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Abstract. *This paper presents information on the historical background of the long-standing controversy over methods of teaching reading, and cites findings on the current seriously inadequate levels of literacy documented in America. It is argued that the low literacy levels and the controversy over teaching methods are likely to continue until attention turns from reading methods to the reading process, and the direct development of two important sensory-cognitive functions that support and enhance oral and written language processing. Evidence is presented that, although genetic differences exist in individuals' spontaneous access to these sensory-cognitive functions, they can be developed through appropriate intervention either preventively or remedially. Descriptions are provided of specific instructional procedures that develop these sensory-cognitive functions, to illustrate the conscious level of sensory feedback and integration that must be experientially elicited through Socratic questioning. This questioning must respond to students' responses to meet students at the level of their processing. It enables both children and adults to be moved by small steps of reasoning to discover concepts involved in becoming self-correcting in language and literacy learning. The position is taken that the direct development of these sensory-cognitive functions needs to be widely addressed, and that the conceptual base they provide permits students to experience success in learning to read regardless of which reading method is used. This would help to dissipate the controversy over reading methods and allow attention and effort to focus on the* process *of reading.*

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History of the Controversy

For decades, controversy has raged among educators over how to teach reading—whether by the *phonics* method, the *sight word* method, or the *whole language* method. Smith (1965) examined over 2,500 sources of information to provide an account of contrasts in philosophies and practices in the history of reading instruction in America. The period from the 1600s, before public education, to 1965 is covered exhaustively. However, since then the controversy has further escalated, and the development of literacy skills has deteriorated to the point where there is national concern about them. The major methods within the progression of the controversy are cited here, to give a sense of the issues involved. A recurring pattern surfaces, which is not found to be a matter of attention of concern among those involved in the controversy, except for the repeated caveat that no one method can be expected to be successful with all students.

In the 1830s Horace Mann led an educational reform movement that resulted in free public education becoming available (Encyclopedia International, 1972). At first, reading was taught by the alphabetic method, which involved having students say the names of the letters and then pronounce the word. When dissatisfaction arose over the level of skill occurring with this method, a phonics approach was introduced in which students were taught to say and sound for the letter to assist in pronouncing words, instead of the letter names (Smith, 1965). At this point reading was taught largely with *McGuffey's Readers,* using a phonics approach and sounding out words in stories that included fables and other tales with a moral (Encyclopedia International, 1972). However, over time it became apparent that some students did not learn to read through phonics, although others did.

A revolt against phonics occurred in the early 1930s, and the *look and say-sight words* proponents entered the scene. They observed that good readers didn't seem to sound out words, but just looked at a word and read it. So these educators thought that was how reading should be taught—by presenting words on flash cards for students to memorize as a visual configuration (Yoakum, 1955). To guard against too big a memory load, a restricted corpus of words was chosen, and repeated again and again in the now famous Dick and Jane stories. Again, some students learned to read, but others didn't.

At that point the *language experience* approach was developed, with the suggestion that some students were failing with the *sight word* approach because the restricted vocabulary was not of interest or was not familiar to them. To remedy this, the language experience approach used the students' own vocabularies. Students told stories which the teacher wrote as they watched. These stories were then used for reading practice (Allen, 1964). Again, some children learned to read and others didn't.

Phonics was now brought back, but made more "multisensory," and the need and the concept of remedial teaching emerged. Fernald (1943) overlapped language experience and multisensory phonics in what was called a visual, auditory, tactile, kinesthetic remedial approach. Students who were having difficulty learning to read were asked to choose words they thought were difficult. The teacher wrote the words, saying each syllable as she wrote. The child then traced the word with a forefinger, pronouncing the syllable at the same time. This action was repeated, over and over, until the student was able to write the word without looking at the model. Letters were written in the air, in salt, on sandpaper, in the palms of students' hands, on student's backs, etc. Again, some children learned to read while others didn't. Many other multisensory phonics remedial programs appeared, based on the work of Dr. Samuel T. Orton (1937), but with various modifications. Descriptive material regarding these programs is available in a special publication authorized by the Orton Society (McIntyre & Pickering, 1995).

A succession of different reading approaches emerged in the 1950s and 1960s, all of which were successful with some students, but not with others. Linguists made a strong entry into the controversy, claiming that teaching individual letters and sounds as in phonics was wrong (i.e., p says "puh") because they considered the syllable the basic unit of language. The linguists held that children should be introduced to reading only through printing syllable units that gradually increased in complexity while regularity was maintained in sound-letter correspondence. This resulted in initial content such as "The fat rat sat on the mat" (Bloomfeld & Bernhart, 1961; Fries, 1965)

In an effort to maintain this extremely "safe" first experience with the print medium for reading, but free students from the restricted, unnatural language of the linguistic reading materials, the Pitman shorthand family developed the Initial Teaching Alphabet (ITA; Mazurkiewicz & Tanyzer, 1966). It provided one grapheme for each phoneme, so the first experiences in reading involved completely predictable sound-letter relationships, but the content could be rich and natural. When students had developed some decoding fluency they made the transition into traditional orthography.

Reading Words in Color (Gattegno, 1967; Moyle & Moyle, 1971) was also an effort involving the *medium* for reading, not a method. Different colors were used, each color representing a different sound no matter what letter or letters were involved, to aid attention to sounds represented within the printed forms of words.

During the most recent period the instructional pendulum swung again, and this time the method was called *whole language*. It emphasized using real literature instead of stories with a restricted vocabulary, so natural context could aid students to engage in the "psycholinguistic guessing-game" of reading (Clay, 1977; Goodman, 1970; Heald-Taylor, 1989). Whole language proponents said spoken language emerges "naturally" for children, without direct teaching, because they are immersed in spoken language. It was their opinion that written language would emerge naturally in the same way if children were immersed in it, by reading to them and then having them read. Phonics was minimized and taught only secondarily in the course of contextual reading, or was not taught at all.

Each of these reading methods made a contribution by bringing a piece or part of the reading process into special focus. But although they were developed because a significant number of students were not learning to read with other methods in use, their particular contribution did not change the pattern: A portion of students failed to learn to read with each successive method.

At present there is a general move for educators to embrace the use of all the methods—phonics, sight words, and whole language—in what is being called a *balanced approach* (International Reading Association, 1997). However, on the basis of our clinical observations and research we predict that this balanced approach will still not solve the problem. We hypothesize that the combination of these approaches will also produce a portion of students who fail to learn to read, just as each method alone did, because even this "balanced approach" does not recognize and address individual differences in sensory-cognitive functions that are basic to independence and full competence in literacy skills.

Literacy Crisis

While this controversy over methods of teaching reading was occurring, America became a nation with a literacy crisis that is well documented. As jobs that are reading-free have disappeared, the level of reading ability has become a matter of national concern. Some state legislatures are making laws about the content of beginning reading instruction, and the federal government is announcing plans for nationwide assistance in reading development through a corps of volunteer tutors supervised by a very large group of government employed reading specialists. However, the Board of Directors of the International Reading Association states, the Board "has grown increasingly concerned about this trend toward noneducators issuing curricular ad legistlative mandates" and notes "the increased politicization of the issue in recent years and the negative effects of "unprecedented public scrutiny' of teachers and schools" (International Reading Association, 1997, p.1).

Estimates indicate that 20 to 30% of the school population experienced moderate to severe reading dysfunction (Conway, 1993; Shankweiler & Liberman, 1989: Yoakum, 1955). These children become the learning disabled population in the upper grades—many remaining disabled readers in spite of the services of reading specialists and tutors. Some of them become juvenile delinquents and then incarcerated adults. A report of the Correctional Education Association estimates that 60% of the more than 700,000 men and women behind bars in adult prisons are either totally illiterate or have a literacy level so low they cannot deal with the ordinary task of daily life (Conway, 1993).

The findings of the 1993 *National Adult Literacy Survey* (NALS), released by the National Center for Educational Statistics, U.S. Department of Education, indicated that more than 90 million Americans (48% of the nation's adult population) do not have functional reading skills. It was found that 22% have virtually no literacy proficiency, and another 26% are at a secondary level so weak they can only sometimes read a road map, and sometimes may be able to get two facts from a newspaper sports page story. It is significant to note that within these two lowest levels of literacy there are a percentage of persons with college degrees (Conway, 1993). In his book *The Teacher Who Couldn't Read,* Cocoran (1994) also documents the reality of having a college degree without being able to read.

Colleges and universities are reporting that it is common to find 30 to 40% of entering freshmen reading below the 7th grade level (Conway, 1993). The problem has caused university systems in the West, Midwest, and East to issue press releases to announce that they will discontinue remedial English Courses in the near future, and remediation of students' reading problems will have to be provided in other settings. Our nation spends over $350 billion annually on education, and provides a wide array of free public education opportunities. There obviously are some missing elements in educators' understanding and development of the reading process, since illiteracy rates remain high in spite of availability of and significant spending on public education.

Factors in the Methods Controversy and the Literacy Crisis

Why has this unproductive controversy and the present literacy crisis come about when all reading methods share the common goals of independent reading ability and good comprehension and enjoyment of written language? It appears probable that it occurred because *methods* of teaching reading became the issue rather than inquiry into the *process* of reading.

The partial failure of each reading method is often justified by human individuality—the idea that everyone learns differently—and this is often presented as the cause of the reading instruction controversy. In fact it appears that educators often interpret individual response to different reading methods as evidence that the reading *process* is different for each individual. Current examples are found in the International Reading Association (IRA) publication *Reading Today* (1997). This issue carries a statement by the Board of Directors representing the organization's position regarding the controversy over whole language versus phonics methods of reading instruction, and statements by IRA officers to the effect that there is no single best way to teach children to read—that "some" students need "some" forms of instruction "sometimes" (p.4).

With regard to individual differences in learning to read, we believe there is an important parallel between biological life processes and dimensions of the learning process. So far as the life process is concerned, at the most basic levels humans are all remarkably matched, more the same than different. In spite of individuality, everyone needs air, everyone needs blood and everyone needs all the basic components of blood. Just as there are minimum content and quality levels necessary for blood and oxygen if one is to have unrestricted activity in the life process, so there are minimum levels of sensory-cognitive processing and integration necessary for freedom and self-correction in the learning process, especially in processing spoken and written language.

It seems to us there are two different issues, apples and oranges, in the relationship between individual differences and learning to read: Individual response to reading instruction methods is a different issue from the basic demands placed on everyone's sensory-cognitive system by the reading process. There is no dispute that everyone does not respond equally to any particular method of reading instruction, but that does not necessarily mean the sensory-cognitive demands of the reading process are different for everyone. We hypothesize that the reading process does require of everyone the same most basic sensory-cognitive processes, whether acquired through instruction or genetics. Individuals vary in their genetic tendency toward these processes but most acquire them in order to be competent, independent readers. In fact, this premise that there are essential precursors to the reading process is confirmed by a whole body of findings on reading—that failure to acquire decoding skills is predictively and predominantly due to a specific sensory-cognitive factor, and not to a wide array of weak sensory-cognitive processes.

The Reading Process and Underlying Functions

The skills that contribute most importantly to reading competence can be divided into two board classes: *word identification* and *comprehension.* Word identification or decoding skills are required in transcoding between written and oral language. These skills enable the reader to identify specific words on the printed page. The other class of skills are those used to construct meaning from text, usually referred to as reading comprehension skills. Decoding and comprehension skills interact with one another in important ways during reading. Accurate and fluent print-based decoding skills provide a needed basis for good reading comprehension, and good comprehension skills allow students to make correct inferences about the identity and meaning of many words in text (Stanovich, 1991). This "interactive skills" view of reading "assigns greater weight to facility in word identification than to language comprehension processes at early stages of reading development and greater weight to language comprehension processes at later stages of development" (Vellutino, Scanlon, & Tanzman, 1994, p. 280).

From a combination of clinical and classroom experience and research in diagnosis, prevention, and remediation, we suggest that two specific sensory-cognitive functions are particularly powerful in their effect on reading, one function underlying word identification skills and the other comprehension: (1) Phonemic awareness: the ability to identify individual sounds and their order within word underlies self-correction in word attack, word recognition, and spelling—the ability to go from the whole to the parts. (2) Concept imagery: the ability to form mental images for the concepts and ideas expressed by language underlies comprehension and the ability to create an imaged gestalt—to go from the parts to the whole.

These two functions have long been assumed to become available by virtue of age and intelligence. But, research shows a wide range of diversity and evidence of genetic transmission in phonemic awareness (DeFries, Fulkes, & LaBuda, 1987). Our clinical observations and case histories [1] indicate diversity and genetic transmission may characterize concept imagery ability as well; further formal investigation is needed.

Phonemic Awareness and Learning to Decode

Through correlational and causal research spanning more than a 25-year period, difficulty in segmenting phonemes within spoken syllables and words has become unequivocally documented as the primary factor in problems in the decoding aspect of reading or dyslexia. This neurophysiological processing problem has been called *lac of auditory conceptual function, phonological awareness,* and *phonemic awareness* by various researchers (Calfee, Lindamood, & Lindamood, 1973; Liberman & Shankweiler, 1985; Lundber, Frost, & Peterson, 1988; Lyon, 1994; Lyon & Krasnegor, 1996; Olsen, Forsberg, Wise, & Rack, 1994; Pennington, 1991; Torgesen, Wagner, & Rashotte, 1996; Wagner, Torgesen, & Rashotte, 1994). Evidence is converging from at least five sources in support of the cause of reading disability being deficits in phonemic awareness. These include studies of behavioral genetics, neurobiology, predictors of reading ability, reading-level match designs, and training studies (Wise, Olson, & Ring, 1997).

Most recently, children with phonemic awareness problems and delay in speech-language development have been called *Language Learning Impaired* (LLI). Deficits in temporal processing (Merzenich, Jenkins, Johnston, Schreiner, Miller, & Tallal, 1996), and deficits in speech discrimination (Tallal et al., 1996) are being suggested as an underlying imput timing-based speech reception deficit in LLI children. Since an impairment in oral language processing is now included as part of the definition of dyslexia, and since the Merzenich and Tallal studies reported significant gains in oral language processing, the question arises as to whether their procedures for remediating underlying timing-based speech reception deficits will also be effective in remediating dyslexia. They have not yet directly applied their procedures to phoneme-grapheme associations

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[1] During diagnostic consultations it is very common to have one or both parents indicate that their own academic experiences have included the same difficulties their child is experiencing. When certain diagnostic tests are demonstrated and their child's performance is described, they verify their awareness that they are also unable to make the judgements involved. They usually express regret, and sometimes even anger, that their own underlying problem was never identified and they have feared they were just less intelligent than other people.

and the remediation of dyslexia, so that question remains to be answered through further research.

Awareness of the segmental structure of words, as an oral language skill, is critically related to acquiring an understanding of alphabetic principle: how letters can be used to represent words on the printed page. In face, this relationship extends even beyond the printed page to the *textured* page: A study of Braille reading-spelling performance (P.D. Lindamood, 1981) showed phonemic awareness to be a stronger predictor of Braille word reading than these other factors combined: age, age at onset of blindness, first language, years of school, and amount of Braille reading instruction. This is further evidence that it is the apprehension of phonemes and not the symbols that represent them that present the challenge of one's sensory-cognitive system.

Although various studies have shown traditional phonics training to be effective in helping student to understand the alphabetic principle and develop independent word reading skills (Adams, 1990; Ball & Blachman, 1991), a common problem with many of the training procedures reported in the research is that they may not be powerful enough to aid students who are most at-risk for the development of reading difficulties.

For example, both Torgesen, Morgan, & Davis (1992) and Lundberg (1988) found that a significant number (20-30%) of the least able students were unable to profit from phonics training procedures. This is because typical phonics activities assume ability to say a word indicates ability to identify its individual sounds. In reality, studies indicate that 20 to 30% of the population lack adequate development of this sensory-cognitive function (Calfee et al., 1973; Shankweiler & Liberman, 1989). Although research shows this lack of phonological awareness to be a genetically transmitted tendency (DeFries et al., 1987), awareness can be developed through appropriate intervention (Alexander, Anderson, Heilman, Voeller, & Torgesen, 1991; Howard, 1986; P. C. Lindamood, 1985; Truch, 1994).

No reading method used over the years—phonics, sight words, guess from context, or variations of them—directly stimulated phonemic awareness. So we hypothesize that each approach succeeded with students who were genetically endowed with the tendency to perceive phonemes, in other words, those individuals who could grasp the logic of the alphabetic principle on their own simply through experience with print or through instruction in sound-symbol relationships. Those with the prerequisite sensory-cognitive tendency could learn to decode whether anyone taught them or not. And likewise, those who lacked the genetic tendency to easily perceive phonemes did not receive sufficient phonemic awareness stimulation in any of the reading approaches, even phonics approaches, and thus tended not to grasp the alphabetic principle whether they received instruction in it or not. Perhaps they made up the resistant group that failed in each reading method. Using this strand of logic, one would predict that if the same student could be taken back in time to each of the eras of reading instruction, he would be likely to fail in each type of instruction if he lacked phonemic awareness—or succeed in each (at least to acquire decoding) if he had it.

Educators are just beginning to understand that decoding requires phonemic awareness as a precursor. A danger here is that educators are hearing and seeing the term *phonemic awareness,* but are not understanding the difference between teaching interaction that elicits the development of phonemic awareness, and instruction that only attempts to exercise it through phonics activities.[2] We hypothesize that teaching every student to read requires more than simple combining all the types of reading approaches. Rather, oral language procedures for developing phonemic awareness must, we believe, precede or be included in any reading instruction.

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[2] There is a general impression that phonics *develops* phonemic awareness. If that were so, there would have been few or no students with decoding problems—no dyslexics—during the era when phonics was a standard part of reading instruction. But that was not the case. Or, if phonics *developed* phonemic awareness, we would not see individuals with severe decoding problems in spite of years of phonics instruction with various programs. But we do.

There is a need to delineate the difference between activities that require and exercise phonemic awareness and those that initially develop it. For example, you do not actually practice to develop your tennis serve. You practice to improve you tennis serve; you must have some form of a serve developed—basic moves to make, when and how—in order to have anything to practice. How you first stimulate the development of some form of serve is notably different from how you practice and refine it.

Consider the following activities: Do they require or develop phonemic awareness, or do they do neither? (1) Rhyming? (2) Counting the sounds in words? (3) Feeling and describing the articulation of sounds? (4) Drawing letters in the air and feeling sandpaper letters? (5) Decoding unfamiliar words? (6) Listening for the first or last sound in a word? (7) Marking whether a vowel is long or short? (8) Recognizing a target sound within a key word? (9) Finding pictures of things that start with a given sound? (10) Reciting the alphabet? (11) Inventing the spelling of a word? (12) Guessing what word would fit in context?

Number 3develops phonemic awareness. The letters do not produce the sounds. They only represent sounds which the mouth produces. The motor activity of the mouth produces. The motor activity of the mouth, coupled with voicing and unvoicing, is the primary source of information that can identify the physical reality of phonemes.

Some of the other activities can exercise phonemic awareness only if some awareness is already present, and some are not even relevant. Unfortunately, many individuals who author reading programs, and teachers who use the programs, think most of those activities are addressing the development of phonemic awareness. They don't understand that students with severely undeveloped phonemic awareness are neurophysiologically unable to respond to instructional activities in which requiring phonemic awareness precedes developing it.

Direct Development of Phonemic Awareness

Currently there are a number of approaches that purport to develop phonemic awareness and/or multisensory processing and its application to decoding. Ball & Blachman (1991), Erickson, Foster, Foster, Torgesen, & Packer (1992, 1993) particularly offer activities for kindergarten and first grade students in the very beginning stages of reading and spelling. The several multisensory remedial approaches based on Dr. Orton's work, Singerland, Spalding, Project Read, Alphabetic Phonics, Herman, Wilson, Sequential English Education, Starting Over, and the Shedd Method (McIntyre & Pickering, 1995) are targeted to a full range of ages from elementary to adult levels. All of these approaches focus students' attention from symbols to sounds.

A number of years ago we developed procedures which provide more direct stimulation of awareness of the oral-motor activity which is the primary source of phonemes, *Auditory Discrimination in Depth* (ADD; C. H. Lindamood & P. C. Lindamood, 1975). It specifically develops phonemic awareness and goes substantially beyond traditional phonics procedures in several ways. It is both more basic and more extensive. The outcome literature shows it as a very promising approach. We will include some information in depth about its features, as it appears to have potential for more far-reaching impact on more difficult to reach children and adults.[3]

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[3] The auditory discrimination in-depth approach does not begin with print, as do the phonics programs mentioned earlier which present individual graphemes and the sounds they represent as isolated, unrelated units. First, it draws on the sciences of linguistics and speech pathology, and develops awareness of the articulatory gestures that produce phonemes. This is in harmony with the motor theory of speech perception (Liberman & Mattingly, 1985). Students discover they can categorize and classify the 24 consonant sounds in 8 unvoiced/voiced pairs, plus 3 other groups, by place and manner of articulation. Mouth pictures are used to concretely represent the articulatory features of these 11 groups and their scientific categories are labeled in common language (i.e., the bilabial plosives /p,b/are lip poppers; the lingual alveolar plosives /t,d/are tip tappers; the labiodental fricatives /f,v/are lip coolers, etc.)

Students also discover that instead of identifying some vowels as "long" or "short" which seems very arbitrary because each vowel can be said in a sustained "long" way or a brief "short" way, the 15 vowel sounds can be categorized and classified in just 4 groups: by place and manner of articulation they can be labeled and processed as "smile," "open," "round," or "sliders." Second, the oral-motor feedback for consonants and vowels is used to track and verify the identity, number, and order of phonemes in syllables and words. By using mouth pictures and colored blocks for "phoneme tracking," a new dimension is brought to the development of phonological awareness as this concretized of phonemic awareness is used to explore and prove the structure of words ranging from single to multisyllable levels. Third, the processing competence developed in phoneme tracking is directly applied to thinking about and verifying the regular vs. irregular sound-letter relationships involved in encoding (spelling) and decoding (word attack and word recognition). As self-correcting becomes evident in single words, activities are extended into reading in context.

Socratic questioning to elicit the integration ofmultisensory information is critical at every step of this process because phonemic awareness cannot be explained to students. It must be elicited for students through problem-solving sensory experiences that give students ownership of the information. A Socratic

We hypothesize that it is vital to include in phonemic awareness stimulation the development of comparator function—the ability to integrate multisensory feedback and language, to analyze and constantly compute the match or mismatch between incoming sensory information and prior information—in order to promote independence and self-correction in application of the alphabetic principle in word attack, word recognition, contextual reading, and spelling. The comparator function factor receives very little attention in the literature, except in Powers (1973) as he delineates the hierarchy in feedback systems that lead from lower to higher levels of control and perception. Comparator function is the ability to use phonemic awareness—or any sensory-cognitive information—at the level of executive function to enable self-correction in spoken and written language.

Preventive Outcomes

In auditory discrimination in-depth preventive application, two classroom longitudinal studies show that the early advantage in reading skills gained by first graders is maintained into upper elementary and middle school grades. In a study with first graders (P. C. Lindamood, 1985), the experimental class received only the auditory discrimination in-depth approach during language arts instruction until January, when virtually all of the class could self-correct encoding and decoding errors in consonant/vowel/consonant (CVC) syllables and words. They were then phased into the district's basal reader curriculum, which had a phonics strand and a comprehension strand, starting in September. There was no significant difference between the classes in September pretesting. In the May posttesting, the experimental class receiving the auditory discrimination in-depth approach was superior to the control class ($p < .0001$) on four individually given measures: phonemic awareness, word recognition, word attack, and spelling (Figure 1).

This superiority was still present in a follow-up study in fifth grade. On the Stanford Achievement Test measures of Reading Comprehension, Word Study Skills, Spelling, and Total Reading, the mean percentile ranking

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questioning environment has two primary parts: (1) asking questions with choice and contrast, and (2) responding to the students' response. In "responding to the response" the teacher directs the student to compare their response to the stimulus (comparator function), meeting them at their level of sensory-language processing. For example, if a student decodes *claps* as *clasp,* the teacher questions:

T: "What do you feel last when you say 'clasp'?"

The student checks articulatory feedback and responds with the description label"

S: "Clasp….I feel a lip popper last."

Then the student's oral response is compared back to the written stimulus:

T: "Check if that's what you *see* last when you look at the word."

S: "No, the lip popper is next to last….just before a skinny air….so it has to say *claps*."

of the 19 remaining experimental students ranged from 63.6 to 81.7, and there was no overlap in percentile rankings with the 66 fifth graders who had not received the auditory discrimination in-depth approach. Their mean percentile rankings ranged from 39.4 to 56.5, and this population included the school's gifted students. Of particular interest in view of the typical resistant group who fail with any reading method: None of the experimental group had word identification, word attack, or spelling below third-grade level at the end of first grade. In the fifth-grade follow-up, still none scored below average in reading or spelling (Figure 2).

In an 11-year longitudinal study reported in a doctoral dissertation, Howard (1986) found that students who received the auditory discrimination in-depth training in first grade had higher reading scores in subsequent grades (second through eighth) ($p>.0001$) on the Reading subtest from the Iowa Tests of Basic Skills (ITBS) than students not receiving such training.

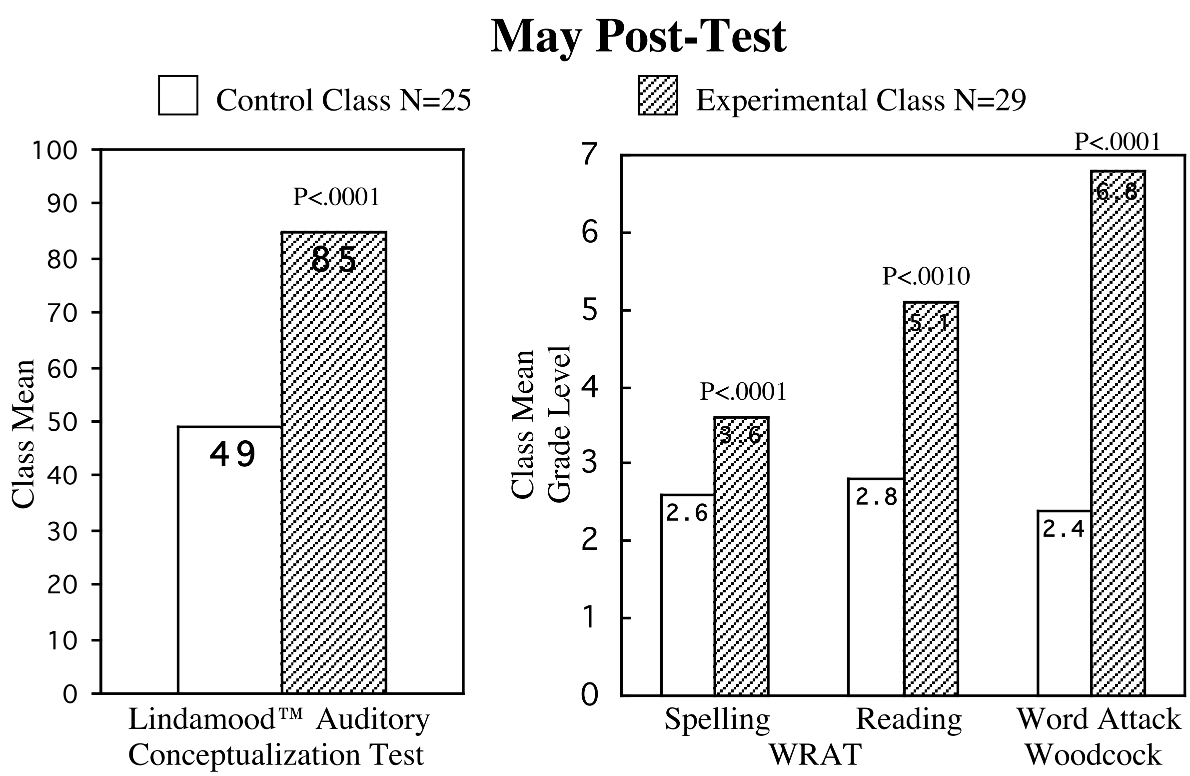


Figure 1. Effect in first grade of stimulating phonemic awareness and its application to reading and spelling.

This conclusion based on a chi-square analysis of 2,525 reading subtest scores from the ITBS for students who did not have auditory discrimination in-depth training in first grade and 888 reading subtest scores from the same tests for students who did have the training. In addition, boys and girls performed equally well after receiving this training (Figure 3).

Also, kindergarten children trained in auditory discrimination in-depth techniques entered first grade with higher word attack skills than students not receiving such training (Table 1).

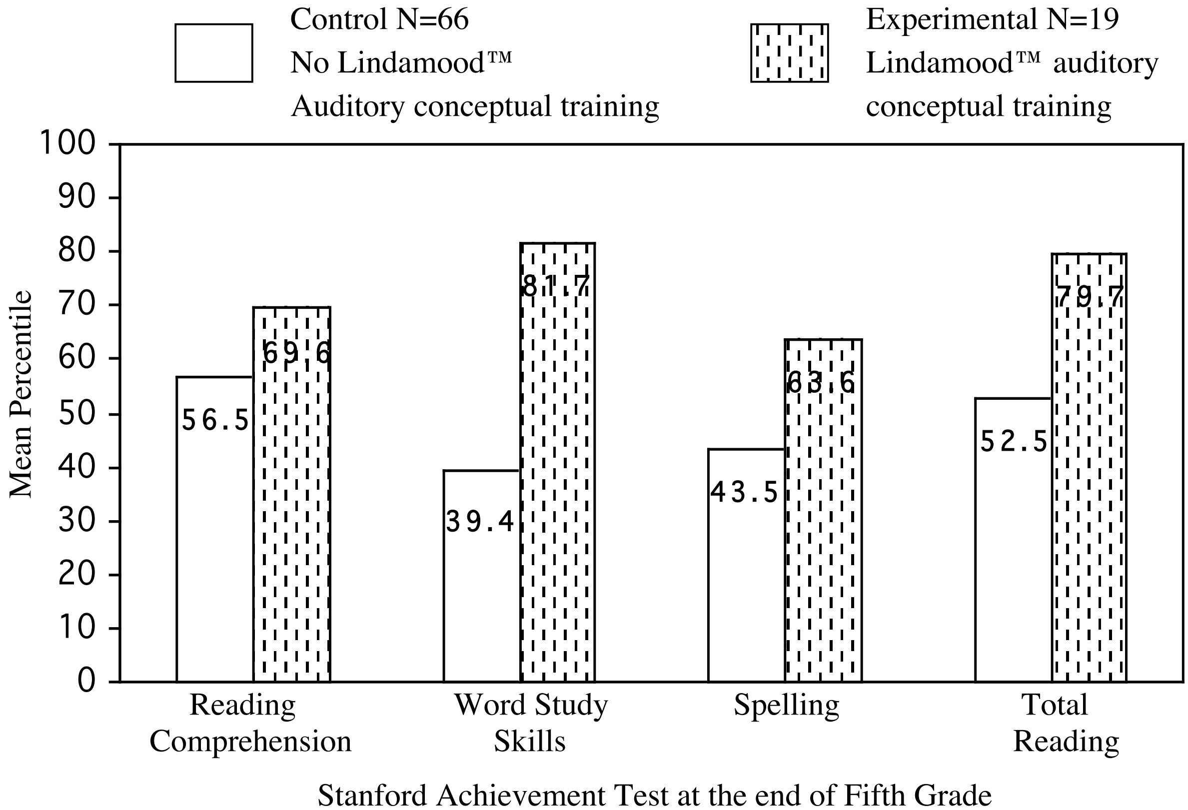


Figure 2. Longitudinal effect of stimulating phonemic awareness in first grade.

The National Institutes of Health is funding an ongoing longitudinal intervention study, in which statistical procedures were used to identify kindergarten students likely to be in the bottom 10% of readers by second grade. One of the goals was to determine the degree to which reading skills could be brought into a normal range for children who presented with severe phonological impairments at the beginning of the study. The 180 children in the final sample were randomly assigned to four instruction conditions, one of which was the auditory discrimination in-depth approach (called PASP in this study). All of the children received 80 minutes per week of one-on-one instruction during the 2 1/2-year intervention period, for a total of about 88 hours of supplemental instruction. Data from the final testing at the end of the intervention period indicate the children in the auditory discrimination

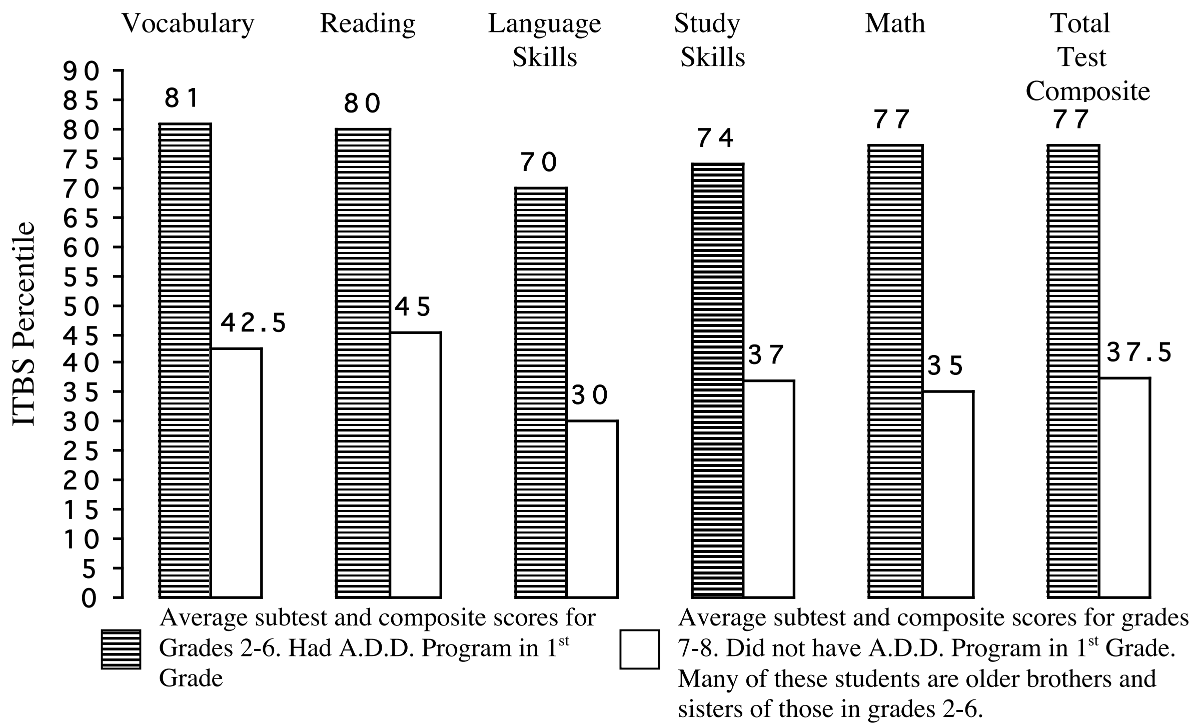


Figure 3. Subtest and composite scores on Iowa Tests of Basic Skills (ITBS) for students with and without phonemic awareness training.

Reprinted by permission. From M. P. Howard, *Phonemic awareness application in an elementary classroom,* presented at the Canadian Learning Disabilities Association Conference, November, 1995, Edmonton, Alberta, Canada.

in-depth approach (PASP) appear to have established a significantly stronger foundation in basic reading skills than children in the other groups.

They also showed the smallest retention rate (9%) in comparison to 25, 30, and 41% for the other groups. All of these children will now be followed without further intervention and will be retested at the end of third and fourth grades to determine whether their present foundation of reading skill sustains continued growth (Torgesen, in press). This long-term follow-up is the only way to determine the ultimate effectiveness of the intervention (Table 2).

Remedial Outcomes

Torgesen (in press) also reports on follow-up findings in a remedial study with 8- to 11-year-old children. Again, the question was whether intervention could bring reading skills into a normal range, this time with older students who had already been identified as learning disabled by the

Table 1

Pretest Means and Standard Deviations of the Relative Mastery Scores on the Word Attack Subtest of the Woodcock Reading Mastery Tests for First Grade Students Who Received No A.D.D. Program Training in Kindergarten (1974-1984) and First Grade Students Who Received A.D.D. Program Training in Kindergarten (1984-1985)

	Year	#	Pre/Word Attack	s.d.
No A.D.D. in K	74-75	20	51.14	2.80
	75-76	20	50.78	2.50
	77-78	24	53.46	2.27
	78-79	24	53.83	2.49
	79-80	26	52.22	2.29
	83-74	50	54.44	1.59
A.D.D. in K	84-85	23	81.9	2.43

Reprinted by permission. From M.P. Howard, *Effects of pre-reading training in auditory conceptualization on subsequent reading achievement*. Doctoral dissertaion, Bringham Young University, 1986.

public school system. These students were randomly assigned to auditory discrimination in-depth instruction or a whole language approach called *embedded phonics,* which gave implicit fill-in-the-gaps phonics along with a reading for content emphasis. The students received more instruction over a shorter period of time: 2-hour sessions, 5 days a week, for 8 weeks, for a total of about 80 hours, and then 1 hour a week for 8 weeks in their learning disability classroom to aid in transition and application of their new skills to classroom assignments. Complete 1-year follow-up data are available on 21 to 51 children. Reading skills for both groups had moved from substantially below average in reading accuracy to performance into the average range when intervention was stopped. The auditory discrimination in-depth approach group had the advantage, with only 9% more than one standard deviation below average in reading accuracy compared to 26% in the whole language approach. Figure 4 presents data illustrating the dramatic change occurring in the growth curve for these students as a result of intensive intervention. Equally important, it also shows *continuing growth* in the year after intervention was stopped, and again, students in the auditory

Table 2

Reading, Phonological Awareness, and Spelling Scores for All Groups at the End of Second Grade

Measure	*Group*							
	***Control* (N=32)**		***RCS* (N=37)**		***PASP* (N=33)**		***EP* (N=36)**	
	X	S.D	X	S.D	X	S.D	X	S.D
Blend Phonemes[a]	16.3	5.4	16.8	5.2	18.0	4.9	17.4	3.6
Phoneme Elision[b]	13.0	4.9	12.0	4.9	15.8	5.7*	11.9	4.5
Phoneme Segmentation[c]	7.1	3.2	7.3	3.3	9.2	3.8*	7.3	2.8
Word Attack[d]	81.6	17.1	86.7	19.4	99.4	16.8*	86.7	13.1
Word Identification[e]	86.3	17.8	92.0	15.5	98.2	17.9	92.1	14.5
Passage Comp.[f]	85.2	15.7	86.4	14.8	91.7	14.5	87.4	15.6
Word Efficiency[g]	16.6	15.2	29.4	16.6	36.4	17.1	30.8	9.7
Nonword Efficiency[h]	10.0	8.8	11.2	12.1	20.5	13.8*	11.7	9.7
Developmental Spell[i]	22.6	4.3	22.5	5.2	25.5	3.7*	22.6	5.6

*The overall comparison among groups was statistically significant, and the PASP group obtained significantly higher scores than children in the other groups.

[a]*Blending Phonemes Test*—a measure of phonological awareness that requires children to recognize words from separately presented phonemes (i.e.,/k/-/a/-/t/=cat).

[b]*Phoneme Elision*—a measure of phonological awareness that requires children to form a new word by deleting a specific sound from a target word (i.e. delete/d/ from card = car).

[c]*Phoneme Segmentation*—a measure of phonological awareness that requires children to pronounce the phonemes in words separately (i.e., cat=/k/-/a/-/t/).

[d]*Word Attack* subtest from the *Woodcock Reading Mastery Test—Revised* (Woodcock, 1987).

[e]*Word Identification* subtest from the *Woodcock Reading Mastery Test—Revised.*

[f]*Passage Comprehension* subtest from the *Woodcock Reading Mastery Test—Revised.*

[g]*Word Reading Efficiency*—a measure of fluency in word reading that requires children to read as many words as possible in 45 seconds from a word list that gradually increases in difficulty.

[h]*Nonword Reading Efficiency*—a measure of fluency in alphabetic reading that requires children to read as many nonwords as possible in 45 seconds from a list that increases from two phoneme nonwords to 10 phoneme words.

[I]*Developmental Spelling Test*—children were asked to spell the words *lap, sick, pretty, train,* and *elephant.* Responses were scored to indicate the phonological accuracy of the spelling.

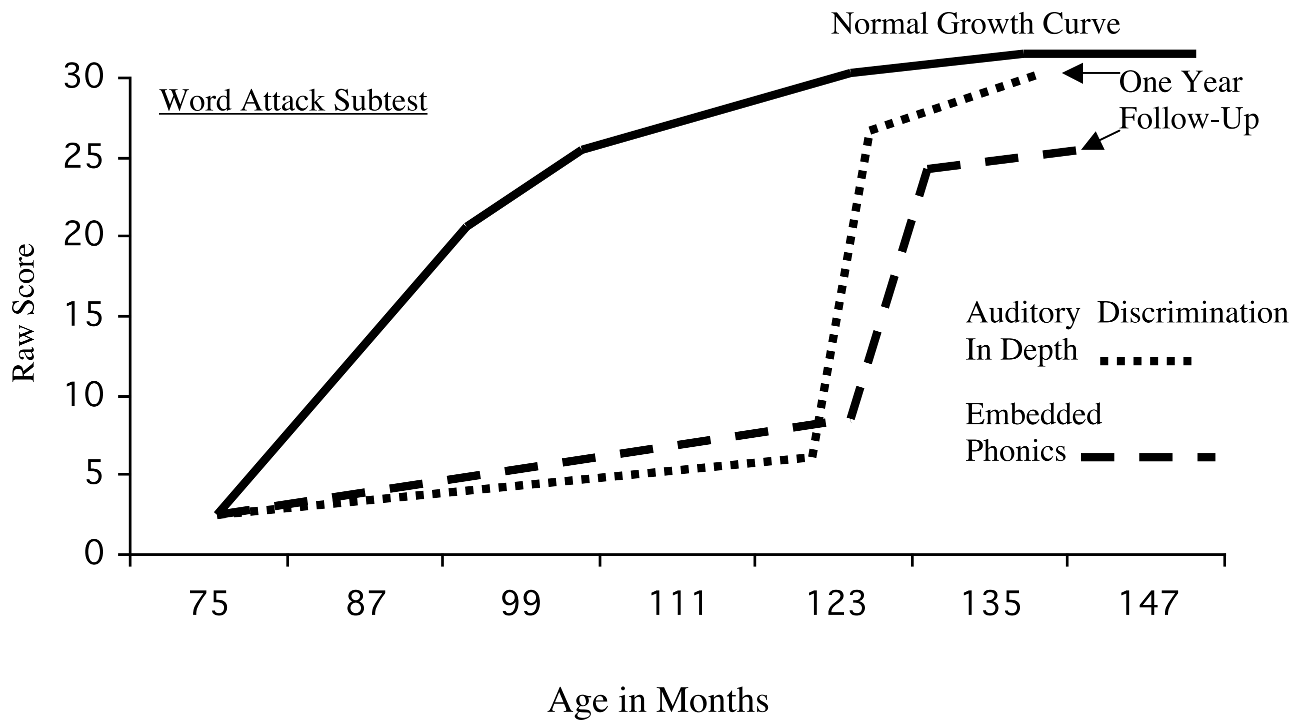
discrimination in-depth approach have the advantage.

Heilman, Voeller, and Alexander (1996) hypothesize that unawareness of articulatory action is related to motor programming or feedback deficits. If their hypothesis is correct, the auditory discrimination in-depth approach emphasis on identifying phonemes by *feeling* the oral-motor features that produce them may be the essential factor in the students' advantage through that approach.

In one recent study (Alexander et al., 1991), the auditory discrimination in-depth approach was used with a group of severely reading-disabled students averaging 10 years, 9 months old, who were reported as having significant amounts of previous unsuccessful intervention. After 65 hours of one-on-one training, this group of 10 students improved from an average standard score of 77 on a measure of alphabetic reading skills, to an average of 98.4 (standard score mean = 100). The poorest reader in the group improved from a score of 62 to 92, which placed him in the average range. This is noteworthy because it does not follow the typical "Matthew effect" (Stanovich, 1991) in which children who have the lowest incoming reading skills gain less and continue to fall further behind in most treatment studies. This group of students had begun treatment with an average score on a measure of phonological awareness of 57.9 (minimum score recommended for their age and grade = 86), and had improved to an average score of 99.9 (total score possible = 100) following treatment.

In a larger remedial study, with 281 individuals, school-age through adults, Truch (1994) also reported powerful effects with the auditory discrimination in-depth procedures. Results indicate 80 hours of intensive individual instruction produced highly significant gains ($p<.0001$) on measures of phonological awareness, sound-symbol connections, word identification, word attack, spelling, and decoding in context.

This research evidence presents a hopeful picture: that it may indeed be possible to teach all students to decode if we determine and address the precursor sensory-cognitive function of phonemic awareness. However, teaching every student to decode was never the ultimate goal of reading instruction; the larger goal of reading instruction is teaching every student to get meaning from print. Although currently phonemic awareness and decoding are commanding the spotlight in the field of reading, our clinical observations and preliminary research indicate that there is an additional and equally critical factor in reaching the larger goal of good reading comprehension.



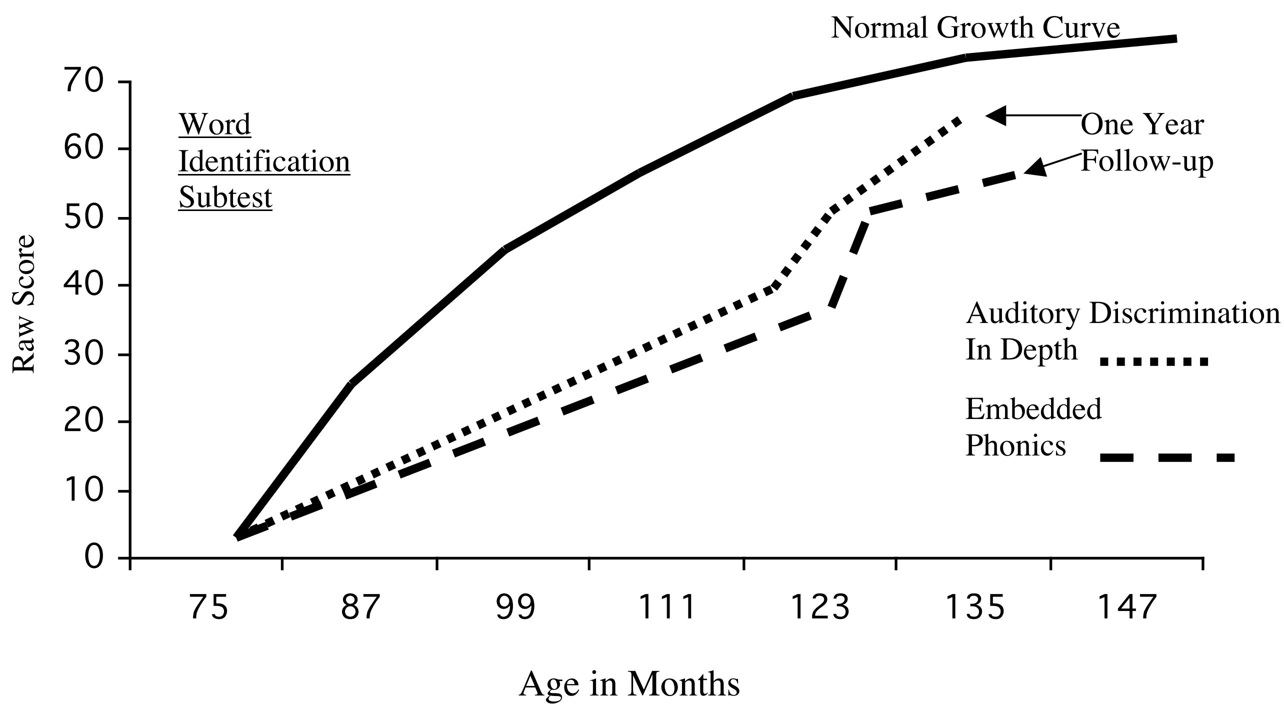


Figure 4. Change in raw scores, during, immediately after, and after 1 year, on the word attack and word identification subtests of the *Woodcock Reading Test—Revised,* following 80 hours of intensive intervention.

Reprinted by permission. From J.K. Torgesen, Instructional interventions for children with reading disabilities. In B. K. Shapiro, P. J. Accardo, & A. J. Capute (Eds.) *Dyslexia: Conceptualization, diagnosis and treatment.* Baltimore, MD, York, in press.

Accurate decoding is critical for reading comprehension but does not produce comprehension. Case studies of "hyperlexic" individuals show this in the extreme: Individuals with phenomenal decoding skills yet extremely weak comprehension. Teachers see less severe versions of this hyperlexic profile every day: Students who can decode but do not get the main idea, draw conclusions, and make inferences, and students who can spell, whose papers are mechanically good, but do not make a point.

A look at the various reading methods shows each making an assumption about the underlying sensory-cognitive basis for comprehension, just as was done with decoding. All of the methods have tended to assume ability to comprehend if vocabulary and decoding are adequate. It is our premise that there has always been a larger failure rate for reading instruction than reported, because those students who decode well, even if they miss the point of the content, can appear and be counted as successful readers. Their problem is at present receiving little attention as the war on how to teach reading rages, focused almost completely on decoding.

Imagery and Language Comprehension

Since worldwide research has finally identified phonemic awareness as the primary contributing factor to the development of decoding skills, many in the field are now calling for investigation of primary factors contributing to the desired result of decoding: adequate reading comprehension and interpretation (Bell, 1991a). Just as phonemic awareness cannot be assumed, language comprehension cannot be assumed, and seems to be diminishing as is noted in numerous recent studies.

For example, the National Assessment of Educational Progress (NAEP) findings have shown particular deficiencies in higher-order reasoning skills, including those necessary for advanced reading comprehension. "Reading instruction at all levels must be restructured to ensure that students learn to reason more effectively about what they have read," states the report, which showed such a drastic and "baffling" decline in the reading comprehension performance of 9- and 17-year-olds that the report was delayed for 5 months while researchers refigured the statistics and reexamined the test items. Dr. Jane Healy noted in 1990, "Despite a serious effort on the part of elementary and high schools to beef up the curriculum, students of all ability levels show virtually no gains in higher-order skills…..Tests which show that young children's scores are rising may simply be focusing on the 'lower level' skills of word reading while neglecting the real heart of the matter: How well do they understand what they have read? Can they reason—and talk, and write—about it?" (p.25). And this weakness in comprehension extends into higher levels, as the College Board recently noted, "Even among students who can *read,* verbal skills have declined on the Scholastic Aptitude Test (SAT)."

Studies of written language comprehension have linked it to listening comprehension, once decoding performance is high (Öney and Durgunoglu, 1997). However, important questions include: What predicts listening comprehension if it is linked to written language comprehension? What are the sensory-cognitive skills basic to both oral and written language comprehension? There is compelling evidence that one of the primary factors is *imagery.* Imagery as been linked to language processing and cognition, including critical thinking, creativity, and reading comprehension. There is very strong historical evidence discussed since Aristotle who stated that it is impossible even to think without a mental picture. Jean Piaget (1936, cited by Bleasdale, 1983) wrote that over time, schemata became internalized in the form of imaged thought. Proceeding chronologically to examine some of the more interesting research and historical commentary, Arnheim (1966) wrote that thinking is concerned with the objects and events of the world we know….that when the objects are not physically present, they are represented indirectly by what we remember and know about them. In what shape do memory and knowledge deliver the needed facts? They do so in the shape of memory images; experiences deposit images. Continuing in the sixties, Allan Paivio (1969), who has written extensively on imagery and cognition, stated, "As every psychologist knows, imagery once played a prominent role in the interpretation of associative meaning, mediation, and memory—or of concrete meaning at least" (p. 241).

Paivio (1971) had been attempting to demonstrate the way in which imagery can affect the acquisition, transformation, or retrieval of different classes of information. His Dual Coding Theory (DCT) for cognition defines imagery as one of two types of cognitive code. The other type is verbal code. Paivio suggested that linguistic competence and performance are based on a substrate of imager. Karl Pribram (1971) stated that all thinking has, in addition to sign and symbol manipulation, a holographic component. Also in the seventies, Kosslyn (1976) conducted a developmental study on the effects and role of imagery in retrieving information from long-term memory. He reported that imagery provided significantly more opportunity for retrieval. Linden and Wittrock (1981) stated, in a study with fourth graders, "the generation of verbal and imaginal relations or associations between the text and experience increased comprehension approximately by fifty percent" (p.55). Further research by Oliver (1982), in three experiments to determine if an instructional set for visual imagery would facilitate reading comprehension in elementary schoolchildren, concluded, "These findings indicate that teachers should try to help children develop the metacognitive skills of visual imagery as a strategy for improving comprehension…Visualization enhances comprehension" (p. 2). The research of Long, Winograd, & Bridge in 1989 provided further evidence regarding the role of imagery in reading:

> Our results suggest that imagery may be involved in the reading process in a number of ways. First, imagery may increase the capacity of working memory during reading by assimilating details and propositions into chunks which are carried along during reading. Second, imagery seems to be involved in making comparisons or analogies—that is, in matching schematic and textual information. Third, imagery seems to function as an organization tool for coding and storing meaning gained from the reading [p.370].

As is evident, theories and research regarding the relationship of imagery to thinking have been held and proven repeatedly throughout history. The nineties have produced further research to support the role of imagery in cognition and reading. "Imaginative processes, including imagery and emotional responses, are necessary to breathe life into the reading experience," Sadoski (1992, p. 111). Dr. Sadoski, in researching DCT, reading theory, and reading efficiency, noted that imagery is directly related to reading comprehension, reading recall, and verbal expression. He has validated Paivio's DCT in numerous studies involving imagery, comprehension, and recall by carefully providing that the more reading concepts are imaged the better they will be comprehended, the longer they will be recalled, and the more interesting they will be to the reader. Regarding DCT, Paivio (1994) stated that *cognition is proportional to the extent that language and mental representations (imagery) are integrated.*

The link between imagery and language comprehension has so long been cited and so heavily researched by cognition psychologists that it appears there is a tendency to assume that all individuals do image. However, through noninvasive brain research it has only recently been noted that some individuals do not spontaneously make images in association with language, and need direct stimulation of this function (Paivio, 1996).[4]

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[4] Our clinical observations and preliminary research indicate that a significant percent of children and adults may not form mental images for the language concepts presented with words, and in particular may not form an imaged gestalt—integrated, active, relevant images that capture the relationship of the parts to the whole. In fact there is a common expression that recognizes this: "If the sensory-cognitive skill of

Direct Development of Concept Imagery

Our clinical and classroom experience in remediating decoding problems for children and adults revealed that phonemic awareness and accurate decoding were only part of the picture. For some students the comprehension of oral and written language was the only issue, or was an additional issue. We discovered a dichotomy existed that we hadn't suspected: Students who had good comprehension made very detailed and vivid images for the concepts expressed by incoming language; those with poor comprehension had no images, or very vague and unconnected images, and consequently no gestalt for the concepts expressed.

To meet this need we developed an approach for building concept imagery called *Visualizing and Verbalizing for Language Comprehension and Thinking* (Bell, 1991b). As we then began to search the literature for more understanding of imagery, we found our clinical experiences were consistent with the theories about imagery and comprehension, but that just as with decoding and phonemic awareness, the underlying sensory-cognitive function tended to be assumed in directions to teachers for developing comprehension.

Dr. Paivio (1996) referred to the theory and steps of the visualizing-verbalizing approach as the methodology of DCT: imagery and language-visualizing and verbalizing. Again, a somewhat detailed description will be included of the specific visualizing-verbalizing procedures that have been found to be effective in developing concept imager. This is to illustrate how

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concept imagery is not available, then good decoding skills or good oral vocabulary skills may not generalize to good language comprehension or the ability to develop higher order thinking skills. Weakness in concept imagery means individuals may get only scattered parts, and often have to read and reread many times before they get the whole, if they get it at all.

Many of our adult students have told painful stories of the effect of only being able to get parts and not the whole of oral and written language communication. One young man described realizing far into the school year that certain of his fellow fraternity members invited him to social situations in order to laugh at his irrelevant contributions to conversation, and that he had spent much of his life laughing because other people were laughing but not understanding the joke. A middle-aged woman described that early in her marriage her husband withdrew from talking with her about his day because, "You always get everything so mixed up that telling you about it is harder than the day itself." A high school student said that, for him, it was as if someone was erasing the teacher's words as soon as they came out of her mouth. This student was maintaining C's and B's, but studying before school, after school, and weekends, and still scoring below his friends on tests. Because his reading and spelling and vocabulary were strong, several professionals evaluating his situation had concluded that he had no problem except perfectionism. Our testing revealed that his reading—recall without the support of multiple-choice format—was extremely weak at virtually every level of content in spite of fluent decoding.

much more basic the interaction must be in comparison to typical suggestions for developing students' comprehension.[5]

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[5] In the visualizing-verbalizing approach the integration of imagery and language move in a carefully sequenced series of steps beginning at the verbalization level. Students describe a given picture prior to describing an imaged picture, and use *Structure Words* such as *what, color, size, shape, movement, number, background, mood, when,* and *sound* to add detail to the verbalization. The questioning interaction between the student and teacher develops and refines sequential verbalization skills. As this is developing, the student is overlapped to verbalizing about one word—a *known noun.* Using the Structure Words to provide detailed imagery, the goal is to develop vivid imagery for the smallest unit of language—a word—prior to moving to the next step of imaging a sentence and then combining sentences to form an imaged gestalt. As imagery develops at the word level, the student is overlapped to the Sentence-by-Sentence step. Receiving a sentence and placing a *colored summary square* to anchor the sentence imagery, the student again uses the structure words to stimulate detailed imagery. Continuing to image and place *colored summary squares,* the student begins the integration of imagery with language by touching each colored square and give a *Picture Summary*, sequentially verbalizing the imagery designated by each square. After completion of the picture summary, where the student has been able to describe his or her imagery in detail, the colored squares are picked up and the student gives a *Word Summary*, paraphrasing the overall gestalt of the paragraph. Then as this imaged gestalt is developing, the stimulation is extended to the development of higher order thinking skills of main idea, conclusion, inference, prediction, and evaluation. For example, the student answers a main idea question by recalling what was mainly in the imagery for the paragraph. The steps extend from low to high level content and from Sentence-by-Sentence to Multiple Sentences, Paragraphs, and Pages of concepts and content—always with higher order thinking questions imaged and verbalized.

As with the auditory discrimination in-depth approach, Socratic questioning to elicit the integration of multisensory information is critical at every step of the visualizing-verbalizing process because ability to image cannot be *explained* to students. Imagery must be *elicited* for students through the Socratic questioning environment, again, (1) asking questions with choice and contrast, and (2) responding to the students' response. In "responding to the response" the teacher directs students to compare their response to the stimulus (comparator function), meeting them at their level of sensory/language processing. For example:

T: "What do these words make you picture? The spider climbs down plant stems into the water."

S: "I picture a spider climbing up a plant." (Since the student may be paraphrasing rather than imaging, the language and imagery are not matching, the Socratic questions begin.)

T: "It's good to picture a spider climbing on the plant. Tell me what you picture for the spider. Is it a big spider or a small spider? Is it black or brown or…?" (Questioning with choice and contrast.)

S: "It is a big spider, and it is black."

T: "Great. And, you said you saw it going *UP* the plant, Let's see if your picture matches the words about how the spider climbed the plant. The sentence said, "The spider climbs down plant stems into the water.'" (The interaction helps students compare their imagery-response to the langage-stimulus.)

As the visualizing-verbalizing instructional model is supported by DCT, the critical steps of the approach are likewise validated by Dr. Sadoski's research: (1) the use of Structure Words to add detailed imagery for enhancing the vividness of the mental representations concretized the imagery and language; (2) the use of the *colored summary squares* for each sentence serve as the "conceptual pegs" Paivio describes in DCT; and (3) the use of the Picture Summary for verbalizing of imagery enhances verbal recall for imagery prior to the Word Summary for paraphrasing or retelling.

Remedial Outcomes

Concept imagery stimulation has not been well studied, but a few studies have shown that it can be developed, with significant effect on oral and written language comprehension. The effectiveness of this type of sensory-cognitive stimulation has been evident from many years in the Lindamood-Bell™ clinical work in noting significant improvement in following oral directions, reading recall, and reading comprehension. Bell (1991a) reports that in 1989, 45 individuals received only the visualizing-verbalizing approach, ranging in age from 9 to 57, and including 22 males and 23 females. Although performing poorly in reading comprehension, their performance on other diagnostic tests indicated that receptive and expressive oral vocabulary were at the upper end of the normal range, as were phonemic awareness, word attack, and word recognition. After an average time of 47.26 hours, with a range of 16 to 110 hours, retesting indicated all had made significant improvement in reading comprehension. For example, the pretesting indicated a percentile mean for reading comprehension on the GORT-R of 43.94 and a post percentile mean of 75.55, showing a significance of $p<.001$. The percentile mean for 16 of 45 individuals, who ranged in age from 15 to 52 years old and were given the Descriptive Tests of Language Skills of the College Board, Reading Comprehension subtest, was 56.06 on the pretesting and 71.29 on the posttesting , with a significance of $p<.001$.

The Chance Program at Graceland College in Iowa used the visualizing-verbalizing approach in a 1988 study with 16 college students referred for reading comprehension problems. On the Descriptive Tests of Language Skills of the College Board, Reading Comprehensive subtest, the mean percentile ranking improved from 29.8 to 51.6, showing significance at $p<.05$. On the Nelson-Denny Reading Comprehension Test, the mean percentile ranking improved from 13.3 to 33.1, placing the students within the normal range of function and showing significance at $p<.001$.

In a Federal Projects study at Window Rock Elementary School on the Navajo Indian Reservation, Kimbrough (in preparation) studied the effects of the visualizing-verbalizing approach on language comprehension with a student selection where a stanine score of 3 below (5 is average) on the Iowa Tests of Basic Skills (ITBS), Reading comprehension subtest. The measured gains were based on National Curve Equivalent Scores (NCES) versus grade level equivalent scores. The Project students received the visualizing-verbalizing approach 30 minutes/day for 5 weeks, in small groups, for a total of 12 hours of intervention. The average gain in reading comprehension was 6.6 points on the NCES. The national average gain is 3 points. Kimbrough states, "In the past, my students have always averaged a gain of 2 to 3 NCES points. After doing the visualizing-verbalizing approach for 5 weeks, my students doubled their scores compared to the years past."

Truch (in preparation) reports using the visualizing-verbalizing approach with 66 subjects in 80 hours of instruction. Subjects were of different ages and ability levels. Overall, 60% were in the age-group 6 to 12; another 25% were from ages 13 to 17, and the remaining 15% were adults ages 18 and over. The average age was 21 years, with 37 males and 22 females. After 80 hours of the visualizing-verbalizing approach, the gains in comprehension scores on the GORT were highly significant, with an average gain of 4 years in reading comprehension. Word reading was not a factor in the weak reading comprehension and the influence of vocabulary as a covariate failed to reach statistical significance.

The effectiveness of the visualizing-verbalizing approach in a classroom setting was studied in a 1994 control-experimental study with fourth graders in a public school (Bell & Paivio, in preparation). Students were given individual standardized tests to measure expressive oral vocabulary, mathematics computation, word identification, following oral directions, verbal absurdities, phonemic awareness, passage decoding accuracy, passage decoding rate, passage decoding combining rate and accuracy, and passage comprehension. The control group had an N of 33 and the experimental group an N of 34. In general, the pretesting indicated both groups did not have strength in expressive oral vocabulary, with the experimental group being modestly higher than the control. Both groups were evenly matches in phonemic awareness and had adequate word identification and passage decoding accuracy, with modestly higher decoding for the experimental group. However, despite these slight differences, interestingly enough both groups performed statistically the same in reading comprehension, indicating that neither oral vocabulary nor word identification was highly predictive of performance in reading comprehension.

Over approximately a 4-month period, from late January to May, stimulation in the visualizing-verbalizing approach was given to groups for about 20 minutes, four to five times a week during the time allocated for content instruction in science. The posttesting indicated a significant increase in reading comprehension for the experimental group (p=.036)(Figure 5), and a higher performance is following oral directions (p=.0693) (Figure 6) that was very close to reaching a statistical level of significance. The interesting aspect of the study was that neither group demonstrated significant changes in expressive oral vocabulary, word identification (in fact the experimental group declined slightly in word identification and passage decoding accuracy), reading rate, phonemic awareness, and verbal absurdities. Statistical correlations were run to determine what could account for the gain in reading comprehension.

Analysis of Gain in Reading Comprehension on GORT-III

To determine if there was a significant difference in the GORT-III Reading Comprehension gains between the experimental and control groups, an analysis of covariance was performed. The covariance was the GORT-III prescores. The groups were coded with 0=experiemental group and 1=control group. The findings are shown in Table 3. Both the covariate (*p*-value=0.000) and the groups (*p*-value =.035) were significant. The best estimate of the difference between the experimental and control groups is a greater increase for the experimental group by 4.2 points (95% confidence interval=4.2+/-3.9).

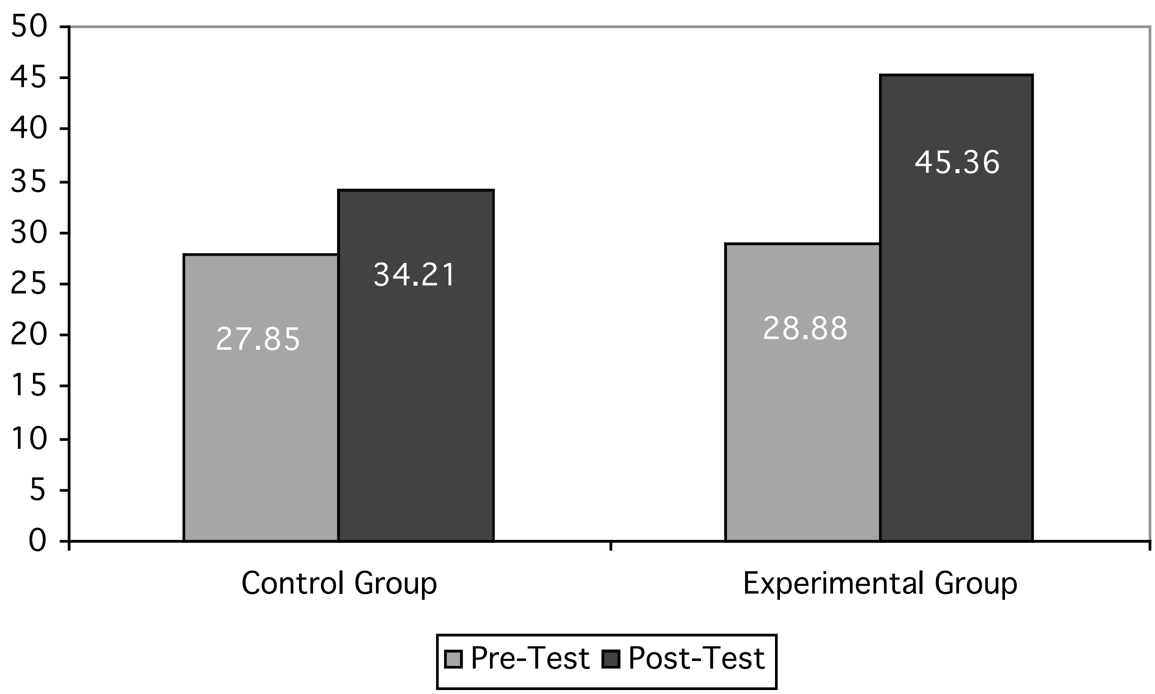

Figure 5. GORT-III Reading Test; Comprehension (%ile)

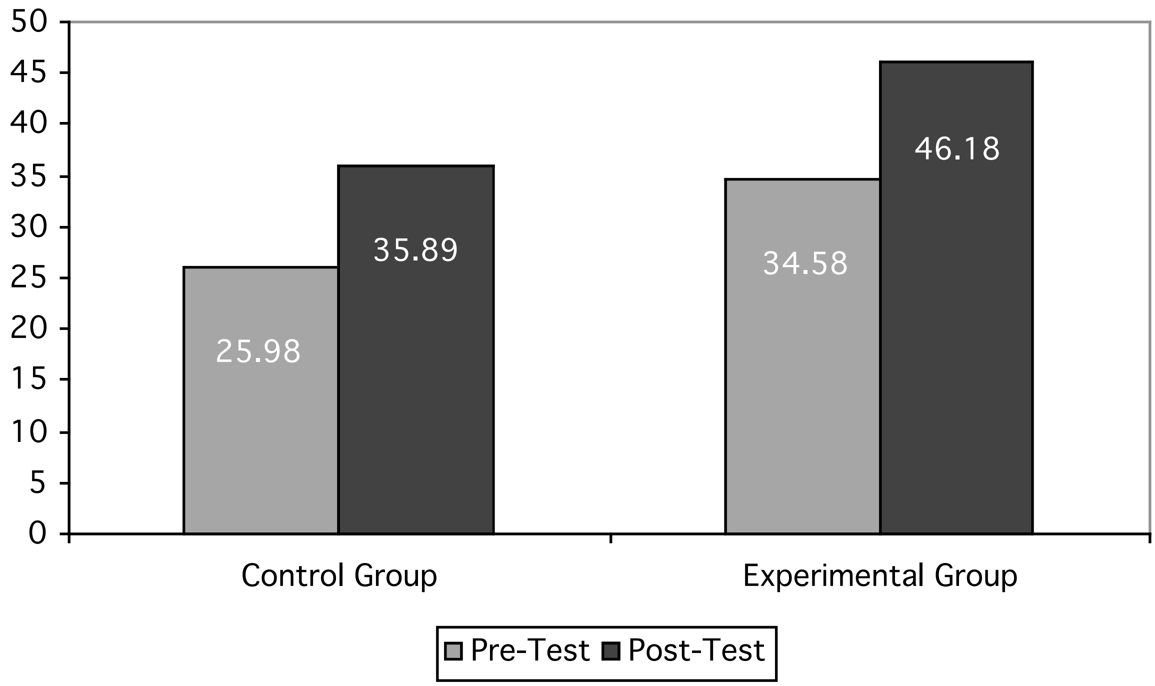

Figure 6. DTLA-II Oral Directions Test (%ile)

Correlations of Pretests to Reading Comprehension on GORT-III

Each of the other pretests were correlated with pretest GORT-Comprehension (raw scores). The results with the *p*-values that test for the significance of the correlations are contained in Table 4. Most correlations were highly significant.

Table 3
Analysis of Gain in Reading Comprehension on GORT-III

Predictor	Coef.	Std. Dev.	T-Ratio	P
Constant	14.037	2.198	6.39	0.000
Pretest/G	-0.3925	0.1017	-3.86	0.000
Group.2	-4.199	1.947	-2.16	0.035

Partial Correlations of Pretests without Word Opposites

Recognizing that the pretests were mutually correlated, the partial correlations of pretest GORT-Comprehension with each of the pretests other than DTLA/WO were obtained for raw scores on the DTLA/WO. The results with the p-values that test for the significance of the partial correlations are contained in Table 5. None of the partial correlations was significant.

Table 4
Correlations of Pretests to Reading Comprehension on GORT-III

Pretest	**Correlation**	**P-Value**
DTLA/WO	0.55	0.000
DTLA/VA	0.45	0.000
DTLA/OD	0.41	0.001
WRAT/Math	0.36	0.002
GORT/Acc	0.35	0.003
GORT/Pass	0.31	0.010
WRAT/Read	0.30	0.013
GORT/Rt	0.23	0.061

Table 5
Partial Correlations of Pretests without Word Opposites
Oral Vocabulary

Pretest	**Partial Correlation**	**P-Value**
DTLA/VA	0.15	0.230
DTLA/OD	0.20	0.105
WRAT/Math	0.18	0.139
GORT/Acc	0.12	0.326
GORT/Pass	0.06	0.633
WRAT/Read	0.09	0.449
GORT/Rt	0.002	0.987

Correlations of Gains in Reading Comprehension with All Tests

GORT-Comprehension gains were correlated with all the other gain scores. The results with the p-values that test for the significance of the correlations are contained in Table 6. None of the correlations were significant.

The above correlations indicate that the gains in reading comprehension could not be statistically accounted for by any changes in skills measured by the other tests used in the study. This is a highly interesting finding since it says that the statistically significant gains in reading comprehension came from something other than what was measured in the study—and the study did not include a quantifiable measure of imagery. Whereas there are tests of phonemic awareness available to correlate to gains in word attack, there are no tests of imagery to correlate to gains in reading comprehension. It seems probable that the stimulation of concept imagery with the visualizing-verbalizing approach was the "something other" that accounted for the gains in reading comprehension, since it was the only factor directly added to the situation between pre- and posttesting.

Table 6

Correlations of *Gains* in Reading Comprehension with All Tests

Gains	Correlation	P-Value
OD (RS)	0.40	0.529
Wrat Rdg	0.09	0.765
WO	0.32	0.574
VA	1.04	0.312
Math	1.01	0.319
Rate	1.19	0.279
Acc	0.14	0.710
Pass	1.12	0.294

The Need for Computer-Assisted Instruction in Phonemic Awareness and Concept Imagery

Children and adults with severe reading and comprehension disabilities seem to profit most from one-on-one tutorial interaction, but this is difficult to provide in classroom settings. If the auditory discrimination in-depth and visualizing-verbalizing approaches are used in classrooms, the concepts can be introduced by teachers to large and small groups. But the development of understanding and skill in applying these concepts for self-correction in reading-spelling and language comprehension is greatly facilitated by closely monitored problem-solving activities which include manipulative activities and carefully structured teacher interaction.

As stated by Greenspan and Bingerly (1997), "Children at every level of ability, from those lacking preparation for learning to the intellectually gifted, benefit from exploring, dissecting, classifying, arguing, and other emotionally engaging aspects of hands-on schooling" (p.222). What Greenspan is calling for are exactly the kinds of activities that are required in the auditory discrimination in-depth and visualizing-verbalizing approaches.

However, these are the kinds of instructional interaction in which teachers have the least training, and for which they have the least time allowed in most curricula, but which could make the most difference for the progress of their students. Software and technology may be the most appropriate way to meet this challenge for our education system.[6]

Summary

In the early days of education it was assumed that students coming to school had adequate vision and hearing. Over time it became evident that this was not necessarily the case, and it is now routine for schools to test the visual and auditory acuity of students so families can be advised if there are impairments that require attention. It was then assumed that if students had normal visual and auditory acuity it was their responsibility to learn the content provided by their teachers.

However, specific levels of sensory-cognitive *processing* are at least as critical to learning as specific levels of sensory *acuity*. The advent of sensory-cognitive measures has equipped us as educators to determine if students are *processing* sensory information consciously enough at the central level to be able to learn, think, and reason. Pribram (1991) clarified this cognitive aspect of perception when he observed that individuals cannot think about something of which they are not consciously aware, and cannot be aware of something not perceived sufficiently at the sensory level to come to consciousness.

All the brain can receive is information from the senses. How individuals can react to it at the central level—how consciously they can perceive incoming sensory information and label, classify, organize, and compare it—significantly affects whether they acquire new concepts and learn quickly and easily, or at an average rate, or slowly and with difficulty. Through interdisciplinary sharing educators can have access to new knowledge becoming available via research on brain plasticity and response to stimulation, and the *central* level multisensory processing that are vital to

[6] Field testing with appropriately designed software for the beginning stages of the auditory discrimination in-depth and the visualizing-verbalizing approaches shows virtually unlimited amounts of problem-solving activity can be supported which consistently provides the sensitive error correction procedures that develop comparator function and self-correction in these two areas. This enables these powerful instructional procedures to be readily accessible to many more students (both children and adults) while preserving the integrity of the instructional interaction. In preliminary research using the software to reinforce phonemic awareness and concept imagery in a remediation application, statistically significant gains were found for upper elementary students. The software is now being further developed and refined into adult levels of application, where there is just as much need as in beginning levels.

different learning tasks. This can help us understand how to provide the most relevant stimulation. Appropriate central processing cannot be assumed. Students will be independent, self-correcting learners to the extent that educators take the responsibility to identify, test for, and facilitate for each student the comparator function and central processing of sensory information so necessary to concept formation. Healy (1990) says this well when she dedicates her book to "Mother Nature and the gift—and responsibility—of neural plasticity."

It is time for the long-standing controversy to come to an end over whether to use a decoding, a sight word memorizing, or a language-context method for teaching reading. All of these elements are involved in the total process of reading. Each element needs attention at points in the continuum of reading instruction if the goal is independent readers who are able to decode accurately and fluently, the function at a critical thinking level in comprehending what they read.

Research is revealing the importance of stimulating the sensory-cognitive functions of phonemic awareness and concept imagery if we want to prevent reading disorders in the first place, and successfully remediate for children and adults who haven't had the advantage of such preventive action or the genetic gift of the functions. Procedures were described and findings presented that indicate a very encouraging picture in respect to the successful stimulation of these critical sensory-cognitive functions for the resistant group consistently seen in education up to now.

It appears that technology and software will be able to assist educators to maintain the integrity of the sensory-cognitive stimulation procedures needed. Software can also assist teachers to provide more sufficient amounts of the problem-solving experiences needed to build these functions, and can place an important part in bettering the development of literacy skills so sorely needed not only in our country, but internationally as well.

Several promising areas for further research have been indicated through our clinical experience. The possible contribution of phonemic awareness and concept imagery needs to be studied in formal research in the areas of organic disorders such as deafness and hearing impairments, cerebral palsy, cleft palate, and apraxia, as well as strokes, aneurysms, and traumatic brain injury. Much to our surprise, we have observed degrees of improvement that we wouldn't have expected for the limited numbers of such clients that we have served. It appears that lack of conscious awareness of sensory feedback and its conscious integration with language, as needed for phonemic awareness and concept imagery, may have more effect on impaired speech or language within these conditions than the organic condition itself. Areas such as developmental delay, high level autism, resistant cases of functional articulation disorder, and the acquisition of a second language also appear to be fruitful areas for further research.

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