the Teachers College task force (Peister et al. 1978-1980) has observed, there were considerable differences in specific techniques among the earlier practitioners of multisensory training. Orton, for example, stated that individual phonic sounds should be pronounced as the child traced a word; Gillingham believed that letter names should be said aloud; Fernald maintained that words should not be broken up artificially, and that whole words should be said aloud while tracing or writing. Today there is general agreement among practitioners of Orton-Gillingham derived methods that letter sounds are pronounced when reading words and letter names when spelling (Cox 1992; Enfield 1976). However, even among these programs there are variations in the degree of multisensory input incorporated in teaching procedures. For example, in order to emphasize precise speech sounds, Cox (1985) uses mirrors to demonstrate different oral positions in pronouncing these sounds, a technique derived from the speech therapy field. Charles and Pat Lindamood (Lindamood and Lindamood 1975) stress the importance of developing oral-motor awareness in children and adults with deficits in auditory conceptualization. Note that Patricia Lindamood's background is in speech/language therapy.

Despite the widespread inclusion of multisensory techniques in remedial programs for students with dyslexia and the almost unanimous conviction among practitioners using these techniques that they work, there is little empirical data to validate their effectiveness. We have substantial evidence that many of the programs incorporating these techniques are effective, but we cannot be sure that it is the multisensory factor that makes the significant difference, for in studies comparing multisensory instruction to an alternative remedial approach, the competing variables have not been well controlled.

There are in fact some practitioners who question the application of multisensory methods as a uniform treatment for all readers with disabilities. Doris Johnson and Helmer Myklebust of the Institute for Language Disorders at Northwestern University, for example, caution that some children with reading disability appear prone to sensory overload; thus the involvement of another sensory modality may serve only to confuse them (Johnson and Myklebust 1967). Unfortunately, these clinicians have not provided empirical data to support this contention, nor have they described in detail the children they have in mind. This research is from an era in which the distinction between readers with dyslexia and garden-variety poor readers was not made.

Susan Bryant (1979) has compared the effects of VA (visual, auditory) with VAKT procedures (visual, auditory, kinesthetic, tactile) on children with reading disability, keeping all other instructional variables constant. In doing so, she found no differing effects due to treatment between methods on either reading or spelling performance, despite the fact that the VAKT procedures demanded more student engaged time. However, because the intervention time in Bryant's study was only six days, efforts to generalize her results to actual clinical or classroom practice should be restrained. Conclusions drawn from one-shot experimental training studies such as Bryant's are always open to question.

After conducting an extensive review of the research on multisensory training, Bryant (1979) suggests two possible effects of multisensory instruction that are not sensitive to experimental manipulation and therefore may have gone undetected in the research thus far. The first is that multisensory methods may provide more feedback to the teacher and the child in initial learning, and the second is that multisensory activities allow for distributed and varied practice, thereby minimizing boredom.

Perhaps the most interesting research to date on the effects of multisensory instruction is that conducted by Charles Hulme. Seeking to understand the rationale for multisensory instruction with disabled readers by investigating the effects of tracing on visual recognition, Hulme (1981) finds that tracing letters significantly enhances the ability of disabled readers to remember letters they have seen and brings their recognition performance up to that of normal readers who have merely been shown the letters; however, tracing has little improvement effect on normal readers. With abstract shapes, on the other hand, tracing benefits both normal and disabled readers, and to a similar extent. Hulme maintains that these findings suggest that good readers have access to a phonological code, which is more efficient for storing verbal material than a visual code. In contrast, poor readers rely on visual memory which may be enhanced by kinesthetic input, such as tracing. Although this hypothesis appears to offer an explanation as to why multisensory teaching might benefit students with dyslexia, the fact that tracing in Hulme's experiments improved recognition of individual items only, but not of the sequences in which the items were presented, weakens, but does not totally invalidate, the credibility of this explanation. As Hulme himself points out, learning to read is dependent upon learning to recognize sequences of letters in words.

In attempting to understand the mechanisms underlying the effects of tracing on visual recognition, Hulme offers two competing hypotheses: 1) that tracing serves to direct attention to the stimuli to be remembered; 2) that tracing increases the information about the stimuli that may be stored in memory. Hulme questions the plausibility of the attentional hypothesis, citing the failure of similar attention-directing activities in previous research, such as haptic inspection of three dimensional objects, to enhance visual memory. Opting for the latter hypothesis, Hulme suggests that the primary effect of tracing is to provide information in memory about the movements made in tracing and posits the existence of a separate motor memory system which acts in conjunction with visual memory of the shapes of the items to be remembered. Lending support to this contention are Hulme's findings that visual interference during the experimental procedure disrupted memory for visually presented shapes but not for shapes that had been traced, whereas motor interference was most disruptive for recognition of shapes that had been traced.

Hulme asks a question more relevant to reading than to the research he conducted on visual memory: Does tracing enhance memory for verbal labels of visual configurations? Using children without reading problems, triplet shapes were paired with high frequency, high imagery nouns. Here, Hulme found that names were better remembered for the triplets that had been traced. He emphasizes the implications for these results for beginning and remedial reading instruction, which involves a similar form of visual-verbal paired-associate learning.

In another exploration of multisensory instruction, Hulme and Lynette Bradley (1984) used an Orton-Gillingham technique called *Save Our Spelling* (SOS)[1] in which a student reads a word and then copies it three times, saying each letter aloud as it is written. Both young normal readers and older poor readers learned to spell more words correctly using the multisensory SOS technique than when using a comparison technique in which lettered tiles were selected for spellings.

None of these studies identify the underlying mechanisms that produce effects for handwritten spellings. Whether or how information processed in one sensory modality can enhance the processing of information in another modality remains to be seen. Yet there is appeal in Hulme's hypothesis that multisensory processing establishes multiple memory traces that reinforce retention of information about spelling patterns. Hulme's conjecture that the benefits gained by disabled readers, but not good readers, from letter tracing are attributable to disabled readers' failure to employ a speech code to memorize letters (Hulme 1981) is credible in light of what is known about the phonological coding deficits in individuals with dyslexia.

Hulme's laboratory-based experiments are important as a way of understanding the underlying psychological processes involved in learning to read for children with dyslexia. Three recent studies designed to compare several treatments have all used some form of multisensory instruction and in all three cases this instruction was the regular school-based reading curriculum for these groups of children, with university-based researchers monitoring teacher training and collecting data periodically. Barbara Wise, who works with Richard Olson in Colorado, has incorporated Patricia Lindamood's Auditory Discrimination in Depth (ADD) program (see Chapter 14) into training that includes a computer-based practice component for young children with reading problems. Working with teachers, children are taught to recognize pictures of mouth positions that refer to the sounds made when their own mouths are in those positions (i.e., top teeth on lower lip producing the sound /f/). These new skills are then practiced on a computer program that incorporates both mouth movements and synthesized speech. ADD training is eventually extended into reading recognition training which also has a computer-practice component. Words that children cannot read can be highlighted for computer-based speech-synthesis production, segment by segment. The computer based segmentation training is called ROSS, or Reading with Orthographic and Speech Segmentation. Children in the ROSS group outper-

[1] The acronym SOS is used by Aylett Cox (1984) for two terms: Save Our Spelling and Simultaneous Oral Spelling (see Chapter 9). Both Cox (1984) and Hulme and Bradley (1984) base their procedures on Orton-Gillingham multisensory techniques. Hulme and Bradley use the technique with irregular words in this study. Note that when SOS is used with regular words, the model is auditory rather than visual; the teacher says the word rather than showing it to the child.

formed a control group trained in reciprocal teaching of phonological awareness and word attack skills after this multisensory training (Wise 1995).

Joseph Torgesen, Richard Wagner, and Carol Rashotte, at Florida State University, are also using Lindamood's ADD training. In their longitudinal study ADD is used in connection with a synthetic phonics instructional program in an intervention with first-grade children who are at risk because of poor phonological awareness skills. This intervention is called PASP, which stands for Phonological Awareness with Synthetic Phonics. Three additional treatment groups include: 1) implicit phonics instruction through the use of partially phonetically controlled basal-reader text, 2) one-to-one support for regular classroom instruction, and 3) regular classroom instruction alone. In contrast to the other treatments, there is indication in the preliminary data from the first year of this study that PASP, the multisensory, direct instruction, synthetic phonics model, is more effective than the other treatment models in terms of nonsense word reading, but not more effective, to date, in terms of real-word reading. On the latter measure, all three treatment groups were superior to classroom controls (Torgesen 1995).

Barbara Foorman, David Francis, and Jack Fletcher, of the University of Houston, are also using multisensory instruction as one of several treatment conditions being explored in a longitudinal study of 108 second- and third-grade children who are receiving resource room help because of poor reading skills. As with the two above studies, treatment is being carried out in the schools as part of the regular instructional program, in this case, by the resource room teachers. The first treatment, Alphabetic Phonics (see Chapter 13), is an Orton-Gillingham based, multisensory, synthetic phonics program. The Neuhaus Center in Houston provided training for teachers working with the Alphabetic Phonics group. The second treatment is a modified version of Recipe for Reading (see Chapter 16), also an Orton-Gillingham program with a multisensory approach, but one that utilizes both synthetic and analytic phonics activities. One modification to Recipe for Reading in this experiment includes training in onset-rime word segments rather than fully segmented phonemes. The third training condition is a whole-word program that involves visual discrimination between similar words and building memory for sight words. Preliminary results favor Alphabetic Phonics training (i.e., synthetic phonics) over both the modified Recipe for Reading training (i.e., analytic/synthetic) and the sight word training in terms of growth in phonological skills. In other words, using multisensory techniques to teach synthetic phonics provided an advantage in phonological skills. Contrary to expectations, however, children in the sight word group had higher scores on both spelling and broad-based reading measures[2] in comparison with the Recipe for Read-

[2] This was a composite reading score from the Woodcock-Johnson Tests of Achievement

ing group (Foorman, Francis, and Fletcher 1995).

The authors of these three studies warn that their results are preliminary and that the children in their studies must be followed for several years before the effects of treatment are fully understood. The Texas and Florida studies are finishing the second year of federally funded five-year programs. Results are complex and will need to be interpreted over time, but initial results do support the use of multisensory synthetic phonics programs to increase ability in phonological skills for students at-risk for phonology-based reading deficits.

MODALITY SPECIFIC INSTRUCTION

Although the question of sensory modality preferences among reading disabled children seems closely related to the issue of multisensory training, it derives from a different theoretical perspective. Efforts to adapt instructional treatments to individual learners became prevalent in the 1960s, as information processing theory gained prominence in educational psychology. Helmer Myklebust and Doris Johnson, leaders in this movement, maintained that there are two types of dyslexic individuals, one type suffering from visual perceptual deficits, the other type from auditory processing deficits (Myklebust and Johnson 1962). Johnson and Myklebust (1967) recommended that visual dyslexics be taught by a synthetic phonics approach and auditory dyslexics by a whole-word or sight approach. Modality specific instruction was popular in the 1960s and early 1970s.

However, aptitude-treatment-interaction (ATI), as modality specific instruction came to be called, began to lose credibility as a viable concept during the 1970s, as accumulating research failed to demonstrate its effectiveness. Helen Robinson conducted an often cited study in which she tested 448 children after matching them for modality preference with either a phonics or sight approach to reading acquisition; she found neither method to be more effective with those children having the most notable differences in modality strengths (Robinson 1972). Two comprehensive ATI literature summaries (Cronbach and Snow 1976; Turner and Dawson 1978) have concluded that modality preference is not strongly related to achievement, teaching approach, or reading. As explanation for these findings, Sally Lipa, in a journal article on reading disability and its treatment, suggests,

> ...modality teaching failed to account for the fact that, regardless of mode of presentation, words must be learned linguistically, notably in the dominant language hemisphere. Teaching in a visual manner could not obviate auditory processing of words (Lipa 1984).

In other words, even if a reliable way to measure preferred modalities could be developed, and we don't have this technology, all children need to learn how to match visual letters with spoken and spell. The demands of reading need to inform instruction. However, the efficacy of modality-specific teaching remains a commonly held notion in the popular literature twenty years after research began to make researchers question it.