# Phonological Awareness Training and Remediation of Analytic Decoding Deficits in a Group of Severe Dyslexics

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*The goal of the present study was to evaluate the effectiveness of the Auditory Discrimination in Depth Program (ADD) in remediating the analytic decoding deficits of a group of severe dyslexics. A group of ten severely dyslexic students ranging in age from 93 to 154 months were treated in a clinic setting for 38 to 124 hours (average of 65 hours). Pre- and post-treatment testing was done with the Woodcock Reading Mastery Test and the Lindamood Auditory Conceptualization to assess changes in phonological awareness and analytic decoding*

Annals of Dyslexia, Vol. 41, 1991.

ISSN 0736–9387

*skills. Results revealed statistically significant gains in phonological awareness and analytic decoding skills.*

Although the concept of developmental dyslexia, or specific reading disability, continues to be a focus of controversy (Coles 1987), there is an emerging consensus on at least two conclusions about the disorder. First, most would accept the idea that there may be a number of different causes for specific reading disabilities. Second, there is wide agreement that the greatest reading problem for dyslexic children involves difficulty acquiring accurate and fluent word identification skills (Stanovich 1982; 1988). Most dyslexic children have great difficulty learning to apply the "alphabetic principle" to take advantage of grapheme-phoneme regularities in reading unfamiliar words. They are often unable to attain fully alphabetic (Frith 1985) reading skills. Not only does this problem limit their ability to read independently, but it may also prevent subsequent development of more sophisticated orthographic word reading strategies (Frith 1985).

An interesting case study of a child with this type of reading disorder was recently presented by Snowling and Hulme (1989). When originally tested at the age of 8 years, 5 months, JM had a WISC-R IQ of 123, but only reached the 7-year level on the Neal Analysis of Reading Ability. Further study of his reading skills showed that his sight vocabulary was equivalent to that of a group of 7-year-olds with normal reading skills, but his ability to pronounce nonwords was seriously impaired in comparison with them. He had essentially no skills in arriving at word pronunciation through an analysis of phonological structure as represented by letters. Following this intitial testing, JM was placed in a residential school that specialized in teaching dyslexic children. The educational program was multisensory and emphasized training in grapheme-phoneme correspondences, use of English spelling patterns and conventions, and other content designed to promote alphabetic reading skills.

After 45 months of training, at the age of 12 years, JM's reading skills were reexamined. His word reading accuracy had increased between 26 and 31 months, while his comprehension scores had improved by 53 months. Almost all of the improvement in reading accuracy occurred because of growth in his sight vocabulary. For example, when compared with a group of 10-year-olds who had a similar overall reading level, he read familiar words almost as well. However, on a set of single-syllable nonwords that the normal readers read with 91 percent accuracy, JM attained a score of only 26 percent. In fact, his reading skills for nonwords were still one standard deviation below that of the normal 7-year-olds to whom he had been compared earlier!

The most widely accepted current explanation for the difficulties



dyslexic children experience in attaining alphabetic reading skills involves a dysfunction "in the phonological component of their natural capacity for language" (Liberman, Shankweiler, and Liberman 1989, p. 1). This difficulty in processing the phonological features of language can be shown on a variety of non-reading tasks that assess either: 1) awareness of the phonological structure of words; 2) ability to represent phonological information in memory; or, 3) subtle speech perception and production skills (Wagner and Torgesen 1987). Either singly or together, these processing deficits are frequently associated with reading difficulties similar to those described in the case study in that they are especially difficult to remediate.

For example, a recent follow-up study of children with severe phonological representation problems showed that these children made almost no progress over a ten-year span in improving their analytic decoding skills (Torgesen in press). These children had received regular instruction in a program for learning-disabled children, and their math skills had reached high school levels. In a study of different subtypes of reading-disabled children, Lyon (1985) found that two subgroups with phonological processing disabilities were among those who made almost no reading progress in a program that involved explicit instruction in phonic strategies for reading.

More recently, Lovett, Benson, and Olds (in press) reported a study in which dyslexic children were randomly assigned to one of three treatment conditions providing training in word recognition and decoding skills, oral and written language, or classroom survival skills. The word recognition and decoding program produced the greatest treatment gains. However, Lovett, Benson, and Olds observed that their subjects improved due to a greater reliance on a whole word reading approach rather than on a phonological decoding approach. These authors suggested that dyslexic children may be incapable of acquiring effective phonological decoding skills. Other programs which have reported effective intervention with heterogeneous samples of reading-disabled children (Ogden, Hindman, and Turner 1989), report much less success with older children who are more severely impaired.

Although it is clear that dyslexic children with phonological processing difficulties can make significant progress in reading through the development of their sight vocabularies and comprehension skills, helping them to acquire better alphabetic reading skills remains a desirable educational goal. Alphabetic reading skills take advantage of the generative qualities of English orthography, and they open to the reader important clues to word identity so that tens of thousands of words can be read independently (Liberman 1987). One important new intervention technique to improve the alphabetic reading skills of dyslexic children is suggested by research on their phonological process-

ing deficits. Specifically, this research has investigated phonological awareness as it relates to the acquisition of early reading skills.

Phonological awareness can be defined as one's sensitivity to, or explicit awareness of, the phonological structure of words in one's language (Liberman, Shankweiler, and Liberman 1989). It can be conceptualized as a kind of understanding or awareness that allows children to see the connections between written and oral language. There are large individual differences in phonological awareness among young children, and children with reading disabilities continue to show difficulties in this area even at older ages (Bradley and Bryant 1978; Gough and Tunmer 1986). Not only is performance on phonological awareness tasks in kindergarten predictive of later reading difficulties (Lundberg, Olofsson and Wall 1980; Stanovich, Cunningham, and Feeman 1984), but also there is beginning evidence that early training in phonological awareness may facilitate the acquisition of word reading ability in young children (Bradley and Bryant 1985; Lundberg, Frost, and Peterson 1988).

These latter studies raise the possibility that phonological awareness training may also be a useful part of educational interventions for many dyslexic children. In fact, one early study (Williams 1980) did show that the analytic decoding skills of learning-disabled children in first grade could be improved significantly by a program of phonics instruction that contained explicit training in phonological awareness. However, this study did not continue long enough to test the limits of awareness training with these children, nor did it focus specifically on reading-disabled children with phonological processing problems. The purpose of the present paper is to report a clinical training study that applied in-depth training in phonological awareness as part of a program to remediate the alphabetic reading deficiencies of a group of older dyslexic children. Although this study did not employ a control group design, the magnitude and consistency of the treatment effects, in light of earlier reported training difficulties in this area, allow us to conclude that the training method employed has substantial promise for dyslexic children.

## Method

### Subjects

The subjects were ten Caucasian children selected from a larger clinic population on the basis of discrepancies between their general intelligence and their word reading and phonological awareness skills. The children came from homes in the middle to upper-middle SES range, were attending private schools or receiving special reading help in the public schools at the time of referral, and all attained a Full



Scale Intelligence score above 85. Their average age was 129 months, with a range from 93 to 154, and they were equally divided by sex. Their phonological awareness skills were assessed with the Lindamood Auditory Conceptualization Test (LAC) (Lindamood and Lindamood 1979), which tests awareness of individual phonemes in words as well as the ability to manipulate the phonemes in various ways. Standard scores are not available for this test, as the distribution of scores is bimodal at the age of our subjects. All subjects in our sample attained scores on the LAC that were substantially below the level expected for children of their age and IQ. Furthermore, nine of the ten displayed a discrepancy of at least 1.5 SD between their full scale IQ and their scores on the Word Identification subtest of the Woodcock Reading Mastery Test (Woodcock 1973). One of the lower IQ subjects did not have a discrepancy this large, but had a Word Identification score more than 2 SD below that expected for her age. Although two subjects had previously been treated with Ritalin, none was receiving pharmacological treatment at the time of the study. Descriptive characteristics for each subject are provided in Table I.

### Procedure

The pretest measures included the LAC, and the Word Identification and Word Attack subtests from the Woodcock Reading Mastery Test (Woodcock 1973). The word analysis test requires children to read a series of increasingly difficult phonologically regular nonwords, and provides a sensitive measure of alphabetic reading skills (Frith 1985). Following administration of the pretests, all children were provided training with the Auditory Discrimination in Depth (ADD) program developed by Charles and Patricia Lindamood (Lindamood and Lindamood 1975). The training was provided in one hour sessions four

Table I
Characteristics of Individual Children in Treatment Group

| Subject | Age (mos) | Sex | FS IQ | Parent Education/Occupation |
|---|---|---|---|---|
| 1 | 144 | M | 101 | M-Master's, F-some college |
| 2 | 142 | F | 126 | M & F College Degree |
| 3 | 130 | M | 89 | M & F College Degree |
| 4 | 154 | F | 105 | M-teacher, F-1 yr. college |
| 5 | 145 | F | 86 | M & F Teachers |
| 6 | 93 | M | 96 | M-Ph.D. Cand., F-B.A. deg. |
| 7 | 132 | F | 108 | M-R.N., F-M.D. |
| 8 | 107 | M | 115 | M-R.N., F-M.D. |
| 9 | 103 | M | 133 | M-Nurse Anesth., F-M.D. |
| 10 | 136 | F | 108 | M-1 yr. college, F-B.A. deg |

times a week for seven subjects; and intensively (four hours per day for six weeks) for three of the subjects. The training was provided in the school setting for three subjects and at the Morris Center for seven of the subjects. Number of hours training varied between 38 and 124, with an average of 64 hours. Training was concluded when the child had finished all levels of the program.

**Description of Training Program**

The Auditory Discrimination in Depth (ADD) Program is a highly structured, scripted program that develops oral and phonological awareness. It was used as outlined in the manual. All students followed the same training sequence. The training sequence included oral and phonological awareness training and generalization of the training to spelling and reading.

Subjects were first trained in oral awareness. The ADD Program uses a multisensory approach to learning. The auditory elements of speech sounds are not separated from the more basic oral motor activity that produces them. The subjects learned to use sensory information from the ear, eye and mouth to identify, classify, and label sounds. For example, 16 individual speech sounds, or phonemes (/p/, /b/, /t/, /d/, /k/, /g/, /f/, /v/, /th/, /*th*/, /s/, /z/, /sh/, /zh/, /ch/, /j/), were categorized into eight voiced/unvoiced pairs or cognates. The pairs were labeled according to their distinctive oral motor characteristics. The students discovered, by observing their mouth movements in a mirror, that /p/ and /b/ are made by closing the lips and then allowing the air to explode or "pop out" of the mouth. The label "lip popper" was chosen to describe the salient oral motor characteristics of the bilabial plosives. The /p/ was identified as the quiet (unvoiced) lip popper.

After discovering, describing, and labeling the oral motor characteristics of 39 speech sounds, the student selected a mouth form picture that pictorially represented each speech sound. Criterion for completion of oral awareness training was 100 percent accuracy on the check out task requiring the student to describe the oral motor characteristics, and identify the label and mouth form picture for each speech sound.

A basic assumption of the ADD program is that using sensory feedback from the eye, ear, and mouth in identifying, classifying, and labeling the consonant and vowel sounds leads to a deeper perception of the sounds. Each sound emerges as a distinct entity because the nature of its contrast to other sounds is experienced consciously. The labels which describe the salient motor characteristics of the speech sounds facilitate the development of metalinguistic ability. After establishing consci[illegible] awareness of the distinctive oral motor characteristics of speech sounds, the task of associating the sounds with their corresponding alphabet symbols was introduced.



Following oral awareness and sound/symbol association training, all subjects received phonological awareness training. Phonological awareness training provided experience at a level prior to where most phonics or reading programs begin. Tracking sounds via a concrete medium is one of the keys to the ADD Program. In a series of problem-solving exercises, the students used mouth form pictures and then colored blocks to represent speech sounds. By arranging and manipulating pictures or blocks (encoding), the students indicated the number, order, and sameness or difference of sounds they felt/heard.

Figure 1 provides examples of the problem types presented during this phase. As in the example, the sounds were first presented as isolated units. In the next phase, the subjects were taught to represent the sequences of sounds when they were pronounced as a single syllable. As students gained experience in tracking and representing sequences of speech sounds with a concrete medium (pictures and blocks), the skill was generalized to representing sequences of speech sounds with letter symbols. Students practiced spelling and reading phonetically regular pseudowords of increasing complexity. As reading and spelling pseudowords stabilized, real words were introduced and phonics rules were explored.

## Results

The dependent variables that were used to assess effects of the training procedures were scores on the LAC, and Word Identification and Word Attack scores from the Woodcock Reading Mastery Test. Pre- and posttest scores on each of these measures, as well as number of hours of training for each subject, are reported in Table II.

A score of 100 on the LAC is a perfect score. All the children improved substantially in their performance on the LAC, and all but one attained a perfect score at the conclusion of treatment. Both the size and consistency of these effects allow us to conclude that the ADD program provided very effective instruction in phonological awareness for the subjects in this sample.

In terms of its effects on reading, the program produced significant gains on both measures. Not only were the changes significant for the group as a whole (Word Identification, $t(9) = 7.5$, $p < .001$, Word Attack, $t(9) = 5.4$, $p < .001$), but they were very consis[illegible]t across subjects. Furthermore, performance on the Word Attack s[illegible]t was "normalized" in the sense that the achievement of all subjects was now in

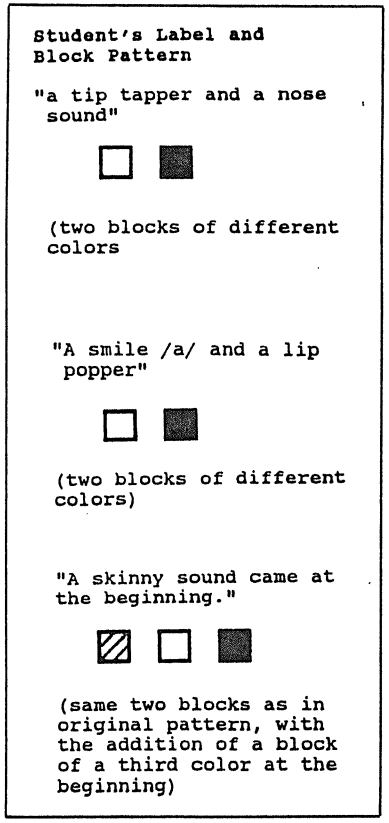


*Figure 1. Examples of problem solving exercises using colored tiles to represent sounds (Lindamood and Lindamood, 1975, pp. 9 and 10).*

the average range. Only two subjects failed to improve their performance substantially on both reading tests. These were highly intelligent students who had been included in the sample because of a discrepancy between their Full Scale IQ and their reading scores, but who had been reading in the average range prior to treatment.

The normalization of scores on the Word Attack subtest suggests that, at the conclusion of treatment, the children had available to them a powerful new strategy for reading words. In order to examine possible changes in their reading strategies between the pre- and posttests, we examined the kinds of errors they made on the Word Identification subtest. We borrowed an error analysis scheme from Snowling, Stackhouse, and Rack (1986) that is designed to elucidate movement from a logographic, or whole word/visual reading strategy, to a more alphabetic one. We classed errors in four categories: 1) logographic—error shares more than 50 percent of its letters with its target, and is always a



Table II
Performance on Phonological Awareness and Reading Measures

| Subject | Hours of Treatment | LAC Pre | LAC Post | Word Ident Pre | Word Ident Post | Word Attack Pre | Word Attack Post |
|---|---|---|---|---|---|---|---|
| 1 | 57 | 70 | 100 | 75 | 85 | 63 | 97 |
| 2 | 47 | 88 | 100 | 78 | 85 | 80 | 97 |
| 3 | 124 | 58 | 100 | 60 | 78 | 68 | 99 |
| 4 | 84 | 33 | 100 | 57 | 65 | 83 | 103 |
| 5 | 57 | 45 | 100 | 68 | 85 | 62 | 92 |
| 6 | 78 | 31 | 100 | 74 | 86 | 83 | 98 |
| 7 | 47 | 63 | 99 | 80 | 98 | 72 | 96 |
| 8 | 67 | 51 | 100 | 90 | 99 | 97 | 99 |
| 9 | 38 | 64 | 100 | 96 | 102 | 99 | 100 |
| 10 | 53 | 76 | 100 | 73 | 93 | 70 | 103 |
| Mean | 65.2 | 57.9 | 99.9 | 75.1 | 87.6 | 77.7 | 98.4 |

real word (e.g., pint/paint, lettuce/letter); 2) lexical-sounding—error shares less than 50 percent of letters with target, is always a real word, thought to reflect partial use of grapheme-phoneme skills (e.g., hatch/ham, sausage/salt); 3) unsuccessful sound attempts—errors reflect greater dependence on alphabetic strategy, are always nonwords, but share significant phonological elements with target word (e.g., urgent/urgruent, prudent/purden); 4) alphabetic—acceptable phonic readings of irregular words (e.g., said/sade).

Unfortunately, pretest errors were available for only seven of the subjects, as three had been pretested in another clinic and actual responses were not available. Table III presents a categorization of all sub-

Table III
Types of Errors Made on the Word Identification Subtest

| Subject | Logographic Pre | Logographic Post | Lexical-Sound Pre | Lexical-Sound Post | USA Pre | USA Post | Alphabetic Pre | Alphabetic Post |
|---|---|---|---|---|---|---|---|---|
| 1 | 4 | 2 | 2 | 0 | 1 | 4 | 0 | 2 |
| 2 | 6 | 2 | 1 | 0 | 4 | 6 | 0 | 1 |
| 3 | 7 | 0 | 5 | 0 | 1 | 8 | 0 | 3 |
| 4 | – | 1 | – | 1 | – | 19 | – | 1 |
| 5 | 3 | 2 | 2 | 0 | 3 | 4 | 0 | 2 |
| 6 | – | 1 | – | 0 | – | 10 | – | 0 |
| 7 | 6 | 5 | 0 | 0 | 5 | 3 | 0 | 0 |
| 8 | – | 2 | – | 0 | – | 2 | – | 0 |
| 9 | 9 | 5 | 3 | 0 | 4 | 6 | 0 | 0 |
| 10 | 5 | 3 | 3 | 0 | 4 | 3 | 0 | 1 |

jects' posttest errors as well as pretest errors made by the seven subjects for whom complete data were available.

For purposes of analysis, the two categories reflecting primarily a logographic strategy were combined, as were the two categories reflecting a greater reliance on alphabetic strategies. Furthermore, analysis was restricted to the seven subjects for whom complete data were available. At pretest, 72 percent of the errors were logographic, while at posttest, only 30 percent were. This represents a significant, $X2 = 23.5$, $p < .001$, change in the type of error, and it suggests that the subjects had a greater tendency to use an alphabetic strategy at the posttest than at the pretest.

## Discussion

The purpose of this study was to assess the effects of extensive training in phonological awareness as part of an intervention program for older dyslexic children with word identification difficulties. All of the children in the sample also showed either moderate or severe performance problems on a pretest of phonological awareness. The results of the study provide at least three sources of evidence about the effectiveness of the program.

First, the program was clearly effective in dramatically altering the level of phonological awareness of all the children in the study. All subjects received perfect, or near perfect, scores on the LAC at posttest. Because of the ceiling effect represented by these perfect scores, we cannot conclude that the awareness skills of the children in our sample were fully equivalent to those of their age peers. However, evidence from previous research with the LAC (Lindamood and Lindamood 1979) suggests that, at the conclusion of training, the trained students had a level of awareness that could no longer be considered a limiting factor in their acquisition of alphabetic reading skills.

A second source of evidence about the effectiveness of the ADD program is found in the posttest standard scores on the Word Attack subtest. Not only was there an improvement of more than 1⅓ standard deviations in standard score from pre- to posttest, but also the final scores were clearly in the normal range for children of this age. These results are very different from other studies cited in the introduction that have followed the progress of dyslexic children through intervention programs designed to increase their alphabetic reading skills.

Finally, there was convincing evidence that students in the study generalized their newly acquired alphabetic reading skills to a test in which they were required to read real words accurately. Although the students were still [illegible]uently unsuccessful in applying these skills to



difficult words, they did show evidence of trying to apply new, and potentially more productive, strategies to the task. If these strategies are applied in other reading situations, they should provide the children a much broader range of independent reading skills than they previously possessed.

As in any clinical training study of this type, our results are clearly limited in important ways. First, this initial investigation needs to be followed up with a more extensive study using a control group design. We are currently planning, and seeking funding, for such a study.

Second, the ADD program is very complex, so that it is not clear which of its many elements was most important in producing the training effects we obtained. It is our clinical impression that the early phases of training, in which the ADD is unique from most other phonological awareness training programs, were very helpful for the severely impaired childen in this study. Many of the children had little sensitivity to the kinesthetic cues associated with the production of different phonemes, and the names that were assigned to phoneme groups helped to make these distinctive articulatory features concrete. These names also made it easier to discuss student errors on the various exercises (encoding, decoding). Subsequent investigations may demonstrate that the early phases of training are necessary only for more severely impaired children. Certainly, a number of programs without these features have successfully improved the level of phonological awareness in samples of younger children (Bradley and Bryant 1985; Ball and Blachman 1988; Lundberg, Frost, and Peterson 1988). However, all of these studies have reported only average effects on performance, so that it is not clear if these overall average improvements are masking the failure of some children to improve at all. One recent study that did report individual effects (Torgesen and Morgan 1990) indicated that, although average training effects were significant, 30 percent of a sample of kindergarten children did not profit from the phonological awareness training at all. Perhaps these children are the type that might profit from the more extensive training activities that make up the early phases of the ADD program.

Finally, this study leaves unanswered many important questions about the ultimate reading outcomes for children in the study. Although the alphabetic reading skills of our sample were normalized in terms of accuracy, we did not measure fluency of word identification processes. It is likely that our students had not attained fully automatic, or fluent use of these skills in their reading. Thus, their rate of decoding individual words was probably slower than their age peers. Given other data reported for children with phonological pro[illegible]sing problems (Torgesen et al. 1987), it is possible that these dyslex[illegible]ldren will be unable to attain normal levels of fluency, even with extensive prac-

tice of their skills. However, it is also true that few other samples of dyslexic children have attained levels of accuracy for alphabetic reading skills as high as those reported in this study, so that future improvements in fluency must remain an open question.

We also did not obtain measures of reading comprehension for our sample, as the intervention was targeted on word reading skills alone. However, there is ample evidence that decoding accuracy and fluency are closely tied to comprehension levels (Perfetti 1985; Roth and Beck 1987), so that we can reasonably expect reading comprehension increases to be the eventual result of improvements in decoding accuracy. In this case, more complete data from one of the subjects in the present study may be instructive. In addition to being dyslexic, this child also had a severe expressive language disorder, including marked verbal dyspraxia, which had been diagnosed at age 2½. He had received extensive speech and language therapy, special education training, and private tutoring with a reading disabilities tutor since preschool. At pretest for this study, when he was 10 years, 10 months old, his scores on the Word Identification and Word Attack subtests were 60 and 68, respectively, and his score on the Comprehension subtest was 58. Over the next five months, he received therapy with the ADD program on a 1:1 basis for a total of 124 hours. At the conclusion of training, his standard scores on Word Identification, Word Attack, and Comprehension, were 78, 99, and 81, respectively. For this child, at least, improvements in his alphabetic reading skills were accompanied by significant improvements in reading comprehension.

Although the nature of this study allows only tentative conclusions about the effectiveness of phonological awareness training for older dyslexic children, the study does underline the need for further research in this area. In addition to its practical and immediate benefits, this research should help us to increase our understanding of the basic disorder. Studies that powerfully manipulate levels of phonological awareness should contribute important information about relationships among different kinds of phonological processing problems, as well as clarify the relative importance of these different kinds of limitations in producing the reading symptoms.

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