Phono-Graphix™: A New Method for Remediating Reading Difficulties

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Eighty-seven children, 6 to 16 years of age, with reading and/or spelling difficulties were trained in a new program (Phono-Graphix™) that emphasizes phoneme awareness training, sound-to-print orientation, curriculum design sequenced by orthographic complexity, and active parental supervision in homework assignments. The children's initial level of competence to access the alphabet code was revealed by diagnostic testing, and individualized sequences of instruction were developed. The children received 12 hours or less of one-to-one training, one hour per week. Children gained an average of 13.7 standard score points on word recognition (1.70 points per clinical hour) and 19.34 standard score points on nonsense word decoding (2.57 points per clinical hour).

In this paper we present research on a new instructional method, Phono-Graphix™, that relies on twenty years of re-

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search on the origin of reading failure. This method is based on a large body of empirical evidence identifying lack of phoneme awareness as a major component of children's poor decoding skills. It is based as well on a new understanding of the rationale and structure of writing systems, and of English orthography in particular. This has made it possible to design a sequence of instruction that fits with the child's logical development. Phono-Graphix is an attempt to integrate these components into one coherent curriculum and method of instruction. The results have been very promising.

The most well-known finding in reading research is that poor reading skills are associated with an inability to access the phonemic level of language, and thus, the phonemic basis of the alphabet code (Rosner and Simon 1971; Calfee, Lindamood, and Lindamood 1973; Fox and Routh 1975; Bradley and Bryant 1978; Shankweiler et al. 1979; Lundberg, Olafsson and Wall 1980, Stanovich, Cunningham and Cramer 1984; Tunmer and Nesdale 1985; and see reviews by McGuinness 1981, 1985; Wagner and Torgesen 1987). It is now equally clear that training in phonological awareness *by itself* does not automatically guarantee superior or even adequate decoding skills, and must be combined with training in the alphabet principle (Bradley and Bryant 1985; Ball and Blachman 1988; McGuinness, McGuinness, and Donohue 1995).

Research shows that natural skill in phonological awareness aids reading acquisition, and that instruction in an alphabetic writing system aids phonemic awareness (Morais et al. 1979; Read et al. 1986; Ben-Dror, Frost, and Bentin 1995). A clear demonstration of this reciprocal effect has been provided by McGuinness, McGuinness, and Donohue (1995). Two first-grade classroom teachers were trained in a reading program (Auditory Discrimination in Depth, Lindamood and Lindamood 1969, 1975) that integrates training in phoneme awareness and the alphabet principle. By the end of first grade, children trained by these teachers had reading test scores superior to a control group trained in whole language plus phonics. Yet, across all groups, phoneme awareness prior to instruction predicted later reading skill. This suggests not only that children can be successfully *trained* in phoneme awareness but also that some children develop phonemic awareness by virtue of some inherent aptitude through simple exposure to an alphabetic writing system. (Howard 1982; McGuinness and McGuinness 1991; Alexander et al. 1991; Truch 1994).

A second line of research, bearing on the issue of reading instruction, comes from comparative analyses of ancient and modern writing systems. This work synthesizes research from paleography and structural linguistics (Kramer 1963; Coulmas 1989; Healey 1990; Robinson 1995; McGuinness in press) and provides important information about the way writing systems are designed. The two most important findings are these:

1. Humans cannot remember more than about 1500–2000 unique signs. For this reason, no whole word (logographic) writing system can ever work or ever did. Oral vocabulary ranges from about 50,000 to over 200,000 words.
2. All writing systems use phonological units as a primary basis for the code, ranging in size from the phoneme to the syllable. The unit most appropriate for a particular orthography is determined by these factors: the use of a phonological unit that is easiest to isolate in speech, the syllable structure of the language, and the number of types of phonological units in the language.

If the language has a simple syllable structure (CV, VC, CVC only) and is agglutinative or combinatorial, such as Sumerian or Chinese, a syllabary will work (a different grapheme for each syllable). By far the most common type of writing system is based upon the CV unit, intermediate between a syllabary and an alphabet. This works for the many languages that are built mainly on repetitive CV-CV-CV sequences. This is a new classification proposed by McGuinness (in press) and called a "diphone system." The CV diphone is an optimal unit for a writing system when it fits the structure of the language. It does not breach the memory load (most languages have about 400 diphones), is as fast to read as an alphabet, and the CV unit is easier to isolate than the phoneme. Many examples from India, starting in the 5th century B.C., show that a CV diphone system was constructed with a complete understanding of the phoneme structure of the language, yet was chosen *in preference to* an alphabet.

Diphone writing systems are common. They were invented by the Mayans, Babylonians, Cypriots, Cretans, and early Greeks (Linear B). There are over 200 modern diphone systems in India alone, and they are used in most countries across Southeast Asia. The diphone is the unit for the katakana/hiragana scripts of Japan, for Han'gul in Korea, and for languages of Ethiopia and the Cherokee nation. An abbreviated type of diphone system or "consonantal alphabet" (C-C-C), where vowels are implied but not marked, was first used by the ancient

Egyptians, and is the basis for all modern Semitic writing systems. In Semitic languages, consonant sequences outline the "root" structure of a word across all grammatical transformations. Consonants carry the bulk of the meaning load in Semitic languages.

When none of these solutions work, the writing system must be alphabetic. Alphabetic writing systems are used for all languages with these characteristics: (1) both vowels and consonants carry the meaning load, and (2) large numbers of consonant blends create a complex syllable structure. These factors are found in European languages. The English language is particularly complex, with 72 consonant blends or clusters, giving rise to 17 syllable patterns, generating over 70,000 phonologically legitimate syllables.

A large body of evidence shows that phoneme awareness is "naturally" a challenge for most people. The discovery that the syllable or diphone is a more preferred (accessible) phonological unit for a writing system, is explained by the fact that phonemes are co-articulated within and even across syllables, making it difficult to isolate most consonants from their accompanying vowels (e.g., Liberman et al. 1967). Because the syllable complexity of English demands representation at the phonemic level, and because the beginning reader (child or adult) is not naturally aware of the phoneme, it stands that any teaching method that emphasizes units larger than the phoneme risks misleading the learner. This includes all whole word methods, as well as certain "phonics" approaches that teach consonants as if they were diphones ("buh," "duh," "guh,") or that teach blends (clusters) and "word families" or "rimes" as if they were "one sound." For example, the large number of rime units in English make extreme memory demands on the reader. English allows for 1240 phonologically legitimate rimes, including only those with the structure VC, VCC, or VCCC (McGuinness in press); over 800 rimes appear regularly in common words (Stanback 1992).

The final issue relevant to optimal teaching of reading concerns the structure of the English spelling code which contains four different mapping logics. It is argued that three are beyond the logical development of 6-year olds (Richards and Commons 1990), unless they are first embedded in a familiar context (Ceci and Roazzi 1994; see McGuinness in press). Young children can readily understand one-to-one mapping, one symbol for each sound, as the phoneme /b/ in English. The first complexity comes with a variation of one-to-one mapping: one-to-one(2) mapping, in which one sound is represented by two symbols (digraphs). Digraphs *reuse* old letters in pairs to stand for a new sound, creating a class-inclusion problem. This can be expressed in propositional logic as an "IF/THEN" construction. ("IF the letter *t* is followed by an *h*, THEN say /θ or ð/, but IF the letter *t* is followed by any other letter, THEN say /t/.")

The third logic refers to the fact that there are multiple spelling alternatives for the same sound (1-to-many mapping). (The sound /ee/ (i:) can be spelled: *been, bean, believe, deceive, theme, be, marine, baby, key.*) Spelling alternatives have two probability structures, one for the total corpus and one for frequency of word use. *Be, he, me, she,* and *we,* are high frequency words, but *e* is a low probability spelling alternative for the sound /ee/.

Finally, there is many-to-1 mapping, which we refer to as "code overlap," where one symbol can represent multiple sounds. (The letters *ou* stand for different sounds in *out, soup, soul, touch.*) These mapping logics can cause serious confusion about the print code if they are not handled in the appropriate sequence, a sequence that must be based on the probability structure of the spelling code.

On the basis of these considerations, in addition to extensive experience with children in the classroom and clinic, we designed a reading and spelling program that radically departs from all other programs, except in one respect. "Phono-Graphix" is a "true" linguistic program, sharing a common rationale with other true linguistic programs that teach English phonemes as the *real* and *stable* units of the writing system, and letter(s) as *arbitrary* (unstable) symbols. The first published program of this type was designed by Dale (1898, 1902). Dale taught beginning readers at Wimbledon High School (ages 6–14 years) in England. She taught phonemes (no letter names) using a discovery method to find out "what's working" in the mouth to produce each sound. After practice in isolating phonemes in initial, final, then medial positions, phonemes were connected to letters, single letters first, digraphs last. Training emphasized place of articulation. Voiced and unvoiced consonant pairs, for example, were taught as "brothers" or "sisters," and the children were encouraged to feel the voicing. Consonants with similar features were called "cousins" (/m/ /n/ /ng/). The vowel "triangle" was used to teach awareness of contrasting vowel sounds.

Dale designed 86 lessons for the classroom, which she stated "works well with up to 70 children."(!) In one of her lessons, children "discovered" the beginning sound in *cup*. A child was chosen to "be" this sound and stood at the front of the room. Next, the children discovered the sound /p/. The child assigned to "be /p/" stood to the left of the other child, leaving a gap. The gap visually signalled a missing middle sound. This was discovered, and a child became /u/, standing between the other two children. The class said each sound in turn (segmenting) and blended the sounds into the word *cup*. The child representing /c/ held up cut-out letter *c*, and so forth, until the word was spelled. Children wrote the letters on blackboards inside the lids of their desk (Dale provides information on materials and cost), saying each sound as they wrote the letter. The cutout letters were then hung on a large letter "frame" organized by linguistic categories. Dale did not develop her method beyond a "Basic Code" level (one sound/one spelling, including digraphs) for each of the sounds in English. Dale had no way in 1898 to test the efficacy of her program.

Since this time, most phonics programs, even those described as "linguistic" (see Chall 1967/1983), teach from letter to sound, setting up the wrong logic. Rudimentary phonics teaches the "26 names and sounds of 26 letters," leaving out 22 sounds in the English language. Other phonics programs vary in complexity from teaching portions of the code to teaching nearly the entire code, which is 179 letter patterns (not including Latin suffixes) representing 235 "sounds" (blends being taught as "one sound"). These problems have also been noted by Henry (1989). Setting up the code this way not only violates the alphabet principle, but it means that the code *cannot reverse;* you cannot teach spelling alternatives for 235 "sounds," because there are not 235 sounds in the English language. This makes it necessary to teach spelling as a separate activity, independent of reading. It is important to point out, that merely adding a "phonological awareness" component to phonics, does not solve this problem.

In the 1960s, another linguistic program appeared that is similar to Dale's—Auditory Discrimination in Depth (Lindamood and Lindamood 1969, 1975). Forty-four phonemes are taught independently of letters using colored blocks and then with letters using a moveable alphabet. The program interweaves teaching phonemes alone, phonemes with pictures of mouth postures, and phonemes connected to letters. Later, 16 different spellings (spelling alternatives) for certain vowel sounds are taught. The manual touches briefly on multisyllable analysis. The teacher training is more comprehensive. The program was designed for the clinic and has a proven track record with both adults and children (Alexander et al. 1991; McGuinness and McGuinness 1991; Truch 1994). It has been used successfully in the classroom with one-to-one training (Lindamood, personal communication, and see McGuinness 1985; Howard 1982) and with small groups taught by the classroom teacher (McGuinness, McGuinness, and Donohue 1995.)

GOALS SPECIFIC TO PHONO-GRAPHIX

Phono-Graphix teaches phonemes as the basis for the alphabet code. Phoneme-grapheme relationships are taught immediately and not in a two-step process. The first goal is to set up a Basic Code for 42 sounds (the w/wh contrast is not taught and /zh/ is not taught here). Digraphs are introduced after one-to-one mapping is stable (creating a "familiar context"). When the child is familiar with the Basic Code and knows that *it is reversible*, spelling alternatives are introduced for each sound, from the most to least probable. Note that the logic does not change. The code is still reversible. Furthermore, the complexity shrinks: 42 symbols are assigned to 42 sounds. The 72 blends are taught as combinations of *two sounds*, most of which obey one-to-one mapping. For example, 'bl' is taught as a combination of /b/ and /l/. One hundred seventy-nine letter patterns minus 42, minus 72, leaves 65 spelling alternatives (1 sound-multiple spellings) and 21 code overlaps (one grapheme—multiple sounds) that the child needs to learn. Other differences between Phono-Graphix and most reading programs are the complete orthographic analysis of the code, the comprehensive curriculum built on this analysis, the pedagogical approach, and parent or family member involvement in the teaching process.

Phono-Graphix was designed for both adults and children. This study reports only on children. The primary goal was to determine how quickly children can be remediated if the diagnosis is accurate, the curriculum effective, and if parents were guided to support the learning process. We hoped they would be able to sustain the gains made at the end of a session through to beginning the next session. Our sense is that the parent as partner in the remedial process can have important ramifications. First, there is a considerable financial savings for parents of children with learning problems. Secondly, it engages parents in a constructive way with their children, so that they can be supportive rather than feeling helpless and overwhelmed. It builds an understanding between parents and children that is almost impossible otherwise, because it provides parents with insights into the complexities of decoding an alphabet script. Most parents who are fluent readers have no awareness of this complexity. Lastly, we hope it will insure long-term stability, because parents can continue to guide the learning process.

METHOD

CLIENTS

Clients were referred for reading and/or spelling problems by teachers, other professionals, and parents. We report on every child who received remedial help over a two-year period. There were 87 children, aged 6 years, 2 months to 15 years, 11 months. Four were "mildly retarded" with IQs below 80 (parent report), and 35 had been diagnosed with a "learning disability" by a third party. Four clients were referred for vision therapy. Children had one-to-one hour-long sessions. Thirty-one children had 3 to 6 hours of therapy total. Fifty-five children had 12 hours, and one child had 15. The mean across all clients was 9.33 hours. Four children had additional sessions at our request (maximum 24 hours), but the data presented reflect their progress after 12 hours.

DIAGNOSTIC TESTING

Diagnostic tests were given to establish reading level, phonological awareness, and knowledge of the code.

Reading. Tests consisted of the Word Identification (Word I.D.) and Word Attack subtests from the Woodcock Reading Mastery Tests-Revised (Woodcock 1987).

Phonemic Awareness. We designed a variation of the Rosner and Simon Auditory Analysis Test (AAT) (1971) using 8 real and 2 nonsense words. Scoring on *deletion* is either correct/incorrect, with a maximum score of 10. The words used, with the phoneme to be deleted in slash marks, include: *pim* /p/, *tog* /g/, *sip* /s/, *stop* /s/, *nest* /t/, *flag* /f/, *plum* /l/, *best* /s/, *grill* /r/, *lost* /s/.

A test of *segmenting* real and nonsense words was also used. Items range from CVC (*dog, pim*) to CCVC/CVCC (*frog, hand, sept*). The tester says the word and the client has to repeat each phoneme in sequence. Each phoneme in sequence scores a point. A perfect score is 63 points. A test of *blending* used 15 real words from CVC to CCVCC (*pig, hat, shell, crunch*). The tester says isolated sounds and the client is asked to join the sounds to make a word. Scoring is correct/incorrect. Maximum score is 15 correct.

Code Knowledge. A test of code knowledge included 50 items consisting of 19 consonant letters, 6 vowel letters, 6 consonant digraphs, and 19 vowel digraphs/phonograms (*eigh, igh*). The complete test is provided in Appendix 1. Clients must say what each letter(s) sounds like if it appears in a word. Any probable decoding is scored as correct (*ea* can sound /ee/ (i:) (*team*), /e/, (*head*) or /ae/ (ei) (*great*)). A percentage was calculated based on the number correct out of 50.

Errors on the Woodcock Word I.D. were analyzed to determine the client's decoding strategy: "global" or whole word guesses, part-word "assembling" of word fragments, orthographic errors due to lack of knowledge of the code, and visual errors. The diagnostic profile derived from these measures was used to determine which subskills were taught and where in the curriculum sequence the client began.

Phono-Graphix Curriculum Design. Prior to designing the Phono-Graphix materials, the first two authors analyzed the spelling probability structure and frequency in print for approximately 3,000 *common* English words. These words were set up in a dictionary ("Allographs") by order of most-to-least likely spelling on one axis, and by alphabetical order on the other. This assisted us in design of the curriculum. The complexity of the spelling code and its probability structure determined the sequence in which concepts were taught. Graphemes for the Basic Code (1-to-1 mapping) were based upon the most frequent or least ambiguous spelling for that sound: i.e., the basic code spelling for the sound /ee/ is *ee* and the basic code spelling for the sound /k/ is *k* (even though *c* is more probable).

PROCEDURE

Children were taught one-to-one in one-hour sessions.

The specific goals of the program are to ensure automaticity of the following skills:

1. Be able to track visually from left-to-right;
2. Be able to segment and blend sounds in spoken and written words;
3. Be able to manipulate sounds in orally presented words;
4. Understand that print is a visual representation of sounds in words by means of what we refer to as "sound pictures." A sound picture contains 1 to 4 letters that stand for *one* sound. *t, ough, mb* are each "sound

pictures." The *bl* cluster contains two sound pictures. (We never use the term "silent letter.");

5. Understand that spelling and reading are reversible processes;
6. Understand the nature of a syllable "chunk," its internal structure of individual phonemes, and the order of those phonemes and "chunks" in words;
7. Automatic recognition of 1-to-1 and 1-to-1(2) "sound pictures" and all spelling alternatives and code overlaps.

Certain methodological approaches overlap all skill levels. The program is oriented to the child's developmental level and teaches by exposure—encountering suitable examples in the right sequence. Instruction avoids abstract or lengthy explanations, time consuming questioning and categorizing activities. Efforts were made to eliminate everything that gets in the way of automaticity in print-to-sound and sound-to-print decoding and encoding. The use of letter names is actively discouraged, as these force the child to translate from letter name to letter sound. Nothing is taught that must be discarded later on, such as memorizing names for articulatory features or key word (category) codes for sounds. Also avoided are spelling "rules," mnemonic devices ("when two vowels go walking"), or other concepts that have no basis in fact, like "long" and "short" vowels.

The goals are accomplished in three major ways:

1. Sequenced hands-on materials. All materials use a controlled vocabulary that is based upon word complexity and the mapping logic involved. The program begins with 1-to-1 mapping logic only. Skills training is set up in four levels that are detailed below.
2. The home curriculum. This contains 250 worksheets, stories, and games, all designed to complement and reinforce what has been taught in the hands-on sessions.
3. Special techniques for correcting errors. Error correction proceeds as follows: Clients are informed immediately of an error and told specifically what they did. A new question is formulated to help the client correct it. If the client cannot do this independently, additional information is provided.

Client reads *dawn* as 'down.'

The therapist points to the digraph *aw* and says, "You read this sound picture as /ou/. That would be /down/. This is not a picture of /ou/. Do you remember this sound picture?" Therapist points to aw. If the client does not remember, he is given the answer, and the lesson continues.

The four levels of instruction proceed as follows:

Skill Level I. Basic Code. one-to-one mapping. The Basic Code is the most probable spelling for 42 sounds. At this level, clients learn 19 consonants and 5 vowels. Non-readers are initially taught a subset of 7 consonants and 2 vowels. Clients familiar with the one-to-one mapping level, skip this step and move to the next level. The main auditory processing materials used at this level include:

Segmenting. Picture cue cards along with corresponding blank cards or letters are used for three-sound words. The client places the cards or letters represented by a picture (a cat) on a board with numbered slots. The therapist asks "What's the first sound in *cat*, what's the next sound in *cat*", and so forth. The numbers help clients understand that sounds are ordered from left-to-right, and to keep track of where they are in a word when they miss out a sound.

Mapping. "Mapping" refers to an encoding strategy in which clients say each sound while writing the appropriate letter. When a word is segmented correctly, clients are asked to say the word again, and then to write the word using "mapping."

Sound Manipulation. A series of real or nonsense words are read to the clients one at a time. They are given a set of letters that correspond to the phonemes in each series. Each new word in the sequence involves one phoneme change. Clients set out the letters for the first word, and proceed by changing one of the letters for each new word (*cat/bat/bit*).

Segmenting/Blending. Reading cards are used in two ways. Clients hear a word and are asked to segment by phoneme (auditory only). They then see the card and are asked to segment by phoneme and then blend the sounds into the word. Finally, they write the word using the "mapping" technique described above.

Stories. There are 7 original stories written for this level that use the letters the children have been taught (*Fat Cat Sat on Top, Bob and Pat Jet to the Vet*). These are used for the youngest children, or for children who cannot read at intake. (We do not ask clients to read simple text if they are using the wrong decoding strategy. This just reinforces that strategy.)

Skill Level II. Basic Code. one-to-one and one-to-one(2) mapping. This level introduces the remaining consonants and blends up to and including CCVCC. Sixty-eight of the 72 blends obey one-to-one mapping (no alternative spellings). Consonant digraphs are /ch/ /ng/ /qu/ /sh/ /th/ /*th*/, and the spelling *ck* is also taught here. The concept of a "sound picture" is used to explain how two letters can stand for one sound. Activities at Level 2 are of the same type and follow the same sequence as in Level 1, but with different materials. Coded text is introduced at this level. This is a print format in which "sound pictures" of digraphs are bolded. Several stories were written for this level (*Jack Rat Ran Past, Mr. Chip on a Ship to Hong Kong*).

Skill Level III. The Advanced Code. This level introduces vowel digraphs and phonograms (*ough, igh,* etc.) and remaining consonant digraphs. Thirteen vowel digraphs (most probable spelling) complete the Basic Code. At this level, clients learn the two remaining logics in the code: *spelling alternatives* and *code overlap*. Initially, spelling alternatives are restricted to the 2 to 4 most common (probable) spelling alternatives. There is strict adherence to a sound-to-print orientation, and the concept of a "sound picture" is critical at this stage. Over 700 one-syllable word cards are used at this level. Stories are written at three levels of vocabulary and content for younger and older clients.

Mapping. Clients sort through a set of word cards each containing a target sound spelled in various ways. They locate the various spellings that represent the target sound (EX- /oe/ *toe*), and write the spellings at the top of a sheet of paper (*oe, oa, ow, o*). Next, they write each word (*goat, ghost, boat, bowl, alone, flow, bold,* etc.) under its spelling alternative, while "mapping" each letter/digraph by saying its sound. When this work is completed, they will see the ways to spell the same sound along with a list of words under each spelling option.

Sound Sorting. Code overlap is introduced from the exercise above. Clients are told, for example, that the spelling *ow* can represent two different sounds: /oe/ (low) and /ou/ (cow). Clients are given word cards in which the same spelling represents different sounds. They must sort the cards into two or more categories depending upon the degree of overlap. (EX- sort these words into categories: *show, cow, snow, now, town,* etc.)

Word Analysis. Clients are provided with a list of words containing the spelling alternatives learned so far and are asked to underline every multiple letter "sound picture" (digraphs and phonograms).

Sound Search. Original stories are presented to emphasize a particular sound and its spellings. Clients read the story and underline the words with the target sounds. The next task is to list those words on a worksheet and write the spelling for the sound beside the word. Titles include: *Kind King Karl* (k, c, ck), *Joe's Goat* (oe, oa, o, ow), *Nigel the Nice* (i-e, i, igh, y), *Lance the Prince and Sometimes King of France* (s, c < e, i, y >, ss, ce, se).

Sound Picture Analysis. Original story series are set up in "coded text" for three age groups (*Snuffy Puppy, The Clubhouse, Bob's Life*). After reading a story, clients are asked to identify what each "sound picture" represents in each word.

Scratch Sheet Spelling. Clients have a worksheet listing all the ways to spell a sound. They are given spelling words orally and are asked to write words with each spelling option and decide which one is correct by circling it. During this exercise, the concept of "orthographic tendencies" is pointed out by example. (Example: The sound /ae/ (ei) tends to be spelled ay at the end of words.)

Skill Level IV. Multisyllable Level. This level introduces systematic work on multisyllable words of from two to five syllables. Clients learn how to break words into linguistic "chunks" and to analyse each chunk in sequence, phoneme-by-phoneme. Over 300 word cards are used at this level.

Multisyllable word analysis. A board is presented with rectangular boxes for each syllable, together with sound pictures for individual phonemes printed on tiny cards. The therapist pronounces a word and asks the client to isolate the "chunks" verbally. For example, *plaster* could be split *plas-ter* or *pla-ster*; either is acceptable. Clients next spell each chunk one sound at a time by placing the little cards in sequence, saying each sound in turn. "Schwa" is introduced at this level.

Controlled Reading. Multisyllable worksheets contain "stop signs" between "chunks." These force clients to stop after each syllable.

Reading Multisyllable Words. Clients read words written without stop signs.

Process Spelling. Clients are taught to spell in chunks. This is a five-step procedure. Clients see a word, read the word, assess how many syllables there are, and underline all digraphs/phonograms. Then, with the word moved out of sight, they spell the word from memory.

Special Endings. The final step at this level is the introduction of Latin suffixes, which are taught as multisound "phonograms." (Example: *tion, cious, cian.*) Latin prefixes do not require special attention as most are spelled according to English spelling probabilities.

Phono-Graphix curriculum materials were developed and designed by the first author. Stories for teaching spelling variations were written by the second author. Worksheets and hands-on materials were produced on a MacIntosh computer using QuarkXPress™, Adobe Photoshop™, and Corel Gallery.™

Parent Involvement. Parents sat in on free testing, were given immediate test score feedback, and their children's problems were discussed. They were told that the program was designed for parent participation. This is a considerable financial savings to parents and no parent refused to participate. Most sessions were scheduled to be completed in 12 weeks, and all children were tested at 12 hours or at their last session, if that session was before 12 hours. Parents could participate in sessions as observers if they chose.

Testing and training were carried out at the clinic by the first and third authors. A new clinician saw four clients in their homes.

RESULTS

This was a quasi-experimental design with pre-test/post-test comparisons and no control group. Not surprisingly, since everyone received individual treatment, everyone improved (dependent t-tests on both the Woodcock tests at $p < 0.0001$). More useful are descriptive data on the degree and rate of that improvement.

Standard score conversions were carried out for each child on the Woodcock tests at intake (Form H) and at post-test (Form G). The mean intake standard score on the Word I.D. was 86.4 and final score, 100.1 (mean gain 13.7). Word Attack intake was 88.6, final score 108.1 (gain 19.5). These scores do not take into account the number of clinical hours, which ranged from 3 to 15 hours. When gain scores were computed as the number of clinical hours for each child, average standard score gains were 1.70 per hour for Word I.D. and 2.57 per hour for Word Attack. A new clinician with one week's training (35 hours), obtained similar results with her first four clients (Average Word ID: pre=85.4, post=101.4. Word Attack: pre=94.3, post=105.5), showing that these gains are not restricted to a few teachers. Rather, it suggests that the techniques can be readily communicated to other instructors.

Data were analyzed separately for three age groups, as each had somewhat different diagnostic test profiles. These were 6 and 7 years, 8 and 9 years, and 10 to 16 years. Table I shows the pre- and post-test standard score means (alternate forms G and

H), standard deviations and range scores for intake and final reading scores, overall gains, and gains per hour. A one-way random groups ANOVA was carried out on gain scores converted to gains/hour, with age (6–7, 8–9, 10–16) as the independent variable. Age did not significantly predict change in Word I.D., F (1, 84) = 2.45, $p > .05$), but did significantly predict Word Attack gains, F (1, 84) = 3.33, $p < .05$, with older children making slightly greater gains. Mean points gained per hour for each age group were 1.81, 2.79, 3.11.

The means for intake and final scores on the three phonological measures and for the Code Knowledge test are shown in table II. One-way random groups ANOVAs, with age as the independent variable, were carried out on the phonological measures using intake scores only. Auditory analysis and blending scores were superior in the two older groups of children—for analysis F (2, 72) = 27.09, $p < .001$; for blending, F (2, 59 = 3.34, $p <$ .05. In contrast, intake segmenting scores were marginally better

Table I.

MEANS STANDARD SCORES AND GAINS ON WOODCOCK WORD I.D

Age	Intake	Final	Gains	Gains/hour
6-7 (31)	89.8	103.0	13.25	1.73
S.D.	12.4	11.39	8.55	1.53
range	63–111	80–132	3–36	.25–8.0
8-9 (27)	86.9	99.7	12.77	1.44
S.D.	14.95	14.69	6.70	1.06
range	47–115	62–122	1–26	.25–4.67
10-16 (29)	82.5	97.6	15.1	1.93
S.D.	19.62	15.92	8.62	1.13
range	42–113	63–117	1–39	.08–3.83
MEAN STANDARD SCORES AND GAINS ON WOODCOCK WORD ATTACK				
6-7	92.8	109.6	16.07	1.81
S.D.	13.03	7.44	10.32	1.03
range	63–111	91–120	1–39	.17–4.2
8-9	88.6	108.5	19.74	2.79
S.D.	14.32	15.07	8.86	2.82
range	54–123	88–151	1–39	.08–13.0
10-16	84.4	106.9	22.21	3.10
S.D.	15.88	15.62	10.88	1.96
range	55–113	76–144	3–52	.25–8.0

for the youngest children, though this effect did not reach significance, F (2, 70 = 2.46, $p < .10$).

Four children in this population were mildly retarded with IQs below 80, as reported by their parents. They had uniformly low intake scores on most measures. However, they gained an average of 9.0 standard score points in Word I.D. and 26.3 points on Word Attack. All had 12 hour-long sessions. They had similar gains to the normal children on the phonological tasks. The discrepancy in gains between the two types of reading test needs further study. It shows that these children could apply their new decoding skill more easily to nonsense words than to real words. This may be a function of items on the Woodcock Word ID subtest. Forty-five percent of the items have low probability or irregular spellings, placing more demands on vocabulary skills and/or visual memory.

We also analysed the profiles of severe poor readers who might be considered "dyslexic." These were children of normal intelligence who scored in the 70s or lower on the Word I.D. at intake. The overlap between children "diagnosed" LD and this population was not substantial except in the 10 to 16 years group. There were five children in the age range 7 years, 0 months to 7 years, 8 months (1 diagnosed LD), 5 children 8 years, 0 months to 9 years, 11 months (2 diagnosed LD), and 9 children 10 years, 0 months to 15 years, 8 months (7 diagnosed

Table II.

MEAN SCORES ON DIAGNOSTIC TESTS

Age	AAT (10)		Blending (15)		Segmenting (63)	
	Intake	Final	Intake	Final	Intake	Final
6-7	4.2	7.4	9.4	14.0	48.4	61.3
8-9	5.2	8.7	11.4	14.9	38.3	61.0
10-16	6.3	9.5	12.2	14.5	41.0	62.3

Maximum scores in brackets.

	Code Knowledge %	
	Intake	Final
6-7	44.89	76.65
S.D.	18.86	12.24
8-9	61.21	85.75
S.D.	14.10	7.80
10-16	70.65	90.31
S.D.	12.93	7.01

LD) who met these criteria. Their data for the Word I.D. subtest are illustrated in table III.

The gains were 18.6 for this group as a whole (gains/hour 2.51). The children in the 6 to 7 age group had an average of only 5.4 hours of training and gains of 3.92 points per hour. Because these gains are at least as great as those achieved overall, these data do not support the validity of a special reading disability based upon a discrepancy measure. They certainly do not support the view that such children do not respond to instruction.

We carried out a number of correlations to discover predictors of initial and final reading scores. Correlations between intake phonological awareness measures to intake and final Word ID scores are shown in table IV. Subjects are fewer than the total sample because diagnostic tests were changed a few months into the study.

These values show that phonological processing at intake predicts 16% to 35% (r^2) of the variance in reading scores at intake and at final testing. Most children were at ceiling on the phonological tasks at the end of their sessions, as shown by table 2 and further correlations could not be computed on these scores. The table also shows equally robust correlations for code knowledge and reading scores. However, the strongest predictor of final reading test scores were initial reading test scores, making it difficult to discern whether the other intake scores made any independent contribution to final reading attainment.

Table III. Word I.D. Standard Score Gains for a "Dyslexic" Group

Age	Intake	Final	Gains	Gains/Hour
6-7 (5)	70.4	89.6	19.2	3.92
S.D.	7.99	6.35	8.58	2.39
range	63–79	80–96	12–32	2.0–8.0
8-9 (5)	67.4	81.0	13.6	1.34
S.D.	11.87	11.71	6.91	.58
range	47–79	62–95	4–23	.33–1.9
10-16 (9)	59.5	86.8	23.0	2.50
S.D.	13.84	11.73	7.95	1.15
range	40–78	63–98	13–39	1.1–3.8
TOTALS	65.8	85.8	18.6	2.51
S.D.	11.23	9.93	7.81	1.37
range	40–79	62–98	4–39	.33–8.0

It appears that children's *relative* ranking in reading remains extremely consistent over time, regardless of their initial diagnostic profile.

Several additional analyses were conducted to make corrections for the differing amounts of time in the program and to assess the source of variability in the rate of gains per clinical hour (see table I). We have already seen that age is not a factor in rate of gains in Word I.D. from the ANOVA results. Correlations were carried out for each age group separately between rate of gains per clinical hour, and initial scores on the phonological tests, the code knowledge test, and the initial scores on the Woodcock Reading Mastery subtests. These correlations were not significant (range r =0.09 to 0.33), except for a negative correlation between rate of gains and the Word I.D. intake scores for the 6- to 7-year-old group only (r = -0.38, p<.05). The lower a child's reading score at intake, the greater the gains. We conclude that none of the diagnostic tests, nor initial reading

Table IV. Correlations of Intake Tests to Word I.D.

Age	Test	Word ID Intake	Word ID Final
6-7			
n=25	AAT	.32	.40*
n=20	BLEND	.55**	.53**
n=24	SEGMENT	.59**	.59**
n=20	CODE KNOW.	.64**	.45*
n=31	WORD I.D. IN		.77**
8-9			
n=23	AAT	.56**	.52**
n=21	BLEND	.41*	.38*
n=24	SEGMENT.	.09	.12
n=24	CODE KNOW.	.41*	.36*
n=27	WORD I.D. IN		.85**
10-16			
n=27	AAT	.50**	.51**
n=21	BLEND	.39*	.51**
n=24	SEGMENT.	.29	.25
n=26	CODE KNOW.	.55**	.41*
n=29	WORD I.D. IN		.93**

*p<0.05

**p<0.01

test scores, predict gains/hour. It appears that the variability in rate of gains is too marginal to matter within a short time period of 12-hour sessions or less.

DISCUSSION

Our data show that most poor readers can be remediated to reading-age norms, or beyond, in 12 one-hour sessions (12 weeks) or less. In general, absolute gains are large even when a child is mildly mentally retarded, or fits a "learning disability" profile of age/IQ discrepancies to reading scores. This confirms other research that has shown the discrepancy measure to be invalid as a diagnostic criteria for a "learning disability" or "dyslexia" (Fletcher et al. 1994; Stanovich and Siegel 1994). In fact, our results challenge the notion of a special reading disability such as "dyslexia," confirming the conclusions of Slavin and his group (Slavin, Karweit, and Wasik 1994) who argue that all children, barring the mentally retarded, can be taught to read if the reading program and the method of delivery are effective.

The older children had superior auditory analysis and blending scores to the younger children, but marginally poorer segmenting skills. Vandervelden and Siegel (1995) showed that all three phonological skills typically increase together across the age span. This suggests that the failure of the children in the 10 to 16 age group to improve in segmenting with age is an environmental effect. At intake testing, they often segmented consonant blends as "one sound." As noted in the introduction, many teachers train this response, creating decoding problems. However, as most children were at ceiling by the end of sessions, this shows that segmenting problems are easy to fix.

Reading test scores at intake were far and away the highest predictors of final reading scores, more predictive than either initial phonological awareness or code knowledge. Yet, initial reading scores did not predict the rate of gains/hour. Our conclusions from this pattern of results is that everyone makes similar and consistent progress through the program, and that individual differences in rate of gain are not sufficient to be of any consequence. This pattern of results argues for high consistency of effectiveness of the program for all children, regardless of age, initial levels of phonological awareness, or code knowledge.

A comment is in order about four children referred by us for vision therapy. Three of these children interrupted their sessions until vision training was complete. Although these children represent a small proportion of poor readers, they had the greatest difficulties learning to read prior to receiving visual training. They were unable to track text smoothly from left-to-right due to instability of binocular fusion while tracking, which causes the print to go in and out of focus. These clients remediated easily once their vision training had been completed.

Clients' progress in word recognition and word attack was more rapid and more consistent than is reported for other remedial programs, though comparisons are difficult because research is often absent to back up claims, or methodologically weak (Clark 1988). Ogden, Hindman, and Turner (1989) looked at the effect of three years of Alphabetic Phonics on an initial group of 251 SLD children. Stanford Achievement test scores for 138 children who remained in the program at three years, showed an increase of 3.1 standard score points in phonetic analysis and 7 points in reading comprehension. Estimated remedial time was approximately 600 hours. Children were taught in small groups. Based upon 200 hours per child, this averages to .035 standard score gains per hour. The authors comment that children in grades 3 and up made "minimal progress."

Shanahan and Barr (1995) review research on the popular Reading Recovery program, a school-based one-to-one program. Despite the large number of evaluations reported, methodology was poor in most studies. Dependent variables consisted of non-standardized word lists, or reading from a book series on which the children had been trained. A study by Pinnell et al. (1994) used standardized tests to compare four remedial programs in 40 schools across 10 school districts. The remedial programs included: the standard Reading Recovery program, delivered by either a teacher with one year's training or with two weeks training, a small group version, and teacher initiated remedial programs. Children made no gains on standardized tests in the latter three types of programs and these will not be discussed further.

Testing was carried out after the first six months (February) and again in late May. Gains on the non-standardized "text reading," a typical measure in Reading Recovery research, were 1.5 *SD* (based upon effect size). However, the Woodcock and Gates I reading gains were less remarkable: .5 *SD*, or 7.5 standard score points, averaging .15 points per hour. Gains on standardized tests were lost by May. Furthermore, only pupils who stayed in the program were tested. Seven percent of Reading Recovery children are transferred to special education, and surveys in New Zealand and the United States show that 25% to 30% of children drop out or are removed for "lack of progress." Thus, 32% to 37% of children are not included in the final data analysis.

Higher and more consistent gains are found with the A.D.D. program (Lindamood and Lindamood 1975). Truch (1994) reports on 281 children (85%) and adults (15%) taught in 4-hour intensive sessions, five times a week, totalling at least 80 hours. Truch analysed his data as proportions of clients falling within ranges of scores, but also reports a mean gain of 17 standard score points on the WRAT Word I.D. for the population as a whole, an average of .21 points per clinical hour.

Alexander et al. (1991) also used the A.D.D. program in a clinical setting. They trained 10 "dyslexic" children ages 7 years, 9 months to 12 years, 10 months, who had Woodcock reading score/I.Q. discrepancies of 1.5 standard deviations (range for Word I.D. intake 57—96). Children were seen for periods ranging from 38 to 124 hours, averaging 65 hours. We computed gains for each client based upon Woodcock pre- and post-test scores and the number of clinical hours per client. These were .23 for Word I.D. (identical to Truch) and .34 for Word Attack.

Phono-Graphix gains per clinical hour of 1.70 and 2.57 are over seven times greater than the A.D.D. program for both Word I.D. and Word Attack. They are eleven times greater than the Reading Recovery program (six months only), and 50 times greater than Alphabetic Phonics. Furthermore, like Truch and Alexander et al., our data included *all* clients, not just a proportion of them.

Shanahan and Barr (1995) worked out the cost per pupil of the Reading Recovery program, taking into account average teacher salaries and benefits, and teacher training. These costs worked out to $4,625 per pupil, *in addition to* the average per pupil cost of $5,938. A teachers case load is about ten children per year. Based upon a $45 clinical hour, the A.D.D. program and Phono-Graphix are much better values for the money.

We credit our results to two major factors. First, we teach the entire structure of the alphabet code in a careful sequence so that it is logical *to the child*. In our clinical experience, confusion about the code is the major cause of reading problems for most children. Children with very weak phonemic analysis skills are the minority, except at young ages when part of the difficulty is due to developmental factors. The percent of children scoring below 50% on our version of the AAT was 68% of 6- to 7-year olds, 39% of 8- to 9-year olds, and 25% of 10- to 16-year olds. Rosner and Simon (1971) reported that the average score for normal 6- and 7-year olds on the original AAT was less than 50% correct.

We also credit parents for supporting their children while they completed their homework and during other literary activities. We have no ability to determine the absolute effect of parent participation, except when they fail to do the homework. This happened in only two cases.

We have not carried out a follow-on study to determine whether these gains have been maintained over time, but we can report on a parent survey. We sent anonymous questionnaires to parents covering a period of over two years. The return rate was 50%. Questions were asked about the status of the child at the beginning of remediation, and the status of the child now. Twenty-six percent of the children had previously been diagnosed as LD. *None* were LD now. Twenty-nine percent of the children were on the honor roll, whereas none had been before. The lowest grade in reading or language arts was a C instead of an F. Prior to therapy, grades were C, D, and F only. Now the majority of children were getting B's and A's (average grade B+). Sixty-three precent now read for pleasure whereas none did before. Behavioral improvement at school and higher self-esteem was reported in 100% of cases. One-hundred percent of parents are still using the Phono-Graphix materials. These are encouraging reports and we hope to carry out a more rigorous follow-on study in the future.

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References

Alexander, A. W., Andersen, H. G., Heilman, P. C., Voeller, K. K., and Torgesen, J. K. 1991. Phonological awareness training and remediation of analytic decoding deficites in a group of severe dyslexics. *Annals of Dyslexia* 41:193–206.

Ball, E. W., and Blachman, B. A. 1988. Phoneme segmentation training: Effect on reading readiness. *Annals of Dyslexia* 38:208–25.

Ben-Dror, I., Frost, R., and Bentin, S. 1995. Orthographic representation and phonemic segmentation in skilled readers: A cross-language comparison. *Psychological Science* 6:176–81.

Bradley, L., and Bryant, P. E. 1978. Difficulties in auditory organization as a possible cause of reading backwardness. *Nature* 271:746–47.

Bradley, L., and Bryant, P. E. 1985. *Rhyme and Reason in Reading and Spelling*. Ann Arbor: University of Michigan Press.

Calfee, R., Lindamood, P., and Lindamood, C. 1973. Acoustic and phonetic skills and reading: Kindergarten through twelfth grade. *Journal of Educational Psychology* 64:293–98.

Ceci, S. J., and Roazzi, A. 1994. The effects of context on cognition. In R. J. Sternberg and R. K. Wagner (eds.), *Mind in Context: Interactionist Perspectives on Human Intelligence*. New York: Cambridge University Press.

Chall, J. S. 1967/1983. *Learning to Read: The Great Debate.* New York: McGraw-Hill.
Coulmas, F. 1989. *The Writing Systems of the World.* Oxford: Blackwell.
Dale, N. 1898. *On the Teaching of English Reading.* London: J. M. Dent and Co.
Dale, N. 1902. *Further Notes on the Teaching of English Reading.* London: Philip and Son.
Fletcher, J. M., Shaywitz, S. E., Shankweiler, D. P., Katz, L., Liberman, I. Y., Stuebing, K. K., Francis, D. J., Fowler, A. E., and Shaywitz, B. A. 1994. Cognitive profiles of reading disabiilty: Comparison of discrepancy and low achievement definitions. *Journal of Educational Psychology* 86:6–23.
Fox, B., and Routh, D. K. 1975. Analyzing spoken language into words, syllables and phonemes: A developmental study. *Journal of Psycholinguistic Research* 4:331–42.
Healey, J. F. 1990. *The Early Alphabet.* London: The British Museum.
Henry, M. K. 1989. Children's word structure knowledge: Implications for decoding and spelling instruction. *Reading and Writing: An Interdisciplinary Journal* 2:135–52.
Howard, M. 1982. Utilizing oral-motor feedback in auditory conceptualization. *Journal of Educational Neuropsychology* 2:24–35.
Kramer, S. N. 1963. *The Sumerians.* Chicago: Chicago University Press.
Liberman, A. M., Cooper, F. S., Shankweiler, D. P., and Studdert-Kennedy, M. 1967. Perception of the speech code. *Psychological Review* 74:431–61.
Lindamood, G. H., and Lindamood, P. C. 1969/1975. *Auditory Discrimination in Depth.* Allen, TX: DLM.
Lundberg, I., Olofsson, A., and Wall, S. 1980. Reading and spelling skills in the first two years predicted from phonemic awareness skills in kindergarten. *Scandanavian Journal of Psychology* 21:159–73.
McGuinness, D. 1981. Auditory and motor aspects of language development in males and females. In A. Ansara, N. Geswind, A. Galaburda, M. Albert, and N. Gartress (eds.), *Sex Differences in Dyslexia.* Towson, MD: The Orton Dyslexia Society.
McGuinness, D. 1985. *When Children Don't Learn.* New York: Basic Books.
McGuinness, D. in press. *Cracking the Literacy Code.* New York: Free Press.
McGuinness, D., and McGuinness, C. 1991. Application of Lindamood ADD program in the remediation of children with learning disabilities. Paper presented at the National Montessori Conference. Boston, November 1991.
McGuinness, D., McGuinness, C., and Donohue, J. 1995. Phonological awareness and the alphabet principle: Evidence for reciprocal causality. *Reading Research Quarterly* 30:830–52.
Morais, J., Cary, L., Alegria, J., and Bertelson, P. 1979. Does awareness of speech as a sequence of phones arise spontaneously? *Cognition* 7:323–31.
Ogden, S., Hindman, S., and Turner, S. D. 1989. Multisensory programs in the public schools: A brighter future for LD children. *Annals of Dyslexia* 39:247–67.
Pinnell, G. S., Lyons, C. A., Deford, D. E., Bryck, A., and Seltzer, M. 1994. Comparing instructional models for the literacy education of high-risk first graders. *Reading Research Quarterly* 29:8–39.
Read, C., Yun-Fei, Z., Hong-Yin, N., and Bao-Qing, D. 1986. The ability to manipulate speech sounds depends on knowing alphabetic writing. *Cognition* 24:31–44.
Richards, F.A., and Commons, M. L. 1990. Postformal cognitive-developmental theory and research. In C. N. Alexander and E. J. Langer (eds.), *Higher Stages of Human Development.* New York: Oxford University Press.
Robinson, A. 1995. *The Story of Writing.* London: Thames and Hudson.
Rosner, J., and Simon, D. P. 1971. The auditory analysis test: An initial report. *Journal of Learning Disabilities* 4:384–92.
Shanahan, T., and Barr, R. 1995. Reading recovery: An independent evaluation of the effects of an early instructional intervention for at-risk learners. *Reading Research Quarterly* 30:958–96.

Shankweiler, D., Liberman, I. Y., Mark, L. S., Fowler, C. A., and Fischer, F. W. 1979. The speech code and learning to read. *Journal of Experimental Psychology: Human Learning and Memory* 5:531–44.

Slavin, R. E., Karweit, N. L., and Wasik, B. A. 1994. *Preventing Early School Failure.* Boston: Allyn and Bacon.

Stanback, M. L. 1992. Syllable and rime patterns for teaching reading: Analysis of frequency-based vocabulary of 17,602 words. *Annals of Dyslexia* 42:196–221.

Stanovich, K. E., Cunninghan, A. E., and Cramer, B. 1984. Assessing phonological awareness in kindergarten children: Issues of task compatibilty. *Journal of Experimental Child Psychology* 38:175–90.

Stanovich, K. E., and Siegel, L. S. 1994. Phenotypic performance profile of children with reading disabilities: A regression-based test of the phonological-core variable-difference model. *Journal of Educational Psychology* 86:24–53.

Truch, S. 1994. Stimulating basic reading processes using auditory discrimination in depth. *Annals of Dyslexia* 44:60–80.

Tunmer, W. E., and Nesdale, A. R. 1985. Phonemic segmentation skill and beginning reading. *Journal of Educational Psychology* 77:417–527.

Vandervelden, M. C., and Siegel, L. S. 1995. Phonological recoding and phoneme awareness in early literacy: A developmental approach. *Reading Research Quarterly* 30:854–75.

Wagner, R. K., and Torgesen, J. K. 1987. The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin* 101:192–212.

Woodcock, R. W. 1987. *Woodcock Reading Mastery Tests-Revised.* Circle Pines: American Guidance Service.

APPENDIX 1 CODE KNOWLEDGE TEST

The child sees columns of 50 letters, digraphs and phonograms in large print. The tester points and asks: "If you saw this in a word, what sound would you say?" The score is "correct" if the child gives any of the probable sounds represented by the grapheme. For example, the letters *ie* can represent /ee/ in *chief* or /ie/ in *die.*

i	b	n	ai	ee
e	c	p	ou	ey
a	d	r	ea	ue
o	f	s	oa	ew
u	g	t	ow	au
sh	h	v	igh	oo
ch	j	w	eigh	ui
th	k	x	ay	oy
ck	l	y	ie	oi
qu	m	z	aw	
ce				