COGNITIVE APPROACH TO READING REMEDIATION

Journal of Research in Reading

Remediating Reading Comprehension Difficulties:
A Cognitive Processing Approach
Cognitive Approach to Reading Remediation

Abstract

The efficacy of a cognitive-based remediation program was investigated in 15 poor readers in Grade 4 who had significant difficulty in comprehension. The comparison group comprised 15 normal readers in Grade 4, and received no remedial program. Both groups were selected from two English medium schools in Orissa, India. Their pretest to posttest changes in word reading and reading comprehension scores, as well as performance on tests of Planning-Attention-Simultaneous-Successive (PASS) cognitive processes were examined. ANOVA showed a marked improvement in comprehension for the treated group and improvement in simultaneous processing as well. The results indicate the efficacy of the cognitive-based remediation program in improving comprehension and its underlying cognitive process among children even when English was their second language.
Remediating Reading Comprehension Difficulties:

A Cognitive Processing Approach

Although the ability to read words in isolation is necessary for reading, readers’ ultimate goal is to comprehend what they read. While learning to read and comprehend, the reader has to simultaneously organize several ideas into a meaningful theme more so than while decoding words and following the syntax of a sentence; the latter require processing letters and words successively, that is, in sequence. In fact, within a framework of simultaneous processing-successive processing, a weakness in simultaneous processing is observed among children with comprehension difficulties, whereas word decoding difficulties are associated with a successive processing weakness in beginning readers (Das, Naglieri, & Kirby, 1994; Das, Parrila, & Papadopoulos, 2000).

Proficiency in reading, therefore, demands mastery over two different skills: (1) word reading and (2) reading comprehension. Although word reading and comprehension have been found to be highly related, subskills within each component and disorders related to reading weaknesses differentiate the two skills (Oakhill, Cain, & Bryant, 2003). Many poor readers have difficulty in both, although some have more pronounced problems with either word reading (decoding) or comprehension. The present research is concerned with those children who experience difficulties in comprehension while their word reading performance remains close to the norm for their grade. This group of readers, often referred to as “poor comprehenders,” experience specific comprehension difficulties (e.g., Nation & Snowling, 1998; Oakhill, 1982; Oakhill & Yuill, 1996). When compared to readers with good comprehension, poor comprehenders have been found to perform less well on tasks involving lower levels of processing, such as reading words.
that require semantic support (Nation & Snowling, 1998) and providing word definitions (Nation, Clarke, & Snowling, 2002). These readers also experience difficulties on higher level tasks including inference generation after reading a passage, being less aware of when they did not understand what they had read, and using working memory to form mental representations of text (Yuill & Oakhill, 1991). It is, then, logical to incorporate the development of the above components in a remediation program in order to improve comprehension. The program we have chosen, PREP (PASS Reading Enhancement Program), attempts to facilitate such development within the PASS framework (Das et al., 1994; see below for details).

**Cognitive Strategies and Reading Improvement**

In recent years, the use of cognitive strategy instruction in reading has proven to be valuable in improving children’s reading performance (see National Reading Panel, 2000; Rosenshine & Meister, 1997). Cognitive-based training programs relevant to reading comprehension have been developed through which children learn to interpret, remember, manipulate, and make use of information (Das et al., 1994; Das et al., 2000; Gaddes & Edgell, 1994; Papadopoulos, Das, Parrila, & Kirby, 2003; Swanson, Hoskyn, & Lee, 1999). The argument is that unless cognitive processes underlying reading are the focus of remediation, remediation will not be successful in promoting transfer to broader aspects of reading (Das et al., 1994; Kirby & Williams, 1991).

The *PASS Reading Enhancement Program* (PREP) is one such remediation program which in recent years has been used successfully in both research and educational settings as discussed below. It was developed as an inductive learning remedial program based on the PASS theory of cognitive functioning (Das et al., 1994).
PASS proposes that cognition is organized in three systems. The first is the Planning system, which involves the executive control system responsible for controlling and organizing behaviour, selecting or constructing strategies, and monitoring performance. The second is the Attention system, which is responsible for maintaining arousal levels and alertness and ensuring focus on appropriate stimuli. The third system is the Information Processing system, which employs simultaneous and successive processing to encode, transform, and retain information. In simultaneous processing, the relationship between items and their integration into whole units of information is what is coded while in successive processing, information is coded so that the only links between items are sequential in nature (see Das et al., 1994 for a detailed description). The goal of PREP is to improve information processing strategies, especially simultaneous and successive processing, which are believed to underlie reading (e.g., Das, Georgiou, & Janzen, in press; Joseph, McCahan, & Naglieri, 2003; Naglieri & Reardon, 1993; Naglieri & Rojahn, 2004).

PREP remediation is structured in such a way as to promote inductive inferencing and internalization of principles and strategies rather than deductive rule learning (Campione & Brown, 1987; Das, Mishra, & Pool, 1993). Such a procedure encourages "ownership" of the strategies that the individual can apply, thereby ensuring transfer to broader aspects of reading. In contrast to direct instruction programs, such as Reading Mastery (Engelmann & Bruner, 1995), PHAST (e.g., Lovett et al., 2000) or RAVE-O (Wolf, Miller, & Donnelly, 2000), PREP avoids explicit teaching of specific reading skills.
PREP consists of eight tasks, which vary considerably, both in content and in what they require from the child. All tasks involve a global training component and an additional curriculum-related bridging component. The global component consists of structured non-reading tasks that require the application of simultaneous or successive strategies. These tasks also provide children with the opportunity to internalize strategies in their own way, thus facilitating transfer. The bridging component involves the same cognitive demands as its global component and provides training in simultaneous and successive processing strategies that are closely linked to reading and spelling (Das et al., 1994).

The cumulative weight of evidence collected over several years of research using PREP has produced positive results with respect to word identification, pseudoword decoding, and reading comprehension tasks in English (see Brailsford, Suart, & Das, 1984; Das, Mishra, & Kirby, 1994; Janzen, 2000; Papadopoulos et al., 2003), in Greek (Papadopoulos, Charalambous, Kanari, & Loizou, 2004), and in Spanish (Molina, Gorrindo, & Das, 1997).

While the present study is really the only one that has used fully developed PREP aimed at improving comprehension, one other study has examined comprehension improvement using similar cognitive-based remediation tasks. The first published study on improvement of comprehension, using an earlier version of PREP-like tasks, was reported by Brailsford et al. (1984). The participants were English-speaking Canadian school children. The study clearly showed that reading comprehension of a sample of learning disabled children whose comprehension score was below the 35th percentile could be significantly improved on post-intervention testing by 1.25 grades following
only 15 hours of remedial training. A control group, by comparison, showed insignificant changes.

**English as a Second Language (ESL)**

Learning to read in English can be a challenge because unlike the writing system of many other Indo-European languages, like Oriya and Hindi, the sounds associated with particular letters in English are not entirely predictable. A recent report (Mishra & Stainthorp, 2007) on Oriya-speaking children educated in English medium schools, like the children of the present study, is particularly helpful to understand the background of schooling in general, and reading in particular. The Indian students in the present research have been exposed to their mother tongue and speak it fluently. Their exposure to English reading and writing began by kindergarten. Most of them also were introduced to reading and writing in Oriya during Grade 2 or 3, and possibly Hindi at the same time as well. What influence such a multilingual literacy might have on English reading and comprehension was examined in a longitudinal study beginning at kindergarten (Mishra & Stainthorp, 2007). In fact, the objective of that project was to determine cross-linguistic development in regard to reading. As the authors observed, learning to read English consistently requires more fine-grained phonological analysis at the level of phonemes than does learning to read Oriya. On the other hand, learning to speak, read, and write Oriya equips children with the skills to analyze words at the level of syllables and words. Other research also has suggested that cross-language transfer exists for ESL readers (Lesaux, Lipka, & Siegel, 2006).

Similarities in the cognitive processes relevant to reading comprehension have been found for monolingual and ESL readers. Specifically, phonological processing,
verbal working memory, and syntactic awareness can explain reading comprehension performance for L1 and L2 readers (Low & Siegal, 2005). In addition, similar metacognitive strategies, such as planning and comprehension monitoring, and cognitive strategies, such as making inferences (Chamot & O'Malley, 1996; Jiménez, García, & Pearson, 1996) are thought to be used by both monolingual and ESL readers during reading comprehension.

Although the relationship between PASS and reading has been confirmed in investigations in Orissa state, and similar patterns of relationships have been indicated elsewhere in an English-speaking population (Mahapatra, 1990; Mahapatra & Dash, 1999), PREP’s efficacy for improving English reading and comprehension has not been studied among children whose first language is not English. In clinical case studies (Mohanty, 2007) however, both word reading and comprehension showed marked improvement.

Some children in the English medium schools, however, do not succeed in learning to read adequately; even if they read words they may experience difficulties in comprehending what they read. Patra (2001) studied English medium school children with similar characteristics to those in the present study. Orissa children in Grade 6 were low in comprehension, but performed at a normal level when reading words in English. We believe their failure can be predicted by the same reading-related processes as in non-ESL native speakers of English. That is, we anticipate that as the cognitive-based remediation program improves information processing strategies, especially simultaneous and successive processing, as applied to curriculum through PREP’s bridging program, it will have a favourable outcome in regard to reading as obtained in previous studies.
Objectives

The primary objective of the present study was to examine the efficacy of a cognitive-based remediation program for improvement of reading comprehension of children who have little or no difficulty in word reading and whose primary language was not English. Their medium of instruction in school was English (see Participants). Such children were selected to examine whether comprehension can be improved following PREP treatment. Since PREP also improves word reading among poor readers, whether or not it will further improve it in the present sample is an open question.

The second objective was to examine whether this cognitive-based remediation program may improve the underlying PASS cognitive processes, especially simultaneous processing that is closely linked to comprehension. If it did, that would indeed be a case of very far transfer of learning (Das, et al., 1994), suggesting a domain-general effect of PREP training.

Participants

This study involved a sample of 30 children, 15 poor readers (7 boys) and 15 normal readers (3 boys), who attended fourth grade in two English medium schools in Cuttack, Orissa. The uneven distribution of sex of participants within each reading group was accepted because differences in reading achievement according to sex were not to be examined in the present study. All children in the sample ranged from 8 to 10 years of age and were from the same socioeconomic background (middle and upper class). The standard of education in the two schools from which the participants were selected is believed to be higher than the general municipal schools. All children in the poor reading
comprehension sample were close to the grade equivalent norm of Grade 4 in word reading. This sample of poor readers scored, on average, 1.8 grades below their grade level in comprehension (mean grade equivalent score = 2.23 in Woodcock Reading Mastery; Woodcock, 1987). A comparison group of normal readers, on the other hand, were, on average, 1.9 grades above their actual grade in comprehension (mean grade equivalent score = 5.88). However, with respect to overall intellectual functioning, participants in both groups were considered as being “average” (for details see Table 1).

To summarize the selection of participants, first, children were selected by their teachers as being normal or poor readers based on their overall performance in the school examinations. Each potential participant was then administered the basic battery of Cognitive Assessment System (CAS) for the assessment (Naglieri & Das, 1997) in the first phase of selection. Only those children with CAS Full Scale scores within the range of 90-109 (Average) were further examined for their reading proficiency in terms of word reading and reading comprehension. The final grouping into normal and poor readers was based on these two reading tests. The poor readers were significantly weak in comprehension, but not in word reading. The tests and measures are discussed next.

Measures

**Word reading and comprehension.** The tests used to assess children’s reading skills were the Word Identification subtest and the Passage Comprehension subtest from the Woodcock Reading Mastery Tests-Revised (WRMT-R; Woodcock, 1987). The Word Identification subtest measures word reading skill and consists of 106 words, arranged according to their difficulty level. The participant is required to correctly identify isolated words that appear in a list of 8 words per page. For an answer to be scored correct, the
participant has to produce a natural reading of the word within five seconds. The task is discontinued after six consecutive errors. This subtest was used rather than the Word Attack subtest because the pronunciations of pseudowords in the test manual are the English pronunciations used in North America, pronunciations most Indian students would find difficult to replicate. The Passage Comprehension subtest measures reading comprehension skill and consists of 68 items arranged in order of increasing difficulty. The task requires the participant to read a short passage (usually two to three lines long) and identify a keyword (represented by a blank line) missing from the passage. The participant is required to read each passage silently, understand the item, and provide a suitable word for the blank space. The participant’s total score is the number of correctly filled blanks. The test is discontinued after six consecutive errors.

*Cognitive assessment.* Strength in PASS processes was assessed using the basic battery of the Das-Naglieri Cognitive Assessment System (CAS; Naglieri & Das, 1997), designed for use with children and adolescents ages 5 through 17 years. The CAS consists of eight subtests, two from each of the four PASS processes. The total score is called the Full Scale. The tests vary in content: Some are verbal, some are not; some involve memory, others do not. Details of the CAS are available in its handbook (Naglieri & Das, 1997) so only brief examples of subtests will be provided here. For example, a Planning task is Matching Numbers which requires the participant to find and underline two identical three-number sequences in a row of six three-number sequences (249, 371, 539, 467, 539, 749). An Attention task is Expressive Attention which requires the participant to read words (i.e., Blue, Yellow, Green, and Red) on the first page, name colours of a series of rectangles printed in the aforementioned colours on the second
page, and name the colour of the ink of words while ignoring the actual colour names printed on the third page (e.g., the word Blue may appear in green ink). In the Simultaneous processing task of Verbal Spatial Relations, the participant is presented with six drawings and a printed question at the bottom of each page that may be read aloud by the examiner (e.g., “Show me the picture that has a triangle to the left of a circle”). A Successive processing task is Sentence Repetition, in which the participant is read 20 sentences aloud and is asked to repeat each sentence exactly as presented (e.g., “The blue is yellowing”).

Remediation Tasks

Following their selection, the poor readers were given the PASS Reading Enhancement Program (PREP). PREP tasks included four mainly successive processing enhancement tasks and four mainly simultaneous processing enhancement tasks (see Appendix A for details and processing strategies in each task). As will be apparent from the details about simultaneous training, the tasks encourage reading words for meaning, inference generation after reading a passage, increasing awareness when children do not understand what they have read, and enhancing working memory to form mental representations of text—these are the skills mentioned earlier in the introduction, and are designed to enhance comprehension.

Procedure

The participants were tested individually for reading and cognitive processing, but for PREP in groups of two or three. They were given remediation in their respective schools by the senior author (SM) with the permission of the principals and cooperation from teachers of the concerned schools. In order to establish adequate rapport with each
participant, the work was carried out in a separate room in the schools and maximum care was taken to keep the participants away from external disturbances during task administration.

The data were collected in three phases. In the first phase (pretest session), each participant in the initial group was individually administered the Word Identification subtest and Passage Comprehension subtest from WRMT-R to assess reading proficiency and the basic battery of Das-Naglieri CAS to assess level of intelligence. These tests were administered across two sessions that were one day apart in accordance to the rules in the manuals. Each participant took approximately 1 hour 45 minutes to complete the tests. Normal and poor readers included in the final group of participants were selected from among a larger group on the basis of their performance on these tests.

In the second phase of data collection (remediation sessions), PREP tasks were administered to the children in the “poor comprehender” group following the prescribed procedure given in the manual. The eight PREP tasks used were administered in the order in which they are described in Appendix A. The participants were divided into small groups of two or three for proper administration of the tasks. Because there were 15 participants, six groups of two children and one group of three children were formed. Remediation was given to the participants during school hours; however, the time was chosen according to the convenience of the participants, as well as their teachers, so they could attend their regular classes along with the remediation program. Remediation continued for 15 sessions, spread over 2 months, with each session being 1 hour in duration. Normal readers, on the other hand, received regular classroom instruction during this time.
In the third phase of data collection (posttest session), poor and normal readers were again individually administered the Word Identification subtest and the Passage Comprehension subtest from the WRMT-R and the basic battery of the Das-Naglieri CAS in order to observe the effect of remediation on the measured skills. The participants were highly motivated and had shown active involvement in the tasks throughout the cognitive-based remediation. As observed by the examiner after each PREP session, it appeared to be an enjoyable experience for the participants.

Results

Performance on Reading Measures

In order to study the effect of the cognitive-based remediation program on the reading achievement of poor readers, the treated group was compared with the normal group with respect to performance on reading measures both before and after remediation. The mean word reading grade equivalent (GE) score of the poor readers in Grade 4 was 3.71 before remediation and 7.42 following PREP remediation, suggesting an increase of 3.7 grades or 2 standard deviations. Similarly, the mean reading comprehension GE score of the poor readers was 2.23 before remediation and 5.14 following PREP training, indicating an increase of 2.9 grades or 2.7 standard deviations. Pre-posttest results, however, were less prone to change for the normal readers receiving no remediation. The mean pretest word reading GE score of normal readers was 5.88 and the retest score after 2 months during which they received regular classroom instruction was 6.59, suggesting an increase of 0.7 grades or 0.4 standard deviations. More importantly for the present study, the mean pretest reading comprehension GE score of normal readers was 4.13 and the retest score was 4.26, indicating an expected rate of
growth of a 0.13 grade increase after 2 months during which they received regular classroom instruction. The means and standard deviations of all measures are presented in Table 1. As can be seen, the first part of the table presents participants' word reading and comprehension scores, while the second half of the table presents CAS scores. Considering reading scores first, the ANOVA results are discussed in the following sections.

Table 1 goes about here

The significance of difference between the means of the two groups under the two testing conditions with respect to word reading and reading comprehension was tested by computing a 2 (group: poor vs. normal readers) x 2 (treatment: pretest vs. posttest) ANOVA with repeated measures. The results for word reading indicated a significant main effect for treatment, $F(1, 28) = 53.63, p < .001$, and a significant Group x Treatment interaction, $F(1, 28) = 24.59, p < .001$. In regard to reading comprehension, a significant main effect for treatment, $F(1, 28) = 29.91, p < .001$, as well as a significant Group x Treatment interaction, $F(1, 28) = 25.12, p < .001$, were observed. A main effect for group, on the other hand, was not significant in either case: $F(1, 28) = 1.12, p > .05$ for word reading and $F(1, 28) = 2.05, p > .05$ for reading comprehension. The interaction effects were the critical evidence for the efficacy of the cognitive-based remediation program.

Of the 15 poor and 15 normal readers, 7 poor and 7 normal readers had almost equal levels of word reading proficiency, whereas they differed with respect to their proficiency in reading comprehension. Because the mean word reading scores of even the poor readers were almost equal to the norm for their grade, but the mean for
comprehension was far below grade-level, we wished to further examine the effect of the
cognitive-based remediation program on comprehension by equating a subsample of 7
children from each group on word reading in a subsequent analysis. The pretest and
posttest scores of these 7 children in each group were compared in an ANOVA. The
means and standard deviations of these scores are presented in Table 2.

Table 2 goes about here

The significance of difference between the means of these two groups under the
two testing conditions with respect to word reading and reading comprehension was
examined by computing 2 (group: poor vs. normal readers) × 2 (treatment: pretest vs.
posttest) ANOVA with repeated measures. The results for word reading indicated a
significant main effect for treatment, \( F(1, 12) = 45.37, p < .001 \), and a significant Group
× Treatment interaction, \( F(1, 12) = 14.19, p < .01 \). In regard to reading comprehension, a
significant main effect for treatment, \( F(1, 12) = 12.15, p < .01 \), as well as a significant
Group × Treatment interaction, \( F(1, 12) = 3.62, p < .01 \), were observed. As before, this
provided the critical evidence that we required for the efficacy of the cognitive-based
remediation treatment. A main effect for group, on the other hand, was not significant in
either case: \( F(1, 12) = 0.83, p > .05 \) for word reading and \( F(1, 12) = 0.31, p > .05 \) for
reading comprehension. These results replicate those obtained from the larger sample.

Performance on Measure of Cognitive Processes

The second section of the results involves the cognitive functioning of children in
the two groups. Both poor and normal readers were found to be “average” with respect to
their overall intellectual functioning (Full Scale score on CAS was within the range of
90-109), but varied in respect to their strength in individual cognitive processes. In order
to understand the effect of the cognitive-based remediation program on these processes, CAS was administered to the poor readers before and after PREP remediation. Similarly, normal readers without treatment were re-administered CAS at the same time (see Table 1 for means and standard deviations of the pretest and posttest scores for both groups).

The significance of mean difference between the pretest and posttest scores of the two groups in respect to the PASS processes was tested by computing a 2 (group: poor vs. normal readers) x 2 (treatment: pretest and posttest) ANOVA with repeated measures. The results indicated a significant main effect for group in the case of simultaneous processing, \( F(1,28) = 7.97, p < .01 \), and significant main effects for treatment in the case of planzing, \( F(1,28) = 5.38, p < .05 \), simultaneous processing, \( F(1,28) = 18.87, p < .001 \), attention, \( F(1,28) = 17.31, p < .001 \), and Full Scale score, \( F(1,28) = 32.31, p < .001 \). In addition, a significant Group x Treatment interaction for simultaneous processing, \( F(1,28) = 4.22, p < .05 \), as well as the Full Scale score, \( F(1,28) = 6.47, p < .01 \), was observed. The interaction term suggests that the cognitive-based remediation program brought about improvement specifically in simultaneous cognitive process in the poor readers. Thus, it enhanced their proficiency in reading along with the salient process in which the poor readers were deficient.

\textit{Correlational Analysis}

The pattern of relationships between the two reading skills and each skill with the four cognitive processes were studied by carrying out correlational analysis. An examination of the correlations indicates that not only was the relationship between word reading and reading comprehension significant \( (r = .72, p < .01) \), but both skills were significantly related to simultaneous processing \( (r = .62 \text{ and } r = .72, p < .01, \text{ respectively}) \).
as well as the overall intellectual functioning (Full Scale) of the children ($r = .39$ and $r = .46, p < .05$) when performance of all 30 children in the pretest condition was taken into consideration. No significant correlation between the reading skills and successive processing was found; reasons for this finding are suggested in the Discussion. However, a closer examination reveals that although the two reading skills were significantly related to each other in the case of poor readers in the pretest condition ($r = .62, p < .01$), they were not in the posttest condition ($r = .21, p > .05$). In the case of normal readers, however, the correlations between word reading and reading comprehension were not statistically significant at either pretest ($r = .35, p > .05$) or posttest ($r = .43, p > .05$) conditions. We are aware that the sample size was small.

These results, nevertheless, suggest that reading proficiency is determined by one’s proficiency in specific cognitive processes along with the level of overall intellectual functioning as reported in previous studies (e.g., Das et al., 1994). However, when both word reading and reading comprehension reach levels above the norm for the appropriate grade, as in the normal reading group, the two skills may become independent of one another. Because this result is based on a small sample size it needs to be replicated.

Discussion

The current study intended to select children with specific comprehension disability without significant word decoding difficulty and then test the efficacy of a cognitive-based remediation program in order to improve their comprehension performance. The program was structured in such a way as to promote inductive inferencing and internalization of principles and strategies rather than deductive rule
learning (Campione & Brown, 1987; Das et al., 1995). The participants read, spoke, and wrote in English because the medium of school instruction was English. In previous studies in the literature, word decoding deficit is typically marked by performance below the 25th percentile, which was not the case in the present sample; even poor comprehenders were very close to their grade norm in word decoding. One reason for this may be the stiff entrance criteria—that includes reading—to English medium schools. A second reason may be the selection criterion for the samples in terms of their overall Full Scale score in CAS, comparable to a general IQ; we included only those students who scored near the mean or above the mean for their age. We expected that the cognitive-based remediation program used would improve comprehension scores. Whether or not word identification scores would also be enhanced remained an open question when we began the study.

As far as the present findings go, it seems as though the PREP cognitive enhancement training turned on a switch and enabled the children to substantially improve their comprehension. As the results clearly show, there was improvement in both word reading and comprehension skills. In both reading skills, but especially in comprehension, the posttest score of the treated group that initially had a significantly low comprehension score exceeded the grade equivalent norm. Most certainly these improvements cannot be attributed to a statistical artifact such as regression to the mean. However, retesting (practice effect) could have partially contributed to the children’s reading improvements, but it did not do so as seen in the posttest performance of the children in the normal group. What is more, the treated group demonstrated significant improvement in comparison with the no-risk normal group. These results suggest that
improvements in reading skills most likely would be due to the effect of the cognitive-based remediation program.

The second objective was to examine whether the cognitive-based remediation program would improve the underlying PASS cognitive processes, especially simultaneous processing that is closely linked to comprehension. In previous research by Carlson and Das (1997), a transfer effect to cognitive process scores had been obtained.

In the present study, at pretest, poor readers were performing at the average range with respect to their planning, attention, and successive processing, but were deficient in simultaneous processing. As expected within the framework of PASS, simultaneous scores had a significant correlation with the group’s skills in word reading and comprehension. In this context, we expected a significant Group x Treatment interaction for simultaneous processing; this was confirmed by the results. Not only did the PREP treatment group improve more in comprehension compared to the non-treated group, it did so in a basic cognitive processing component theoretically linked to comprehension (e.g., Naglieri, & Das, 1988). We discuss briefly the observation that further confirms the influence of PREP on comprehension of verbal-spatial tasks.

The author (SM) who observed each child during CAS remarked that before PREP training, poor readers were comprehending the text by processing the information at the surface level. In the present study PREP seems to have facilitated not only the expansion of the children’s vocabulary, but also their development of logical-analytical and inferential thinking leading to a deeper level of processing text as they progressed through remediation. The cognitive-based remediation program, thus, seems to have facilitated the growth of reflective knowledge of the language while reading.
Discussing further, the correlations between the two reading measures and the CAS tasks at pretest re-afirm the role of simultaneous processing. However, no significant correlation between the reading skills and successive processing was obtained in the present sample. We think this may be so because of the sample's already high performance score in word reading. When reading scores are generally above-average and the children are not beginning but advanced readers, successive processing may not contribute significantly to individual differences in word reading.

The present study is unique in two ways. First, the cognitive-based remediation program substantially enhanced the treated group's sub-average level of comprehension. The program had the same beneficial effect on word reading even when this group of readers had almost average scores at pretest. Second, the cognitive-based remediation program resulted in an improvement in simultaneous processing, which was at sub-average level. As mentioned previously, this cognitive process is closely associated with comprehension. We suspect that the treated group of readers acquired adequate cognitive strategies and language analysis skills to push them over the norm for comprehension of their second language (English). Following such acquisition, they could apply it and benefit from regular classroom instruction. However, there is a need for a maintenance study to explore these speculations. Replication of the study with non-ESL students with similar cognitive profiles is also necessary.

While the findings are suggesting a causal link between PREP training and comprehension enhancement, they are also limited by the small sample size and the selection procedure for entrance into English medium schools in India that may not admit obviously reading disabled children. In spite of such selection procedure, however, we
could obtain a sample of poor comprehenders first identified by their teachers as “poor readers.” Even by Grade 1, teachers might be able to identify poor comprehenders as shown in previous research (Papadopoulos et al., 2003). Subsequently, we could have monitored the effect of the cognitive-based remediation program longitudinally on English comprehension and word identification as these children proceed to higher grades. A microgenetic approach (Kuhn, 1995), then, would further pinpoint aspects of the cognitive-based remediation program that build comprehension after each session of PREP. Studying the effect of cognitive remediation earlier, before Grade 3, will avoid complications that are introduced as children are taught to read and write in their mother tongue and other languages (see Mishra & Stainthorpe, 2007). In spite of these limitations, however, the current study has introduced evidence that PREP as a cognitive remediation program improves comprehension and simultaneous processing strategies for children who do not speak English as their first language.
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cognitive intervention for reading difficulties: The PREP remediation in Greek.


Appendix A

Description of PREP Tasks

Out of the ten tasks of PREP, eight were used in the present study: Joining Shapes, Connecting Letters, Window Sequencing, Transposition Matrices, Tracking, Shape Design, Shapes and Objects, and Sentence Verification.

**Joining Shapes.** This task facilitates the development of successive processing. The global component of the task requires the participant to join a series of geometric shapes (e.g., triangle, square, hexagon) following a series of verbal instructions and a set of rules provided by the facilitator. Difficulty is increased by number of shapes and number of instructions induced. The bridging component, on the other hand, requires the participant to join a series of letters following a set of rules to make words. Difficulty is increased by increasing the length of the words. Working memory for rules is demanded in this task.

**Connecting Letters.** This task facilitates the development of successive processing. The global component of this task involves lines of differing colours connecting a letter on the left side of the page to a letter on the right side. The participant is required to follow these lines and find their corresponding letters. The difficulty level of the task increases by changing the coloured lines to black lines and then including distracter lines among them. The bridging component again requires the participant to follow lines, but this time there are 2-4 lines interspersed on each line. The participant connects the letters mentally and says/writes the word spelled by the letters. In this task, word decoding is the salient reading skill enhanced by successive processing.

**Window Sequencing.** In the global component of this task, the participant produces a series of shapes (colour is held constant), colours (shape is held constant) or coloured
shapes (colour and shape vary) presented by the facilitator. The difficulty level of the task increases by increasing the number of items in the series. In the bridging component, on the other hand, the participant reproduces a series of letters in the same order presented by the facilitator and says/writes the word produced by the letters. The difficulty level of the task increases by increasing the phonetic complexity of the words used. The task facilitates the development of successive processing. Short-term memory (successive processing) is utilized for phonemic awareness.

Transportation Matrices. This task facilitates the development of both simultaneous and successive processing. In the global component of the task, various transportation pictures are presented along with some distracters (pictures) in a changed sequence after the original presentation by the facilitator. The participant is to find and rearrange the originally seen pictures. Difficulty level of the task increases by increasing the number of pictures in the series. The bridging component, on the other hand, involves two tasks. The first one requires the participant to reproduce a series of letters in the correct order (as shown by the facilitator) and state the word formed by the letters. The difficulty level corresponds to the phonetic complexity of the words. The second task, on the other hand, requires the participant to memorize and recall sets of words (four, six or eight words) made up of semantically related word pairs. Difficulty level of this task increases by increasing the number of words in the series.

The 4 PREP tasks that focus on simultaneous processing and comprehension are described below.

Tracking. There are two versions of the global component of this task. In the first version, the participant is presented with a “village map”, with “numbered houses” and “lettered
trees” and tracking cards that illustrate a path from a starting point to either a house or a tree. The participant is to survey each card and map and locate the number of the house or the letter of the tree on the map. In the second version, the participant is presented with a “letter map” and tracking cards with squares identified by a letter of the alphabet and is to locate the appropriate lettered square. The house and tree identification are the tasks of difficulty level 1 and level 2, respectively, whereas, the level 3 task involves identification of lettered squares. Both parts encourage the use of planning and simultaneous processing. In the bridging component, the participant is given a printed text consisting of two separate story segments. The task is to study the illustration, read the printed text, and answer a number of questions related to each segment using some of the cues in the illustration. This task facilitates the development of simultaneous processing as well as its application in text comprehension.

Shape Design. In the global component of this task, the participant is required to study a design presented for 10 seconds and reproduce the design with the coloured shapes provided. The shapes include circles, rectangles, squares, and triangles in three colours (red, blue, and yellow) and two sizes (big and small). The difficulty level increases with the complexity of the design. In the bridging component, the participant reads a phrase or story from a card that describes how animals are arranged in relationship to one another. The participant visualizes the scene with the animals positioned appropriately and then arranges the animals to correspond with the scene as described in the phrase or story. Three difficulty levels are presented, each corresponding to the number and complexity of relationships. This task involves the use of simultaneous processing, and in its bridging part, verbal planning and comprehension.
Shapes and Objects. This task facilitates the development of simultaneous processing. In the global component of this task, the participant is given a series of pictured objects and is required to match the general shape of the items to one of three abstract geometric shapes. In the bridging component, the participant is presented with sets of phrases or sentences belonging to certain categories along with a distracter in each set. The participant reads the sentences or phrases with or without the support of the facilitator, groups them into categories based on their semantic content, and identifies the distracter in each set. Clearly, the task encourages forming verbal categories, abstraction, and comprehension.

Sentence Verification. In the global component of this task, the participant is shown a set of photographs that have similar themes. Each set of photographs is accompanied by a short printed passage which the participant reads with or without the facilitator’s support and chooses the photograph that best matches the passage. This has three levels of difficulty. In the bridging component, on the other hand, the participant is shown a single photograph and given 3-4 short passages to read after which he/she chooses which passage best matches the photograph. The bridging task is completed in three sessions. This task demands text processing in both its global and bridging part.
Table 1
Pretest and Posttest Means and Standard Deviations of Reading and CAS (N = 15 in each group)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Poor readers</th>
<th>Normal readers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
</tr>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Word identification (Grade-Equivalent)</td>
<td>3.71 (1.49)</td>
<td>7.42 (2.64)</td>
</tr>
<tr>
<td>Passage comprehension (Grade-Equivalent)</td>
<td>2.23 (0.64)</td>
<td>5.14 (2.37)</td>
</tr>
<tr>
<td>Planning scale</td>
<td>99.00 (9.67)</td>
<td>102.93 (13.61)</td>
</tr>
<tr>
<td>Attention scale</td>
<td>95.40 (8.85)</td>
<td>99.60 (6.50)</td>
</tr>
<tr>
<td>Simultaneous scale</td>
<td>89.60 (0.17)</td>
<td>101.33 (8.79)</td>
</tr>
<tr>
<td>Successive scale</td>
<td>103.47 (15.30)</td>
<td>111.07 (12.92)</td>
</tr>
<tr>
<td>Full scale</td>
<td>96.60 (7.39)</td>
<td>105.33 (8.39)</td>
</tr>
</tbody>
</table>
Table 2

Pretest and Posttest Means and Standard Deviations on Measures of Reading for Poor and Normal Readers matched on Word Identification

<table>
<thead>
<tr>
<th>Measure</th>
<th>Poor Readers Pretest</th>
<th>Poor Readers Posttest</th>
<th>Normal Readers Pretest</th>
<th>Normal Readers Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word identification</td>
<td>5.04 (1.06)</td>
<td>9.09 (1.74)</td>
<td>5.69 (1.79)</td>
<td>6.83 (2.39)</td>
</tr>
<tr>
<td>Passage comprehension</td>
<td>2.70 (0.37)</td>
<td>6.37 (2.98)</td>
<td>4.19 (0.37)</td>
<td>4.31 (0.20)</td>
</tr>
</tbody>
</table>

Note. $n = 7$ in each group, equated for Word ID.
Article I. LIST OF CAPTIONS

1. TITLE PAGE
   a) Running head
   b) Title
   c) Author(s) names and affiliations
   d) Acknowledgement
   e) Address for correspondence

2. ABSTRACT

3. FULL ARTICLE TEXT
   a) Remedying reading comprehension difficulties: A cognitive processing approach (Title)
   b) Method
   c) Results
   d) Discussion
   e) References
   f) Description of Tests and Tasks (Appendix A)
   g) Tables
      i) Table 1 (Pretest and Posttest Means and Standard Deviations of Reading and CAS; N = 15 in each group)
      ii) Table 2 (Pretest and Posttest Means and Standard Deviations on Measures of Reading for Poor and Normal Readers matched on Word Identification)