"Ay", "Bee", "Cee", "One", "Two", "Three": Using Adaptations of Simultaneous Oral Spelling with Reading-disabled Adults

by

Elaine C. Benton

A thesis submitted in conformity with the requirements
for the degree of Master of Arts
Department of Curriculum, Teaching and Learning
Ontario Institute for Studies in Education of the
University of Toronto

0-612-33977-7

Thesis Title:
"Ay", "Bee", "Cee", "One", "Two", "Three":
Using Adaptations of Simultaneous Oral Spelling with Reading-disabled Adults

Degree: Master of Arts
Year of Convocation: 1998
Name: Elaine C. Benton
Department: Curriculum, Teaching and Learning
University: Ontario Institute of Education at the University of Toronto

ABSTRACT

A sample of six reading-disabled adults showed variations in responses to Alphabetic, Numeric and Logographic adaptations of a print-word learning technique called Simultaneous Oral Spelling (SOS). SOS conditions encourage students to associate a whole spoken word and a whole printed word (Logographic) plus a letter naming (Alphabetic) or a letter counting (Numeric) component analysis. Responses corresponded with patterns in students initial test results. Subjects who had relative strengths in mathematics, word attack and phoneme awareness achieved higher scores and were able to use all SOS variations to their advantage while those who had relative strengths in spelling, word identification and memory were more dependent on Alphabetic training and achieved lower word-learning scores. These results indicate that students' skill "ratios" may predict their print word-learning success. Findings also suggest that rapid, pre-attentive item enumeration ("subitizing") may be a factor in the reading development of students who have already acquired phonological skill.

Remedial reading instruction can only be a "remedy" when it has effects that students need and are able to use. Responses to training will vary with the relative strengths and weaknesses in an individual's pre-existing skills and potentials and it is precisely these variations that interest practitioners and theoreticians. By examining them we may be able to make more accurate determinations about student progress, appropriate instruction and the development of reading and writing skills in general.

As such, reading intervention studies provide us with opportunities to examine the interaction of practical and theoretical concerns. In them we measure the effect of instruction on factors that research has successfully implicated in the development of reading ability. The findings may, accordingly, enrich our evaluation of existing research and theory, current practice and the relevance of each to the process of effective learning in the classroom.

This particular study will examine six reading-disabled adults and their responses to three paired-associate, word learning techniques: one that involves whole word learning, one that incorporates a letter naming analysis and another that involves counting the letters in words. It will attempt to replicate and extend the findings of other studies that have examined adaptations of a teaching tool called Simultaneous Oral Spelling and it will relate its findings to a number of assessment and programming issues in remedial adult education. All of the participants in this study obtained WRAT3 standard test scores that are classified as "deficient". (Jastak & Wilkinson, 1993) (p. 33) In fact, none of the subjects was able to score higher than the 2nd percentile. Their standard WRAT3 reading scores were 51, <45, 56, <45, 45 and <45 respectively.

Simultaneous Oral Spelling (SOS) is a multi-facetted word learning technique that teaches students to store new words in memory by associating their "whole" appearance and pronunciation with the strings of letter symbols, the sequences of letter names and the handwriting motions that, respectively, determine, describe and reproduce their spellings.

In step one of the process, students associate a "whole" spoken word with its "whole" print referent i.e. they say a word that has been written and read aloud for them. In step two, they analyze the components of the written word by naming and simultaneously copy writing each of its constituent letters as demonstrated by an instructor. Finally, in step three, they associate the "whole" spoken word with its' "whole" print referent once more by repeating the word when it is presented as a "whole" and read aloud for them a second time. In the second, analytic step, the letters in the word are examined visually, named audibly and written manually, in the appropriate sequence, so that component visual, auditory and motor information might be associated and stored with the word's "whole" spoken pronunciation and its' "whole" visual presentation.

Essentially, the technique integrates a "whole word" learning routine (steps one and three) and a "word component" analysis (step two) that involves letter naming and letter writing; two analytic elements that can be omitted or manipulated in order to isolate and examine their individual and combined effects. As such, there are three primary variations of the Simultaneous Oral Spelling process: "whole word", "letter naming" and "letter writing".

The "whole word" variation of SOS involves steps one and three of the entire process. It is the "Logographic" training condition in this study. In this condition students are shown a word on a card. They see the experimenter underline the word with her finger and they hear her read the word aloud. They are asked to repeat her motion and say the word themselves. Then the whole routine is repeated a second time.

The "letter naming" variation of SOS involves steps one, two and three but omits the copy writing activity in step two. It is the "Alphabetic" training condition in this study. In it, a target word is presented, underlined and read to the student who reproduces these actions. The instructor then sequentially names each letter in the word while holding her finger beneath it. Students repeat these actions as shown and, lastly, the instructor and the student repeat the whole word underlining and reading procedure a second time.

Finally, the "letter writing" variation of SOS involves steps one, two and three of the SOS process but omits the letter naming activity in step two. In it a target word is presented, underlined and read by the instructor and then by the student. The instructor then writes each letter in the word, in sequence so that the student can copy and/or repeat her actions. When the student has finished writing all of the letters in the word, the instructor and then the pupil repeat the whole word underlining and reading process a second time in order to finish.

This "letter writing" variation of SOS has not been included in the present study. Hulme & Bradley (1984) and Cunningham & Stanovich (1990) have already examined it in detail. Instead students' responses to the Logographic and Alphabetic variations of SOS are compared one to the other and to those associated with a Numeric, "letter counting", adaptation of the process.

The Numeric version of SOS involves steps one and three of the SOS procedure and adds a letter counting rather than a letter naming or a letter writing analysis in step two. In it the instructor and then the student underline and read or say a word aloud when it is presented on a card. Then, the instructor counts each letter in the word out loud while holding her finger beneath it. The student repeats these actions as demonstrated and, finally, the instructor and the pupil repeat the whole word underlining and reading process, in turn.

Simultaneous Oral Spelling has been examined in a number of studies that have established a variety of conditions and proposed several explanations for its relative successes. Hulme and Bradley (1984) compared the full SOS procedure, its' "letter naming" and its' "letter writing" variations to an untrained control condition. Prior, Frye and Fletcher (1987) contrasted the full SOS procedure with an untrained control condition and Thomson (1988) compared the full SOS technique to both an untreated control condition and an unsupervised "visual" word learning exercise. All examined the responses of reading disabled subjects and found that SOS produced significantly better results.

Scott and Ehri (1990), however, incorporated normally developing readers in a study that compared the "letter naming" variation of SOS with a "letter counting" technique. Subjects repeated a word that was read aloud by the experimenter while she moved her finger underneath its spelling. They then responded to the spellings in one of two ways. In the letter-name condition they named the letters while pointing to each in order. In the letter-count condition they counted the letters while pointing to each in order. (p.155) Scott and Ehri (1990) found that letter naming did not produce better learning than letter counting and determined that "it was not necessary to direct subjects' attention to letter names in order for them to use this information in learning to read words."(p.159)

These findings pose one or both of two different questions. First, the "letter naming" variation of SOS may (Hulme & Bradley, 1984) be superior to no training but not (Scott & Ehri, 1990) to a "letter count" training. Second, SOS may be particularly useful for 'disabled' (Hulme & Bradley, 1984; Prior, Fry & Fletcher, 1987; Thomson, 1988) but not for 'normally' developing readers (Scott & Ehri, 1990).

The first of these two questions (is SOS letter naming superior to a letter counting technique?) is addressed in the present study while the second question (is SOS "letter naming" superior for disabled but not for normal readers?) was examined in Hulme and Bradley (1984). Hulme & Bradley (1984) used a within-subject design, an untrained control condition and three different training conditions to systematically vary the multi-sensory components of Simultaneous Oral Spelling and identify the components that were critical to its success. Reading-disabled and normal students were exposed to the following conditions so that their responses could be compared and contrasted. A "VAM" (visual, auditory, motor) condition used the entire SOS procedure including letter naming (A) and letter writing (M). A "VM" (visual, motor) training incorporated letter writing but omitted letter naming and a "VA" (visual, auditory) condition used letter naming but not letter writing. As such, "VM" and "VA" were SOS "letter writing" and SOS "letter naming" conditions. Hulme and Bradley (1984) compared the "VAM" to the "VA" results in order to isolate the effects of "M" (letter writing) and the "VAM" to the "VM" results in order to isolate the effects of "A" (letter naming). They found that all conditions ("VAM", "VA" and "VM") were more effective than an untaught control condition for a group of six year old "normal" readers and for a group of eleven year old "disabled" readers. The letter writing (M) component produced significant improvements in both groups' spelling performances while the letter-naming (A) component appeared to benefit only the disabled readers.

The positive effects of motor/kinesthetic writing activities seen in Hulme and Bradley (1984) had already been established (Hulme, 1981) and were to be elaborated in other studies (Hulme, Monk & Ives, 1987; Cunningham & Stanovich, 1990). Hulme (1981) involved a series of experiments that were designed to investigate the effects of tracing on normal and reading-disabled students' learning of (1) letter names, (2) letter sequences and (3) abstract forms. In them, tracing appeared to improve disabled students visual recognition of all three types of stimuli. Hulme, Monk & Ives (1987) examined the effects of manual tracing on visual-verbal paired-associate learning and also discovered that it improved the learning of letter names. Finally, Cunningham & Stanovich (1990) used three different types of motor activity (typing on the computer, sorting tiles and handwriting) in the SOS procedure. They replicated Hulme & Bradley's (1984) results for normal students and also discovered that the handwriting condition was superior to the use of tiles or computers.

The particularly unique finding of Hulme & Bradley (1984) did not relate, therefore, to the importance of motor activity. It was, instead, the fact that reading-disabled and normal students showed differential responses to the auditory, letter naming component of the SOS procedure. Hulme and Bradley (1984) suggested that "the systematic naming of each letter" helped disabled readers because it circumvented "the need for any explicit analysis of the word into its constituent phonemes." By setting up "a simple, one-to-one relationship between the written letters and their names", sequential letter naming might have 'enabled' the disabled reader to code spelling patterns more effectively than he or she could otherwise have done. In fact, the variation in response between normal and disabled readers might be attributed to "a specific benefit" that could have been afforded to the latter because they had problems "segmenting speech and coding print into verbal memory."(p.441)

If Hulme and Bradley are correct in this assessment, reading disabled students have specific deficits that are partially remedied or, at least, circumvented by the letter naming activity in Simultaneous Oral Spelling. The technique involves activities and/or generates information that they need and are able to use. What then, might those particular activities and/or that particular information be? Are they related to the letter naming process and letter name information in particular or are they related to the segmentation process and the products of word analysis in general? Is the "remedy" a derivative of letter naming and letter names or is it a function of segmentation analysis regardless of the means? Would a "letter counting", segmentation analysis achieve the same ends as a "letter naming" word-learning routine? It might if student only needed visual and not auditory word segmentation or if subjects 'did not need to have their attention directed to letter names in order for them to use this information in learning to read words' as suggested by Scott & Ehri (1990).

The specific objectives of the present study are to address some of these questions by examining the effectiveness of an Alphabetic (SOS "letter naming"), as well as, and in comparison to, a similar word learning technique that incorporates a Numeric

(SOS "letter counting") segmentation analysis. It was hypothesized that one or both of these conditions would have significant effects on students' reading, reading-related and spelling skills. It was expected that these effects would be greater than those experienced in conditions that involved Logographic (SOS "whole word") training or no instruction at all. And finally, it was expected that the effects of conditions might reveal differences between the individual participants in a sample of reading disabled adult students from one English Literacy classroom.

SOS "whole word"(Logographic), SOS "letter naming" (Alphabetic) and SOS "letter counting" (Numeric) conditions were compared in this study in an attempt to isolate the effects of the word segmentation and the letter naming components of the Simultaneous Oral Spelling technique. What could students' varying responses tell us about the nature of word segmentation and letter naming and their importance to word learning, reading and spelling? And finally, how might this information be used in the remediation of this particular student population?

METHOD

Subjects

Four male and two female students were recruited from an adult literacy class in the Greater Toronto Area. Ages ranged from 21 to 57 years with the mean age being 38 years.

All participants spoke English as their only language, belonged to the lower socio-economic class and were born in Jamaica, St. Vincent or Guyana. Although their adult basic skills training had varied, none of the learners were afforded adequate educational opportunities as children. They cited poverty, family obligations and, in two cases, epileptic seizures as the most significant reasons for infrequent early school attendance.

None of the subjects in this study scored higher than the 2nd percentile on the Wide Range Achievement Test. Their standard WRAT3 reading scores were 51, <45, 56, <45, 45 and <45 respectively.

Materials

Twelve short texts and lists were used in this study. They were reproduced and created from the first twelve selections provided by a program called Individualized Directions in Reading (Steck-Vaughn, 1974).

Each of the twelve texts was a short story that covered similar subject matter, was written for beginning students and was also appropriate in content for adult new readers.

Each of the twelve lists was created by writing all of the words in one of the stories in reverse order so that each story was, effectively, written backwards in vertical columns.

Each of the stories was presented with its own, accompanying list so that students read the text first and then encountered it again in its' list format. All texts and lists were presented to students in an 18pt font. One of the most difficult examples is given in Appendix A.

Design and Procedures

Six single subject examinations were conducted for this study: with each subject progressing through an Initial Testing, an Instruction and a Final Testing Phase. Initial Testing included standard achievement tests, measures of reading related skills and a number of text and list readings. Instruction followed a repeated baseline design that alternated between one of three Un-Trained and one of three Trained conditions. Four post-training dependent variables and four Pre/Post training dependent variables were used to measure the effects of these six conditions on (a) target word learning and (b) reading related skills respectively. Pre/Post tests of reading-related skills i.e. of letter naming ability, phoneme awareness, phonological recoding and memory, were conducted the day before and the day after each training session while measures of target word learning were taken the day after each condition and again in the Final testing phase of the study. Final testing of target-word learning occurred three weeks after all of the training had been completed. Reading-related skill tests were not repeated at that later date.

The same six sets of eight target words were used for word learning in the Instruction phase of each and every case in the study. They were counterbalanced across the six trained and untrained conditions, which were, in turn, counterbalanced across the six different subjects. As such, each participant in the study received his or her training in a unique sequence with no one target word set being associated with a particular condition. Table 1 illustrates this design.

Table 1: Six single-subject designs: Instruction Phase

	Subject (1)	Subject (2)	Subject (3)	Subject (4)	Subject (5)	Subject (6)
Day 1						
Training:	Logographic Word set 2	Logographic Word set 1	Numeric Word set 6	Numeric Word set 5	Alphabetic Word set 4	Alphabetic Word set 3
Testing:	Untrained Word set 1	Untrained Word set 6	Untrained Word set 5	Untrained Word set 4	Untrained Word set 3	Untrained Word set 2
Day 2						
Testing:	Logographic Word set 2	Logographic Word set 1	Numeric Word set 6	Numeric Word set 5	Alphabetic Word set 4	Alphabetic Word set 3
Testing:	Reading-Related skills	Reading-related skills	Reading-related skills	Reading-Related skills	Reading-related skills	Reading-related skills
Day 3						
Training:	Numeric Word set 4	Alphabetic Word set 3	Logographic Word set 2	Alphabetic Word set 1	Logographic Word set 6	Numeric Word set 5
Testing:	Untrained Word set 3	Untrained Word set 2	Untrained Word set 1	Untrained Word set 6	Untrained Word set 5	Untrained Word set 4
Day 4						
Testing:	Numeric Word set 4	Alphabetic Word set 3	Logographic Word set 2	Alphabetic Word set 1	Logographic Word set 6	Numeric Word set 5
Testing:	Reading-Related skills	Reading-related skills	Reading-related skills	Reading-Related skills	Reading-related skills	Reading-related skills
Day 5						
Training:	Alphabetic Word set 6	Numeric Word set 5	Alphabetic Word set 4	Logographic Word set 3	Numeric Word set 2	Logographic Word set 1
Testing:	Untrained Word set 5	Untrained Word set 4	Untrained Word set 3	Untrained Word set 2	Untrained Word set 1	Untrained Word set 6
Day 6						
Testing:	Alphabetic Word set 6	Numeric Word set 5	Alphabetic Word set 4	Logographic Word set 3	Numeric Word set 1	Logographic Word set 1
Testing:	Reading-Related skills	Reading-related skills	Reading-related skills	Reading-related skills	Reading-related skills	Reading-related skills

Initial Testing

Standardized Tests

Standard testing was conducted on the first day of the Initial Testing Phase of each experiment. Students were given the Reading, Spelling and Mathematics sub-tests of the WRAT3 (Jastak & Wilkinson, 1993), the Word Identification and Word Attack sub-tests from the Woodcock-Johnson Tests of Cognitive Ability (Woodcock & Johnson, 1989) and both of the Auditory Sequential Memory and the Visual Sequential Memory sub-tests of the Illinois Test of Psycholinguistic Ability (Kirk, McCarthy & Kirk, 1968). Each testing session lasted approximately one and one half hours.

Text/List Reading

Initial readings were conducted over four days during four, one and one-half hour sessions. Students were asked to read twelve short texts and twelve short lists: one text followed by one list, at a time, so that there were twelve, text/list, reading exercises in total.

The experimenter instructed participants to read out loud so that their errors could be transcribed phonetically during each of the exercises.

Subjects' errors from each of the text/list reading exercises were subsequently compiled and compared so that commonly made errors could be isolated. Six target word sets of eight words each were determined in this manner. Word set one contained four words from story one and four from story two. Set two incorporated four words from story three and four from story four etc.

Text and list readings may not have presented an equal challenge to each of the subjects in this study. It was hoped, therefore, that this method of selecting target words would ensure that the target words would be of comparable difficult for all of the six subjects in the study. Target-word sets are given in Appendix B.

Initial Tests of Reading-related Skills

Four different reading-related skills were measured in this study. They were letter naming, phoneme awareness, phonological recoding and memory. A number of measures of each skill were given in the Initial Testing phase of each experiment and were repeated after each training condition in the Instructional phase that followed. The objective was to measure participants' reading-related skills prior and subsequent to each training session in order to detect any changes that might occur because of them.

At the end of the study, tests were scored and expressed as proportions of correct responses. These proportions were then averaged in order to calculate a total, composite score for each skill category. Measures, and their order of presentation, were as follows:

Letter Naming: Subjects received three different tests of letter-naming skill; one to measure accuracy, one to measure speed and one to measure their ability to name letters that were presented in groups or pseudowords.

The Letter Identification Test Sheet (Clay, 1993) was used during the accuracy and the speed tests. It is a page of randomly ordered lower and upper case letters. The test of letter naming accuracy had no time limit. Students were told to 'take their time' and 'do their best' to read the letters on the sheet. They were awarded one point for each correct response to a letter with a maximum score of 54. In the letter naming speed test students were asked to 'do their best' to read the letters 'as quickly as they could'. The number of seconds taken to name 54 letters was recorded.

A final test of "letter knowledge" (Vandervelden & Siegel, 1995) was used to measure students' ability to correctly name each of the letters in each of the following stimuli: di, mo, ta, sup, mif, fak, tok, bes, kus, pif, dep, hub, gam, bisk and spak. These letter sequences were presented in lower-case and then again, in upper case. The maximum score was 86.

Phoneme Awareness: Subjects received seven different tests of phoneme awareness; initial phoneme recognition, final phoneme recognition, phoneme location, phoneme recognition/location and phoneme blending, sequential segmentation and rhyme detection.

Initial phoneme recognition (Vandervelden & Siegel, 1995). The experimenter instructed subjects to "listen for" a particular sound at the beginning of four words. Students responded "yes" it is there or "no" it is not there. Target phonemes were: /s/, /j/, /m/, /k/, /r/, /b/, /t/, /p/ and /h/.Test stimuli are shown in Appendix C. There was a 50% likelihood of "chance" successes on this test. The maximum score was 36.

Final phoneme recognition (Vandervelden & Siegel, 1995. The examiner requested that students "listen for" a particular sound at the end of four words. Participants responded "yes" it is there or "no" it is not. Target phonemes were the same as for the initial phoneme test with the omission of /h/. Word stimuli are given in Appendix D. There was a 50% likelihood of "chance" successes on this test. The maximum score was 32.

Phoneme location (Vandervelden & Siegel, 1995. The experimenter asked students to indicate whether a particular sound was present at the beginning or at the end of four different word stimuli. Individuals responded by saying "first" or "last". Target phonemes were the same as those used in the test of final phoneme recognition. Word stimuli are given in Appendix E. There was a 50% likelihood that correct responses could be achieved by "chance". The maximum score was 32.

Phoneme recognition/location (Vandervelden & Siegel, 1995). Subjects were instructed to give the location of a target phoneme if they detected it in each of four different word stimuli. Participants responded by saying "first", "last" or "no". Target phonemes were the same as those listed in the final phoneme recognition test. There was a 33% likelihood of "chance" success on these test items. The maximum score was 32. Word stimuli are listed in Appendix F.

Sequential segmentation (Vandervelden & Siegel, 1995). The examiner requested that subjects repeat a word that was spoken for them: once as a whole and once "very slowly so that we can hear all of the sounds in it". Target stimuli were: /bat/ (4), /top/ (4), /mitt/ (4), /dime/ (4), /feet/ (4), /hook/ (4), /puck/ (4), /kite/ (4), /sock/ (4), /hump/ (5), /desk/ (5), /skate/ (5), /basket/ (7); /mif/ (4), /fak/ (4), /tok/ (4), /bes/ (4), /himp/ (5), /skete/ (5).The maximum score was 84. Credit was given for the students' whole word and for their word segmentation responses.

Phoneme blending (as in Yopp, 1988). Participants were asked to "tell what word we would have if we put the following sounds together". Thirty words were presented in three groups that corresponded to (a) two phoneme words, (b) three to four phoneme words that were segmented into onset and rime (e.g. st-ep, f-at) and (c) three to four phoneme words that were segmented into three parts (e.g. c-a-t, d-e-sk). The component sounds of each word were spoken at approximately half-second intervals. After each word, the student was asked to tell what word he or she heard if he or she blended the sounds together. Word stimuli are given in Appendix G. Students were awarded one point for each correctly blended word. Partial scores were not given. 30 was the maximum score.

Rhyme detection (Yopp, 1988). Twenty word pairs were presented to each subject after the concept of rhyme had been defined as "words that sound the same at the end". Students were asked to indicate whether or not the two words in each pairing rhymed with one another. Word pairs are listed in Appendix H. There was a 50% likelihood of "chance" successes on each test item. There was a maximum score of 20.

<u>Phonological Recoding:</u> Participants received five different tests of phonological recoding; letter-sound recognition, letter-sound production, speech-to-print matching, pseudoword reading and spelling.

Letter-Phoneme recognition (Vandervelden & Siegel, 1995). Students were asked to point to a letter whose sound had been said by the experimenter. The letters b, f, m, s, g and b, t, k, p, d were presented. A score of 10 was the maximum.

Letter-Phoneme production (Vandervelden & Siegel, 1995). Students were required to say the sound of the letters that the experimenter pointed to. The letters b, f, m, s, g and b, t, k, p, d were presented. Again, 10 was the maximum score.

Speech-to-print matching (Vandervelden & Siegel, 1995) Students were told that the experimenter would say a word and that they were to find and point to its match in a set of three words on a card. Thirty-two spoken words were then presented aurally, one at a time, so that participants could indicate their appropriate matches in the accompanying sets of three printed words. Printed words were ordered to assess phonological recoding from partial to complete: making a distinction between "mask, dress and boat", for example, depends on initial consonant differences while making a "meat, mask, mold" distinction depends on final consonant differences. A third and fourth set of words could only be distinguished by final consonant and vowel differences. These sets included sets like "milk, mask, monk" and "big, bug, bag". First and final consonant letters or phonemes were restricted to the set: /b/, /d/, /f/, /g/, /h/, /k/, /m/, /p/, /s/ and /t/. Target word sets one, two, three and four are presented in Appendix I. There was a maximum score of 32.

Pseudoword reading (Vandervelden & Siegel, 1995). Fifteen pseudowords were presented one at a time, on word cards, for participants to read. Students were told that the words would be "strange" and that they probably would not have seen them before. They were asked to do their best to figure and say the words out loud. Complete retrieval recoding measured accuracy in reading the pseudowords di, mo, ta, sup, mif, fak, tok, bes, kus, pif, dep, hub, gam, bisk and spak (totaling 15). Partial retrieval recoding was then measured (1) by crediting the number of letters recoded correctly for each pseudoword across the set (totaling 44) and (2) by computing sub-scores for initial, final and vowel recoding. The latter were based on the following subsets: sup, mif, fak, tok, bes, kus, pif, dep, hub, gam (totaling 20) to assess initial and final consonant recoding and sup, mif, fak, tok, dep (totaling 5) to assess vowel recoding. These particular subsets were used in order to measure the development of students' phonological skill as it may have progressed in its thoroughness from the initial to the final and to the medial locations of the letters and sounds found in words.

Spelling (Vandervelden & Siegel, 1994). Students were asked to "do their best" to spell the following set of words and pseudowords: bat, mitt, puck, sock, deck, top, feet, dime, mif, fak. Their responses to these dictations were scored on the number of phonemes represented by their spelling. Three scores were given: initial consonant recoding (with a maximum score of 10), final consonant recoding (with a maximum score of 10) and vowel recoding (with a maximum score of 5 based on the following subset: bat, mitt, puck, deck, top). Again, subsets were used in order to describe and credit phonological recoding skills at various stages in their development from partial to complete.

Memory: Three measures of memory were administered. They were auditory memory, visual memory and listening span.

Auditory memory (Siegel & Ryan, 1989). Participants were read six sets of five letters on them. Half of these sets contained rhyming letters and the other half listed nonrhyming letters. The order was intermixed and determined randomly. Subjects were told that they would hear some letters that they should write down when the experimenter had finished saying all of them. They were asked to write down the letters exactly as they remembered hearing them. Rhyming letter sets included: B, C, D, G, P, T and V while nonrhyming sets included: H, K, L, Q, R, S and W. Only letters that were recalled in the correct serial position of each trial were scored as being correct. Letters were read at approximately ½ second intervals. There was a maximum score of 30. Letter stimuli are given in Appendix J.

Visual memory (Siegel, 1994) (similar to Shankweiler et. al, 1979). Participants were shown six different cards that each had five letters on them. Three of the cards contained rhyming letters and three contained non-rhyming letters. The order was intermixed and determined randomly. Subjects were informed that they would be shown several cards with letters on them. They were told to write down the letters as they remembered seeing them, as soon as the experimenter turned the card face down on the table. Stimuli were presented for three seconds and the maximum score was 30. Letter stimuli are given in Appendix J.

Listening span (Siegel & Ryan, 1990) (based on Daneman & Carpenter, 1980). Four sets of sentences were presented to participants aurally; each sentence presented with the final word missing. The task for the participant was to state the missing word aloud and to repeat all of the missing words from the set when it had been completed. There were four set sizes or levels (2, 3, 4 and 5). Sentences were chosen so that their missing word would be highly predictable, thereby, minimizing word-finding problems on the part of the students. Examples from set one are as follows:

Sentence one: "The sun comes up in the ...." (morning)

Sentence two: "People often drive in ...." (cars)

(morning) (cars)

Participants were asked to (1) complete each sentence as it was given and (2) repeat each of the words that they used, in the correct order, when all of the sentences in a set had been completed. Probable responses are given in brackets. Students may have responded differently and were awarded full marks provided that they were able to reiterate their own responses in the order that they gave them in. Word sets one through four are given in

Appendix K. One point was awarded for each word remembered in its correct order to a maximum score of 14 in total.

Initial pre-tests of reading-related skills were given in one session that lasted one and one half hours.

Instruction

The Training Phase of the experiment was conducted over six days. Students were trained and tested individually in sessions that lasted approximately one hour. Untrained target word sets were tested and Trained target word sets were learned on odd number days while Trained target words and reading-related skills were tested on the following, even number days. Table 1 outlines the activities that were involved in each day of the instruction schedule.

Experimental Conditions.

Each subject's training required that they learn one, unique set of eight target words in each of three different paired-associate learning conditions. A single instructional session was devoted to each of the following Logographic (SOS "whole word"), Numeric (SOS "letter counting") and Alphabetic (SOS "letter naming") training conditions. See Table 1 for details.

Logographic.

In this whole word training condition, target words were presented one at a time on cue cards. The experimenter read each word while running her finger beneath it. Subjects repeated the pronunciation while underlining the word with their own finger. Experimenter and participant each repeated the entire procedure so that each word was read and underlined four times in total; twice by the experimenter and twice by the learner.

Alphabetic.

This letter naming condition duplicated the Logographic condition but with an additional, intermediate, step. Each word was read aloud and underlined once by the experimenter and once by the subject. The experimenter then sequentially named each letter in the word while pausing her finger beneath it. Participants repeated these actions as demonstrated. Finally, the experimenter and then the subject repeated the whole word reading and underlining procedure a second time as in the Logographic condition. As such, Alphabetic conditioning included Logographic training and added a letter naming component to it.

Numeric.

The letter counting training also duplicated the Logographic condition but included a different, additional analysis. Each word was read aloud and underlined once by the experimenter and once by the subject. The experimenter then counted each letter in the word while pausing her finger beneath it. Participants repeated these actions as demonstrated. Finally the experimenter and then the subject repeated the whole word reading and underlining procedure a second time as in the Logographic condition. The Numeric condition was, then, the same as the Logographic condition but with an additional, numerical analysis.

Measures of Target Word Learning

Effects of practice and training were measured with four dependent variables; Number of Learning Trials, Target Word Discrimination, Reading and Spelling.

Learning Trials.

The Learning Trials variable was used to measure the number of trials taken by a learner to achieve a predetermined success criterion on all eight of the target words in a set. Success was defined as occurring when the participant had read a target word correctly on three consecutive trials. (Vandervelden & Siegel, 1996) This variable only applied to the Logographic, Numeric and Alphabetic training conditions and the specific target word sets that were used in them. Since there was no explicit training or learning in the untrained baseline conditions, there is not learning trials data for those conditions and/or the specific word sets that were used in them.

Discrimination.

Discrimination was assessed by a subject's ability to recognize and/or distinguish target words when each was placed in a list of ten visually similar words. Foil words differed from the target in only one respect. They each had one incorrect letter in either the initial, final or medial position. Individuals' responses were scored highest if they were correct but partial scores were given to errors. Chosen foils that differed by letters in the medial position were scored higher than those that differed by a letter in the final position. Words that differed from the target by their initial letter were given the lowest possible score. The following example illustrates and explains this system in more detail. The target word "purr" appeared in the following list: perr, purs, curr, porr, purt, burr, pirr, purr, purl, purn, furr, parr. If the subjects chose the correct word from the list, they were awarded four points. If they chose perr, porr or parr, they were given three. If they pointed to purs, purt, purl or purn they scored two and, finally, if they selected curr, burr or furr, they scored a single point.

Reading.

Reading was measured by the difference between the number of target words read correctly in students' initial readings and the number read correctly in final tests that were administered the day after each target word training session.

Spelling.

The spelling variable was used as a measure of participants' post-training ability to spell target words that were given to them in dictation. Partial scores were given for the number of correct letters and/or phonemes that a student was able to record.

Pre/Post Tests of Reading-related Skills

Measures of reading-related skills were taken between training sessions during the Instructional phase of each case in this study. The same tests of letter naming, phoneme awareness, phonological recoding and memory that were used in the Initial testing phase were used again, before and after each of the training conditions, in order to measure any changes that occurred in these reading-related skills because of them. Post-tests of one condition also served as pre-tests for the next. Tests were given in the same order and used the same stimuli on each of the four occasions that they were delivered.

Final Testing

In order to obtain a measure of long term word learning effects, three of the aforementioned tests of conditional target word learning (Discrimination, Reading and Spelling) were given to students a second time three weeks after the Training Phase of the experiment was completed. These dependent variable scores will be referred to as the " +3" results.

Reading Error Types and the Analysis of their Distribution

Initial and post Condition text and list readings were recorded so that the type, severity and distribution of errors could be determined.

Four types of error were defined; Minus Ones, Good Guesses, Wild Guesses and Non-responses. Minus One errors deviated from the target word by no more than one letter-phoneme correspondence. An actual example was "mane" instead of "male". Good Guesses were off by an affix or were able to identify two of the target word's initial, final and medial sounds. Actual examples included "hunt" instead of "huge". A Wild Guess matched one or none of the initial, final and medial phonemes correctly. Examples from students' readings included "grade" instead of "grew" and "always" instead of "lawyer". See Appendix L for more examples taken from the transcripts of subjects' readings.

SOS Word Retrieval

Three of six subjects typically used letter naming as a method of recalling difficult words from memory. If they could not remember a word while reading, they would stop and try to retrieve it by sequentially reading out the names of each its letters. This practice was permitted during the study when students would otherwise have had no response. Non-response errors were registered in the students' reading data but their SOS recall responses were also recorded in order to measure the recall technique's effectiveness.

RESULTS

Descriptive/Graphic and Statistical means of analysis were employed in this study. In the more descriptive examination, Subjects' Standard test, Pre/Post test and conditional target-word learning scores were tabled and/or plotted graphically. Standard scores and proportions of correct responses were used to determine and describe initial and change profiles for each participant on each of the four different word-learning measures. Student profiles were then compared and contrasted in order to isolate relative strengths and weaknesses that might explain why some participants did better than others and why each individual achieved his or her best target-word learning scores in a given set of conditions. The objective of this data treatment was to capitalize upon the single-subject design of the study (Borg & Gall, 1989) and provide a detailed analysis of the total sample findings.

The combined, (N=6), data were subsequently assessed statistically in a quantitative analysis. Non-parametric tests of statistical significance were used to compare differences in training effects and tests of bivariate correlation were used in order to assess the strength of relationships between pairs of dependent and standard test variables. Kendall's tau-b coefficients were used with two-tailed tests of significance. A total sample analysis was conducted, in this manner, in order to provide a context for the individual case treatments.

Finally, there is a descriptive evaluation of subjects' attempts to use Simultaneous Oral Spelling as a word recall technique. The results of these efforts were compared to students' initial reading results. Differences in their word recall performances were then assessed and characterized as positive, negative or neutral.

Descriptive and Graphic Analysis

Standard test, Pre/Post test and target-word learning scores were collected and assembled in order to determine and describe a profile of each student's abilities and responses to training. The standard scores from participants' WRAT3 and Woodcock-Johnson tests and the standardized age norms (year-month) from their ITPA tests are shown in Table 2.

Table 2: WRAT3 and Woodcock-Johnson Standard Test Scores and ITPA Standardized Age Norms

Participant/ Test	1	2	3	4	5	6
WRAT3: Reading	51	<45	56	<45	45	<45
WRAT3: Spelling	62	55	50	48	55	49
WRAT3: Arithmetic	60	60	65	46	67	48
Woodcock-Johnson: Word-Identification	67	31	54	52	44	48
Woodcock-Johnson: Word Attack	56	30	63	57	44	64
ITPA: Auditory Sequential Memory	4-2	3-1	7-11	4-0	5-0	8-4
ITPA: Visual Sequential Memory	5-1	5-7	5-7	5-7	4-10	5-4

Subjects' initial scores on reading-related skill tests were expressed as proportions of correct responses. These were summed and averaged to provide the composite scores that are given, by type, in Table 3. Each of these combined scores represents the proportion of correct responses that a subject achieved on his or her skill tests. The Letter Naming Accuracy composite combines the proportions of correct responses from two of the three Letter Naming Skills tests that were administered. Test results from the letter naming speed test have been shown separately in Table 4 and in Figures 2, 4, 6, 8, 10 and 11 because they could not be expressed as a proportion of correct responses. Letter naming speed scores were recorded as the number of seconds that it took a subject to read 54 letters. These figures were converted and written as a measure of letters per second.

Table 3: Initial Reading-Related Skill Test Composite Scores (Proportions Correct)

Participants/ Composite Scores	1	2	3	4	5	6
Letter Naming Accuracy	1.0	.99	.99	.96	.99	.98
Phoneme Awareness	.00	.49	.84	.57	.64	.61
Phonological Recoding	.77	.75	.84	.77	.90	.66
Memory	.51	.58	.7	.66	.43	.68

Figure 4: Initial Letter Naming Speed Scores (letters per second)

Participants/ Scores	1	2	3	4	5	6
Letter Naming Speed	1.13	1.17	1.2	1.5	.86	1.06

Calculations are shown in Appendix O.

The relationships between students' test scores are made more explicit in Table 5. Test names are abbreviated as follows: Mathematics (M); Spelling (S); Reading (R); Word Identification (WI); Word Attack (WA); Auditory Sequential Memory (ASM); Visual Sequential Memory (VSM); Phoneme Awareness (PA); Phonological Recoding (PR) and Memory (M). WRAT3, Woodcock-Johnson and ITPA scores were standard scores and reading-related skill scores were composites.

Table 5 Test and/or Skill Relationships

Test type/ Participant	WRAT3 Tests	Woodcock-Johnson Tests	ITPA Tests	Initial Reading-Related Skill Tests
P1	S>M>R	WI>WA	VSM>ASM	PR>M>PA
P2	M>S>R	WI=WA	VSM>ASM	PR>M>PA
P3	M>R>S	WA>WI	ASM>VSM	PA>PR>M
P4	S>M>R	WA>WI	VSM>ASM	PR=M>PA
P5	M>S>R	WI=WA	ASM>VSM	PR>PA>M
P6	S>M>R	WA>WI	ASM>VSM	M>PR>PA

Participants' scores on all measures of target-word learning are shown in Table 6. These tests were conducted the day after each training and again three weeks after the cessation of all training. The latter are described, in Table 6, as +3 measures. All scores represent the proportion of correct responses achieved by a student. Reading and Reading+3 scores represent increases or decreases (shown in brackets) that were seen between initial reading scores and post-training scores (Read variable) or between initial reading scores and the target-word reading scores that were collected three weeks after the cessation of all training (Read+3 variable). Untrained numbers are averages of the proportions of correct responses from all three untrained word-learning conditions.

Table 6: Measures of Target Word Learning

Measure/ Participant: Conditions	Learn	Discrim	Discrim+3	Read	Read +3	Spell	Spell +3
Participant 1:							
Logographic	.54	.72	.63	.00	.25	.41	.30
Alphabetic	.43	.78	.69	.42	.38	.71	.50
Numeric	.49	.75	.69	.31	.50	.58	.45
Untrained average	N/A	.67	.73	.25	.34	.51	.52
Participant 2:							
Logographic	.39	.66	.78	.32	.75	.67	.60
Alphabetic	.50	.81	.75	.43	.50	.78	.65
Numeric	.45	.81	.81	.10	.38	.56	.51
Untrained average	N/A	.79	.79	-.05	.25	.60	.59
Participant 3:							
Logographic	.34	.88	.84	.58	.50	.86	.83
Alphabetic	.34	.88	.81	.31	.75	.79	.74
Numeric	.33	.72	.78	.13	.50	.65	.50
Untrained average	N/A	.69	.74	.37	.37	.74	.70
Participant 4:							
Logographic	.61	.84	.81	.30	.50	.67	.74
Alphabetic	.40	.75	.69	.11	.38	.73	.64
Numeric	.53	.78	.63	.00	.75	.75	.78
Untrained average	N/A	.78	.81	.39	.50	.69	.67
Participant 5:							
Logographic	.33	.88	.81	.46	.50	.90	.82
Alphabetic	.60	.81	.88	.50	.88	.76	.70
Numeric	.56	.75	.88	.58	.50	.93	.81
Untrained average	N/A	.78	.79	.15	.63	.85	.78
Participant 6:							
Logographic	.60	.63	.69	.21	.25	.60	.60
Alphabetic	.49	.72	.78	(.30)	.50	.72	.72
Numeric	.65	.75	.50	.14	.25	.51	.49
Untrained average	N/A	.71	.70	.07	.38	.55	.57

Within Subject Analyses

Initial reading-related skill scores, Standard test results and target-word learning measurements were used to determine the following profile evaluations. Each profile has two primary components; a description of the relative strengths and weaknesses that were evident in a participant's initial test scores and an examination of the differences between a subject's Logographic, Alphabetic and Numeric target-word learning scores. The first component is intended to provide a description of the students and the abilities that they brought to the study. The second is meant to provide a set of labels that describe a subject's responses to the three training conditions that they received during the study. Which training conditions were associated with higher word-learning scores; Logographic (L), Alphabetic (A) or Numeric (N)? What kind of information was the student best able to use in their word-learning efforts? Four different labels were used to categorize students' responses to training as revealed by their scores on the learning trials, discrimination, reading and spelling measure of target-word learning. Logographers" achieved higher scores with Logographic training than they did with Numeric or Alphabetic training (i.e. L>A and L>N). "Segmenters" performed better in the Numeric and Alphabetic than they did in the Logographic condition (i.e. A>L and N>L). "Letter Namers" had higher scores in Alphabetic and Logographic conditions than they did in Numeric training (i.e. A>L and L>N) and "Letter Counters" achieved their best performances with Numeric and Logographic rather than Alphabetic training (i.e. L>A and N>L).

Post-training fluctuations in students' reading-related skill scores are also given in the profiles that follow. They are shown graphically in Figures 1 through 12.

Participant 1 (P1) was a 57 year-old male who had significant difficulty processing instructions during the study. He was a shy and careful individual who spoke, wrote and moved slowly and deliberately. He did not recall ever having learned letter-sound correspondences but he had been taught to use SOS letter naming as a word retrieval strategy. In fact, P1 used SOS letter naming habitually and tended to speak of learning and knowing "spellings" rather than "words".

Initially, P1 scored higher on his spelling than on his mathematics and reading tests. His word identification was better than his word attack and his visual sequential memory was superior to his auditory sequential memory. Wild guesses and non-responses were his predominant reading errors and letter naming was his strongest reading-related skill. P1 had particularly poor phoneme awareness and phonological recoding skills. He was able to complete test measures of the latter but was unable to comprehend and could not respond to the tests of phoneme awareness. They were discontinued. See Table 2, 3 and 4.

P1 did not appear to benefit from all forms of instruction. The average of his untrained target-word learning scores was as good or better than the average of his trained results. See Appendix M for details. Context and overall text/word difficulty all appeared to be as great a factor as instruction and the subject's best reading improvements occurred in conditions that had relatively higher success rates from the outset. Generally, his correct readings increased when his wild-guesses decreased. See Appendix N for details.

Training may also have had mixed effects on this subject's reading-related skills. His composite reading-related sub-skill scores all decreased after Logographic training.

Figure 1
Reading-Related Skills
Participant 1

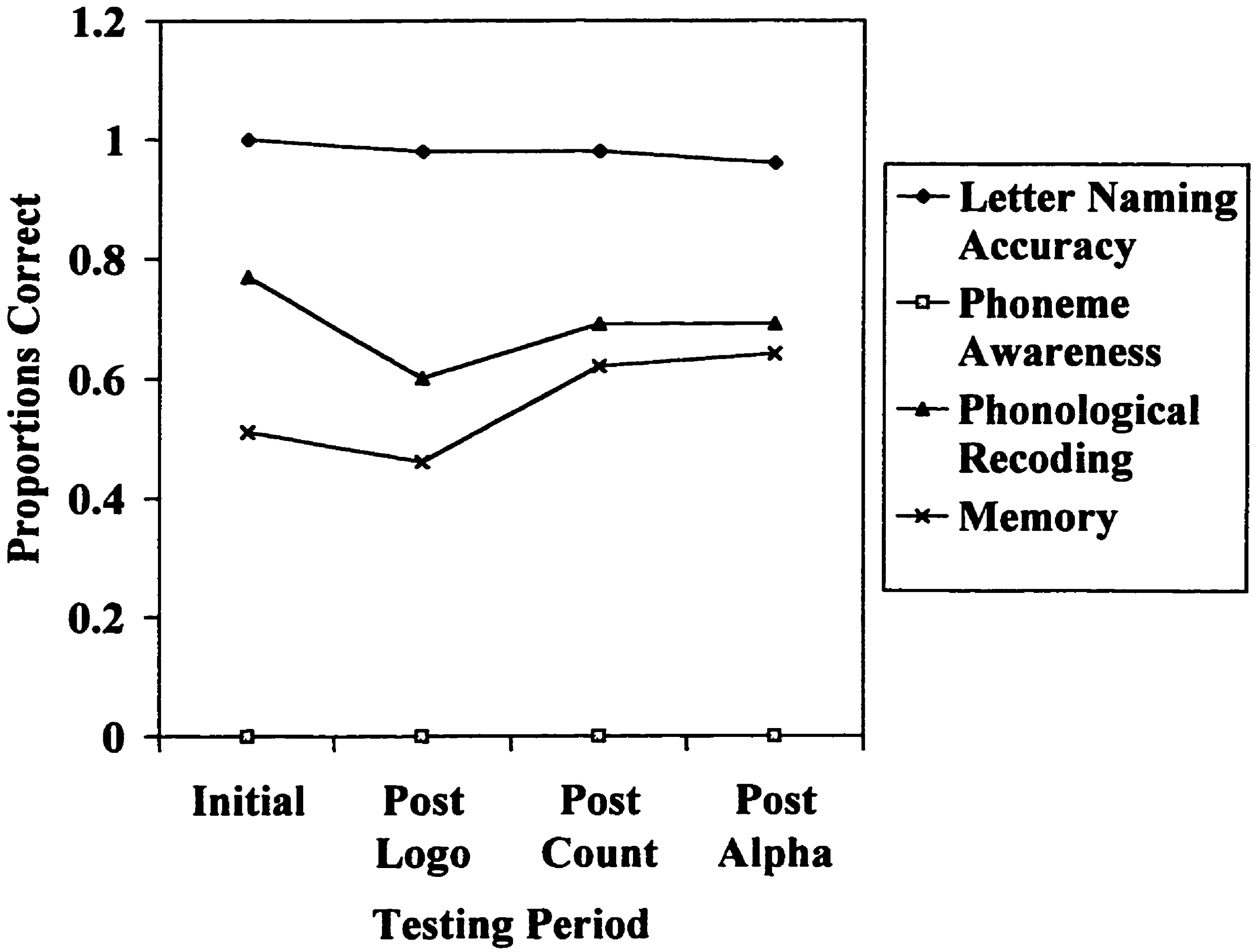
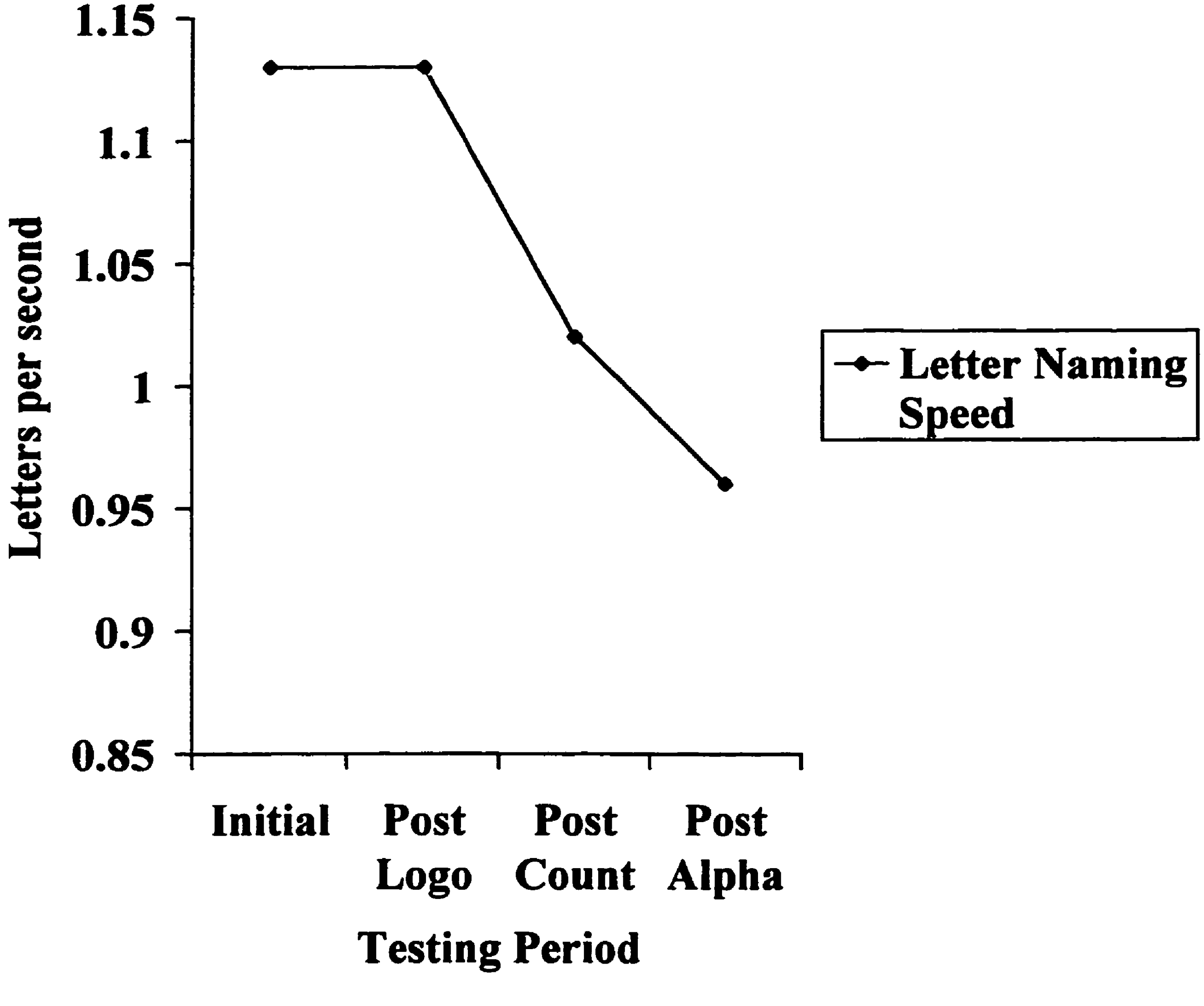


Figure 2
Reading-Related Skills
Participant 1



Phonological recoding and memory recovered, somewhat, during the Alphabetic and Numeric conditions but it was only memory that showed any improvement with training. See Figures 1 and 2. Specific test results showed that letter-naming, pseudoword reading and letter-sound recognition and production remained constant or worsened while speech-to-print matching and spelling were stable or improved. The latter occurred after Alphabetic and Numeric instruction. See Appendix O.

Overall, Logographic training was associated with P1's poorest results and, according to the differences seen in Table 7, he consistently fit the Segmenter processing profile. His best responses were to Alphabetic and Numeric training. Unfortunately, even these target-word learning results deteriorated significantly during the three weeks that followed training.

Table 7 Participant 1: Logographic, Alphabetic and Numeric Target-word Training Scores

Condition	Learn	Discrim	Discrim+3	Read	Read +3	Spelling	Spelling+3
Logo	.54	.72	.63	.00	.25	.41	.30
Count	.49	.75	.69	.31	.50	.58	.45
Alpha	.43	.78	.69	.42	.38	.71	.50
Logo vs. Count	.05 Count	.03 Count	.06 Count	.31 Count	.25 Count	.17 Count	.14 Count
Logo vs. Alpha	.11 Alpha	.06 Alpha	.06 Alpha	.42 Alpha	.13 Alpha	.30 Alpha	.20 Alpha
Alpha vs. Count	.06 Alpha	.03 Alpha	.00	.11 Alpha	.13 Count	.14 Alpha	.05 Alpha
Processing Profile	Segmenter	Segmenter	Segmenter	Segmenter	Segmenter	Segmenter	Segmenter

Figure 3
Reading-Related Skills
Participant 2

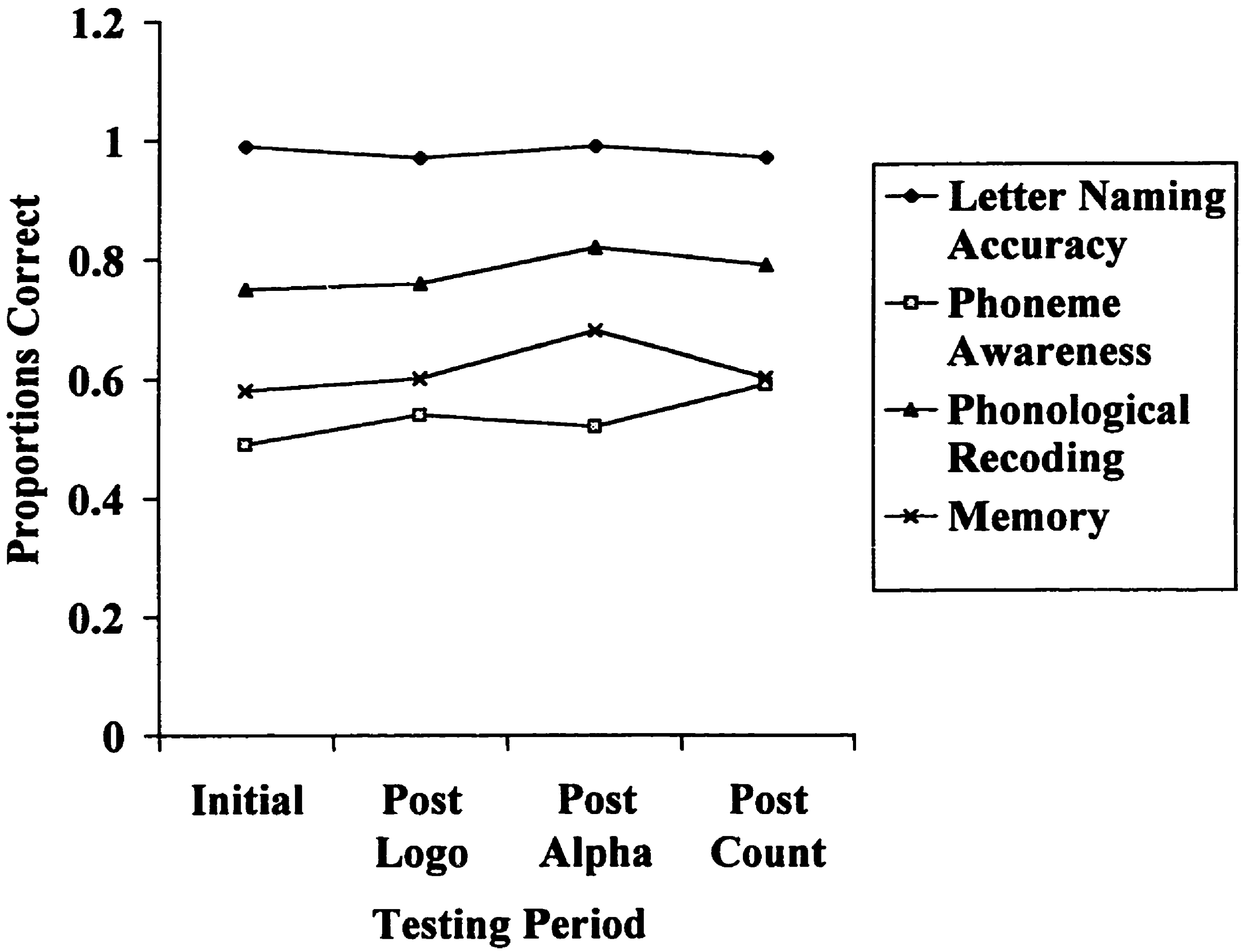
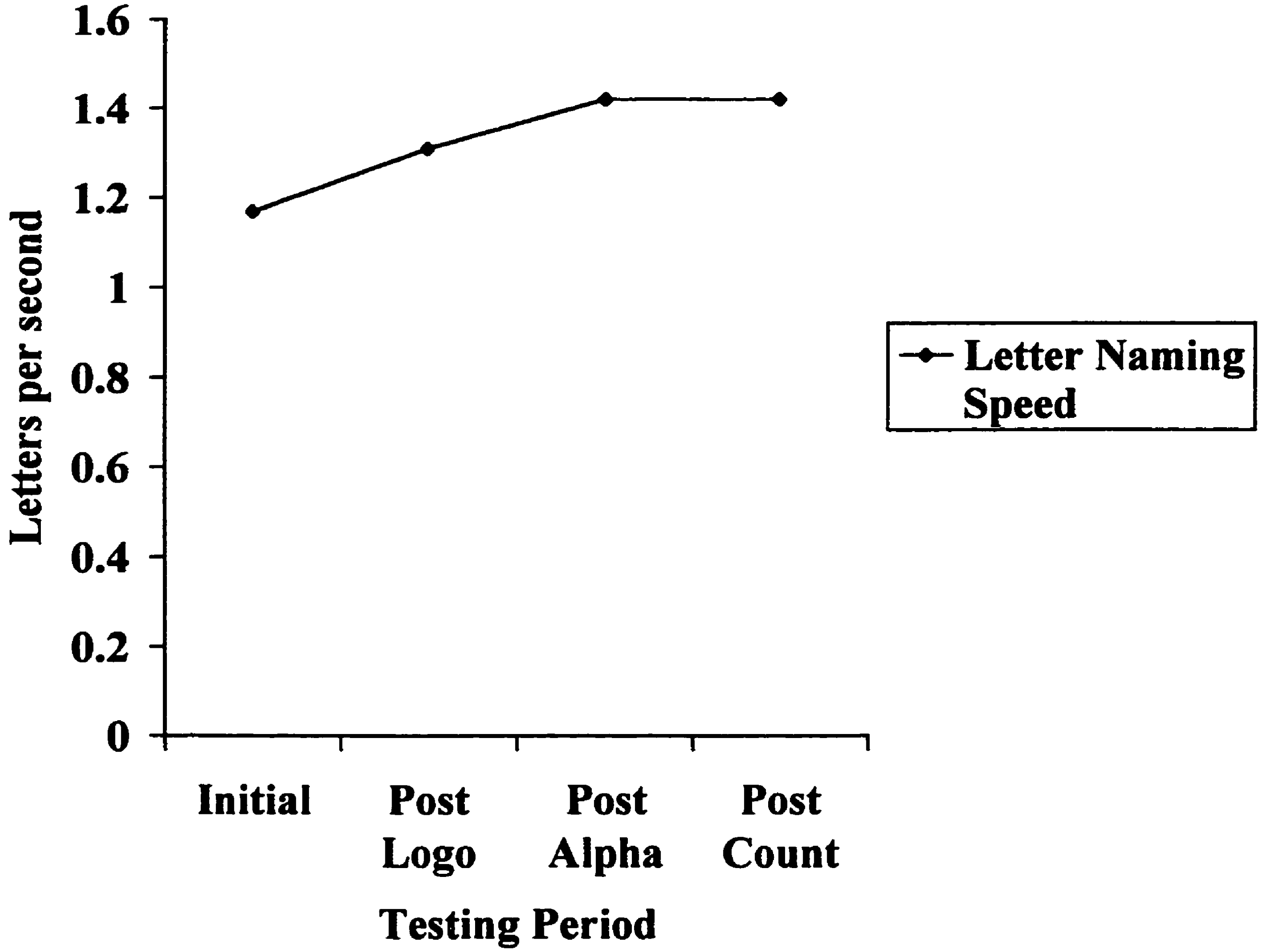


Figure 4
Reading-Related Skills
Participant 2



Participant 2 (P2) was a 32 year-old female. She was particularly conscious of her poor pronunciation and was, not infrequently, reluctant when attempting to enunciate words that were difficult for her to say aloud. Non-responses were her predominant reading errors. Initially, P2 achieved higher standard scores on her mathematics than she did on her spelling and reading tests. Her word identification was slightly better than her word attack and her visual sequential memory exceeded her auditory sequential memory. Her memory scores were proportionally greater than her phoneme awareness but were not as good as her phonological recoding. See Table 2, 3 and 4. Letter naming skills were stronger and more stable but listening span, speech-to-print matching and pseudoword reading were not.

P2 appeared to benefit from her training. Non-responses decreased when her correct readings increased. Composite reading-related sub-skill scores improved marginally with Logographic training and more with Alphabetic instruction. Numeric training was associated with letter naming and phoneme awareness scores that were as good as or exceeded Logographic but not Alphabetic training results. Phonological recoding scores, however, responded most to Numeric instruction. See Figures 3 and 4. Specific test results showed that letter-sound recognition and production improved in all conditions, speech-to-print matching improved in Alphabetic and diminished with Numeric while pseudoword reading deteriorated after each training session, particularly the Logographic and Numeric sessions. Visual memory improved in all training sessions, auditory memory in the Alphabetic and listening span in the Logographic. Rhyme sensitivity, however, deteriorated in all conditions. See Appendix O.

According to the differences seen in Table 8, P2 was a Namer in reading and spelling, a Counter in discrimination and a Logographer on the learning trials variable.

Table 8 Participant 2: Logographic, Alphabetic and Numeric Target-word Training Scores

Condition	Learn	Discrim	Discrim+3	Read	Read +3	Spelling	Spelling+3
Logo	.39	.66	.78.	.32	.75	.67	.60
Count	.45	.81	.81	.10	.38	.56	.51
Alpha	.50	.81	.75	.43	.50	.78	.65
Logo vs. Count	.06 Logo	.16 Count	.03 Count	.22 Logo	.38 Logo	.11 Logo	.09 Logo
Logo vs. Alpha	.11 Logo	.16 Alpha	.03 Logo	.11 Alpha	.25 Logo	.11 Alpha	.05 Alpha
Alpha vs. Count	.05 Count	.00	.06 Count	.33 Alpha	.13 Alpha	.22 Alpha	.14 Alpha
Processing Profile	Logo-grapher	Segmenter	Counter	Namer	Logo-Grapher	Namer	Namer

Participant 3 (P3) was a 21 year-old male with a history of epilepsy and a stutter that had both responded to medication and treatment. He had been a full-time continuing education student for approximately one year and had made significant gains in that time.

P3 did not use SOS letter naming as a word-retrieval tool. He was the only subject in the study who consistently attempted to use sound-symbol correspondences in an effort to "get the sounds out". He was also the student who showed the strongest phoneme awareness and the most obvious phoneme blending and sequential segmentation skills. He appeared to have a sense of phoneme location and sequence and showed no disproportionately low reading-related test scores. Initially, his mathematics and

Figure 5
Reading-Related Skills
Participant 3

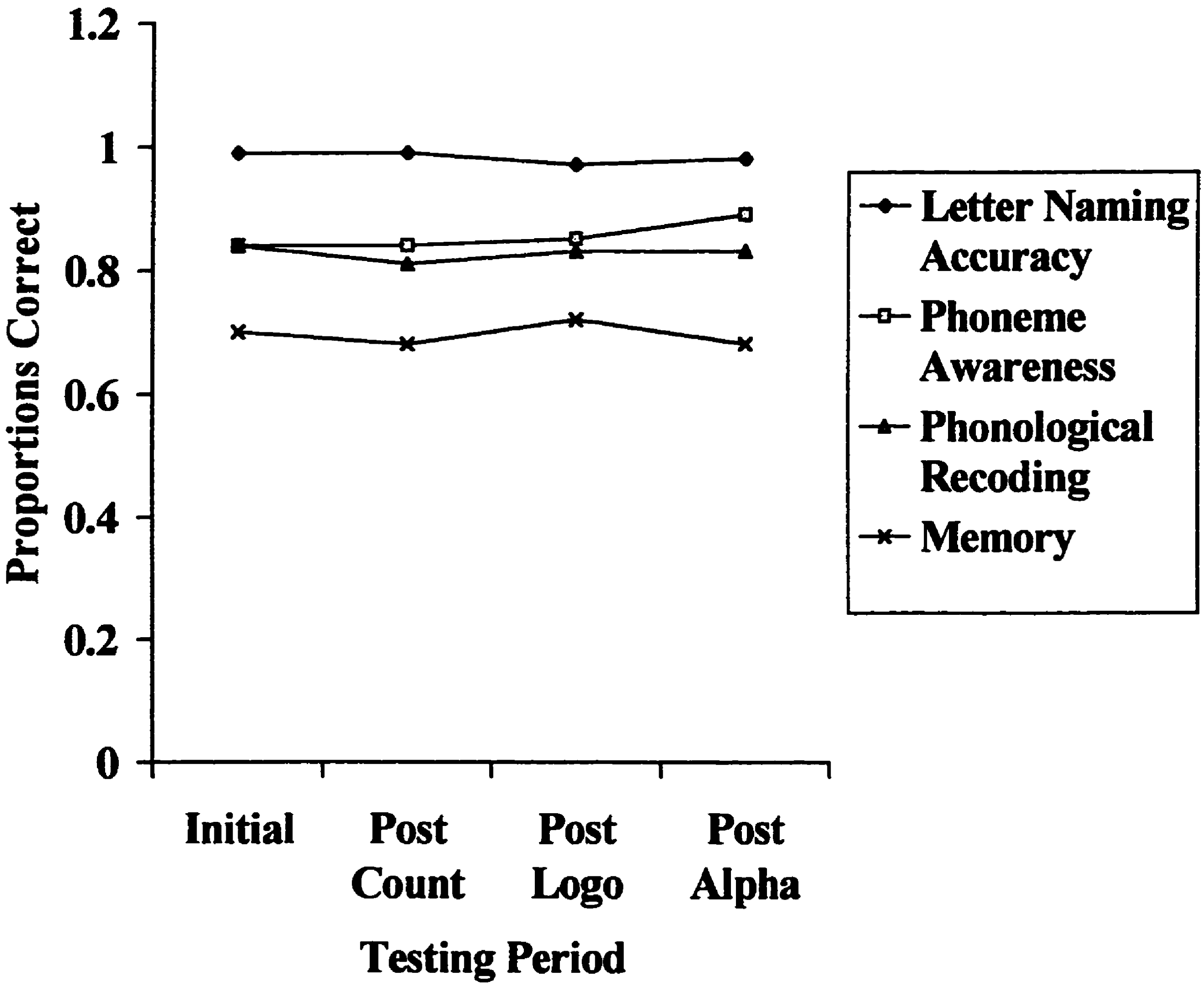
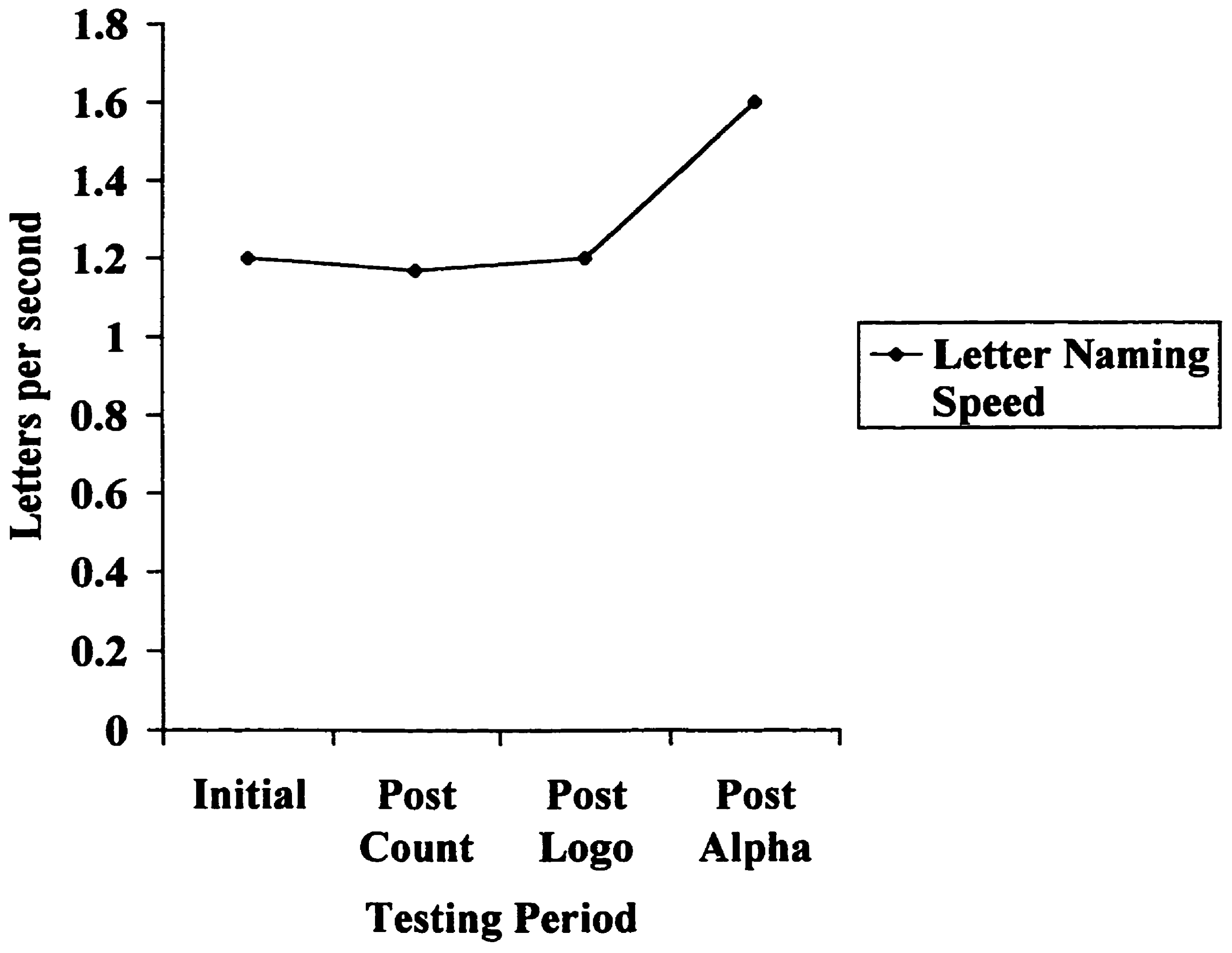


Figure 6
Reading-Related Skills
Participant 3



reading were higher than his spelling; his word attack was 17% higher than his word identification and his auditory sequential memory was better than his visual sequential memory. See Tables 2, 3 and 4. Both phoneme awareness and phonological recoding were superior to memory while letter naming skills were strong and stable. Wild Guesses were his predominant reading error. P3's composite reading-related sub-skill scores were fairly stable during the experiment. His letter naming skills, particularly, appeared to benefit from Alphabetic training. See Figures 5 and 6.

P3 generally achieved his best target-word learning scores when he had been given Logographic or Numeric instruction. According to the differences see in Table 9, P3 was a Logographic processor on all measures except Reading (in the long term) and on Learning when he was classified, respectively, as a Namer and a Counter.

Table 9 Participant 3: Logographic, Alphabetic and Numeric Target-word Training Scores

Condition	Learn	Discrim	Discrim+3	Read	Read +3	Spelling	Spelling+3
Logo	.34	.88	.84	.58	.50	.86	.83
Count	.33	.72	.78	.13	.50	.65	.50
Alpha	.34	.88	.81	.31	.75	.79	.74
Logo vs. Count	.01 Count	.16 Logo	.06 Logo	.46 Logo	.00	.21 Logo	.33 Logo
Logo vs. Alpha	.00	.00	.03 Logo	.28 Logo	.25 Alpha	.07 Alpha	.10 Logo
Alpha vs. Count	.01 Count	.16 Alpha	.03 Alpha	.18 Alpha	.25 Alpha	.14 Alpha	.24 Alpha
Processing Profile	Counter	Logo-grapher	Logo-Grapher	Logo-grapher	Namer	Logo-grapher	Logo-grapher

Figure 7
Reading-Related Skills
Participant 4

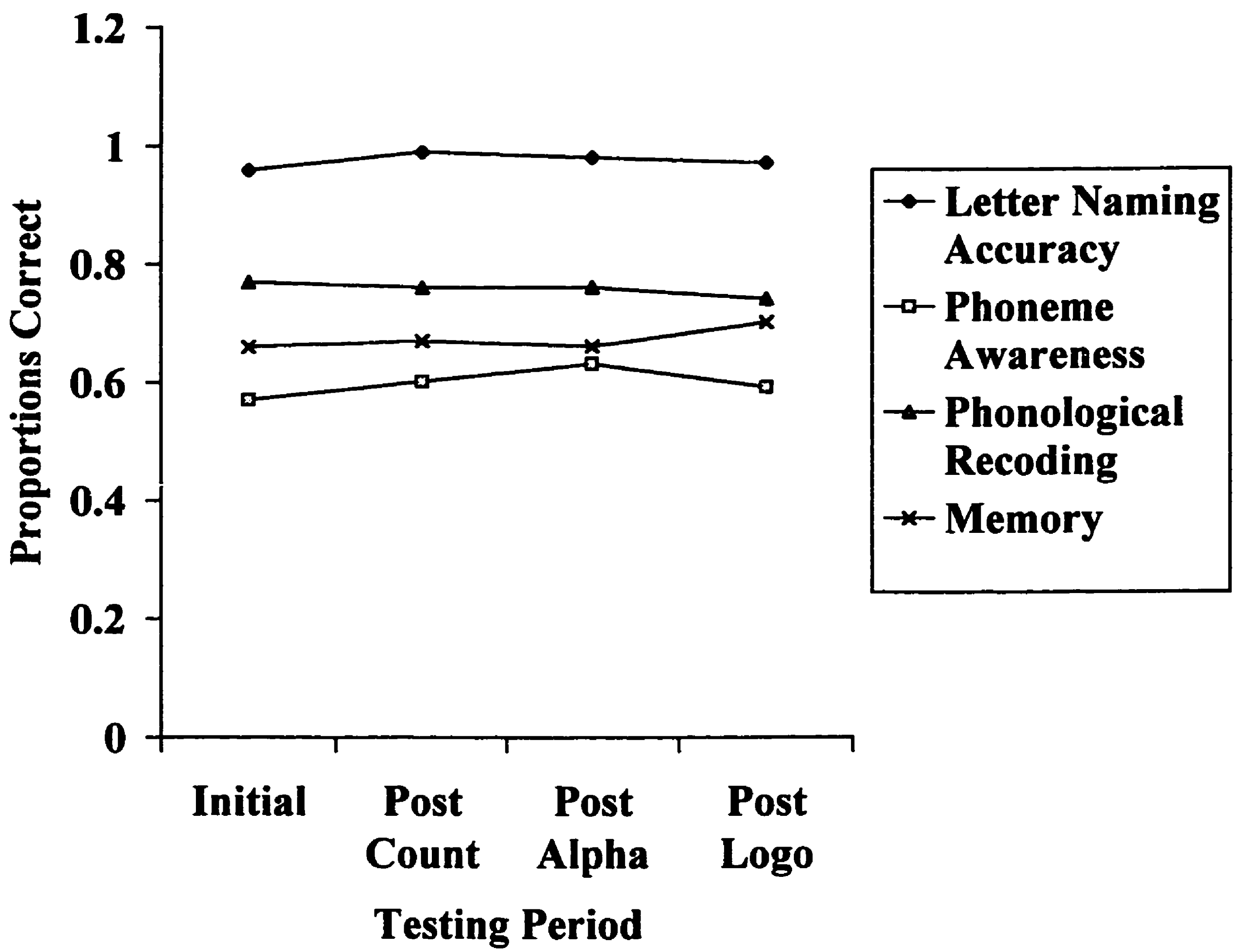
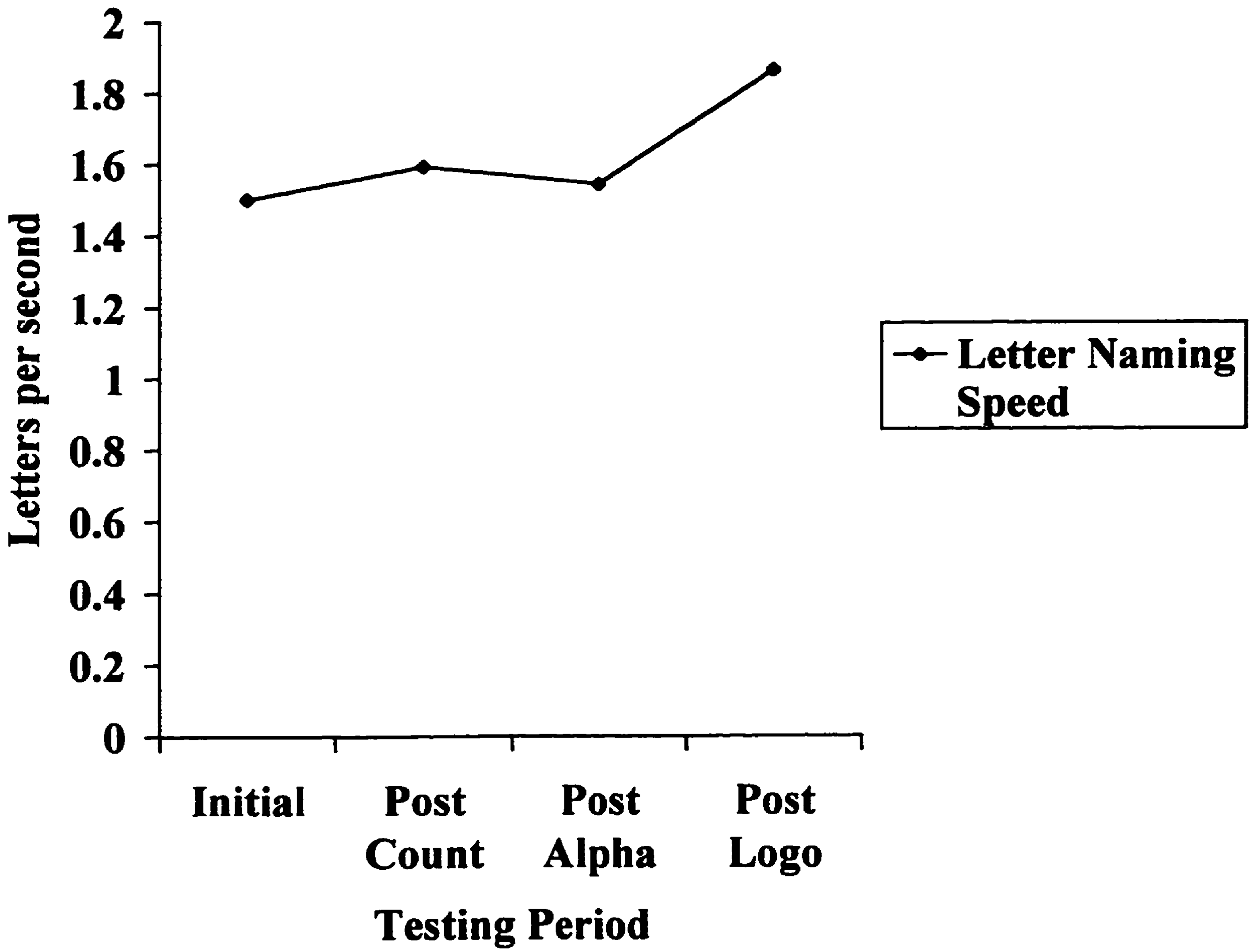


Figure 8
Reading-Related Skills
Participant 4



Participant 4 (P4) was a 45 year-old male who consistently used SOS letter naming as a word retrieval tool. Initially, his spelling and mathematics scores exceeded his reading test results. Word attack was better than word identification and visual sequential memory was better than auditory sequential memory. In terms of reading-related pretests, P4's memory scores were better than his phoneme awareness and equal to his phonological recoding. See Tables 2, 3 and 4. Letter naming and speech-to-print matching were his relative strengths while letter-sound recognition, sequential segmentation and auditory memory were his relative weaknesses. The majority of P4's reading errors were wild-guesses. See Appendix M.

P4 responded well to training. Composite reading-related skill scores remained fairly stable with memory and letter naming skills improving in the Logographic condition. Phonological recoding also improved somewhat, particularly with Alphabetic instruction. See Figures 7 and 8. During the study, P4 was able to increase his correct reading responses when he reduced his wild guesses. His processing profile was varied. He was more of a Segmenter or Counter in learning and spelling but tended toward being a Logographer on measures of discrimination and reading. See Appendix N and Table 10.

Figure 9
Reading-Related Skills
Participant 5

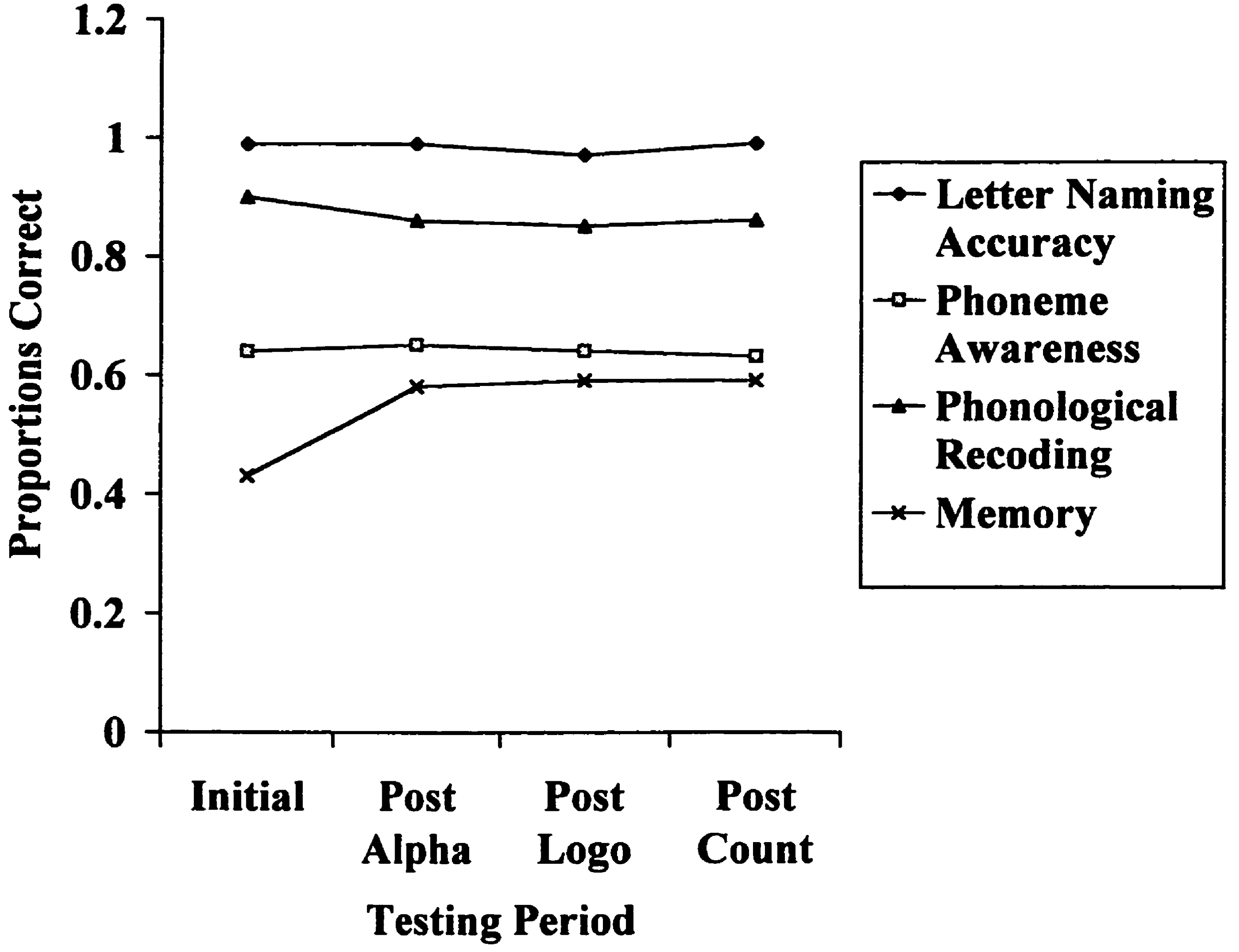


Figure 10
Reading-Related Skills
Participant 5

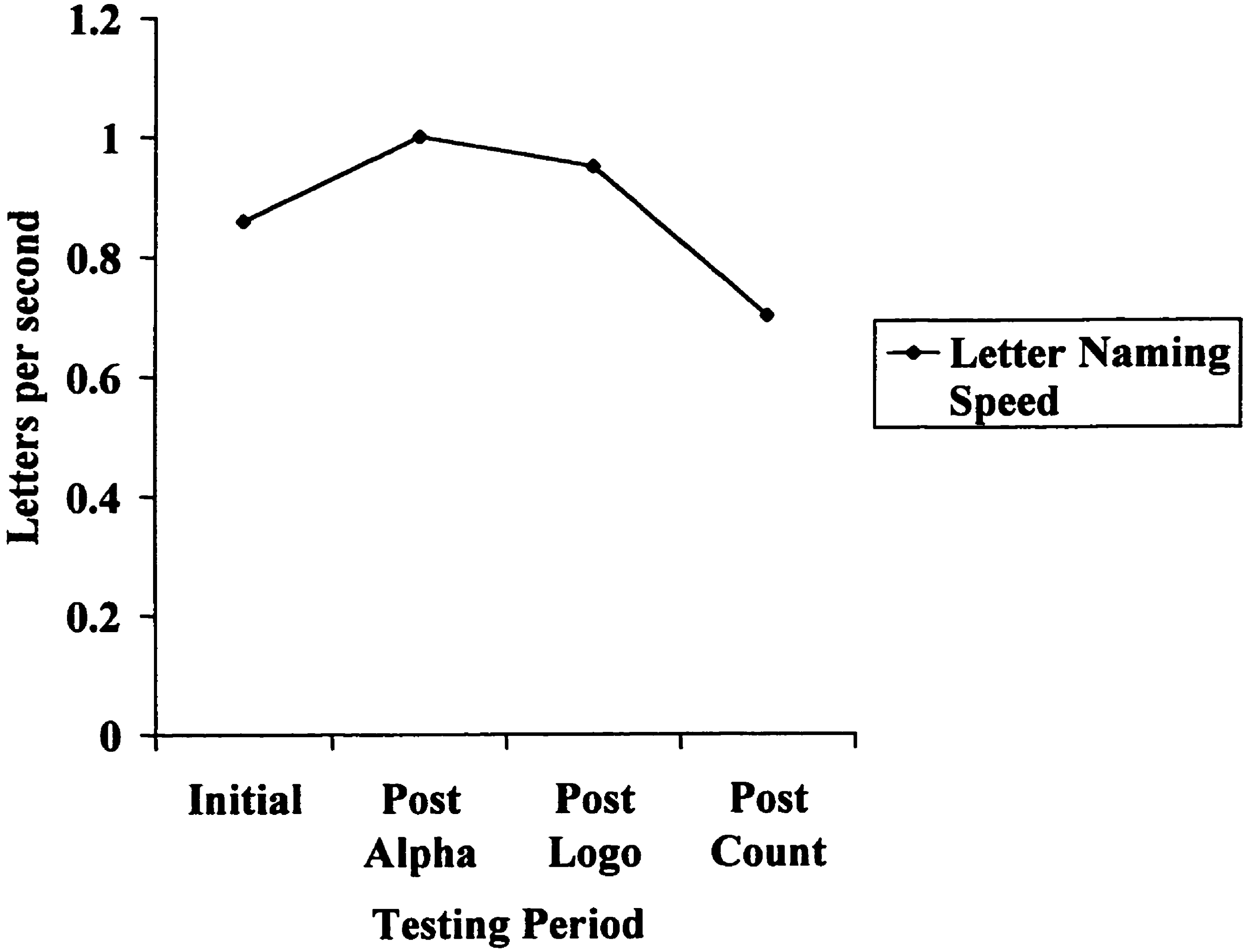


Table 10 Participant 4: Logographic, Alphabetic and Numeric Target-word Training Scores

Condition	Learn	Discrim	Discrim+3	Read	Read +3	Spelling	Spelling+3
Logo	.61	.84	.81	.30	.50	.67	.74
Count	.53	.78	.63	.00	.75	.75	.78
Alpha	.40	.75	.69	.11	.38	.73	.64
Logo vs. Count	.09 Count	.06 Logo	.19 Logo	.30 Logo	.25 Count	.08 Count	.03 Count
Logo vs. Alpha	.21 Alpha	.09 Logo	.13 Logo	.19 Logo	.13 Logo	.06 Alpha	.10 Logo
Alpha vs. Count	.13 Alpha	.03 Count	.06 Alpha	.11 Alpha	.38 Count	.02 Count	.13 Count
Processing Profile	Segmenter	Logo-grapher	Logo-grapher	Logo-grapher	Counter	Segmenter	Counter

Participant 5 (P5) was a 33 year-old male who was receiving treatment for an epileptic condition. His verbal language skills and pronunciation were not standard or consistent. His speech was somewhat slurred on occasion and his attention was easily diverted from his work.

Initially, P5 performed better on his mathematics and spelling than he did on his reading tests. His word attack was equal to his word identification and his auditory memory score was superior to his visual sequential memory score on the ITPA. His letter naming skills were relatively good and his phoneme awareness and phonological recoding were better than his memory scores. See Tables 2, 3 and 4. In fact, P5 may have had a significant deficit in his working memory; of which he is personally aware. Wild Guesses and Minus 1's were, initially, his predominate error types.

Training supported P5's target-word learning and his memory skills. Composite scores indicated that phonological recoding was stable, phoneme awareness declined marginally and letter naming skills improved somewhat with Alphabetic and Numeric training. See Figure 9 and 10. His Auditory memory, visual memory and listening span test scores all improved notably. Other reading-related sub-skills deteriorated but they had, with the exception of pseudoword reading, been initially close to ceiling. See Appendix O.

P5 was a Logographer and/or Counter on the learning trials and spelling target-word learning measures. The majority of his best scores were achieved during the Logographic or the Numeric conditions. See Table 11.

Table 11 Participant 5: Logographic, Alphabetic and Numeric Target-word Training Scores

Condition	Learn	Discrim	Discrim+3	Read	Read +3	Spelling	Spelling+3
Logo	.33	.88	.81	.46	.50	.90	.82
Count	.56	.75	.88	.58	.50	.93	.81
Alpha	.60	.81	.88	.50	.88	.76	.70
Logo vs. Count	.24 Logo	.13 Logo	.06 Count	.12 Count	.00	.03 Count	.01 Logo
Logo vs. Alpha	.28 Logo	.06 Logo	.06 Alpha	.04 Alpha	.38 Alpha	.13 Logo	.12 Logo
Alpha vs. Count	.04 Count	.06 Alpha	.00	.08 Count	.38 Alpha	.17 Count	.11 Count
Processing Profile	Logo-grapher	Logo-grapher	Segmenter	Segmenter	Namer	Counter	Logo-grapher

Participant 6 (P6) was a 42 year-old woman who had been attending continuing education classes twice a week for several years. She relied heavily on SOS letter naming as a word retrieval tool and had not been taught to use letter-sound correspondences in her reading or spelling. Some of the texts in this study were particularly difficult for her and the majority of her reading errors were non-responses. See Appendix N.

Initially, P6 scored marginally better on her spelling and mathematics than on her reading tests. Her word attack was minimally stronger than her word identification and her auditory sequential memory was better than her visual sequential memory. The proportion of correct responses on her initial memory pretests was higher than the proportion of correct responses on her initial phoneme awareness and phonological recoding pretests. See Table 2, 3 and 4. Letter naming and letter-sound production appeared to be P6's relative weaknesses while pseudoword reading, rhyme and auditory memory provided her with her relative strengths. Her ability to read pseudowords was, in fact, very surprising when one considers the fact that she had had no formal training in sound-symbol correspondences. She used the SOS letter-naming retrieval technique to help her attack "the funny words".

P6 responded fairly well to her target-word training, particularly in the Alphabetic condition. See Appendix M. Composite reading-related skill scores showed that phoneme awareness improved in all training sessions, particularly with Alphabetic instruction while phonological recoding was stable with some improvement given Numeric training. See Figures 11 and 12. Specific test results revealed that Auditory memory increased with letter name and letter count training while visual memory and listening span improved with whole word training. See Appendix O. Generally, P6's non-response reading errors decreased while her correct responses increased. See Appendix N. On most target-word learning measures her processing profile was Namer. See Table 12.

Figure 11
Reading-Related Skills
Participant 6

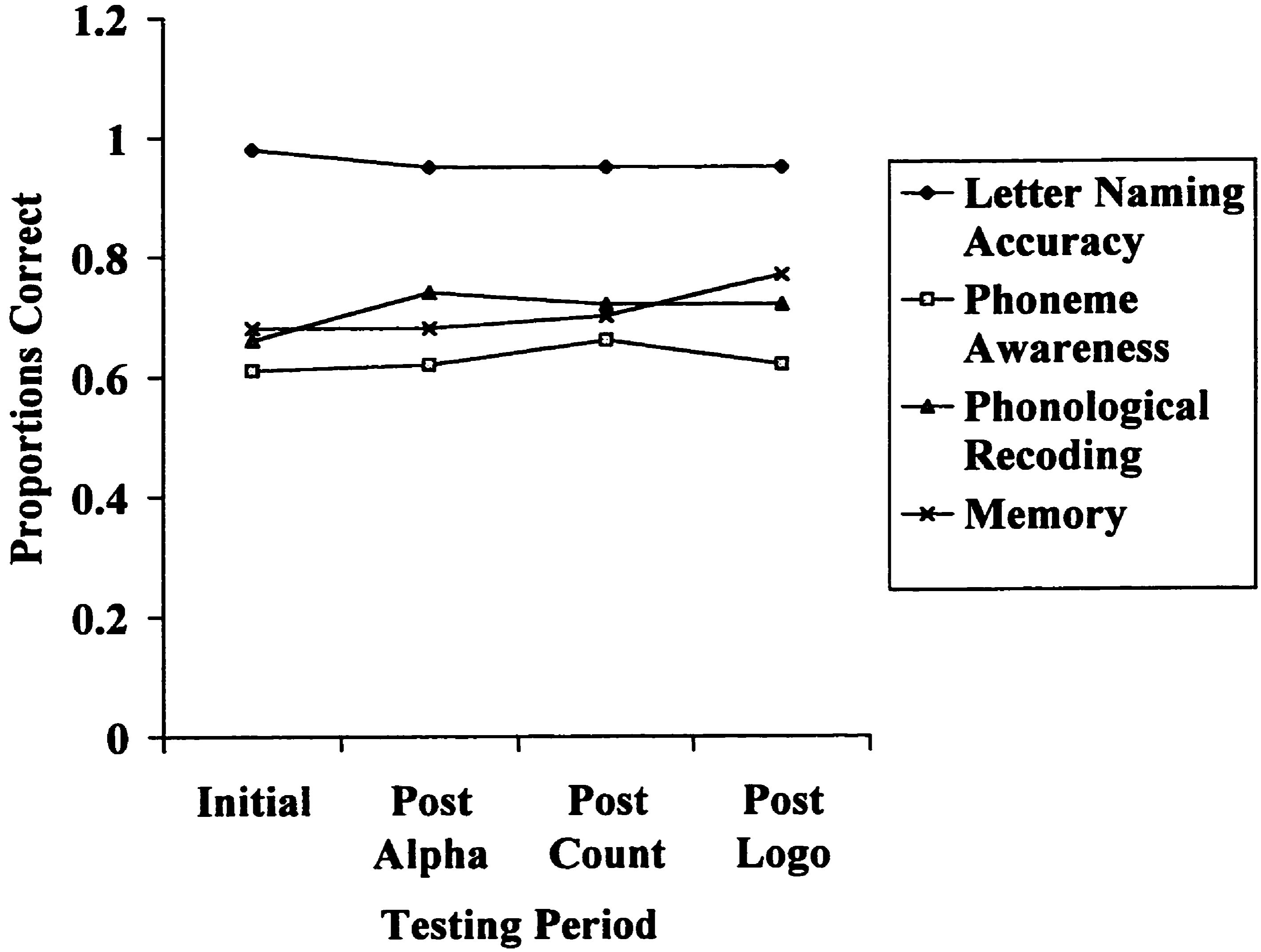


Figure 12
Reading-Related Skills
Participant 6

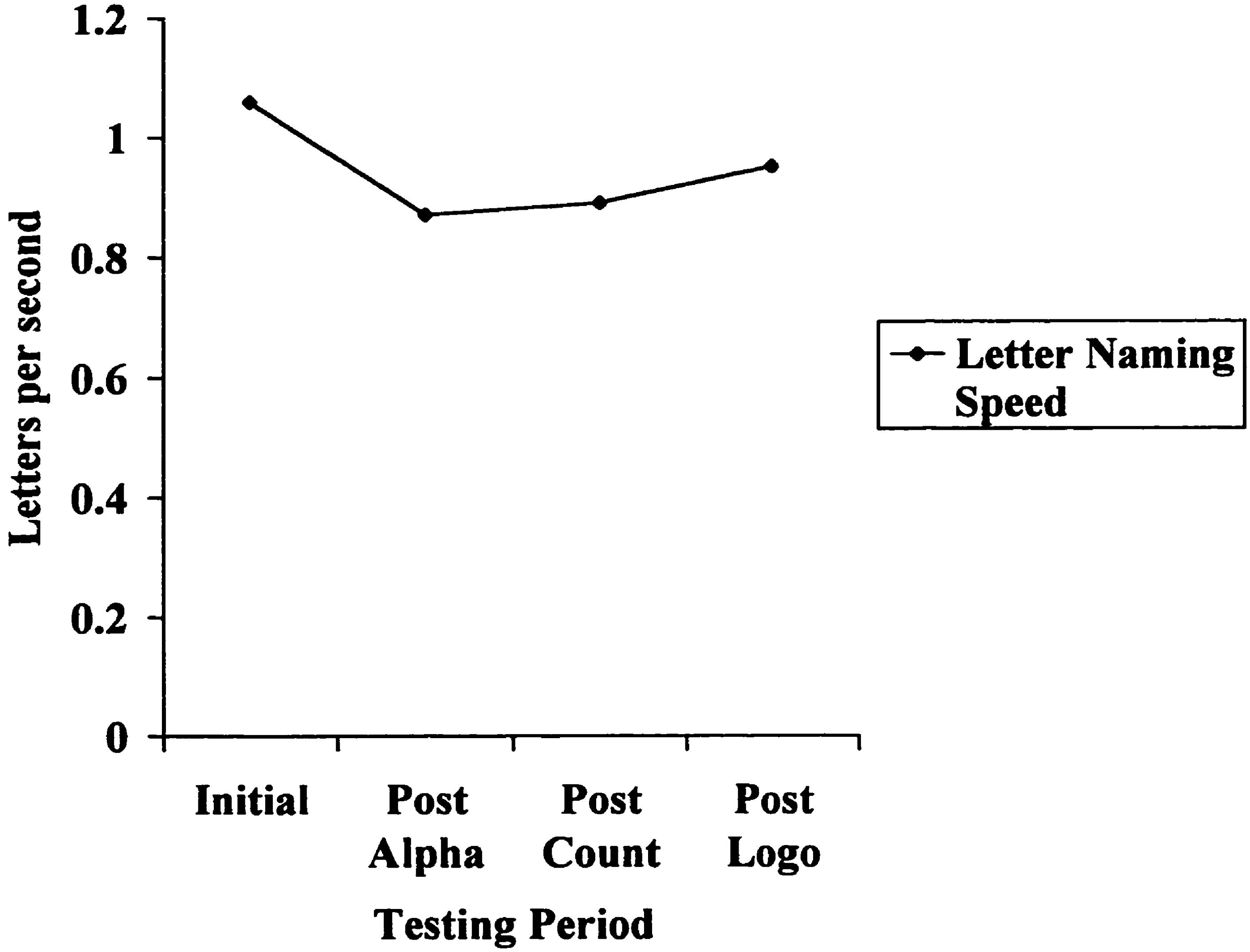


Table 12 Participant 6: Logographic, Alphabetic and Numeric Target-word Training Scores

Condition	Learn	Discrim	Discrim+3	Read	Read +3	Spelling	Spelling+3
Logo	.60	.63	.69	.21	.25	.60	.60
Count	.65	.75	.50	.14	.25	.51	.49
Alpha	.49	.72	.78	(.30)	.50	.72	.72
Logo vs. Count	.05 Logo	.13 Count	.19 Logo	.07 Logo	.00	.09 Logo	.11 Logo
Logo vs. Alpha	.11 Alpha	.09 Alpha	.09 Alpha	.51 Logo	.25 Alpha	.12 Alpha	.12 Alpha
Alpha vs. Count	.16 Alpha	.03 Count	.28 Alpha	.44 Count	.25 Alpha	.21 Alpha	.23 Alpha
Processing Profile	Namer	Segmenter	Namer	Logo-grapher	Namer	Namer	Namer

Between Subjects

Students' best scores and the condition that they achieved them in are given in Table 13.

Table 13 Participants' Best Target-word Learning Scores and Conditions

Participant	Learning Trials	Discrim	Discrim+3	Reading	Reading+3	Spelling	Spelling+3
P1	.43 Alphabetic	.78 Alphabetic	.69 Alphabetic	.42 Alphabetic	.50 Numeric	.71 Alphabetic	.50 Alphabetic
P2	.39 Logo-graphic	.81 Alphabetic /Numeric	.81 Numeric	.43 Alphabetic	.75 Logo-graphic	.78 Alphabetic	.65 Alphabetic
P3	.33 Numeric	.88 Logo-graphic	.84 Logo-graphic	.58 Logo-graphic	.75 Alphabetic	.86 Logo-graphic	.83 Logo-graphic
P4	.40 Alphabetic	.84 Logo-graphic	.81 Logo-graphic	.30 Logo-graphic	.75 Numeric	.75 Numeric	.78 Numeric
P5	.33 Logo-graphic	.88 Logo-graphic	.88 Numeric	.58 Numeric	.88 Alphabetic	.93 Numeric	.82 Logo-graphic
P6	.49 Alphabetic	.78 Numeric	.78 Alphabetic	.50 Logo-graphic	.72 Alphabetic	.72 Alphabetic	.75 Alphabetic

Participants 3 and 5 consistently achieved the highest scores in this study while Participants 2 and 4 generally scored in the second third and Participants 1 and 6 had the lowest results on all but two out of six variables.

Students with better target-word learning results generally achieved them subsequent to Logographic or Numeric training. They scored somewhat higher on their WRAT3 Mathematics sub-tests than they did on their WRAT3 Spelling tests. Their Auditory Sequential Memory scores were somewhat better than their Visual Sequential Memory scores and their Word Attack results were marginally superior to their Word Identification scores. They also scored higher on Phoneme Awareness and Phonological Recoding measures than they did on tests of their Memory.

The second two students were alike in that their Visual Sequential Memory was better than their Auditory Sequential Memory and their Word Attack skills were as good or better than their Word Identification abilities. Their best target-word learning results were scattered across all conditions. Their Memory scores were better than their Phoneme Awareness but not their Phonological Recoding.

Finally, the lowest scoring subjects performed at their best when they were given Alphabetic training. They differed from the better performers in that their Spelling was superior to their Mathematics skills. Their Memory scores were higher than their Phoneme Awareness test results.

Thus, students with relatively higher math, auditory sequential memory and word attack scores may have a more successful processing profile than those who perform better on their spelling, visual sequential memory and word identification tests. Students with higher mathematics than spelling scores appear experience relatively greater successes in learning, reading and spelling. Furthermore, students with higher scores in mathematics and in auditory sequential memory appear to perform better than students who show relative strengths in mathematics and visual sequential memory. Similarly, students with the combination of relative strength in spelling and visual sequential memory appear to perform somewhat better than those with higher spelling and auditory sequential memory scores.

Processing Labels

In the within-subject analysis, participants were labeled with one of four "processing" labels on each of the experimental variables. They were described as "Logographers", "Segmenters", "Letter Namers" and "Letter Counters". "Logographers" performed better with Logographic training than they did with Numeric or Alphabetic training (i.e. L>A and L>N). "Segmenters" showed the opposite pattern and performed better in Numeric and Alphabetic than they did in the Logographic condition (i.e. A>L and N>L). "Letter Namers" had higher scores in Alphabetic and Logographic conditions than they did in Numeric training (A>L and L>N) and "Letter Counters" achieved their best performances with Numeric and Logographic rather than Alphabetic training (L>A and N>L).

Once these classifications had been made, participants' initial skills and target-word learning scores were compared and contrasted for each profile in order to determine whether students with a particular profile shared characteristics that they did not have in common with subjects who belonged to a different profile. When completed, the analysis revealed the following patterns.

Generally, Logographers and/or Counters achieved higher target-word learning scores than Segmenters and Namers. Letter Namers were, in fact, the group least likely to show improved reading-related skills subsequent to their target word training sessions. Their Memory scores improved while Letter Counters, Segmenters and Logographers improved in Memory, Letter Naming and Phonemic Awareness.

Subjects who improved on tests of Letter Naming and Phoneme Awareness did so after their Alphabetic or their Alphabetic and their Numeric training. Improved scores in Phonological Recoding only occurred after Alphabetic training while Memory scores increased after all training types. Positive Memory skill changes were more likely to occur after Logographic and Numeric training than after Alphabetic training.

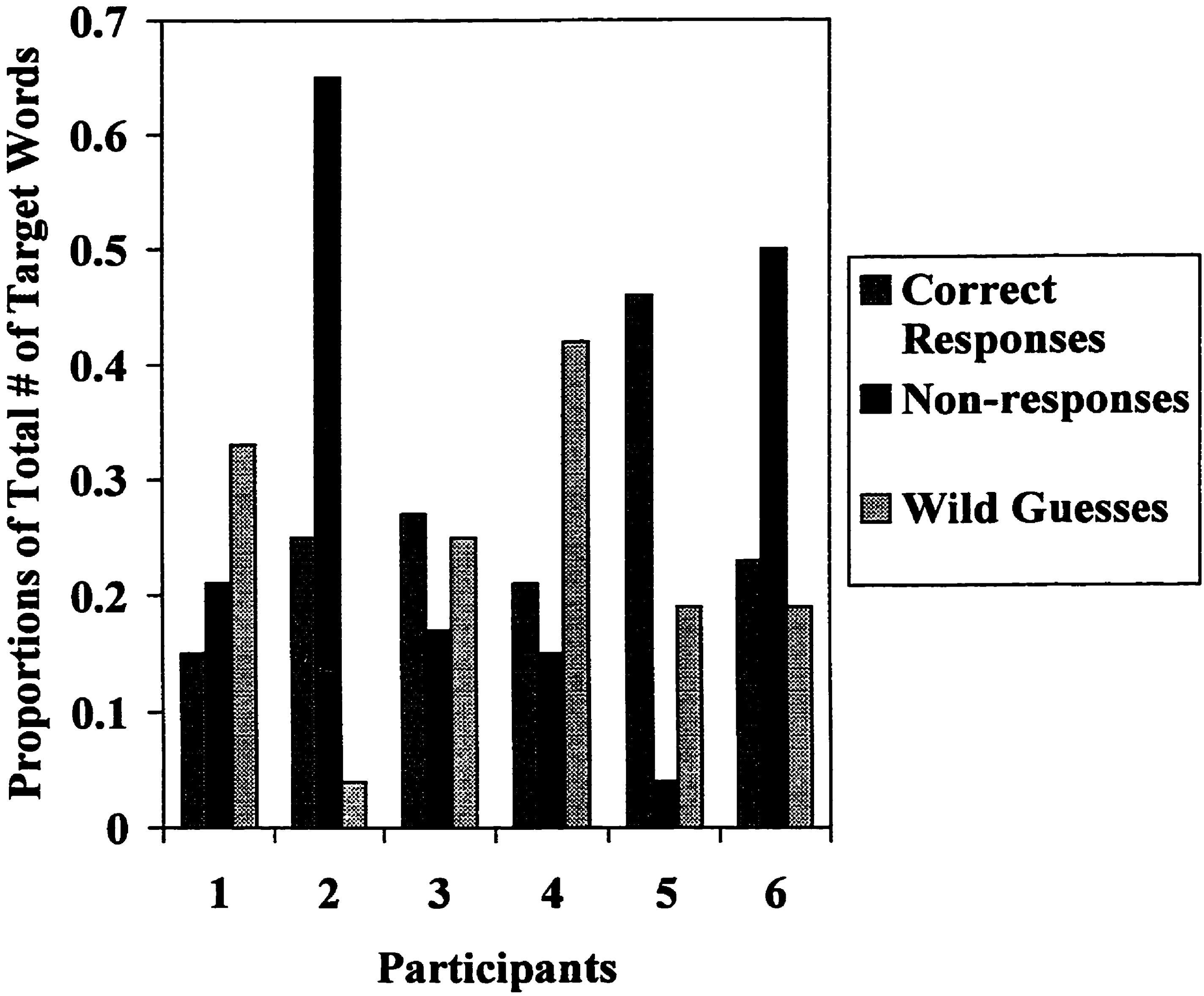
Changes in Error Type Distributions

Initial, post-condition and final error type distributions were examined in detail. Patterns were only evident, however, in students' initial reading errors. These are shown in Figure 13 and can be described as follows.

The two "better" students in the study began it with the following error pattern: Correct responses > Wild Guesses > Non-responses (C > WG > NR). These were the students who had higher phoneme awareness scores i.e. they were Participants 3 and 5 whose WRAT3 Math, Word Attack, Phoneme Awareness and Auditory Sequential Memory exceeded their WRAT3 Spelling, Word Identification, Memory and Visual Sequential Memory scores.

Participants 1 and 4 appeared to be more visual processors. They both had the following error pattern: Wild Guesses > Non-Responses and Wild Guesses > Correct responses (WG > NR and WG > C). They each had WRAT3 Spelling and Visual Sequential Memory results that were better than their WRAT3 Math and Auditory Sequential Memory scores.

Figure 13
Initial Error Distributions
Proportions
of the Total # of Target Words



Finally, Participants 2 and 6 had the following pattern: Non-responses > Correct responses > Wild Guesses (NR > C > WG). Their only profile similarity was that their Word Attack were greater than or equal to the Word Identification scores.

Statistical Analysis (N=6)

Effects of Conditions

The mean proportions of correct responses and the standard deviations for all variables are shown in Table 14. Non-parametric tests for K related samples (Kendall's W test to compare Trained conditions) and for two related samples (Wilcoxon signed ranks test to compare Trained and Untrained conditions) showed, however, that these differences in mean scores were not statistically significant.

Table 14 Mean Proportions of Correct Responses and Standard Deviations for all Dependent Variables

	Trained	Untrained	Alpha	Numeric	Logo
Learn	-	-	.46	.50	.47
			(.09)	(.11)	(.13)
Discrimination	.77	.74	.79	.76	.77
	(.04)	(.05)	(.05)	(.03)	(.11)
Discrimination+3	.75	.76	.77	.72	.76
	(.08)	(.04)	(.07)	(.14)	(.08)
Reading (change)	.26	.20	.25	.23	.31
	(.17)	(.17)	(.30)	(.19)	(.20)
Reading+3 (change)	.49	.41	.57	.48	.46
	(.14)	(.13)	(.20)	(.17)	(.19)
Spell	.70	.66	.75	.66	.69
	(.10)	(.13)	(.04)	(.15)	(.18)
Spell+3	.63	.63	.66	.59	.65
	(.13)	(.09)	(.08)	(.16)	(.20)

The Learn trials variable was used to measure the number of trials taken to achieve three correct readings of a target word during training. In Table 14 the number of trials is expressed as a proportion of the maximum number possible. On this variable, smaller proportions indicate faster and/or easier learning than higher ones. On all other variables, however, larger proportions are more indicative of success. This includes the

Reading and Reading+3 variables. These were used as measures of change in students correct readings. More precisely, they are measures of pre-post training changes in the proportion of correct responses.

Changes in Error Distributions:

The number of defined errors (Numeric, Identity, Sequence and Non-response) were expressed by type as proportions of total errors. Proportions were calculated for each subject's initial, pre-training, readings; for their final, post-training, readings and for the changes that occurred between the first and the last. These are shown in Appendix N. The mean changes are shown in Table 15. The latter are used to provide a record of mean changes in the proportions of defined error types.

Table 15 Means Changes and Standard Deviations for Proportional Error Distributions

	Alpha	Numeric	Logo
Minus Ones	.19	-.13	-.07
	(.38)	(.29)	(.17)
Good Guesses	-.24	.13	.17
	(.24)	(.30)	(.45)
Wild Guesses	.09	.08	-.21
	(.38)	(.41)	(.17)
Non-responses	-.03	-.09	-.17
	(.28)	(.47)	(.27)

Non-parametric tests for K related samples (Kendal's W test to compare Trained conditions) showed, however, that these differences in mean scores were not statistically significant.

SOS Word Reading Retrieval

Three of the six participants in this study successfully employed an SOS retrieval procedure whenever they were unable to respond to words in the print. Whenever they found themselves in a non-response situation, these students would name the letters in the spelling out loud in an attempt to trigger their recognition of the word.

Word readings that were produced in this manner were subsequently compared to those that had been recorded during the student's initial readings. Characterizations of their attempts are provided in Tables 17, 18 and 19. Correct responses and errors that were less severe than the initial response are referred to as being "positive". Those that were equivalent to the initial error or were more severe than the initial error, are described, respectively, as being "neutral" or "negative". Situations where there were continued silences despite the use of the SOS recall technique, are characterized here as being "non-retrievable" (NR).

Table 17 Participant 1: Changes in the severity of errors with SOS Retrieval

Characterization of error changes	Alphabetic	Numeric	Logographic	Untrained
Positive	50%	33%	55%	65%
Neutral	13%	66%	20%	4%
Negative	6%		10%	4%
NR	31%		15%	27%

Table 18 Participant 4: Changes in the severity of errors with SOS Retrieval

Characterization of error changes	Alphabetic	Numeric	Logographic	Untrained
Positive	86%	67%	82%	72%
Neutral		17%	6%	14%
Negative		8%		2%
NR	14%	8%	12%	12%

Table 19 Participant 6: Changes in the severity of errors with SOS Retrieval

Characterization of error changes	Alphabetic	Numeric	Logographic	Untrained
Positive	62%	79%	77%	59%
Neutral		4%	6%	3%
Negative				8%
NR	38%	17%	17%	30%

The results were, overall, very clear. The vast majority of SOS Retrievals produced a reading: one that was likely to be "positive" or at least "neutral" in character. P4 and P6 benefited most but even P1 recorded a greater than fifty percent improvement in his reading. P1 used the technique to its best advantage in Untrained conditions while P4 and P6 experienced better results when they used it after Training. P4 did particularly well with SOS Retrieval given Alphabetic and Logographic training while P6 recorded her best results in the Numeric and Logographic conditions.

With such positive feedback it is not difficult to understand why these three students use the SOS word Retrieval procedure as habitually as they do. It provides them with a recall strategy that can be easily, immediately and effectively applied.

DISCUSSION

Sequential letter naming was obviously an effective word retrieval strategy for the three students who used it in this study. At least, it appears to have helped them to remember spellings and the pronunciations that are associated with those spellings. The long-term appropriateness of using this strategy is, however, another issue; one that requires and awaits a more detailed examination.

This particular study primarily concerned the effectiveness of SOS letter naming and letter counting in their capacity as word learning tools. The main hypotheses were that these techniques would be associated with better target-word learning scores than whole word and untrained target-word learning and that students varying responses would reveal individual differences within the small sample of reading disabled students who participated in this study.

Overall effectiveness

The results were varied in this study; so much so that the first of its major hypotheses could not be supported in an unqualified fashion. No one or two training conditions were associated with superior performances in all cases or on all measures of word learning.

Mean scores and standard deviations on the variables tended to suggest that Alphabetic instruction might have provided training that had a somewhat more positive, longer lasting influence on students learning. Generally, Trained mean scores exceeded Untrained mean scores; Logographic results were better than Numeric and, particularly after three weeks time, Alphabetic instruction maintained somewhat higher scores on most measures of target-word learning.

These differences were not, however, conclusive. They were not statistically significant and they were not supported by the findings of the descriptive analyses. The latter clearly indicated that SOS letter naming was not the most effective training for all participants. In fact, the second hypothesis in the study provided a more accurate description of the findings. Students' responses to training corresponded with differences in their initial skill profiles. In fact, these initial differences appeared to be the most important factors in students' learning. They were not likely, however, to be the only influences. It is necessary to consider a number of other factors that may also have contributed to these findings.

First, the size and composition of the sample in this study is likely to have affected the conclusiveness as well as the reliability of results. There were only six subjects who were all at the very low end of the reading ability spectrum. Second, there was the fact that training conditions only targeted eight words in sessions of very limited duration. Finally, the design of the interventions may also have played an additional role. The Alphabetic and Numeric conditions in this study duplicated the Logographic training format and then added extra segmentation activities to it so that differences in results could be more precisely attributed to the effects of letter naming and counting. Results may have been more pronounced, however, if Logographic routines had not been incorporated into all of the training conditions quite this thoroughly. If the segmentation conditions had involved naming or counting and only one repetition of a word's pronunciation then there may have been more significant differences between the students' responses to each of them.

The fact remains, however, that individual differences corresponded with participants' varied responses to training. There was a concurrence between target-word learning results and the various Initial Test/skill Profiles of its' subjects. So, although sample statistical analysis lends moderate support to the superiority of SOS letter naming over time, single-subject examinations force the qualification of this conclusion. The relative strengths and weaknesses in a student's initial skills appear in large part to influence his or her response to this and other forms of instruction. There were, in fact, no uniformly superior word learning conditions in this study.

Individual Differences

Subjects whose WRAT3 Mathematics > Spelling, Woodcock-Johnson Word Attack > Word Identification and ITPA Auditory Sequential Memory > Visual Sequential Memory also tended to perform better on measures of target-word learning than those whose test results were WRAT3 Spelling > Mathematics; Woodcock-Johnson Word Identification > Word Attack and ITPA Visual Sequential Memory > Auditory Sequential Memory. Relative strengths in phoneme awareness and phonological recoding rather than in memory (i.e. PA > M or PR > M test scores rather than M > PA or M > PR test scores) also appeared to predict superior target word learning and better, wider ranging improvements in these and other reading-related skills.

Some students, it seems, had relative skill profiles that were either the result of, or a reason for their past and present successes. They were better able to use all word learning conditions to their advantage. When exposed to Alphabetic training they made the more extensive improvements in reading-related skill areas and when given Numeric and Logographic instruction they were able to achieve the higher scores on measures of target word learning. Thus, the relatively successful students in the study appear to have had a more marked propensity to improve their sub-skills and their reading and spelling performances; a result that may illustrate what Stanovich (1986) called Mathew effects.

Given the same instruction, more highly skilled, 'richer' students become even more able and accomplished while relatively lower achieving, 'poorer', students become even less successful in comparison. In this case, the more disadvantaged students were less able to improve their reading-related sub-skills, were less able to perform with Numeric and Logographic training and were, more or less, dependent on Alphabetic instruction in order to achieve their best target word learning.

This 'best' target word learning is not, however, inconsequential. It may provide a foundation for a 'poorer' student's eventual success. SOS letter naming did not have statistically superior effects on students' immediate performances in this study. It did not have the strongest effects on the better students' target word learning but it did promote sub-skill development for all learners and it did appear to enable some 'poorer' students to obtain greater word learning frequencies than they would otherwise have been able to achieve. It may, therefore, exert less influence on current readings but exert greater pressure on both the acquisition of a print lexicon and the improvement of sub-skills that would result in better readings in future. As such, given longer-term objectives, Simultaneous Oral Spelling may be a method of choice in the preliminary or a priori skill acquisition of students who are having or may have difficulty learning to read and spell.

SOS letter naming may, therefore, be an effective co-requisite to other forms of instruction that specifically target the development of reading-related sub-skills. Research has clearly shown that a majority of reading disabilities are associated with specific phoneme awareness and verbal coding, deficits that are best remedied with specific phonological training. In fact, SOS might be an appropriate precursor and/or adjunct to these types of instruction. Students may require something of an existing print lexicon before they can acquire greater phoneme awareness and stronger phonological processing skills. Without this lexicon, the learning process may lack sufficient input and/or students may not have internalized enough examples to generalize and abstract.

Further research is required to determine whether phonological deficits might be remedied more effectively in students who had received or were concurrently receiving SOS target-word training as well. Simultaneous Oral Spelling may, or may not, prove to be of particular value to students who need to improve their phoneme awareness and/or phonological recoding. It may, or may not, be of particular value to students who are acquiring letter-sound knowledge but are not yet able to utilize letter-sound correspondences when storing and retrieving words in and from memory.

Unfortunately, this study did not include a letter sound condition. It would have been interesting to know whether its' participants were able to use such information in their word learning and, if so, to what extent and effect. It is possible that higher scoring students may have been more able to use phonological information in their word learning and were more able to use Numeric and Logographic training as a result. Less successful subjects may have been less knowledgeable and/or skilled in the use of phonological information. As a result, they may have been in greater need of SOS letter name bridging.

Absolute and Relative Categories

Students whose phoneme awareness and phonological recoding scores exceeded their memory scores generally obtained better word learning results than other subjects whose memory skills were relatively stronger than their phonological recoding and phoneme awareness. The former were generally described as Counters and Logographers in this study while the latter were most often categorized as being Segmenters and Namers. It should be noted that these labels were used in order to characterize individuals' processing profiles i.e. to reflect the training conditions that they were and were not able to use in their target word learning. Such constructs might be useful in predicting these students' reactions to further intervention but they are not necessarily intended as descriptions of general or naturally occurring processing types.

In fact, it is tempting to assume that the students in this study could be categorized in these ways. Making such classifications would, however, be something of an illusory exercise. The constructs used in this study are only relative. General, objective classifications are, difficult to make. Prior, Fry and Fletcher (1987) had great difficulty assigning subjects to 'Chinese' and 'Phonecian' processing categories. They managed to classify only about one third of their students as belonging to one or the other of these classifications and were forced to conclude as follows.

> "Disabled readers may be conceived as being at the lower end of a distribution of phonological awareness with 'Chinese' at the lower extreme (and therefore most handicapped) and 'Phonecians' further up the distribution but still well below the average. This concept would fit the children in this study much better than one which saw them as being distinct sub-groups." (p.70)

They then supported Gittelman's (1985) belief and suggestion "that disabled readers are a heterogeneous population and that remedial approaches should involve identification of individual differences." (p. 70)

The evidence in this study also supports these contentions. Individual differences appeared to predict students' responses to training. Participants' relative abilities and needs corresponded to their reactions to different methods of target word training. In fact, it would be worthwhile to pursue this observation in subsequent research. Perhaps there is practical and/or theoretical value in the identification and determination of readers' relative skill relationships. Ratios of one reading-related sub-skill to another may prove to have a predictive value that would help practitioners to select appropriate instructional techniques; ones that remedial reading students need and would be able to use. Ratios may also prove to have independent significance as factors in word learning and reading acquisition. Phonological, and to a lesser extent, orthographic skills account for what may be most, but not all, of the variance in reading and spelling performances. (Stanovich & West, 1989) It would be interesting to see whether or not the relationships between phonological, orthographic and memory skill could account for some small portion of the variance that remains unexplained. At the very least, relative skill ratios might enable us to quantify and/or analyze theoretical constructs like reading "strategies" and/or reading disability "sub-types".

Current findings suggest these and other possibilities. They may also suggest that it would be both prudent and productive for practitioners to assess and consider students' arithmetic abilities when deciding on the components of a remedial reading program. Mathematics scores may help to predict the success of different word-learning techniques. At least the data collected here suggest that this possibility ought to be examined more rigorously in future.

Arithmetic and Letter Counting Skills

Word Attack, Auditory Sequential Memory, Initial Phoneme Awareness and Phonological Recoding skills were closely associated with subjects' relative successes in this study but so were individuals' relative achievements on the WRAT3 Mathematics sub-test. Participants who attained higher scores on the Mathematics than they did on the Spelling and Reading sub-tests of the WRAT3 also performed relatively better on measures of target word learning (including reading). This was an unexpected, somewhat counter-intuitive finding that warrants discussion. What could relatively stronger math skills indicate about the students' who have them?

Mathematics scores by themselves might merely indicate the overall breadth of an individual's educational experience or they might be related to the development of a more analytic approach to problem-solving and learning tasks. They might provide us with a measure of cognitive capacity or they might reflect underlying, cognitive, learning skills that are required in the acquisition of basic math and basic reading processes. Demonstrated successes in one area of study may suggest that important capabilities are available for use on other tasks in other academic domains. Basic math skills may, for instance, indicate that working and/or long-term memory are sufficient to sustain adequate learning.

Relatively stronger Mathematics than Spelling or Reading, on the other hand, may indicate that some students have experienced a particular instructional emphasis or that they have some generally unfulfilled academic potential.

The question remains open. In fact, these possibilities have largely gone unexamined. The particular importance of number knowledge and of counting skill has, however, been examined in a number of reading research studies. The recognition, discrimination and rapid naming of letters and numbers have been found to correlate with early reading achievement (Torgesen, Wagner, Simmons & Laughon, 1990) and, specifically, with word reading and spelling (Ackerman, Dykman & Gardner, 1990). Torgesen et al determined that serial naming of digits and letters was a more powerful predictor than the naming of items that were presented one at a time in isolation. They found that counting fluency or speed was an important skill indicator: counting rates alone accounted for a considerable amount of the variance between individuals' word reading skills.

It is believed that these measures predict word reading skill because they differentiate students on the basis of their ability to form, store and retrieve phonological and, to a lesser extent, orthographic representations of words in memory. Inaccurate and/or poorly defined representations in memory may account for poor overall word recognition and/or production skills. The coding of phonological information is liable to be the primary source of difficulties but symbolic representations may well be a secondary source. (Stanovich & West, 1989)

There may be some evidence in this particular study that the subjects needed to improve their ability to form, store and/or retrieve both phonological and orthographic representations in and from memory. This is evident if one accepts the assumption that letter naming is more likely than letter counting or whole word training to provide segmented phonological information while letter counting and whole word instruction are more likely to provide students with accurate orthographic stimuli alone. The relatively higher scoring students in this study were able to use Alphabetic, Numeric and Logographic information in their word learning but were able to achieve greater results with Numeric and Logographic training. They may have been able to use phonological and orthographic stimuli but needed to pay more attention to and/or needed more help processing the latter. Lower scoring students, on the other hand, may have needed both letter naming and letter counting information but were only able to use the former effectively. Their primary need may have been to improve their phonological representations while their more able peers primary need was to improve their orthographic representations and/or their amalgamations of the two.

Given that these assumptions are correct, the patterns seen in this study would parallel the phases in Frith's (1985) model of reading acquisition. Frith's model describes three stages: Logographic, Alphabetic and Orthographic and predicts two loci for reading disability. "Developmental arrest prior to or early in the Alphabetic stage would lead to the most common type of poor reader: one with deficient phonological and spelling-to-sound decoding skills" while "developmental arrest at the next stage results in reading problems more closely associated with orthographic processing problems." (Stanovich & West, 1989)

Frith's (1985) framework, as such, describes the findings of this study more satisfactorily than two stage models are able to. The lower functioning students in these experiments could be more involved in an Alphabetic stage and the higher functioning subjects could be closer to being in a later, more Orthographic phase. The more purely visual, segmentation inherent in letter counting was much less useful to the former than to the latter who may have been relatively better able to use it.

The fact that this more visual segmentation should be more successful applied subsequent to phonological skill development supports the contention that " the development of orthographic processing skill must be somewhat dependent on phonological processing abilities"(Stanovich & West, 1989).

In fact, the overall performance of the Numeric condition in this study and its relatively superior effectiveness for more advanced readers may affirm the notion that "phonological skills are necessary but not sufficient for the full development of word recognition fluency" (Stanovich & West, 1989). Perhaps orthographic skill development only becomes an extensively useful proposition once an individual's phoneme awareness skills have become relatively stronger, or at least as strong as, their memory skills. Attention to sound-letter recoding at that particular juncture would, in turn, bring phonological recoding skills into a relatively superior position in the individual's overall, relative skill relationship. This would improve ones' chances of accurately forming, storing and retrieving precise, amalgamated, representations of encoded words in and from memory.

Arithmetic and letter counting skills may, therefore, be more related to visual processing skills and the association of symbols with phonemes that can be isolated in the speech stream. If they bear on phoneme awareness it may be due to their making on-to-one, letter-to-sound correspondences more salient to the learner thereby making the sound associations easier to segment and/or isolate.

Consider the following hypotheses. Trick & Pylyshyn (1993) have examined two separate processes in item enumeration; a rapid, pre-attentive one called "subitizing" which is able to accommodate small numbers and a more time-consuming and error prone one that is commonly referred to as "counting". They suggest that the former is not possible when spatial attention is required to resolve the items that are to be enumerated. Subitizing operates after the spatially parallel processes of feature detection and grouping but before the serial processes of spatial attention. "Counting", however, is required in the enumeration of large numbers of items or events and probably involves both time and energy to move an attentional spotlight through a series of focal points.

In other words, they contend that "subitizing" occurs prior to attention but only if our attention is not required in order to resolve the items to be enumerated i.e. to discriminate, recognize and perhaps be able to identify or name them. It may or may not be done accurately and there is a great deal of variability in the subitizing ranges of different individuals.

This potential variability may help to explain differences in individuals' responses to Numeric instruction. Some subjects in this study may have been unable to resolve the letter items in words with sufficient accuracy or speed or they may have had more limited subitizing ranges that responded to the letter count training. Forcing them to count the letters in words may have inhibited or circumvented their subitizing processes thereby helping them to improve their enumeration accuracy and/or attend to the letters more carefully. Thus, letter counting may assist individuals who are still experiencing difficulty in letter or syllable resolution processes and/or have subitizing ranges that are on the shorter end of the spectrum. Students who gained from letter counting activities may have improved these capacities or they may have circumvented their inadequacies.

In fact, "letter counting" instruction might have helped students in a number of ways. It may have simply improved the accuracy of word storage and retrieval by making word length explicit or it might have improved the thoroughness of students' speech-print recoding during the word learning process. The accuracy of phonological recoding and initial word storage would depend on there being an appropriate, salient number of letter targets for phoneme transposition and/or sound-symbol amalgamation in memory.

This amalgamation may, in fact, be an inherently difficult task. Trick & Pylyshyn (1994) suggest that event (i.e. sound) and item (i.e. object) enumeration are differently affected by heterogeneity and memory load and that they may work in different ways and have different subitizing ranges. (p.83) Event enumeration is more easily affected by both of the aforementioned factors and is likely to have the smaller of the two ranges "though this conclusion must be made with trepidation because it is difficult to know how temporal and spatial resolutions correspond." (p.83)

Given that enumeration underlies, or is at least involved in, identification, one can see some of the reasons why phoneme awareness appears to be more difficult to acquire than symbol awareness and why its development might become the greater hurdle for the majority of students who have difficulty.

Finally, Trick & Pylyshyn's analysis may also give us some further insight into the connections between and the sequence of phonological and orthographic skill acquisition. They suggest that, in relation to the visual system, the assignment of names may be more than just a convention or convenience. It might be a necessity (p.85-86) because it makes it possible to refer to a particular item when it is among others, even though the item's location and properties change in relation to those others. In short, it makes it more possible to locate an object; a factor that must, in turn, affect our ability to match and associate it, in the case of reading, with the appropriate sound correspondences.

These and other speculations require further examination. The letter counting results in this study were unexpected, intriguing and raise questions about the role of enumeration in word recognition and reading. In fact, parallels between the study of reading and the study of enumeration ought to be pursued in much greater detail.

The importance of letter naming and counting in reading remediation

It would seem that letter naming and letter counting may have independent and joint influences in reading acquisition. Both involve segmentation activities and provide segmentation information that students appear to need and, at various stages, given various preexisting skills, are able to use. Their effects may be exerted directly on target word learning and more indirectly on reading-related skills such as phoneme awareness, phonological recoding and verbal memory.

The effects of letter naming appeared to be the somewhat more positive and longer lasting than the effects that might be associated with the other training conditions. Individuals' differences are likely, however, to have interacted with the effects of Alphabetic training so that they were of relatively greater use to some students than they were to others. Relatively better students gained in their sub-skill performances and in target word learning while poorer students gained more in terms of their immediate word learning results and their memory sub-skill scores.

As such, all students benefited from the letter naming in Simultaneous Oral Spelling while subjects with more advanced reading-related sub-skills achieved even higher scores with Numeric (letter counting) and Logographic (whole word) training.

Segmenting words by counting and naming their letters appeared to contribute to subjects' sub-skill and target word learning. Participants with relative strengths in phoneme awareness and phonological recoding were the only individuals in this study who were able to utilize Logographic training that did not explicitly involve a forced segmentation of words.

It was, in fact, reading-related skill ratios that appeared to predict students' responses to the various training conditions in this study; a fact that raises an assessment and an instructional issue. Do we evaluate and teach to people's strengths, weaknesses or would it be more profitable to do both by examining the relationships and ratios between skills? The findings presented here suggest that we could productively assess and teach to individuals' profiles of relative strength and weakness. Our interventions must, after all, provide effects that students need and are able to use.

They must also, however, offer activities and/or information that contribute to skill development as well as improvements in current performance. It is possible to interpret the latter as being "success" rather than as being a contextual, momentary manifestation of success. The strength of SOS letter naming derives from its potential to affect word learning and the development of important reading related skills in students who might need help in these areas. It appears to have a positive influence on students' spelling, reading and reading sub-skill development.

This is not meant to imply that it would be appropriate to use SOS letter naming and letter counting predominately or for extended periods of time. There are other, more precisely targeted, tools for the development of phoneme awareness and phonological recoding that may benefit from its concomitant use. There are also other, more advanced word learning tools that should supplant Simultaneous Oral Spelling as soon as students have mastered and begun to use letter-sound correspondences. Movement to phonetic word learning is the appropriate objective and must be the ultimate priority. For some students, however, Simultaneous Oral Spelling may provide a bridge to the threshold of that achievement.

REFERENCES

Ackerman, P.T., Dykman, R.A., & Gardner, M.Y. (1990). Counting rate, naming rate, phonological sensitivity, and memory span: major factors in dyslexia. Journal of Learning Disabilities, 23, 325-327.

Adams, M.J. (1990). Beginning to read: Thinking and learning about print. Cambridge, Massachusetts: MIT Press.

Badian, N.A. (1977). Auditory-visual integration, auditory memory, and reading in retarded and adequate readers. Journal of Learning Disabilities, 10, 49-55.

Badian, N.A. (1993). Phonemic awareness, naming, visual symbol processing, and reading. Reading and Writing: An Interdisciplinary Journal, 5, 87-100.

Baron, J. (1979). Orthographic and word-specific mechanisms in children's reading of words. Child Development, 50, 60-72.

Baron, J. & Strawson, C. (1976). Use of orthographic and word specific knowledge in reading words aloud. Journal of Experimental Psychology: Human Perception and Performance, 2, 386-393.

Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. Developmental Medicine and Child Neurology, 15, 375-389.

Borg, W.R., & Gall, M.D. (1989). Educational Research: An Introduction. New York: Longman.

Bowers, P.G., & Wolf, M. (1993). Theoretical links among naming speed, precise timing mechanisms and orthographic skill in dyslexia. Reading and Writing: An Interdisciplinary Journal, 5, 69-85.

Bradley, L. (1980). Assessing reading difficulties: A diagnostic and remedial approach. Basingstoke: MacMillan Education.

Bradley, L. (1981). The organization of motor patterns for spelling: An effective remedial strategy for backward readers. Developmental Medicine and Child Neurology, 23, 83-91.

Castles, A., & Coltheart, M. (1993). Varieties of developmental dyslexia. Cognition, 47, 149-180.

Clay, M.M. (1993). An Observation Survey of Early Literacy Achievement. Portsmouth, N.H.: Heinemann.

Crispin, L., Hamilton, W. & Trickey, G. (1984). The relevance of visual sequential memory to reading. British Journal of Educational Psychology, 54, 24-30.

Cunningham, A., & Stanovich, K. (1990). Early spelling acquisition: Writing beats the computer. Journal of Educational Psychology, 82, 159-62.

Ehri, L.C. & Wilce, L.S. (1985). Movement into reading: Is the first stage of printed word learning visual or phonetic? Reading Research Quarterly, 20, 163-179.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K.E. Patterson, J.C. Marshall, & M. Coltheart (Eds.), Surface Dyslexia (pp. 301-330).

Frith, U. (1986). A developmental framework for developmental dyslexia. Annals of Dyslexia, 36, 69-81.

Gittelman, R. (1985). Controlled trials of remedial approaches to reading disability. Journal of Child Psychology and Psychiatry, 26, 843-846.

Gough, P.B. (1993). The beginning of decoding. Reading and Writing: An Interdisciplinary Journal, 5, 181-192.

Gough, P.B., & Hillinger, M.L. (1980). Learning to read: An unnatural act. Bulletin of the Orton Society, 30, 179-196.

Gough, P.B., & Hoover, W. (1990). The simple view of reading. Reading and Writing: An Interdisciplinary Journal, 2, 127-160.

Gough, P.B. & Juel, C. (1991). The first stages of word recognition. In L. Rieben, & C.A. Perfetti (Eds.), Learning to read: Basic research and its implications (pp. 47-56). Hillsdale, NJ: Lawrence Erlbaum Associates Inc. Publishers.

Hohn, W.E., & Ehri, L.C. (1983). Do alphabet letters help prereaders acquire phonemic segmentation skill? Journal of Educational Psychology, 75, 752-762.

Hulme, C. (1979). The interaction of visual and motor memory for graphic forms following tracing. Quarterly Journal of Experimental Psychology, 31, 249-261.

Hulme, C., & Bradley, L. (1984). An experimental study of multi-sensory teaching with normal and retarded readers. In R.W. Malatesha, & H.A. Whitaker (Eds.), Dyslexia: A Global Issue (pp. 431-443). The Netherlands, NATO ASI Series.

Hulme, C., Monk, A., & Ives, S. (1987). Some experimental studies of multi-sensory teaching: the effects of manual tracing on children's paired-associate learning. British Journal of Developmental Psychology, 5, 299-307.

Jastak, S., & Wilkinson, G.S. (1993). The Wide Range Achievement Test 3. Wilmington, DE: Jastak Associates.

Katz, R.B., Healy, A.F., & Shankweiler, D. (1983). Phonetic coding and order memory in relation to reading proficiency: A comparison of short-term memory for temporal and spatial order information. Applied Psycholinguistics, 4, 229-250.

Kirk, S., McCarthy, J.J. & Kirk, W. (1968). The Illinois Test of Psycholinguistic Ability. Urbana: University of Illinois Press.

LaBerge, D. (1983). Spatial extent of attention to letters and words. Journal of Experimental Psychology, 9, 371-379.

Mayr, U. (1996). Spatial attention and implicit sequence learning: Evidence for independent learning of spatial and nonspatial sequences. Journal of Experimental Psychology, 22, 350-364.

McLeod, J., & Greenough, P. (1980). The importance of sequencing as an aspect of short-term memory in good and poor spellers. Journal of Reading Disabilities, 13, 27-33.

Moustafa, M. (1995). Children's productive phonological recoding. Reading Research Quarterly, 30, 464-476.

Prior, M., Frye, M., & Fletcher, C. (1987). Remediation for subgroups of retarded readers using a modified oral spelling procedure. Developmental Medicine and Child Neurology, 29, 64-71.

Rosner, J. (1973). Perceptual skills curriculum: Auditory motor skills training. New York: Walker.

Scott, J.A., & Ehri, L.C. (1990). Sight word reading in prereaders: Use of logographic vs. alphabetic access routes. Journal of Reading Behavior, 22, 149-166.

Siegel, L.S. (1989). IQ is irrelevant to the definition of learning disabilities. Journal of Learning Disabilities, 22, 469-478.

Siegel, L.S. (1994). Working memory and reading: A life-span perspective. International Journal of Behavioral Development, 17, 109-124.

Siegel, L.S. & Ryan, E.B. (1989). The development of working memory in normally achieving and subtypes of learning-disabled children. Child Development, 60, 973-980.

Stanovich, K.E. (1981). Relationships between word decoding speed, general name-retrieval ability, and reading progress in first-grade children. Journal of Educational Psychology, 73, 809-815.

Stanovich, K.E. (1986). Mathew effects in reading: Some consequences of individual differences in the acquisition of literacy. Reading Research Quarterly, 21, 360-406.

Stanovich, K.E. (1992). Speculations on the causes and consequences of individual differences in early reading acquisition. In P. Gough, & C. Juel (Eds.), Reading Acquisition (pp. 307-342). Hillsdale, NJ: Lawrence Erlbaum Associates Inc. Publishers.

Stanovich, K.E. & West, R.F. (1989). Exposure to print and orthographic processing. Reading Research Quarterly, 24,402-429.

Daniels, P.R., Schiffman, G.B., Stull, K., Kelly, E. & Fondessy, K. (1974). Individualized Directions in Reading: A Performance-based Instructional System. Direction IV. (1974). Austin, Texas: Steck-Vaughn Co.

Torgesen, J.K., Wagner, R.K., Simmons, K. & Laughon, P. (1990). Identifying phonological coding problems in disabled readers naming, counting or span measures. Learning Disabilities Quarterly, 13, 236-243.

Trick, L.M., & Pylyshny, Z.W. (1994). What enumeration studies can show us about spatial attention: Evidence for limited capacity preattentive processing. Journal of Experimental Psychology, 19, 331-351.

Trick, L.M., & Pylyshyn, Z.W. (1994). Why are small and large numbers enumerated differently? A limited-capacity preattentive stage in vision. Psychological Review, 101, 80-102.

Vandervelden, M.C. & Siegel, L.S. (1995). Phonological recoding and phoneme awareness in early literacy: A developmental approach. Reading Research Quarterly, 30, 854-875.

Wolf, M. (1984). Naming, reading, and the dyslexias: A longitudinal overview. Annals of Dyslexia, 34, 87-115.

Wolf, M. (1991). Naming speed and reading: The contribution of the cognitive neurosciences. Reading Research Quarterly, 26, 123-141.

Wolf, M. (1991). The word-retrieval deficit hypothesis and developmental dyslexia. Learning and Individual Differences, 3, 205-223.

Woodcock, R.W. & Johnson, M.B. (1989) Woodcock-Johnson Tests of Cognitive Ability: Standard and supplemental batteries. Chicago: Riverside Publishers.

Yopp, H.K. (1988). The validity and reliability of phonemic awareness tests. Reading Research Quarterly, 23, 159-177.

APPENDIX A

READING #11 (TEXT)

Martin Luther King

Martin Luther King was a famous black man.
He was a leader of black people.
When Martin was young,
there were places
where black people could not go.
Martin knew that this was wrong.
He knew that all people should have the same rights.
He wanted to do something about this.
He thought it was time to change things.
Martin Luther King became a minister like his father.
Martin talked to his people.
His people listened to him.
He told them that they should work
to change things.
He believed that they should do this
without fighting.
He believed that people
should talk things over.
There were also many white people
who listened to Martin.
They worked to change things too.
Martin and other people
worked to change laws.
They worked for black people
to have the same rights as white people.
People will always remember Martin Luther King
for his work.

APPENDIX A

READING #11 (LIST)

work
his
for
King
Luther
Martin
remember
will
people
all
people
white
as
rights
same
the
have
to
people
black
for
worked
they
laws
change
to
worked
they
Martin
to
listened
who
people
white
many
also
were
there
over
things
talk

should
people
believed
he
fighting
without
this
do
should
they
that
believed
he
things
change
to
work
should
they
that
them
told
he
him
to
listened
people
his
people
his
to
talked
Martin
father
his
like
minister
a
became
King
Luther

Martin
things
change
to
time
was
it
thought
he
this
about
something
do
to
wanted
he
rights
same
the
have
should
people
all
that
knew
he
wrong
was
this
that
knew
Martin
go
not
could
people
black
where
places
were
there

young
was
Martin
when
people
black
of
leader
a
was
he
man
black
famous
a
was
King
Luther
Martin

APPENDIX B

Target Word Sets

Word Set One:

cheetah, purr, giraffe, tallest, light, hard, groups, herds

Word Set Two:

strays, huge, knock, grew, studied, lawyer, ruled, president

Word Set Three:

leads, afraid, leopards, stripes, tall, head, tried, goes

Word Set Four:

thick, fight, hear, smell, Luther, famous, wrong, became

Word Set Five:

turns, leader, pounds, male, mane, bushy, female, rest

Word Set Six:

Africa, Asia, grass, leaves, uses, claws, spots, fur

APPENDIX C

Initial Phoneme Recognition Test

Target Phonemes and Word Stimuli

/s/	/fat/; /soup/; /sock/; /meat/
/j/	/row/; /jab/; /big/; /john/
/m/	/man/; /son/; /rag/; /mitt/
/k/	/let/; /foot/; /kite/; /kids/
/r/	/rich/; /sit/; /right/; /pull/
/b/	/bite/; /bar/; /time/; /hook/
/t/	/grip/; /pen/; /tick/; /toe/
/p/	/pit/; /pill/; /day/; /bill/
/h/	/foot/; /hot/; /row/; /hell/

APPENDIX D

Final Phoneme Recognition Test

Target Phonemes and Word Stimuli

/j/	/jack/; /joe/; /fudge/; /ledge/
/m/	/mop/; /him/; /mud/; /hem/
/k/	/hack/; /kind/; /neck/; /kill/
/r/	/fur/; /were/; /row/; /run/
/b/	/bake/; /bash/; /tub/; /fib/
/s/	/bess/; /less/; /sew/; /see/
/t/	/toe/; /fat/; /knit/; /tell/
/p/	/push/; /nap/; /pull/; /sap/

APPENDIX E

Phoneme Location Test

Target Phonemes and Word Stimuli

/s/ /miss/; /fat/; /hiss/; /meat/

/j/ /mitt/; /barg/; /madg/; /hook/

/m/ /dam/; /slam/; /kick/; /skate/

/k/ /dime/; /best/; /back/; /wack/

/r/ /sat/; /car/; /stir/; /puck/

/b/ /wage/; /web/; /far/; /ebb/

/t/ /fit/; /sail/; /pan/; /boot/

/p/ /shut/; /rug/; /flip/; /tip/

APPENDIX F

Phoneme Recognition/Location Identification Test

Target Phonemes and Word Stimuli

/j/	/fudge/; /joke/; /wish/; /luck/
/m/	/note/; /same/; /made/; /what/
/k/	/rose/; /base/; /bike/; /hook/
/r/	/floor/; /step/; /rope/; /help/
/b/	/been/; /hope/; /lab/; /note/
/s/	/seek/; /sell/; /none/; /call/
/t/	/when/; /puck/; /teach/; /heart/
/p/	/look/; /heep/; /weep/; /sack/

APPENDIX G

Phoneme Blending

Word Stimuli

Part one:
a-t
m-y
t-o
o-n
s-o
i-s
a-s
n-o
i-t
o-f

Part two:
f-at
wh-en
l-augh
n-ot
w-ill
b-een
r-ock
g-et
b-ad
s-it

Part three:
c-a-t
b-a-ck
sh-ee-t
s-i-p
r-u-n
f-o-r
r-a-t
wh-e-n
b-a-ll
a-n-d

APPENDIX H

Rhyme Sensitivity Test

Word Pair Stimuli

and/hand
in/pin
all/bell
said/sad
than/then
it/wit
much/which
he/she
for/more
like/nice
are/far
at/bat
from/for
be/we
his/her
or/for
work/book
water/where
by/why
now/know

APPENDIX I

Speech-to-Print Matching Test
Spoken/Pronounced words and Printed Words for Matching

Set 1: (requires only recognition of the relationship between the initial phoneme and the initial letter)

Soap	duck soap boat
Mask	mask dress boat
Frog	sad mitt frog
Tip	plant dirt tip
Boat	boat swim drum
Kiss	paint kiss milk
Park	frog park swim
Duck	soap pot duck
Goat	swim goat mask
Head	head dress swim

Set 2: (requires phonological recoding that exceeds the initial letter but can be made by recognizing the relationship between the final letter and phoneme)

Frog	fight frog flop
Map	map mom miss
Duck	drum duck drip
Swim	swim swap sick
Boat	book boat boom
Heart	hop hug heart

Set 3: (requires recognition of letter-phoneme matches for letters between word boundary letters)

Mask	milk mask monk
Fast	felt faint fast
Drink	duck dunk drink
Belt	boat belt blot
Sink	sink speak slink
Host	host halt heat

Set 4: (requires recognition of letter-phoneme matches for medial vowel letters found between word boundary letters)

Bug	big bug bag
Pet	pet pot pat
Bag	bug bag big
Pot	pet pit pot
Bit	bit bat but
Bike	bike bake boke
Pete	pite pote pete
Tube	tabe tube tobe
Smoke	smeke smoke smuke
Make	make mike meke

APPENDIX J

Short-term Memory Tests

Letter Stimuli

AUDITORY MEMORY:

Rhyming letters:	P, C, G, B, T. V, G, P, B, C. G, B, T, V, P.
Nonrhyming letters:	S, L, Q, H, R. K, W, H, Q, K. R, H, W, S, K.

VISUAL MEMORY:

Rhyming letters:	V, B, C, T, D. D, G, V, C, P. R, H, W, S, K.
Nonrhyming letters:	Q, H, L, R, K. S, K, Q, W, R. B, R, K, S, W.

APPENDIX K

Listening Span Test

Level one:

The sun comes up in the .... (morning).
People often drive in ..... (cars).

Level two:

Dogs like to chase .... (cats).
We often dress baby girls in ..... (pink).
People use boats to go .... (fishing).

Level three:

The grass is ..... (green).
You can see clouds up in the ..... (sky).
When a wave rolls in, it hits the .... (beach).
We are all hoping to win the ..... (lottery).

Level four:

Skydivers jump out of .... (planes).
People sometimes climb ..... (mountains).
To avoid drowning, you must learn to ..... (swim).
We hang pictures on .... (walls).
Everyone needs to have food to ..... (eat).

APPENDIX L

Examples of Students' Errors by Type

Target word	Student response	Error
knock	Knock	N/A
mane	Male	-1 (minus 1)
stays	States	-1 (minus 1)
president	Non-response	N/A
ruled	Non-response	N/A
lawyer	Always	-5 (wild guess)
studied	Supposed	-4 (wild guess)
grew	Grade	-4 (wild guess)
become	Believe	-4 (wild guess)
spots	Store	-4 (wild guess)
leader	Learnder	-3 (good guess)
huge	Hunt	-3 (good guess)
hard	Head	-3 (good guess)

APPENDIX M

Measurements of Target-word Learning
(Proportions Correct)

Participant 1

Measure	Untrained 1	Logo	Untrained 2	Count	Untrained 3	Alpha
Learning trials	n/a	.54	n./a	.49	n/a	.43
Discrimination	.69	.72	.66	.75	.66	.78
Discrimination+3	.78	.63	.69	.69	.72	.69
Target word reading in list- before training	.36	.13	.00	.39	.23	.42
Target word reading in list –after training	.57	.13	.13	.69	.64	.83
Target word reading in list- change	.21	.00	.13	.31	.41	.42
Target word (only) reading +3 weeks	.25	.25	.38	.38	.38	.25
Spelling	.44	.41	.40	.58	.70	.71
Spelling+3	.36	.30	.42	.45	.78	.50

APPENDIX M

Measurements of Target-word Learning
(Proportions Correct)

Participant 2

Measure	Untrained 1	Logo	Untrained 2	Alpha	Untrained 3	Count
Learning trials	n/a	.39	n/a	.50	n/a	.45
Discrimination	.91	.66	.63	.81	.84	.81
Discrimination+3	.81	.78	.78	.75	.78	.81
Target word reading in list- before training	.46	.54	.00	.36	.58	.50
Target word reading in list –after training	.38	.86	.00	.79	.50	.60
Target word reading in list- change	(.09)	.32	.00	.43	(.08)	.10
Target word (only) reading +3 weeks	.50	.75	.00	.50	.25	.38
Spelling	.74	.67	.44	.78	.62	.56
Spelling+3	.66	.60	.39	.65	.64	.51

APPENDIX M

Measurements of Target-word Learning
(Proportions Correct)

Participant 3

Measure	Untrained 1	Count	Untrained 2	Logo	Untrained 3	Alpha
Learning trials	n/a	.33	n/a	.34	n/a	.34
Discrimina-tion	.53	.72	.81	.88	.72	.88
Discrimina-tion+3	.69	.78	.75	.84	.78	.81
Target word reading in list- before training	.50	.50	.36	.42	.10	.54
Target word reading in list –after training	.64	.63	.73	1.0	.70	.85
Target word reading in list- change	.14	.13	.37	.58	.60	.31
Target word (only) reading +3 weeks	.25	.50	.25	.50	.63	.75
Spelling	.73	.65	.69	.86	.79	.79
Spelling+3	.75	.50	.62	.83	.74	.74

APPENDIX M

Measurements of Target-word Learning
(Proportions Correct)

Participant 4

Measure	Untrained 1	Count	Untrained 2	Alpha	Untrained 3	Logo
Learning trials	n/a	.53	n/a	.40	n/a	.61
Discrimina-tion	.78	.78	.91	.75	.66	.84
Discrimina-tion+3	.91	.63	.85	.69	.66	.81
Target word reading in list- before training	.58	.36	.31	.46	.00	.10
Target word reading in list –after training	1.0	.36	.82	.57	.25	.40
Target word reading in list- change	.42	.00	.51	.11	.25	.30
Target word (only) reading +3 weeks	.50	.75	.88	.38	.13	.50
Spelling	.69	.75	.82	.73	.57	.67
Spelling+3	.74	.78	.71	.64	.57	.74

APPENDIX M

Measurements of Target-word Learning
(Proportions Correct)

Participant 5

Measure	Untrained 1	Alpha	Untrained 2	Logo	Untrained 3	Count
Learning trials	n/a	.49	n/a	.60	n/a	.65
Discrimina-tion	.72	.81	.84	.88	.78	.75
Discrimina-tion+3	.72	.88	.84	.81	.81	.88
Target word reading in list- before training	.50	.38	.79	.54	.79	.33
Target word reading in list –after training	.80	.88	.93	1.0	.79	.92
Target word reading in list- change	.30	.50	.14	.46	.00	.58
Target word (only) reading +3 weeks	.50	.88	.63	.50	.75	.50
Spelling	.70	.76	.98	.90	.87	.93
Spelling+3	.72	.70	.88	.82	.73	.81

APPENDIX M

Measurements of Target-word Learning
(Proportions Correct)

Participant 6

Measure	Untrained 1	Alpha	Untrained 2	Count	Untrained 3	Count
Learning trials	n/a	.49	n/a	.65	n/a	.60
Discrimination	.72	.72	.72	.75	.69	.63
Discrimination+3	.63	.78	.72	.50	.75	.69
Target word reading in list- before training	.00	.40	.42	.50	.39	.07
Target word reading in list –after training	.13	.10	.50	.64	.39	.29
Target word reading in list- change	.13	(.30)	.08	.14	.00	.21
Target word (only) reading +3 weeks	.25	.50	.38	.25	.50	.25
Spelling	.48	.72	.50	.51	.66	.60
Spelling+3	.46	.72	.62	.49	.63	.60

APPENDIX N

Target-word Reading Error Distributions
Identity Errors from Experimental Conditions (L)(A)(N):
Minus 1 (m1), Good Guesses (gg), Wild Guesses (wg) and Non Responses (nr)
(Proportions of Total Errors)

Participant/ Error Types	1	2	3	4	5	6
Initial						
L-m1	.14	.17	.17	.13	.25	.00
L-gg	.14	.00	.17	.13	.25	.00
L-wg	.43	.17	.33	.50	.50	.29
L-nr	.29	.66	.33	.25	.00	.71
A-m1	.14	.00	.25	.00	.20	.00
A-gg	.57	.17	.25	.20	.40	.00
A-wg	.14	.00	.25	.40	.40	.40
A-nr	.14	.83	.25	.40	.00	.60
N-m1	.00	.00	.50	.14	.50	.20
N-gg	.00	.00	.00	.14	.16	.00
N-wg	.50	.00	.50	.57	.33	.40
N-nr	.50	1.0	.00	.14	.00	.40
Final						
L-m1	.00	.00	.00	.00	.00	.13
L-gg	.29	1.0	.00	.40	.00	.00
L-wg	.43	.00	.00	.40	.00	.13
L-nr	.29	.00	.00	.20	.00	.75
A-m1	.00	.50	1.0	.20	.00	.00
A-gg	.00	.00	.00	.00	.00	.14
A-wg	.50	.00	.00	.60	1.0	.00
A-nr	.50	.50	.00	.20	.00	.86
N-m1	.00	.00	.00	.14	.00	.40
N-gg	.33	.66	.00	.14	.00	.00
N-wg	.00	.33	.66	.57	1.0	.20
N-nr	.66	.00	.33	.14	.00	.40
Change						
L-m1	(.14)	(.17)	(.17)	(.13)	(.25)	.13
L-gg	.15	1.0	(.17)	.27	(.25)	.00
L-wg	.00	(.17)	(.33)	(.10)	(.50)	(.16)
L-nr	.00	(.66)	(.33)	(.05)	.00	.04
A-m1	(.14)	.50	.75	.20	(.20)	.00
A-gg	(.57)	(.17)	(.25)	(.20)	(.40)	.14
A-wg	.36	.00	(.25)	.20	.60	(.40)
A-nr	.36	(.33)	(.25)	(.20)	.00	.26
N-m1	.00	.00	(.50)	.00	(.50)	.20
N-gg	.33	.66	.00	.00	(.16)	.00
N-wg	(.50)	.33	.16	.00	.66	(.20)
N-nr	.16	(1.0)	.33	.00	.00	.00

APPENDIX O

Participant 1:Reading-Related Skills Pre/Post test scores
(Letter naming speed is a measure of letters per second)
(All other scores are Proportions Correct)

Pre/post tests	Initial test	Post Logo test	Post Count test	Post Alpha test
Letter naming speed	1.13	1.13	1.02	.96
Letter naming accuracy	1.0	.96	.96	.94
Letter naming in words	1.0	1.0	.99	.98
Composite Letter Naming Accuracy score	1.0	.98	.98	.96
Phoneme recognition	1.0	.60	.90	.90
Phoneme production	.80	.55	.65	.55
Speech-to-print matching	.81	.81	.87	.84
Pseudoword reading	.48	.25	.23	.38
Spelling	.76	.76	.80	.76
Composite Phonological Recoding score	.77	.60	.69	.69
Initial phoneme recognition	-	-	-	-
Final phoneme recognition	-	-	-	-
Phoneme location	-	-	-	-
Phoneme recognition/ Location	-	-	-	-
Sequential segmentation	-	-	-	-
Phoneme blending	-	-	-	-
Rhyme sensitivity	-	-	-	-
Composite Phoneme Awareness score	-	-	-	-
Auditory memory	.63	.53	.63	.77
Visual memory	.70	.57	.87	.87
Listening span	.20	.29	.36	.29
Composite Memory score	.51	.46	.62	.64

APPENDIX O

Participant 2: Reading-Related Skills Pre/Post test scores

(Letter naming speed is a measure of letters per second)

(All other scores are Proportions Correct)

Pre/post tests	Initial test	Post Logo	Post Alpha	Post Count
Letter naming speed	1.17	1.31	1.42	1.42
Letter naming accuracy	.98	.98	.98	.93
Letter naming in words	1.0	.96	1.0	1.0
Composite Letter Naming Accuracy score	.99	.97	.99	.97
Phoneme recognition	.90	1.0	1.0	1.0
Phoneme production	.90	1.0	1.0	1.0
Speech-to-print matching	.68	.68	.84	.81
Pseudoword reading	.45	.30	.43	.40
Spelling	.80	.80	.84	.72
Composite Phonological Recoding score	.75	.76	.82	.79
Initial phoneme recognition	.89	1.0	1.0	1.0
Final phoneme recognition	.66	.78	.78	.78
Phoneme location	.63	.78	.75	.97
Phoneme recognition/ Location	.59	.75	.53	.75
Sequential segmentation	-	-	-	-
Phoneme blending	-	-	-	-
Rhyme sensitivity	.65	.45	.55	.60
Composite Phoneme Awareness score	.49	.54	.52	.59
Auditory memory	.67	.43	.80	.63
Visual memory	.70	.93	.87	.80
Listening span	.36	.43	.36	.36
Composite Memory score	.58	.60	.68	.60

APPENDIX O

Participant 3: Reading-Related Skills Pre/Post test scores

(Letter naming speed is a measure of letters per second)

(All other scores are Proportions Correct)

Pre/post tests	Initial test	Post Count	Post Logo	Post Alpha
Letter naming speed	1.2	1.17	1.2	1.6
Letter naming accuracy	.98	1.0	.93	1.0
Letter naming in words	1.0	.97	1.0	.96
Composite Letter Naming Accuracy score	.99	.99	.97	.98
Phoneme recognition	1.0	1.0	1.0	1.0
Phoneme production	1.0	.95	1.0	1.0
Speech-to-print matching	.84	.87	.84	.90
Pseudoword reading	.53	.43	.58	.55
Spelling	.84	.80	.72	.68
Composite Phonological Recoding score	.84	.81	.83	.83
Initial phoneme recognition	.94	.94	.94	.97
Final phoneme recognition	.94	.94	1.0	1.0
Phoneme location	1.0	1.0	1.0	1.0
Phoneme recognition/ Location	.91	.94	.78	.94
Sequential segmentation	.80	.72	.74	.68
Phoneme blending	.73	.77	.90	1.0
Rhyme sensitivity	.60	.60	.60	.65
Composite Phoneme Awareness score	.84	.84	.85	.89
Auditory memory	.63	.70	.73	.73
Visual memory	.83	.90	.87	.80
Listening span	.64	.43	.57	.50
Composite Memory score	.70	.68	.72	.68

APPENDIX O

Participant 4: Reading-Related Skills Pre/Post test scores
(Letter naming speed is a measure of letters per second)
(All other scores are Proportions Correct)

Pre/post tests	Initial test	Post Count	Post Alpha	Post Logo
Letter naming speed	1.5	1.59	1.54	1.86
Letter naming accuracy	.94	.98	.98	.96
Letter naming in words	.98	.99	.98	.98
Composite Letter Naming Accuracy score	.96	.99	.98	.97
Phoneme recognition	.80	.70	.90	.90
Phoneme production	.90	.95	.90	.85
Speech-to-print matching	.87	.94	.90	.90
Pseudoword reading	.45	.45	.43	.28
Spelling	.84	.76	.68	.76
Composite Phonological Recoding score	.77	.76	.76	.74
Initial phoneme recognition	.92	.92	.89	.97
Final phoneme recognition	.75	.84	.88	.78
Phoneme location	.69	.78	.84	.75
Phoneme recognition/ Location	.72	.72	.78	.66
Sequential segmentation	-	-	-	-
Phoneme blending	.37	.33	.43	.40
Rhyme sensitivity	.55	.60	.60	.60
Composite Phoneme Awareness score	.57	.60	.63	.59
Auditory memory	.80	.83	.73	.83
Visual memory	.83	.83	.83	.83
Listening span	.36	.36	.43	.43
Composite Memory score	.66	.67	.66	.70

APPENDIX O

Participant 5: Reading-Related Skills Pre/Post test scores
(Letter naming speed is a measure of letters per second)
(All other scores are Proportions Correct)

Pre/post tests	Initial test	Post Alpha	Post Logo	Post Count
Letter naming speed	.86	1.0	.95	.70
Letter naming accuracy	1.0	.98	.96	1.0
Letter naming in words	.98	1.0	.98	.98
Composite Letter Naming Accuracy score	.99	.99	.97	.99
Phoneme recognition	1.0	1.0	1.0	1.0
Phoneme production	1.0	.95	1.0	1.0
Speech-to-print matching	.94	.97	.87	.90
Pseudoword reading	.60	.53	.50	.58
Spelling	.96	.88	.88	.84
Composite Phonological Recoding score	.90	.86	.85	.86
Initial phoneme recognition	1.0	1.0	1.0	1.0
Final phoneme recognition	.84	.97	1.0	1.0
Phoneme location	.97	.97	1.0	.94
Phoneme recognition/ Location	1.0	.97	1.0	1.0
Sequential segmentation	-	-	-	-
Phoneme blending	-	-	-	-
Rhyme sensitivity	.70	.65	.45	.45
Composite Phoneme Awareness score	.64	.65	.64	.63
Auditory memory	.29	.50	.50	.29
Visual memory	.70	.73	.63	.70
Listening span	.29	.50	.64	.79
Composite Memory score	.43	.58	.59	.59

APPENDIX O

Participant 6: Reading-Related Skills Pre/Post test scores
(Letter naming speed is a measure of letters per second)
(All other scores are Proportions Correct)

Pre/post tests	Initial test	Post Alpha	Post Count	Post Logo
Letter naming speed	1.06	.87	.89	.95
Letter naming accuracy	.98	.93	.91	.91
Letter naming in words	.98	.97	.98	.99
Composite Letter Naming accuracy score	.98	.95	.95	.95
Phoneme recognition	.70	.90	.70	1.0
Phoneme production	.60	.55	.60	.35
Speech-to-print matching	.87	.90	.84	.87
Pseudoword reading	.40	.58	.63	.50
Spelling	.72	.76	.84	.88
Composite Phonological Recoding score	.66	.74	.72	.72
Initial phoneme recognition	.88	.92	.92	.88
Final phoneme recognition	.91	.91	.94	.88
Phoneme location	.75	.78	.84	.66
Phoneme recognition/ Location	.72	.72	.66	.69
Sequential segmentation	-	-	-	-
Phoneme blending	.43	.47	.50	.53
Rhyme sensitivity	.55	.55	.75	.70
Composite Phoneme Awareness score	.61	.62	.66	.62
Auditory memory	.80	.87	.83	.80
Visual memory	.67	.80	.77	.87
Listening span	.57	.36	.50	.64
Composite Memory score	.68	.68	.70	.77

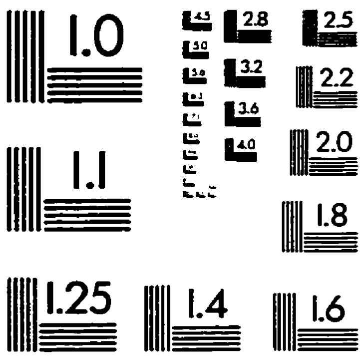
APPENDIX P

Initial Target-Word Reading Response Distributions

(Proportions of the Total Number of Target Words)

Participant/ Response Type	1	2	3	4	5	6
Correct	.15	.25	.27	.21	.46	.23
Minus 1	.13	.04	.17	.04	.19	.04
Good Guess	.19	.02	.15	.19	.13	.04
Wild Guess	.33	.04	.25	.42	.19	.19
Non-response	.21	.65	.17	.15	.04	.50

IMAGE EVALUATION TEST TARGET (QA-3)



150mm

6″

APPLIED IMAGE . Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989