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A PROCESS APPROACH TO REMEDIATING WORD-DECODING DEFICIENCIES IN CHAPTER 1 CHILDREN

Jerry S. Carlson and J.P. Das

Abstract. Difficulties in remediating reading deficiencies in Chapter 1 children have been well documented. Using samples of children from this population, we report the results of two studies employing a recently developed program designed to remediate word-decoding deficiencies. The Process-Based Reading Enhancement Program (PREP) is based on the Luria-Das model of information integration. It involves instruction twice weekly over 14 to 16 weeks. In Study 1, 50 children were randomly selected from a fourth-grade Chapter 1 population. From this group, random assignment was made to experimental and comparison groups ($N=25$ in each group). The PREP was administered using a student-teacher ratio of 2 to 1. The Word Attack and Word Identification subtests of the *Woodcock Reading Mastery Tests-Revised* (WRMT-R) were used as pre- and posttests. For both measures, significant group-by-time interactions were detected. In Study 2, a different sample of 100 Chapter 1 fourth-grade children was randomly divided into remediation and comparison groups (after attrition, $Ns=37$ and 41, respectively). As in Study 1, all children were pretested and posttested on alternate forms of the Word Attack and Word Identification subtests of the WRMT-R. The time x treatment interactions were significant for both measures. The results of these studies support the efficacy of the PREP to improve word-reading and decoding abilities.

The United States Congress authorized federal financial assistance to school districts through the 1965 enactment of Title 1 (after 1982 called Chapter 1) of the Elementary and Secondary Education Act (ESEA). The purpose of this legislation was to provide remedial services to educationally deprived students whose parents are below the government-defined poverty line. Two groups of children were included under the "educational deprivation" rubric (Vanecko & Ames, 1987): (a) those who have need for special educational assistance in order to raise the level of their educational attainment to that appropriate for children of their age and (b) those who have disabilities. At present, approximately five million students (one in nine) in American schools are in Chapter 1 programs and more than 90% of the nation's school districts receive Chapter 1 funding.

Although school districts enjoy considerable

latitude in selecting schools and designing programs to receive Chapter 1 support, students are generally selected on two criteria: poor performance on national reading and mathematics achievement tests and teacher recommendation. On average, elementary-grade students entering Chapter 1 programs score at the 29th percentile on standardized reading tests; students scoring below the 25th percentile are usually not included in these programs, as they often receive alternative placements (Birman et al., 1987).

Most investigations concerning Chapter 1 have been descriptive, focusing primarily on the

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demographic characteristics of the students (Kennedy, Birman, & Demaline, 1988; Vanecko & Ames, 1987); the relationships between financial expenditures and academic achievement (Carter, 1984; Hanushek, 1981); teaching practices (Brophy, 1988); and classroom variables (Rowan & Guthrie, 1988). Surprisingly little research has been done on student achievement and the efficacy of particular programs to improve performance in target curricular areas. The most notable exception to the paucity of research in this area is the Sustaining Effects Study carried out in the late 1970s (Carter, 1982).

The data from the Sustaining Effects Study indicate that Chapter 1 programs are effective for improving reading abilities of only a small minority of participants. The factors that seem to account for the gains in reading achievement that result from a Chapter 1 experience appear to be less related to the programs themselves than to the children's initial level of performance: low-performing students tend to improve marginally or not at all, whereas higher performing students improve to grade level (Carter, 1984).

Reviewing the literature on the effects of Chapter 1 programs on educational achievement, Walberg (1984) came to a similar conclusion: "On balance Chapter 1, (sic) appears to have done little good for students: it has neither raised the achievement of the educationally-deprived and poorest students, nor reduced the gap between them and other students" (p. 17).

Reading Deficiency and Information Processing

Based on the structural model proposed by Atkinson and Shiffrin (1968), earlier approaches to remediating learning and reading difficulties often focused on improving memory through control processes. A number of subsequent investigations (Belmont & Butterfield, 1971; Borkowski & Cavanaugh, 1979; Palinscar & Brown, 1984; Paris & Oka, 1986) demonstrated that while specific strategies for children with reading disabilities could be improved through instructional intervention, only marginal gains could be shown in children's ability to transfer the information acquired to similar but new tasks.

Children with reading children disabilities typically have problems recognizing words (Lovett, Ransby, Hardwick, Johns, & Donaldson, 1989) and difficulty in learning incidentally and transferring acquired skills (Bjorklund & Bernholtz,

1986). The lack of improvement of children with reading disabilities exposed to learning grapheme-phoneme rules in the Lovett et al. study suggests that unlike normally achieving readers, children with reading disabilities do not incidentally learn appropriate reading strategies. This may be a primary reason why direct, orthographic-based teaching of reading materials has met with only partial success (Chall & Curtis, 1990; Share & Stanovich, 1995).

In our view, children with reading disabilities require a method of instruction that is based on specific elements of information integration that are fundamental to reading and constitute a main source of their reading difficulties. (See also Siegel, 1989.) For this reason, we have applied the PASS model to analyze the difficulties Chapter 1 children have with word and phoneme decoding and the Pass Reading Enhancement Program (PREP) model to remediate these difficulties.

PASS and Reading Deficiencies in Chapter 1 Children

The Luria-Das (Das, Kirby, & Jarman, 1979; Naglieri, 1992) model of information integration comprises four elements: planning, attention, simultaneous processing, and successive processing (PASS). Planning and attention represent the processing elements primarily involved in the selection of information to which an individual attends. Through planning and attention, individuals can select from their repertoires of prior knowledge that which is relevant to particular problems and, at the same time, create operations (plans) to solve problems. Successive integration occurs when information is coded in temporal sequence. For example, successive processes are involved if one spells a word, commits a poem to memory, or analyzes a word by breaking it into its sequential phonemes. Simultaneous integration is involved when information is coded holistically such as when one concurrently perceives the relationships among the constituent parts of a problem.

In a recent investigation (Little, Das, Carlson, & Yachimowicz, 1993), we applied the PASS model to determine (a) the cognitive similarities and differences between Chapter 1 and non-Chapter 1 children and (b) which of the PASS variables underlie the decoding and word-reading difficulties these children have. Principal-factor analysis of the PASS measures revealed two clearly differentiated factors: successive

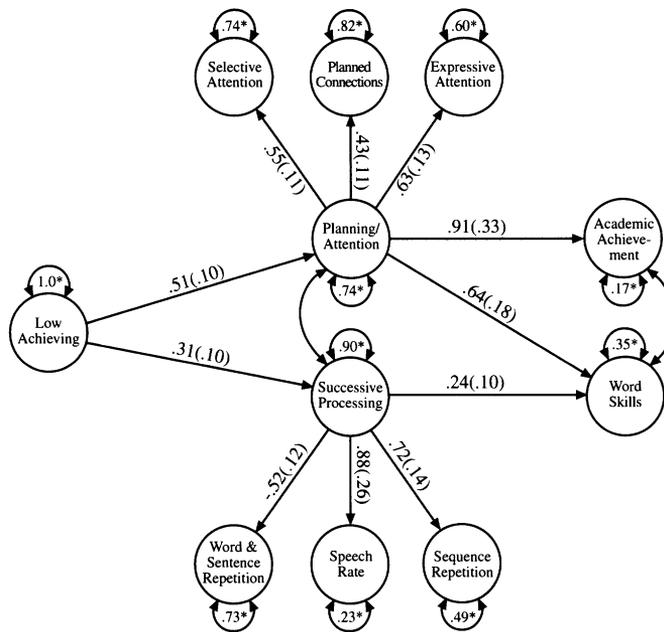


Figure 1. Structural relations among the lower- and higher-order factors of the PASS cognitive abilities battery and word skills and academic achievement.

processing (sequence repetition, word series, sentence questions, speech rate) and planning and attention (planned connections, expressive attention, selective attention, speech rate). The reading measures used were the SAT reading and the revised *Woodcock-Johnson* Word Attack and Word Identification tests.

The relationships between the reading variables, PASS performance, and Chapter 1 status were analyzed by structural equation modeling. As can be seen in Figure 1, Chapter 1 status alone (low-achieving factor) had no direct relationship with either of the two outcome factors: SAT reading or word skills (a composite of the two *Woodcock-Johnson* tests). Deficits in achievement associated with the group differences in SAT reading skills were mediated by deficits in the abilities represented by planning and attention; deficits in word skills were mediated mainly by planning and attention and to a lesser extent by successive processing. (See also Carlson & Das, 1992; Das, 1984.)

These results imply that instructional intervention of poor reading achievement of Chap-

ter 1 children should focus on those areas of processing in which the children are deficient. Accordingly, we instituted a program designed to remediate word-reading and word-decoding difficulties by taking the child through structured experiences that emphasize those areas of cognitive functioning that the child has difficulty with: successive processing and planning and attention.

The Process-Based Reading Enhancement Program (PREP)

The Process-Based Reading Enhancement Program (PREP) was designed to improve selected aspects of children's information-processing skills and increase their word-reading and decoding abilities. PREP, an alternative to direct training of strategies for remediating reading skills, is based on the notion that transfer of principles can be facilitated through inductive rather than deductive inference. Accordingly, the remedial training program is structured in such a way that inductive inference should occur spontaneously with internalization occurring through induction rather than deductive rule

learning (Campione & Brown, 1987; Das, Mishra, & Pool, 1995; Vygotsky, 1962).

The program comprises eight tasks, each with a global processing training form and a curriculum-related bridging form. The global form has no reading content. It provides a structured series of exercises that require application of successive strategies as well as planning and attentional resource allocation. The bridging form has the same cognitive demands as its matched global form but employs letters and their combinations. Each task has three levels of difficulty. The easiest level allows the child to have initial success with the materials and become familiar with the task and the expectations of the training program. The more difficult levels build on the easiest level through added complexity. The program is administered individually or in small-group settings of up to six children at a time.

Depending on the progress the child makes, instruction typically requires 15 to 18 hours over approximately 8 weeks. (A description of the PREP materials can be found in the Appendix.)

Effectiveness of the Remediation Program

In order to evaluate PREP's effectiveness with Chapter 1 populations, two studies were carried out. The first study was exploratory; the second was a replication and an extension of the first.

EXPERIMENT 1

Method

Participants. The sample was selected from two schools serving a mid-sized southern California community: one school served a middle-class neighborhood; the other school served a lower middle-class neighborhood. All the children in the sample were in Chapter 1 programs. Assignment to Chapter 1 was based on parental income, low SAT scores, and teacher recommendation. The sample comprised approximately equal numbers of males and females from Anglo or Hispanic ethnic backgrounds.

The subjects in the original sample of 50 fourth-graders were randomly assigned to remediation ($N=25$) and comparison groups ($N=25$). The two schools in the study were equally represented in the sample. The remediation and comparison groups were given identical tests at the beginning of the intervention as well as at the end. The children in both groups received regular instruction, including Chapter 1 services, over the time span of the intervention.

In addition, those in the remediation group received the "add on" of the PREP. Due to attrition, caused mainly by students moving out of the district, a number of subjects were lost over the course of the intervention. The final sample upon which the analyses are based is 22 in the remediation group and 15 in the comparison group.

The Woodcock Reading Mastery Tests-Revised (WRMT-R). The WRMT-R (Woodcock & Johnson, 1990) was used with all children in the sample to obtain a standardized measure of word recognition (decoding). Two subtests were used: Word Attack and Word Identification. Norms for the WRMT-R are based on 6,089 subjects from various areas of the U.S. and controlled for ethnicity, community size, and socioeconomic status. Internal consistency reliability, as measured by the split-half Spearman-Brown formula, provides a median full score reliability of .98. The Word Attack subtest has a reliability of .87; the Word Identification subtest has a reliability of .97. Equivalent forms of the WRMT-R were used for the pretests and posttests to reduce practice effects.

Intervention

PREP instruction was carried out with pairs of children. Each child had his or her own set of materials. The children sat next to one another facing the instructor. The intervention consisted of 15 hours distributed over 8 weeks. Each session usually involved training on two global and two corresponding bridging tasks and lasted approximately 50 minutes. The tasks were presented in the following order: related memory set, joining shapes, transportation matrices, connecting letters, serial recall, and window sequencing. This order of presentation was used to maximize the variety of materials and to maintain the students' interest (see Appendix).

Results

Table 1 displays the means and standard deviations of the remediation and comparison groups.

The data were subjected to repeated-measures analyses of variance. The choice of mixed-model F tests over a MANOVA omnibus test for repeated measures was based on the relatively small sample size and the ensuing threat to power (Brogan & Kutner, 1980; Hertzog & Rovine, 1985), as well as the high correlation (.76) between the depen-

Table 1
Remediation Results, Study 1: Means and Standard Deviations

Measure and Group	Pretest		Posttest	
	Mean	SD	Mean	SD
Word Identification				
Remediation	51.0	7.5	58.1	7.9
Comparison	50.5	9.9	50.8	8.6
Word Attack				
Remediation	16.7	7.3	25.1	8.2
Comparison	13.7	7.4	17.3	7.8

Word Identification

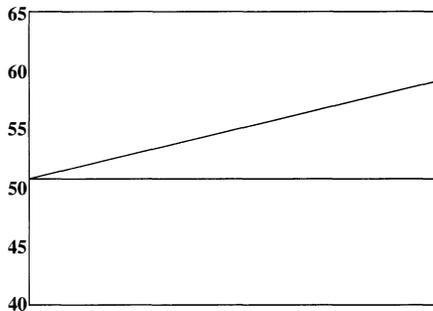


Figure 2. Pretest-posttest scores for the experimental and control groups on the Word Identification test.

Word Attack

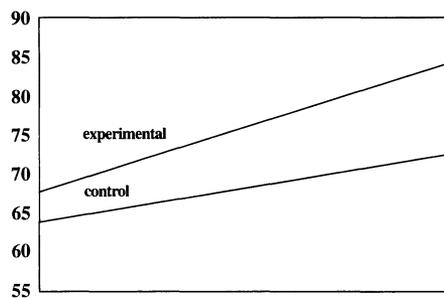


Figure 3. Pretest-posttest scores for the experimental and control groups on the Word Attack test.

dent measures (Woodcock & Johnson, 1990).

In each analysis, significant group-by-time (pretest vs. posttest) interactions were found. For Word Attack and Word Identification, these were $F(1,34)=11.03, p < .01$ and $F(1,34)=12.21, p < .01$, respectively. The interactions are depicted in Figures 2 and 3.

The Word Attack and Word Identification scores were converted to grade-equivalent scores (Woodcock, 1987). For Word Attack, the pretest-posttest change was from 2.57 years to 4.38 years for the remediation group, and from 1.99 years to 2.36 years for the comparison group. Word Identification pretest-posttest changes were 2.9 years to 3.6 years for the remediation group, and 3.0 years to 2.9 years for the comparison group.

EXPERIMENT 2

Method

Participants. An initial sample of 100 children was randomly selected from the fourth-grade Chapter 1 population of two elementary schools serving the same southern California community as in Study 1. Random assignment was made to remediation and comparison groups. Attrition resulted in complete data on 41 children in the remediation group and 37 children in the comparison group. Representation by ethnic group in the final sample was 54% Anglo, 45% Hispanic, and 1% African-American.

Measures. As in Study 1, all the children in the sample were pretested and posttested on alternate forms of the Word Attack and Word Identification subtests of the WRMT-R.

Intervention. The PREP materials described

in the Appendix were used. The only difference from the procedure used in Study 1 was a modification of the student-to-teacher ratio. In Study 1 the ratio was 2 to 1; in Study 2 the ratio was 4 to 1.

Results

The means and standard deviations for the remediation and comparison groups on the raw scores for Word Identification and Word Attack tests are reported in Table 2.

Because of the high correlation between the two dependent measures and the specificity of the hypotheses under test, the data were subjected to repeated-measures analyses of variance rather than a repeated-measures MANOVA. The time x treatment interactions were significant for both Word Identification and Word Attack:

$F(1,57)=11.45, p < .01$ and $F(1,57)=26.09, p < .01$, respectively. The interactions are graphically displayed in Figures 4 and 5.

Grade-level comparisons showed that the group receiving the remediation increased from 2.9 years to 3.6 years on Word Identification and 2.6 years to 4.4 years on Word Attack. Changes for the comparison group were 3.0 years to 2.9 years for Word Identification and 2.0 years to 2.4 years for Word Attack.

DISCUSSION

The results of these studies stand in contrast to the majority of the reported attempts to improve the word-reading abilities of Chapter 1 children. Examination of the pre- and posttest scores for the comparison groups shows that only minimal

Table 2
Remediation Results, Study 2: Means and Standard Deviations

Measure and Group	Pretest		Posttest	
	Mean	SD	Mean	SD
Word Identification				
Remediation	37.9	8.9	45.1	11.5
Comparison	31.8	10.4	35.0	13.1
Word Attack				
Remediation	9.7	4.9	15.5	7.1
Comparison	8.2	7.1	9.1	8.2

Word Identification

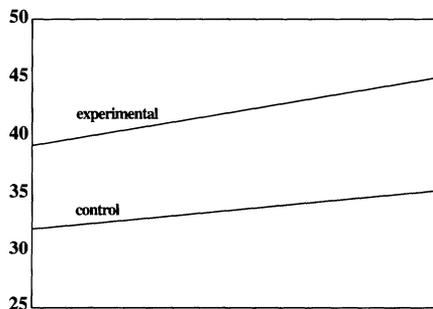


Figure 4. Pretest-posttest scores for the experimental and control groups on the Word Identification test.

Word Attack

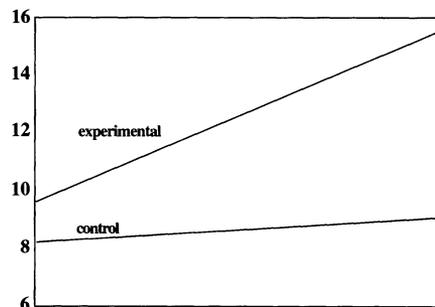


Figure 5. Pretest-posttest scores for the experimental and control groups on the Word Attack test.

and nonsignificant gains were made over the duration of the study. When one considers the fact that the subjects in the comparison group received regular Chapter 1 services, these results are consistent with the rather disheartening conclusions of the Sustaining Effects Study (Carter, 1982, 1984). By contrast, the gains made by the remediation group on both the Word Identification and the Word Attack tests were substantial.

The efficacy of PREP has also been demonstrated for groups of children with decoding and word-reading deficits different from the Chapter 1 sample in the present study (Das, in press; Das et al., 1995). These children were not disadvantaged by economic conditions but were selected from a middle-class community in a very different geographic location (western Canada). They were given the entire PREP program, comprising both global and bridging training tasks, resulting in substantial gains in Word Identification and Word Attack scores. It is, therefore, clear that PREP is effective in spite of differences in population or geographic location. The question we now wish to discuss is how we account for the improvement in word-reading and decoding skills.

Our approach is to focus on the first of the four fundamental components of reading: decoding, assigning meaning to a word, sentence comprehension, and paragraph comprehension. The reason for this emphasis is that it is necessary to translate the printed word into a pronounceable form before language processing can occur at the lexical, syntactic, and semantic levels.

Several interrelated factors may explain why the group receiving PREP improved in decoding skills and word-reading ability. These include memory enhancement, increased knowledge base, expanded attentional capacity and/or deployment, and greater efficiency in successive processing.

With some exceptions, Torgesen has recognized that the majority of children with reading disabilities have shorter memory spans than those who do not have reading disabilities (Torgesen, 1995; Torgesen & Houck, 1980). Research on the cognitive bases of memory span has offered some support to Baddeley's (1986) theory of working memory. However, the relationships between working memory, memory span, naming time, and articulation, on the one hand, and reading competence, on the other, need to be elaborated and understood in order to account for the gains brought about by PREP in the Chapter 1 children.

Children with reading disabilities who are of average or better intelligence typically have difficulty with both articulatory and phonological coding processes (Stanovich, 1988; Torgesen, Kistner, & Morgan, 1987). Das and Mishra (1991) found weak correlations between memory span and naming time as well as between these two variables and speech rate, which is a measure of phonological coding and articulation used in PASS. This, along with results of studies such as those carried out by Bowey, Cain, and Ryan (1992) that report rather weak connections between working memory and reading disability, suggests that many poor readers have average or even good memory spans. Hence, it may be uneconomical for remedial programs to focus mainly on memory enhancement.

Within the context of successive processing, PREP involves tasks that require both phonological coding and articulation, especially in the bridging tasks where words are named. It is obvious that reading requires overt articulation involving the motor programming of speech. At the same time, naming the words also requires phonological coding. Thus, it is not surprising that a remedial effort to facilitate phonological coding and articulation within successive processing tasks yields better results than an attempt solely to enhance memory. As shown in previous research (Das & Mishra, 1991), the path from memory span to reading must pass through a latent variable created by both naming time and speech rate.

Torgesen, Wagner, Simmons, and Laughon (1990) expressed the belief that a combination of reliable measures of word span and articulation rate may provide a good index of phonological coding processes in young children. The PREP program comprises several tasks that involve a combination of the two while requiring successive processing of the information provided.

As Torgesen (1995) and others have observed (see Share & Stanovich, 1995), explicit phonics training programs are not always successful, especially with dyslexic children. Indeed, they may be inappropriate. A principal reason for this is that direct phonological training may place excessive demands on an already weak phonological system. We suggest that the source of dyslexia does not only lie in the skills that are found exclusively in reading tasks, but is also related to cognitive deficits that need to be

ameliorated such as successive processes.

In our judgment, the PREP is optimally successful in cases where the cognitive profile of the children matches the emphasis on successive information integration and the planning and attentional processes in the program. Thus, Chapter 1 children who are deficient in the ability to process information successively and have deficits in attentional resource allocation will most likely benefit maximally from the intervention.

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APPENDIX

PREP: Description of Global and Bridging Remediation

Following is a brief description of the tasks and their administration. As described in the article, each item has three levels of prompts, each task has a criterion level with a parallel form to administer if the criterion is not met, and each item is followed by discussion of

the strategies used. As can be seen by examining the Word Probes, the words used in the PREP remediation are regular words, and can be readily identified by sounding out and blending the phonemes. The students are encouraged to use this as one of their strategies for identifying the words.

Transportation - Global

The students are shown a strip of pictures of different vehicles. After they look at the full strip, and then each picture in its place on the matrix individually, the pictures are covered. Students must reproduce the order on a blank matrix with individual pictures. The correct pictures are mixed in with five distracters. Level 1 contains six items with four pictures per item. Level 2 contains six items, three with four pictures, three with six. Level 3 contains six items with six pictures. Patterns change from simple to more complex using type of vehicle and color to create the pattern.

Transportation - Bridging I

The students are shown a word in a straight line matrix. After they see each letter individually in its matrix position, it is covered and they build the word with individual letters. Available letters include the correct ones with five distracters. The students then identify the word, taking turns on alternate words, one identifying, the other verifying the word.

Transportation - Bridging II

A series of cards with individual words are placed in front of the students. Related words are arranged in alternating or more complex patterns. The students are helped to read the words, if necessary, then repeat them a number of times. After the words are removed, the students repeat them in order. Early items contain four words, up to a maximum of eight at the end of Level 3. The students look at the word cards in order following each item and pick out the related pairs, with discussion of the pattern used.

Joining Shapes - Global

The students use a printed arrangement of shapes, rows of triangles, squares and hexagons alternating with rows of circles. They have four rules to follow, one being that their straight lines must always pass through a circle. They listen to directions asking them to join specific shapes and then join them following the rules. The Level 1 task begins with three rows of geometric figures and one instruction, changing by the end of Level 3 to seven rows of geometric figures and three instructions.

Joining Shapes - Bridging

This task parallels the global task, with letters on paper that look much like a word search puzzle. The students follow similar rules to the global task, joining letters diagonally to form words. Again, they are asked to identify the word.

Window Sequencing - Global

A series of colored circles and squares are shown to the students one at a time through a window arrangement. Using the required shapes with no distracters, the students then reproduce the sequence. Level 1 has only one color, Level 2 only one shape, whereas Level 3 has variation in both color and shape.

Window Sequencing - Bridging

The identical format is used for this task, with students seeing the letters of a word in sequence through the window. They then reproduce the word with individual letters and identify the word.

Connecting Letters - Global

Five pairs of letters are aligned horizontally on opposite sides of the page. A meandering line from a letter on one side joins it to one of the letters on the other side. All five letters on one side are joined with lines that intertwine to the letters on the other side. The students follow the line with their eyes, identifying what pairs of letters are joined. Level 1 items are joined with colored lines. In Level 3 all lines are black, with distracter lines included.

Connecting Letters - Bridging

The lines joining the letters on either side have letters along the strings that make specific words. The students follow the strings with their eyes, identifying the five words on each sheet. Level 1 items begin with three-letter words. At the end of Level 3, seven-letter words are used. All items in this task are joined with colored lines.

Related Memory Set - Global

The outlines of three animal fronts are displayed. The students are shown the back of one of the animals with an intervening space and must verbally identify and justify which animal front is the match. At Level 1, animals with stripes and spots are included. By Level 3 many animals that look very similar are included.

Related Memory Set - Bridging

The students are shown three word beginnings, with one word ending on the other side of the page. The students identify verbally which beginning fits the end letters to make a word, without putting front and back units together. The words are separated into on-set, rhyme units, or syllable units.

Matrices - Global

The students are shown first numbers, then letters in a five-cell matrix designed as a cross. After each matrix is displayed for 5 seconds and covered for 5 seconds, the students are asked to name the sequence in order as the instructor points to each cell of a blank matrix.

Matrices - Bridging

The matrix cells contain four related words and one unrelated word. The students go through the same process as in the global task of remembering the words in sequence. After the words have been identified correctly, the students are asked to identify the related words and explain how the words are related, as well as why the unrelated word does not fit.

Sentence Verification - Global

The students are shown two, three, or four pictures and are given a card with two or three sentences relating to one of the pictures. The students identify which picture matches the text.

Sentence Verification - Bridging

The students are given one picture with two, three, or four brief texts. The students choose the text that matches the picture context.

Tracking - Global

A map containing identical houses with numbers, identical trees with letters and a street grid is displayed about an arm's length from the students. The students are then given three cards, each containing a different house and the minimal street grid necessary to allow identification of a specific house. The time taken by the students to identify the house number or the tree letter for all three cards is recorded. Three sets of three cards are presented following this format. The child then goes through a training process involving the use of three different strategies, and repeats the process with the nine original cards. Level 1 and 2 use the houses and trees, respectively. In Level 3 a map is displayed with only squares containing letters and lines connecting them to the starting point. The cards the students see have the same line and box configurations, but the letters are missing. Students identify the letter.

Tracking - Bridging

A map of West Edmonton mall is displayed with various symbols, such as book stores identified by a colored book symbol. The students are given a story card containing a list of tasks that require planning and demonstrating the most efficient route. Level 2 involves a line drawing of a playground. The students read a story about three boys at the playground and have to identify from various positional cues where one of the boys is hiding. Level 3 uses the West Edmonton mall map again, with more complex tasks.

Shape Design - Global

An arrangement of geometric shapes is displayed for 5 seconds. The student, given only the shapes in the design, then reproduces the design. Each level consists of six items.

Shape Design - Bridging

The students read cards describing animals in different relational positions and then position the animals in the correct configuration. Level 1 has positions on one plane, Level 2 on two planes. In Level 3, a picture setting is displayed. Students listen to a story, then place the animals from the description in the story in the correct position in the setting.

Shapes and Objects - Global

The students sort line-drawing pictures into shape categories, matching the shape of the picture to an abstract shape. In Level 2, the same format is followed with geometric shapes. Both of these tasks are timed, they are repeated once.

Shapes and Objects - Bridging

The students are given two, three, or four category phrases and then asked to sort a number of phrases into the different categories. One phrase does not fit in any of the categories. Once the phrases are sorted, the students justify their selections.