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Stimulating Basic Reading Processes Using Auditory Discrimination In Depth

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Recent research indicates that a major cause of reading (decoding) disabilities lies in an inability to manipulate speech at its phonemic (phonological) level. The Auditory Discrimination in Depth Program (ADD program), stimulates basic phonological awareness and has been used extensively at The Reading Foundation in Calgary, Alberta. Here we present pre- and post-test data from 281 clients (ranging from school-age through adulthood) seen over a two year period; post-test data was collected after 80 hours of ADD instruction. To assess whether significant gains had been achieved, an analysis of covariance was performed, covarying for age and initial vocabulary scores. After 80 hours of intensive instruction, highly significant gains ($p<.001$) were evident on measures of phonological awareness, sound/symbol connections, word attack, word identification, spelling, and decoding in context. In addition to the treatment effect, age and vocabulary had some influence on some of the variables. The data was also analyzed to determine whether the results went beyond a "group effect" only. A total of 229 cases were tabulated for gain or losses on the word attack subtest and on the reading and spelling subtest of the WRAT-R. Results indicate that the remediation was effective for all subjects, though gains on spelling tended to be less than on the two reading scores.

Background

The importance of phonological awareness to the subsequent development of the decoding process has been underscored in a number of research studies. For example, a study by Bradley and Bryant (1983), which has subsequently been replicated across various ages and cultures (Bradley and Bryant 1985; Ball and Blachman 1988; Bradley 1987; Lundberg, frost, and Peterson 1988) highlights the importance of phonological awareness to the development of decoding and spelling. Each of the studies cited have gone on to demonstrate that early stimulation of phonological awareness in kindergarten years assists the subsequent development of the decoding process in groups of normal and at risk children.

Phonological awareness is not the same thing as instruction in phonics. Recent work in phonological awareness makes it clear that more than phonics is required. There is a "missing link" so to speak, at a more basic level of processing for many students. For example, Bradley and Bryant's work makes clear that many students with good intelligence lack sufficient phonological awareness to make an easy transition to decoding and spelling in an alphabet system. For those students, stimulation of phonological awareness at an early age made significant difference to reading outcomes that extended well beyond the early elementary years. For example, Bradley's (1987) follow up of subjects who had received early stimulation in phonological awareness in

grade 1 indicated they were reading at grade-level in their teen years. By contrast, students who did not receive such stimulation were significantly delayed in their reading and spelling ability in their teen years despite having had several years of traditional remedial work.

Although these studies of children identified and treated prior to any experience of reading failure are encouraging in terms of their preventive implications, what about older students who are already reading-disabled? The experience of most remedial teachers is that the decoding difficulty is very entrenched indeed. Many students simply don't seem to respond to any forms of treatment and many students linger in remedial programs for years without making significant gains. Although teachers often lament about the lack of time they have with students, increasing the amount of time with them does not necessarily produce better results. For example, in a well-controlled study by Lovett (1991), increases in word recognition alone were demonstrated in a group of severely learning disabled students who received 35 hours of direct instruction using a combination of whole-word and phonics instruction. The results, the author states (p.301):

> ….are positive in demonstrating that the word recognition skills of dyslexic children can be greatly improved by providing plenty of practice with reading and spelling words but are discouraging because these improvements were not attributable to more generalized skill in using sound-letter correspondences to decode unfamiliar words.

The author concludes that the gains were made primarily by "acquiring specific lexical knowledge," but that for no group was there any evidence that the children had extracted any information about letter-sound correspondences. On other words, the gains can be attributed primarily to memorization rather than improvements in the decoding process itself.

It should be noted that even when phonological awareness is added to the treatment, positive results are not always present for individual children, For example, Torgesen and Morgan (1990) indicated that while average training effects were present for a group of kindergarten children receiving early phonological stimulation, up to 30 percent of the children did not benefit at all.

A further concern for interpretation is that the methods used to teach phonological awareness vary from study to study. Published programs are rare at this point and different programs emphasize different aspects of broad spectrum of phonological awareness. For example, some programs (Rosner 1990) focus exclusively on phoneme deletion, others on segmenting and blending and others on rhyming (Bradley and Bryan 1985). Different researchers present quite distinct lists of the "essential" phonological processes (e.g., Lindamood and Lindamood 1975, 1979; Yopp 1988). All of this leads to variations in treatment and possibly in outcomes.

In my review (Truch 1990) of programs and strategies that were directed to stimulating phonological awareness, I indicated that the Auditory Discrimination in Depth program, (ADD) developed by Pat and Charles Lindamood, (1975) was the best program developed to date in this area. The ADD program incorporates a number of

essential features that I believe make it unique and powerful in dealing with the phonological awareness problems that seem to plague so many disabled readers.

One important feature of the ADD program is the fact that a number of important phonological judgments are stimulated. According to Pat Lindamood, these include judging the identity, order and number of phonemes in a spoken syllable; segmenting and blending phonemes; and finally, recognizing when and where a phoneme change occurs when one adds, subtracts, substitutes, shifts, or repeats a phoneme in a spoken syllable. The student then learns to make the transition from the phonological level to actual decoding and decoding where the same judgments are required with letter symbol. Notably, the program can be used as an "early intervention" program or with reading disabled students of any age. A number of school districts have used the program as an early introduction to reading with grade 1 students and many resource teachers have used the programs in their classes with disabled readers.

While the ADD program has been in existence for a number of years, and has been much praised by clinicians, few published studies regarding its effectiveness can be found. Some encouraging data were recently reported by Alexander et al. (1991). In that study, a group of 10 severely dyslexic clients aged 93 to 154 months were treated for an average of 65 hours in the ADD programs. Although the number of subjects is small, significant gains on the Woodcock Reading Mastery Test (Word Identification and Word Attack subtests) and on the Lindamood Auditory Conceptualization Test were made for all the subjects. These results are promising, but more published work is required.

One drawback to the ADD program, in terms of using it in remedial settings, is the significant amount of training that is necessary to achieve competence in program delivery. Training courses for interested professionals are held on a regular basis at the Lindamood-Bell clinic, but the delivery of an intensive clinical program requires much more than an exposure to the training. Furthermore, the ideal delivery of the program for reading-disabled individuals is on a one-to-one basis, four hours daily, five days a week for a minimum of four consecutive weeks. This is far different from traditional "tutoring" and remedial approaches that typically consist of one hour visits weekly. Although these features make the program difficult (though not impossible) to deliver in a school setting, a number of private clinics now exist throughout North America that offer the ADD program in the intensive fashion recommended for disabled readers.

The Reading Foundation in Calgary, Alberta is one such clinic. In the time period spanning July 1990 to October 1992, a total of 348 clients of all ages received intensive remediation and all were pre- and post-tested on the same battery of tests. These 348 clients represents 95% of all persons receiving ADD remediation at the clinic during that time; the records for the remaining 5% were either not available or not included in the present analyses for extraneous reasons. Thus, the total subject pool is large and cuts across a number of diverse categories such as age, sex, ability, and diagnostic labels.

All clients who come to the clinic are first assessed for their individual needs and then, if warranted, given treatment in the ADD program and/or the comprehension process using Nanci Bell's (1991b) visualization/verbalization program. The decision regarding which program or programs to use with any given individual is a clinical judgment made by the author who pre-tests all clients. This decision is based on performance on the battery of tests, client history and concerns. As much pertinent information as possible is used in the decision-making process.

Clients who are recommended for the ADD program have a need to develop more fluency and/or accuracy in their decoding and encoding. The ultimate objective is to have the client develop "automaticity" in the decoding process. The importance of automaticity in decoding has long been recognized and was underscored recently by Spear-Swerling and Sternberg (1994).

Description of the ADD Program

The Auditory Discrimination in Depth program is highly structured. All clinicians at The Reading Foundation were trained initially by Pat Lindamood and myself (I was trained at the Lindamood-Bell clinic in San Luis Obispo). Advanced training for clinicians was also provided with follow-up visits to the Calgary clinic from Pat Lindamood and consultants from the Lindamood-Bell clinic.

All students who are recommended for the ADD program follow the same therapy sequence, but modifications are made in special cases and adjustments are always made for individual differences. The scope and sequence of the clinical program and the training programs extend further than the ADD Manual provides, particularly at the multi-syllable level.

In general, students in the ADD program are first given training in an awareness of the consonants and vowels of the English language, particularly with reference to the articulatory actions that produce them. Students learn to use sensory information from the eyes, ears, and mouth to identify, classify, and label phonemes. For example, the bilabial plosives /p/ and /b/ are called "lip-poppers" because of the articulatory processes involved; in contrast, the alveolar stops /t/ and /d/ are called "tip-tappers." The labels provide an added dimension of cognitive processing for the learner that is particularly unique to this program. Once the learner can label something, he or she has another way to think about it. This also provides the clinician with another avenue for questioning if the student makes an error. Once students have internalized this processing (i.e., labels, sounds and articulatory feedback), then the letter symbols associated with the phonemes are introduced. These come as separate manipulative tiles with the ADD kit.

After being introduced to the consonants and vowels, the student is then taught how to "track" sounds within the speech stream using coloured wooden blocks to represent the sounds. "Tracking" is an important part of the program as it directly stimulates awareness of the identity, order, and number of phonemes. It teaches segmentation and blending as well as the addition, deletion, substitution, and shifting of phonemes. For example, the student might be asked to track the pattern /ib/. In this case, the student would begin by taking out two different coloured blocks and placing them on the table. Let's say the student took out a black block and a red one. The clinician would then say, "If that says /ib/, show me /ab/." The student would then have to substitute the black block for another of a different colour, perhaps yellow. The clinician might then say, "If that says /ab/, show me /bab/." The student would then have to take another red block and place it at the beginning of the pattern. The sequence would then be a red block, a yellow one and another red one. This would be an encoded version of the syllable pattern /bab/. Any errors that are made are questioned in a guided fashion until the student discovers the correct answer.

Students who can "track" phonemes within spoken syllables and show their facility in doing so with the coloured blocks are then allowed to discover the connection between this process and decoding and spelling. The transition to word identification and spelling occurs in a sequenced fashion that moves from simple to complex to multi-syllable levels. Work is done with both nonsense patterns (to minimize memorization) and real words. Overlap to contextual reading is also made using material at about the same level as the student can "track." Spelling exceptions and irregularities in real words are introduced in a systematic fashion.

The starting point of the ADD program then, is with phonological awareness. Once this foundation is solidly established in a student's mind, then the overlap to orthography begins. By contrast, most phonics programs begin with orthography and do not usually include much additional feedback regarding phonology. For example, the student may be told that a "p" makes a /p/ sound, "e" makes an /e/ sound and "t" makes a /t/ sound. The students may memorize all the letters and their corresponding sounds and yet *still* decode the word "pet" incorrectly as /pit/. This confusion is usually at the phonological level and because of it the student has no way to judge that what he or she is saying is matching what he or she is seeing. Thus, the student has no basis for self-correction. The ADD program is particularly useful for clearing up such confusions.

The clinical teaching method is one of "guided discovery" (as opposed to a direct: "No, that's wrong, this is correct" approach) and "responding to the response" is an integral part of handling errors when a student makes them. So, if the student had said /pit/ when the word actually was "pet," the sample of error-handling dialogue" might go something like this:

> Clinician: (covers up written word) and asks student: "When you say /pet/ what sound do you feel right after the lip-popper?"
>
> Student: "Hmm, I think it's /e/."
>
> Clinician: "You're right. Now let's check to see if the letter we see matches that /e/ sound."
>
> Student observes the letter "i" and says: "No, that doesn't match" (student makes this decision based on what he or she has already learned about vowel sounds and letters in the ADD Program). "That letter should make me say /i/."
>
> Clinician: "Right. So what will the word say if you make the /i/ sound after the Lip-popper?"
>
> Student: "Pit."
>
> Clinician: "Great matching."

"Skill and drill" and negative feedback are greatly minimized as the student learns to consciously make decisions regarding the various phonological processes and his or her own errors. This develops the basis for self-correction as the student advances in the

program. As a result, students are generally challenged and happy to come. Complaints of "boredom" are rare, but when such feedback does occur, then "trouble-shooting" takes place immediately to determine what adjustments are needed. Progress is carefully monitored throughout.

Method

Subjects

An overwhelming amount of information was available for this analysis. An analysis of covariance was chosen in order to determine whether age and initial vocabulary level might have an effect on outcomes or indeed, whether their influence was more important than the treatment itself. For the analysis of covariance, just those subjects who received only the ADD treatment without comprehension training were used. Age and vocabulary scores were covaried for each of the dependent variables to determine their possible influence.

The majority of the clients seen at The Reading Foundation (n = 281) received the ADD program only. Of the 348 clients with reading problems, only 67 did not require training in phonological awareness; rather they required and received intensive work in reading comprehension. The data for those 67 individuals will form the focus of a separate paper. Also excluded from the present analysis were clients who received additional therapy in the ADD program beyond the 80 hours, and some who received a combination of ADD and comprehension instruction. Those clients will also be excluded from the present analyses.

Of the 281 clients included in the present analysis, some 60% were in the age-group 6 to 12; another 25% were from ages 13 to 17 and the remaining 15% were adults aged 18 and over. The younger clients came primarily on parental motivation or through inter-agency referrals. The adults were generally self-referred but some also came because of referrals from other agencies. No attempt was made to classify subjects into various disability categories. However, the vast majority of subjects met traditional criteria for "learning disabled" (i.e., average intelligence or better but with a discrepancy between reading potential and performance) or "dyslexic." Some of the subjects would be classified as "slow learner" or "mentally challenged." A few subjects also suffered brain injury as a result of accidents or trauma. Some also met the current DSM III-R criteria for "attentions deficit disorder." Again though, no attempt was made to classify subjects on the basis of these categories. What the 281 subjects had in common was an initial deficit in phonological awareness (as measured by the LAC Test) and all of them complained of some difficulty in reading (decoding), spelling or written language.

The youngest subject to attend the clinic was 5 years old. The oldest was 55. The average age of the student in the ADD Program was 12.85 years. The ratio of male to female subjects receiving ADD treatment was 2.27:1 (196 males, 85 females). The average vocabulary score turned out to be 100.

Measures

All subjects were screened on a standard battery of tests that included:

1. The Lindamood Auditory Conceptualization Test (LAC) (Lindamood and Lindamood 1979) as a measure of phonological awareness. The examiner presents the student with patterns of sounds in isolation and the student uses coloured wooden blocks to encode the sounds. For example, on the easier part of the test, the examiner might say /g/, /g/, /s/. The student would then demonstrate his understanding of that auditory pattern by choosing two blocks of the same colour followed by a third block of a different color and placing them in the correct sequence on the table. For the more difficult part of the test, the student encodes patterns in a syllable. Changes are made to each pattern and the examiner can determine the extent to which the student is phonologically aware. So the examiner might say, "Show me /a/." The student would then take out one coloured block. The examiner would then say, "If that says /a/, show me /ab/." The student would then demonstrate his awareness by choosing another block of a different colour and placing it right after the first block. The changes on this part of the test represent additions, substitutions, deletions, shifts, or repetitions of phonemes. The syllable patterns do not exceed four phonemes. Therefore, the test is extremely basic. Scores are given weighted values and then added together. A student is given 1 point for each of the 10 easier items he or she correctly encodes; 3 points for each of the 6 items of moderate difficulty and 6 points each for the final 12 patterns. The maximum score on the test is 100. These weighted scores, calculated from the information provided on the LAC Test itself, were the ones used in the analysis.

   Minimum cut-off scores and predictive validity for grade 1 to 6 and adult levels were determined during test development by comparing LAC scores of 660 students in grades 1 to 12 with their scores on the WRAT Reading and Spelling subtests (Lindamood and Lindamood 1979). The LAC scores then, do not represent "average" or "grade-level" scores but instead are predictive of success in reading and spelling performance at particular age or grade levels. Thus, if a student receives a score of 61 on the LAC Test, that is a minimum cut-off score for a student at the beginning of the grade 2 year. Thus, there are no standardized norms for the test. As a result, skill in clinical judgment is needed to interpret the results. In many cases, the results are obvious and straightforward. Low scores indicate a lack of phonological awareness. In other cases, great skill in interpretation and knowledge of the over-all ADD program is needed in order to decide whether or not a student requires some treatment in the ADD program. For example, an older student may get 100 on the test and still require some treatment in the ADD program. That is because the student may have no difficulty in making judgments when the syllable structure contains only four phonemes. However, the student may breakdown entirely when the syllable patterns involve five sounds or when more than one syllable is present. A newer and updated version of the LAC Test which addresses some of these shortcomings will soon be available.

2. An informal sound-to-symbol test developed at the Lindamood-Bell clinic (SS Test) as a measure of "phonics" connections (an examiner says a phoneme, the student is asked to write the letter or letters that represents that phonemes - a total of 32 phonemes is sampled). So the examiner might say /p/ and the student is expected to print the letter "p." The total items correct (raw scores) were used in this analysis.
3. The Word Attack subtest from the Woodcock Reading Mastery Test (Woodcock 1973) as a measure of decoding. On this subtest, the student is asked to decode a list of nonsense patterns that become increasingly more complex. This test is important because it measures the degree to which a student has a depth of processing regarding the alphabet code. Many students have memorized a number of real words and can therefore appear to be decoding. The Woodcock controls to some extent for the effect of such memorization. Individuals who truly "decode" are able to read lists of nonsense words almost as quickly as real words despite never having seen them before. Poor decoders, by contrast, will make errors and generally process more slowly than good decoders.

   The scores used for the analysis of covariance were grade-equivalents obtained from the test manual. Strictly speaking, grade-equivalent scores should not be used in parametric analysis. However, those were the scores available for this analysis.
4. The Reading Subtest from the Wide Range Achievement Test-Revised (WRAT-R) (Jastak and Wilkinson 1984) as a measure of word identification was used as a measure of real-word reading without the benefit of context. The standard scores for this analysis were obtained from the WRAT-R manual. They have a mean of 100 and a standard deviation of 15.
5. The Spelling subtest from the WRAT-R was used as a measure of spelling ability. Standard scores were obtained from the manual and also have a mean of 100 and a standard deviation of 15.
6. Finally, the original Gray Oral Reading Test (GORT) (Gray 1963) was used as a measure of both decoding speed and accuracy. While the GORT has been updated to the GORT-R and now the GORT-3, the original version provides a nice dichotomy between decoding (as a measure of errors *x* speed) and comprehension (basic recall). For this analysis, the grade-score of the GORT can be considered a "decoding index" or a "fluency index" that measures the degree to which "automaticity" or "fluency" (as a function of time and errors) is developing. If warranted, subjects who did Form A paragraphs on the GORT were post-tested using Form B to control for recall effects. This decision was made on an individual basis. For example, many students were non-readers on the pre-test. Using Form A on both occasions would likely have occurred and should not have confounded the results.

Finally, as a measure of vocabulary, the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn and Dunn 1981) was administered and/or the Vocabulary

subtest from the WISC-R, (Wechsler 1974) the WISC III (Wechsler 1991) or the WAIS-R (Wechsler 1981) with supplemental subtests administered as needed. In many cases, the full Wechsler Scale had already been administered. This measure was needed to determine in some way the client's language base separate from reading skill.

Many subjects had also been tested by other agencies; those scores assisted in diagnosis but were not included in the analyses. Supplemental testing at the clinic to further assess certain hypotheses was also done as needed, but not presented here. The standard battery was administered prior to instruction (pre-test) and again at the end of programming (post-test).

Procedure

The vast majority of subjects attended the clinic for four hours daily, five days a week, for four consecutive weeks either in the mornings or afternoons. This intensity of service is recommended by Lindamood-Bell and is based on their clinical experience with the ADD program over the years. (This intensity would be the equivalent in total time of a student seeing a tutor two hours weekly for a ten-month school year). The cooperation of the school was encouraged when students had to miss any class time and generally, this was given. Many of the subjects however, did attend in the summer period, when missing school was not an issue. Some adults were not able to attend the clinic in this fashion so scheduling in some cases was not quite as intense.

The scope and sequence of the ADD program was generally followed as outlined in the ADD manual. However, the manual lacks much detail at the multi-syllable level. The phonological structure of multisyllabic words was made explicit during the training and during the intervention period. Since the time of this analysis, further modifications at The Reading Foundation have been made in the sequence of the program, but these did not apply to any clients included in the present analysis.

Results

A total of 281 individuals completed at least 80 hours of ADD therapy. A univariate analysis of covariance was performed where the LAC Test, the informal sound/symbol test, the Woodcock Word Attack subtest, the Reading subtest of the WRAT-R, the Spelling subtest of the WRAT-R and the decoding index of the GORT became the dependent variables with time of test (pre-test versus post-test) as the independent variable. Age and vocabulary level (using either the PPVT-R or Vocabulary score of the Wechsler Scale) were covaried. These variables were entered in order to see if, in addition to the treatment itself, they might have an influence on any of the variables.

Table I shows the pre- and post-test means, the levels of statistical significance and the influence of age and vocabulary for each of the dependent variables.

Table I
Effect of 80 Hours of Auditory Discrimination in Depth Therapy (n = 281)

Variables	Pre	Post	*F*	df	MSE	Sig.	Covariates Age	Covariates Vocab
LAC (Weighted raw scores)	64	92	837.59	1,279	130.31	<.0001	ns	ns
Sound – Symbol (Raw Score)	23	31	1134.47	1,255	8.13	<.0001	ns	ns
Woodcock Word Attack (Grade-Equivalent scores)	2.96	7.31	666.23	1,278	3.95	<.0001	<.01	<.03
WRAT-R Reading (Standard scores)	76	93	1027.32	1,277	40.59	<.0001	<.01	ns
Spelling (Standard scores)	76	93	447.49	1,277	36.89	<.0001	<.01	ns
GORT (standard scores)	3.46	4.53	161.33	1.277	302.60	<.0001	<.02	<.03

Results presented in table I indicate highly significant gains on all variables. This is clear evidence of a treatment effect for the group as a whole. In addition to the treatment effect, the influence of age and vocabulary on some of the variables is present. The positive effect of age as an influencing variable is somewhat surprising given the commonly held belief that older students cannot be taught any more of the "basics." In addition, vocabulary had an influence on the largely "bottom-up" task of the sound/symbol test but no influence on the Reading score of the WRAT-R, where it might have been expected. It also appeared to influence improvement on the GORT, where one would anticipate an effect.

Students in general made significant gains in phonological awareness. In fact, all the subjects (with but one exception) posted a gain on the LAC Test. On the post-test 58% of the subjects achieved a "ceiling" level score of 100 on the LAC and an additional 17% made just one error.

On the sound/symbol test, the average gain in raw scores was also significant. On this variable, 62% of the clients achieved a ceiling score of 32/32, an additional 16% made just one error, and a further 10% made just 2 errors. Thus, 88% of the clients obtained a score of 30/32 or greater on this test from an average starting point of 23/32; initial scores began as low as 5/32 items correct. There were no cases of regression on this variable; scores improved for all subjects.

Students also improved in their ability to apply their knowledge of sound/symbol connections to the process of decoding, as measured by the Woodcock Word Attack subtest. In addition to the significant gains on this variable posted by the group as a whole, the scores from 229 of the clients were analyzed by age and levels of gain with the results as seen in table II.

Table II
Percentage of Student Showing Gains on the Woodcock Word Attack Measure as a Function of Age and Degree of Gain (n=229)*

Degree of Gain	Age 6-12 years (n=156)	13-17 years (n=49)	18+ years (n=24)
Loss of gain	0%	0%	0%
Up to 2 years (grade equivalent)	30%	8%	8%
2-4 years (grade equivalent)	33%	20%	8%
4 years of more gain (grade equivalent)	37%	72%	84%

(*Because of the way the information was initially coded by hand, the results for all 281 subjects were not available for this part of the analysis. It is highly unlikely that the additional data would have changed these over-all trends in any significant way).

These results seem to indicate a powerful effect of the ADD program on the process of decoding. Since speed is not a factor on the Woodcock, it should be noted that these scores represent gains in accuracy. It is our experience that it takes time and sometimes more intensive therapy to build "automaticity;" however, one must first be accurate before speed can be achieved. The results, tabulated in this fashion, also indicate what the analysis of covariance showed for the group; there is an effect for age in that older students as a group made greater gains in accuracy.

Growth in the standard scores on the Reading subtest of the WRAT-R also suggest a powerful group effect. As a group, students started almost two standard deviations below average, and ended up in the lower end of the average range for their respective ages. In table III, we see the results tabulated by degree of gain and age.

Table III
Percentage of Students Showing Gains on the Reading Subtest of the WRAT-R as a function of Age and Degree of Gain (n = 229)

Degree of Gain	Age 6-12 years	13-17 years	18+ years
0 – 7 points	12%	10%	17%
8-15 points	33%	31%	25%
16-30 points	45%	55%	41%
31 points or more	10%	4%	17%

(Because the standard deviation on the WRAT-R is 15 points, the cut-off points were established as above).

It should be noted that just two subjects in the group of 229 showed no change in standard score points (i.e., zero growth from pre-test to post-test). Gains of more than one standard deviation were evident for the majority of clients at all age groups.

We have found that the spelling process is more difficult to change. Perhaps this is because a student can use memorization and semantic cues to help "figure out" some real words in the course of reading. That is not as likely for spelling. If a student does not have all the letters correct on the WRAT-R, he or she does not get a point. While the group effect shows similar starting and ending points, the average gains in spelling tended to be lower than on the Reading subtest.

As seen in table IV, spelling was the first variable for which a "loss" column had to be included. Five subjects in the 6 to 12 group registered a loss from pre- to post-testing in their spelling. In one client, the loss was 1 point; for three of the clients, the loss was 2 standard score points and for the final case, the loss was 6 points. Greater numbers of clients posted gains of 1/2 standard deviation or less, when compared to their Reading gains on the WRAT-R. The majority of client gains on this variable were between 1/2 and 1 standard deviation. An error analysis showed that most clients became far more phonetic in their misspellings. An index to measure this kind of processing change would have been most interesting. As a group however, the growth in standard scores is still strong with students functioning closer to the average range upon completion of the ADD program.

Table IV
Percentage of Students Showing Gains on the WRAT-R Spelling Subtest by Age and Degree of Gain

	Age		
Degree of Gain	6-12 years	13-17 years	18+ years
Loss	3%	0%	0%
0-7 points	38%	37%	33%
8-15 points	36%	45%	33%
16-30 points	21%	16%	26%
31 or more points	2%	2%	8%

Finally, the group results on the GORT also indicate a significant gain on average. On an individual level, six of the students posted a gain of 0 on the GORT from pre- to post-testing; the rest showed at least a small gain. Our experience with this test is that it is extremely rigorous. Gains from pre- to post-testing are usually present, but since the majority of students gain in accuracy (but not speed), the immediate gain on the index is often small. We have however, noted growth over time in this index for clients who have returned, something which I have started calling the "percolation effect." A more rigorous follow-up study is needed however, to provide some data on this issue.

Discussion

The results of this analysis demonstrate that school age children and adults can be taught phonological awareness and that such remediation yields significant gains in decoding, word identification, spelling, and contextual reading. This is encouraging in that traditional remedial efforts in the past have often brought disappointing results. The results are consistent with the data and research that is now being conducted in the area of phonological processing, but extends the success to much older ages. It would seem that an important key to the decoding process has been unlocked for students who have difficulty in this area.

Of note is the fact that on an individual level, very few subjects who entered therapy at The Reading Foundation showed any form of regression. Spelling was the one area where some regression was registered for younger students. In part, this may have been due to the test itself, as the WRAT-R spelling test contains a number of irregular words. Some of the younger students may have been caught in the middle of switching

from a "sight" strategy to a more effective use of letter / sound knowledge. Thus, a student might have spelled a word like "right" correctly on the pre-test (from sight) and then incorrectly as "rite" on the post-test. This transition from a visually based strategy to better us of phonological awareness and then back to using appropriate visual cues takes time. For the vast majority of clients however, the gains on all variables were impressive. This was generally noticed and commented upon by the parents, the students themselves and by many of the students' teachers.

The total time (80 hours) spent in remediation is significant, it is roughly equivalent to a student seeing a tutor twice a week for an hour each time for the ten months of the school year. While many parents and professional were concerned about the student's ability to maintain interest and attention for four hours daily, this was not an issue for the vast majority of students. On occasion, the routine might have to be changed, but in most cases students were excited about learning. Parents frequently commented on changes in attitude, behaviour, and self-confidence and the fact that the student was willing to come to the clinic. This was in sharp contrast to many of their previous experiences with remedial programs. The fact that the ADD program is not a "skill-and drill" one is important to this process. Students are questioned and guided through that questioning to discover relationships of which they were previously unaware. Ownership of the program belongs to the students right from the start and once they discover they *are* learning, the process becomes intrinsically satisfying.

Other researchers who use strategies that begin at a phonological level (rather than an orthographic level) have also noted encouraging gains. Of special note is the work being done by Benita Blachman (Blachman 1991). Her program focuses on phonological segmentation and blending initially and then helps students make the transition to decoding and encoding in a structured way. Students are taught to use paper clips, buttons, blocks, etc. as representations of sounds and then taken through a sequence of "tracking" speech sounds, first in isolation and then in structured syllable patterns. Students then move on to using a grapheme representation for the phonemes. High-risk inner city students who received a total of 10-12 hours of small-group instruction in kindergarten showed substantial reading gains. One difference between her procedures and the ADD program is the fact that students in the former begin with the instructor saying phonemes in isolation. Students never learn to use the articulatory form of feedback present from the motor movements of the tongue, lips, jaws, etc. in order to discover additional information about the phoneme. Thus, the input is primarily "auditory" in nature. In the ADD program, the focus on articulatory feedback (ie., the way the mouth, tongue, and lips form the shapes of sounds) and the labelling of the sounds and their reference to the student's own speech mechanism takes place before any attempts are made to actually begin "tracking" sounds. Some students may therefore still require these more basic steps before procedures in Blachman's programs would be fully effective. Nevertheless, the ease of learning Blachman's procedures is an enticing feature and many high-risk students are likely to benefit from it.

Limitations of this study

The major limitation of this analysis is the fact that this was not a controlled study. Because no comparison group was used, we cannot be sure that effects were due primarily to the ADD program. Other variables such as motivation of the family, the student, the instructors themselves, or the sheer intensity of the program may have been responsible. However, many of these alternative explanations are inconsistent with the history of the client. Work by other researchers, particularly the work of Lynette Bradley (Bradley 1987) shows clearly that the stimulation of phonological awareness is critical to success in decoding and further, that early stimulation of phonological awareness brings results in long-term effects. The results of this analysis give some hope that similar effects are possible even with students and adults who have experienced long-term problems with decoding and encoding.

Additional limitations include the self-selecting nature of the subjects and the lack of any quantitative long-term data for this particular group of clients. Are those clients who completed the program three years ago, for example, still reading and spelling as effectively as when they left? This particular analysis does not answer that question, but future studies could address that issue more directly. Indirectly, feedback is often obtained from parents who maintain contact with the clinic and frequently report on positive and apparently long-term gains as well as to the subsequent development of decoding "automaticity" for many of the subjects. In addition, a confidential telephone survey was conducted in the fall of 1993. Some 300 past clients of The Reading Foundation were contacted and asked a number of questions regarding their child's progress in the time since leaving the clinic. Perceptions were uniformly positive with only a small percentage (4%) indicating dissatisfaction with the long-term results. However, those comments might be self-selecting and therefore a formal study using quantitative data is still needed.

The issue of comprehension was not addressed in this particular analysis of the data. Many individuals who operate from a "whole-language" philosophy might be concerned about the inordinate amount of time the student spends on developing decoding tools in their time at the clinic. However, unless the student has a separate comprehension dysfunction, our experience has been that semantic cues "kick in" appropriately once the student has developed more accurate decoding facility. Our experience is consistent with the theoretical model and research review presented by Adams (1990) and with the recent model presented by Spear-Swerling and Sternberg (1994) who state that normal reading acquisition requires that the individual develop "automatic" decoding skills. In the absence of such development, the reader may stray into four different patterns of reading-disabled performance. These patterns are: (1) *nonalphabetic*, where the reader relies heavily on visual cues to recognize words and has no phonetic skills; (2) *compensatory*, where the reader has some phonetic skills, but relies heavily on sentence context or sight words for word recognition; (3) *nonautomatic*, where the reader has decoding skills, but these require effort and are not automatic (context cues may assist such a reader). The fourth category, (4) *delayed*, includes readers who have finally achieved automatic word recognition, but lagged far behind their peers in the acquisition of such skills. According to these models and our clinical experience, good comprehension can never be a replacement for "automatic" decoding facility. Certainly,

some readers are able to use their "top-down" processing very well and do a good job of "contextual guessing." However, this is a compensatory process and it too usually begins to fail when a student encounters more difficult encoded language (Byrne, Freebody and Gates 1992).

Some students have a true comprehension problem separate from the decoding issue. There is, in our experience, another form of reading disability which is primarily comprehension-based. A separate program developed by Nanci Bell (1991a), who is Pat Lindamood's partner, deals with this problem (Bell 1991b). The results on the 67 subjects who required treatment in this program will be discussed in a separate paper.

The ADD program is unique in dealing with the phonological awareness issue and in helping students eventually develop "automatic" decoding facility. Many other programs and procedures are now being developed to stimulate phonological awareness. Future theoretical work and research can help clarify which features are essential for decoding/encoding and the practical limits of each program. Continued work in this area is extremely important and implications for educational practices, particularly the teaching of reading, are profound.

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