

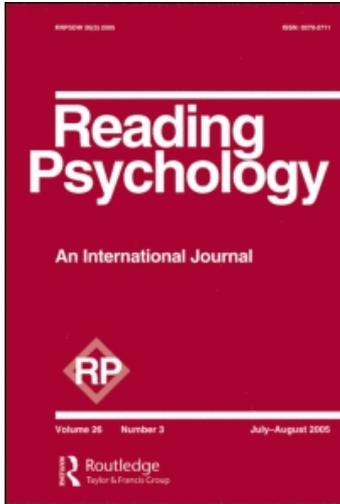
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REMEDIATING READING COMPREHENSION DIFFICULTIES: A COGNITIVE PROCESSING APPROACH

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The efficacy of a cognitive-based remediation program was investigated with 14 English-as-a-second-language (ESL) poor readers in Grade 4 who had significant difficulty in comprehension and 14 normal ESL readers in Grade 4 who received no remediation. Both groups were selected from 2 English-medium schools in India. We examined pretest-to-posttest changes in word reading, comprehension, and planning–attention–simultaneous–successive cognitive processes. Analyses of variance (ANOVAs) showed marked improvement in comprehension and some improvement in simultaneous processing for the treated group. The results indicate that the cognitive-based remediation program has potential for substantially improving comprehension and its underlying cognitive process among ESL children.

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 coherent mental model, whereas decoding words and following the syntax of a sentence 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 demands mastery over two different components: (a) word reading and (b) reading comprehension.

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Although these are highly related, subskills within each component and disorders related to reading weaknesses differentiate the two components (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 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 activating relevant background information, generating inferences while reading, being less aware of when they do not understand what they read, and combining information in working memory to form mental representations of text (Yuill & Oakhill, 1991; see Nation, 2005, and Perfetti, Landi, & Oakhill, 2005, for recent reviews). It is, then, logical to incorporate the development of the above components in a remediation program to improve comprehension. Within the Planning–Attention–Simultaneous–Successive (PASS) framework, the PASS Reading Enhancement Program (PREP) attempts to facilitate such development (Das et al., 1994; see below for details).

Cognitive Strategies and Reading Improvement

In recent years, cognitive strategy instruction 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, 2000; Gaddes & Edgell, 1994; Papadopoulos,

Das, Parrila, & Kirby, 2003; Swanson, Hoskyn, & Lee, 1999). The argument is that unless cognitive processes underlying reading are included in the remediation, remediation will not be successful in promoting transfer to broader aspects of reading (Das et al., 1994; Kirby & Williams, 1991).

PREP is one example of a cognitive-based remediation program that has been used successfully in both research and educational settings. 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 behavior, 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 interrelated larger units of information is the focus, while in successive processing information is coded so that the only links between the items are sequential in nature (see Das et al., 1994, for a detailed description).

The four processes can be assessed in a test battery, the Das-Naglieri Cognitive Assessment System (CAS; Naglieri & Das, 1997b). These tests have been used for understanding, assessment, and intervention in regard to educational problems (reading disability, autism, and attention-deficit), cognitive changes in aging, and decision making in management (Das, Kar, & Parrila, 1996). Construct validity of the CAS has been indicated by significant correlations between academic achievement variables and the Full Scale scores of the CAS Basic and Standard batteries, with correlations ranging from .66 to .73 (Joseph, McCachran, & Naglieri, 2003; Naglieri & Das, 1997a; Naglieri & Rojahn, 2004). The CAS has been found to have high predictive validity when predicting achievement (Naglieri & Das, 1997b) and discriminant validity when classifying students with and without LD (Johnson, Bardos, & Tayebi, 2003). The CAS subtests of the Basic

Battery have been reported to have high reliability: Full Scale, .87; Planning, .85; Simultaneous, .90; Attention, .84; and Successive, .90 (Naglieri, 2005).

The goal of PREP is to improve information processing strategies, especially simultaneous and successive processing, which are believed to underlie some aspects of reading (e.g., Das, Georgiou, & Janzen, 2008; Joseph et al., 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 (Campioni & Brown, 1987; Das, Mishra, & Pool, 1995). 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 (Lovett et al., 2000), or RAVE-O (Wolf, Miller, & Donnelly, 2000), PREP avoids explicit teaching of specific reading skills.

PREP consists of eight tasks that 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 nonreading 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 linked to reading and spelling (Das et al., 1994).

The cumulative 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, Snart, & Das, 1984; Das, Mishra, & Kirby, 1994; Janzen, 2000; Papadopoulos et al., 2003), in Greek (Papadopoulos, Charalambous, Kanari, & Loizou, 2004), and in Spanish (Molina, Garrido, & Das, 1997).

Though the present study is the first to use fully developed PREP aimed at improving *comprehension*, Brailsford et al. (1984) used different PREP-like tasks and reported improvements in comprehension. The participants were English-speaking Canadian school children with learning disabilities. Their study

clearly showed that the reading comprehension of a sample of learning-disabled children whose comprehension score was below the 35th percentile could be significantly improved on postintervention testing: Children's scores increased by 1.25 grades following only 15 hours of remedial training. A control group, by comparison, showed insignificant changes.

English as a Second Language

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. Students who are learning English as a second language (ESL) usually do so in an environment where other individuals predominantly speak English. What is unique to the current study is that students are learning English as a foreign language in an environment with predominantly non-English-speaking individuals. The Indian students in the present research speak their mother tongue 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 and language environment might have on English reading and comprehension was examined by Mishra and Stainthorp (2007) in a longitudinal study beginning at kindergarten. 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 whole words. Other research also has suggested that cross-language transfer exists for ESL readers (e.g., 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 native English speakers and ESL speakers (Low &

Siegel, 2005). Vocabulary knowledge may play a key role in reading comprehension performance for ESL readers as well. Specifically, weaker vocabulary knowledge of children learning a second language is likely to have an impact on their reading comprehension abilities (Hutchinson, Whiteley, Smith, & Connors, 2003; Sen & Blatchford, 2001). In addition, similar metacognitive strategies, such as planning and comprehension monitoring, and cognitive strategies, such as making inferences (Chamot & O'Malley, 1996; Jiménez, Garcia, & Pearson, 1996), are thought to be used by both monolingual and ESL readers during reading comprehension.

However, some children in English-medium schools—where curriculum is taught in English within non-English-speaking countries—do not succeed in learning to read adequately. That is, even if they read words they may experience difficulties in comprehending what they read (e.g., Sen & Blatchford, 2001). 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. One possibility is that these individuals fail to activate and integrate the relevant information while reading English, either because they still focus more on the decoding level or because they have not successfully transferred these skills from first language listening comprehension to second language reading comprehension. If this is the case, the result would be a poorer mental model of the text. We anticipate that as the cognitive-based remediation program improves information processing strategies, especially simultaneous processing, as applied to curriculum through PREP's bridging program, it will have a favorable outcome in regard to reading comprehension as obtained in previous studies.

Objectives

The primary objective of this study was to examine the efficacy of a cognitive-based remediation program for improving the English reading comprehension of children who have little or no difficulty in word reading and whose primary language is not English. Their medium of instruction in school was English (see Participants). These children were selected to examine whether comprehension could be improved following PREP treatment. Because PREP

also improves word reading among poor readers, whether it will further improve it in the present sample was an open question. Although the relationship between PASS and reading has been confirmed in investigations in Orissa, India, 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.

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

Method

Participants

This study involved a sample of 28 children, 14 poor readers (7 boys) and 14 normal readers (3 boys), who attended fourth grade in two English-medium schools in Orissa, India. Children who show the characteristics of being average in word reading but experience problems with reading comprehension are relatively few (e.g., Stothard & Hulme, 1996; Yuill & Oakhill, 1991). Thus, we were not able to secure enough participants for a treatment and control group with these similar characteristics. Instead, we chose to compare the target group's performance with readers considered "normal" on both word reading and comprehension. All children in the sample ranged from 8 to 10 years of age ($M = 9.4$ years) and were from middle and upper class socioeconomic backgrounds.

The children were first selected by their teachers as being normal or poor readers based on their overall performance in the school examinations; there were 42 children in this group. In the case of poor readers, with the permission of their teachers, the researchers spoke to parents to discuss perceptions and observations of their children. Most of the parents reported that they felt

their children lacked interest in their studies and hoped that there was something that could bring about a change in their children's school performance. Each potential participant was then administered the basic battery of CAS (Naglieri & Das, 1997b). 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 normal readers were average in both word reading (standard scores ranged from 94 to 128) and reading comprehension (99 to 110). The poor readers were significantly weaker in comprehension (standard scores ranged from 62 to 91) but not in word reading (standard score range 79 to 122; for details, see Table 1). Four poor readers, however, had word reading standard scores that could be considered low average (between 79 and 83).

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 5 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

TABLE 1 Pretest and Posttest Means and Standard Deviations of Reading and CAS

Measure	Poor Readers		Normal Readers	
	Pretest <i>M</i>	Posttest <i>M</i>	Pretest <i>M</i>	Posttest <i>M</i>
Word Identification				
<i>Standard score</i>	92.50	116.21	112.50	114.93
<i>Raw score</i>	57.00	79.79	74.79	78.07
Passage Comprehension				
<i>Standard score</i>	80.29	105.29	105.93	104.57
<i>Raw score</i>	20.57	38.93	38.00	38.07
Planning Scale				
<i>Standard score</i>	98.93	103.36	100.79	106.00
Attention Scale				
<i>Standard score</i>	95.50	99.57	99.14	102.36
Simultaneous Scale				
<i>Standard score</i>	89.07	101.86	99.79	104.50
Successive Scale				
<i>Standard score</i>	107.00	112.29	109.71	110.00
Full Scale				
<i>Standard score</i>	97.00	106.07	103.64	107.14

Note. $N = 14$ in each group.

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, 1997b), designed for use with children and adolescents ages 5 through 17 years. The total score is called the Full Scale score. The four PASS scales and the Full Scale standard scores have a mean of 100 and a standard deviation of 15, based on a representational sample of the population in the United States (Naglieri & Rojahn, 2004). The CAS consists of eight subtests—two from each of the four PASS processes. The tests vary in content: Some are verbal, some are not; some involve memory, others do not. A brief description of each subtest used within the present study is provided below. Further details of the CAS are available in its manual (Naglieri & Das, 1997b).

Planning subtests require the participant to generate a plan of action, appraise the value of the selected method, monitor its effectiveness, and alter the plan as tasks demand change (Naglieri, 1999). The Matching Numbers subtest 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, 742). The Planned Codes task requires the participant to assign a code (e.g., XO or OO) under a corresponding letter (A, B, C, or D). Each letter is repeated five times, for a total of 20 items on a page. An effective planning strategy, such as completing the page by letter, results in a high score on this subtest, compared with someone who does not develop and use a plan (Naglieri, 1999). For the above-mentioned subtests, the raw score is based on the combination of time (total seconds) and number correct for each item.

Attention subtests on the CAS require the participant to focus his or her attention on an activity, resist distracting stimuli, and maintain this concentrated attention throughout the task. To illustrate the attention requirements for these subtests, the Expressive Attention task requires the participant to read words (i.e., Blue, Yellow, Green, and Red) on the first page, name colors of a series of rectangles printed in the aforementioned colors on the second page, and then name the color of the ink of the words while ignoring the actual color names printed on the third page

(e.g., the word *blue* may appear in green ink). It is this last part of the task that is sensitive to attention because the participant must ignore the word and focus on the color in which it is printed. The raw score for this subtest is based on the combination of time (total seconds) and number correct for each item. Number Detection consists of rows of numbers, both targets (numbers that match the stimuli) and distracters (numbers that do not match the stimuli). The participant is required to underline the numbers that match those at the top of the page. The raw score for this subtest is based on a combination of time (total seconds) and accuracy (number correct minus number of false detections).

Simultaneous processing subtests require the participant to understand the relationship among words or ideas, understand how things fit together, and view several things at one time (Naglieri, 1999). For example, in the Verbal-Spatial Relations task, 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"). The items require evaluation based on logical and grammatical relationships. Nonverbal Matrices is a 33-item multiple choice task that presents geometric shapes interrelated through spatial or logical organization. For each item the participant is to decipher the relationship among the parts of an abstract pattern and then select the best choice from the six options provided to complete the matrix. The raw score for both of the above-mentioned subtests is the sum of the number of items correct.

Successive processing subtests require the participant to perceive and comprehend stimuli in a sequence (e.g., words, sounds, ideas; Naglieri, 1999). For example, in the Sentence Repetition task the participant is read 20 sentences aloud and is asked to repeat each sentence exactly as presented (e.g., "The blue is yellowing"). In the Word Series task, the participant is required to repeat a series of single-syllable, high-imagery words (e.g., "book-key-wall") in the same order in which the examiner says them. The raw score for both of the above-mentioned subtests is the sum of the number of items correct.

Remediation Tasks

Following their selection, the poor readers were given PREP. PREP tasks included four mainly successive processing

enhancement tasks and four mainly simultaneous processing enhancement tasks, which are described in detail below.

JOINING SHAPES

The global component of the task requires the participant to join a series of geometric shapes 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 requires the participant to join a series of letters following a set of rules to make words. Difficulty is increased by increasing word length. This task facilitates the development of successive processing. Working memory for rules is demanded in this task.

CONNECTING LETTERS

The global component of this task involves lines of differing colors 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 colored 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 (color is held constant), colors (shape is held constant), or colored shapes (color 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, 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 is utilized for phonemic awareness.

TRANSPORTATION MATRICES

In the global component, 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 involves two tasks. The first one requires the participant to reproduce a series of letters in the correct order and state the word formed by the letters. The difficulty level corresponds to the phonetic complexity of the words. The second task requires the participant to memorize and recall sets of words made up of semantically related word pairs. Difficulty level increases by increasing the number of words in the series. This task facilitates the development of both simultaneous and successive processing.

The four 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 colored shapes provided. The shapes are presented in three colors (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

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 sentences belonging to certain categories along with a distracter in each set. The participant reads the sentences 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 facilitates the development of simultaneous processing and 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 is accompanied by a short printed passage that 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, the participant is shown a single photograph and given 3–4 short passages to read after which he or 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.

As was 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. Most of the strategies that are associated with comprehension—which we list again as a reminder—are found in these Simultaneous PREP tasks. These strategies include readers activating relevant background information, generating inferences while reading, being less aware of when they do not understand what they read, and combining information in working memory to form mental representations of text (Yuill & Oakhill, 1991).

Procedure

The participants were tested individually in their respective schools by the first author (SM). 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 external disturbances to a minimum during task administration. All measures were administered in English.

Pretesting included the Word Identification subtest and Passage Comprehension subtest from WRMT-R and the basic battery of Das-Naglieri CAS. 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.

Following the pretesting, PREP remediation tasks were administered to the children in the poor reader group following the prescribed procedure given in the manual. 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. The participants were highly motivated and showed active involvement in the tasks throughout the remediation. As observed by the examiner after each PREP session, it appeared to

be an enjoyable experience for the participants. Normal readers received regular classroom instruction during this time.

During the posttest sessions, poor and normal readers were again administered individually the Word Identification subtest and the Passage Comprehension subtest from the WRMT-R and the basic battery of the Das-Naglieri CAS.

Results

The means and standard deviations of all measures are presented in Table 1. The first part of the table presents participants' word reading and comprehension scores, and the second half of the table presents the CAS scores. The difference between the mean word reading score of the poor readers before and after PREP remediation was equivalent to an increase of 3.5 grades. Similarly, the difference between the mean reading comprehension score of the poor readers before and after PREP training indicated an increase of 3.2 grades. A comparison of the mean pretest and posttest word reading scores obtained after 2 months of regular classroom instruction suggested an increase of 0.6 grades for the normal readers. More importantly for the present study, the difference between the mean pretest and posttest reading comprehension scores of normal readers indicated an expected rate of growth of a 0.02 grade increase after 2 months during which they received regular classroom instruction.

Mixed method analyses of variance (ANOVAs) with time (pretest vs. posttest) as the within-factor and group (poor vs. normal readers) as the between-factor were calculated next, separately for word reading and reading comprehension. The results for word reading indicated a significant main effect for time, $F(1, 26) = 80.48, p < .001, \eta_p^2 = .76$; a significant main effect for group, $F(1, 26) = 5.26, p = .03, \eta_p^2 = .17$; and a significant Group \times Time interaction, $F(1, 26) = 45.02, p < .001, \eta_p^2 = .63$. In regard to reading comprehension, a significant main effect for time, $F(1, 26) = 135.51, p < .001, \eta_p^2 = .84$; a significant main effect for group; $F(1, 26) = 25.57, p < .001, \eta_p^2 = .50$; as well as a significant Group \times Time interaction, $F(1, 26) = 133.41, p < .001, \eta_p^2 = .84$, were observed. Post hoc analyses indicated that normal readers scored significantly higher than poor readers on pretest word reading,

$F(1, 27) = 17.82, p < .001$, and especially on pretest reading comprehension, $F(1, 27) = 63.88, p < .001$, whereas no significant differences were observed between normal and poor readers' word reading posttest performance, $F(1, 27) = 0.27, p = .61$, or reading comprehension posttest performance, $F(1, 27) = 0.39, p = .54$. Thus, the interaction effect can be considered as evidence for the efficacy of the cognitive-based remediation program.

Though many poor and normal readers had almost equal levels of word reading proficiency, the differences in pretest scores between the groups were still significant. We wanted to examine further whether the interaction effect observed for reading comprehension would survive if pretest word reading scores were equated. Mixed method analysis of covariance (ANCOVA), with pretest and posttest reading comprehension scores and pretest word reading score as a covariate, showed a significant Group \times Time interaction, $F(1, 25) = 66.73, p < .001, \eta_p^2 = .73$. In addition, we equated a subsample of 8 children from each reading group on pretest word reading scores and ran the mixed method ANOVA with these smaller matched groups. Again, a significant Group \times Time interaction, $F(1, 14) = 92.40, p < .001, \eta_p^2 = .87$, was observed, replicating the results obtained from the larger sample. As before, this provided the critical evidence that we required for the efficacy of the cognitive-based remediation treatment.

Performance on Measures of Cognitive Processes

The second section of the results involved 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, a multivariate analysis of variance (MANOVA) with the difference scores (posttest minus pretest) for the four individual processes as the dependent variable and group as the between-subject factor was performed. This approach, instead of four separate mixed method ANOVAs with time (pretest vs. posttest) as the within-factor and group (poor vs. normal readers) as the between-factor,

was chosen to provide a conservative control of the family-wise error rate. All four difference scores were normally distributed—all skewness and kurtosis values divided by their errors were within the -2 to $+2$ range.

The MANOVA results indicated that the difference scores were significantly different from zero, Wilks' $\Lambda = .318$, $F(4, 23) = 12.35$, $p < .001$, but the differences between the groups were not, Wilks' $\Lambda = .726$, $F(4, 23) = 12.35$, $p = .104$. Subsequent ANOVAs indicated that difference scores were significantly different from zero for Planning, $F(1, 26) = 5.66$, $p = .025$, $\eta_p^2 = .18$; Attention, $F(1, 26) = 13.74$, $p = .001$, $\eta_p^2 = .35$; and Simultaneous processing, $F(1, 26) = 21.97$, $p < .001$, $\eta_p^2 = .46$, and approached significance for Successive processing, $F(1, 26) = 3.38$, $p = .077$, $\eta_p^2 = .12$. The group difference, equivalent Group by Time interaction, was significant only for Simultaneous processing, $F(1, 26) = 4.67$, $p = .04$, $\eta_p^2 = .15$ (all other p values $> .10$). The significant group difference suggests that the cognitive-based remediation program brought about improvement specifically in simultaneous cognitive process in the poor readers. However, because the multivariate test was not significant, these results should be treated as tentative.

Correlational Analysis

The pattern of relationships between the two reading skills and the four cognitive processes were studied further by carrying out correlational analysis. First, an examination of the correlations indicated that not only was the relationship between word reading and reading comprehension significant ($r = .81$, $p < .001$), but both skills were significantly related to simultaneous processing ($r = .62$ and $r = .75$, $p < .001$, respectively) as well as the overall intellectual functioning (Full Scale) of the children ($r = .44$, $p = .02$ and $r = .48$, $p = .01$) when performance of all 28 children in the pretest condition was examined. 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 ($r = .73$, $p = .003$), they were not in

the posttest condition ($r = .41, p > .05$). In the case of normal readers, however, the correlations between word reading and reading comprehension were not statistically significant at either pretest ($r = .18, p > .05$) or posttest ($r = -.51, p > .05$) conditions. We are aware that the sample size was small. Second, an examination of correlations between the difference scores indicated that comprehension and word identification difference scores were significantly correlated ($r = .84, p < .001$) and both correlated significantly with the Simultaneous processing difference score ($r = .43, p = .021$, for comprehension and $r = .45, p = .016$, for word identification) but not with any other cognitive process difference score (all p values $> .10$).

These results suggest that reading proficiency, as well as improvement in reading proficiency, is partly determined by one's proficiency in specific cognitive processes 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 more independent of one another. Because this result is based on a small sample size it needs to be replicated.

Discussion

The current study selected children whose reading comprehension was poorer than their word reading and then tested the efficacy of a cognitive-based remediation program in improving their comprehension performance. The remediation 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 reading deficit was typically marked by performance below the 25th percentile, which was not the case in the present sample; even poor comprehenders were close to their grade norm in word reading. 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 or above the mean for their age. We expected that the cognitive-based remediation program used would improve comprehension scores; whether word identification scores would also be enhanced was an open question.

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 the posttest score of the treated group exceeded the grade equivalent norm. We believe that proficiency in reading comprehension developed in children with the use of PREP because some of its tasks facilitated the development of specific cognitive processes underlying comprehension. For example, in the global part of the Shapes and Objects subtest, when the children were asked to put the picture cards under the shapes they resemble most the children looked at each picture and “abstracted” the shape the picture would fit best. Some children also outlined the pictures with their fingers in order to match them with their appropriate shapes. In the bridging part of the task the children were given some sentence cards to be sorted out in categories based on thematic similarity. The children tried to grasp the essential idea of each sentence and put it under the appropriate category. Some children, when presented with the sentences, used self-talk to work through the problem, analyzing each sentence before categorizing it.

Similarly, the Sentence Verification task required the children to read some printed passages, study the accompanying sets of photographs, and select the photographs that best illustrate the contents of the passages. Some read the passages silently, asked the facilitator the meaning of the difficult word (if they found any), and tried to match them with their corresponding pictures. But some children, when going through the sentences, started talking to themselves, nodding their head, and showing excitement when they got an appropriate match for a sentence. As the children experienced the task they also learned to observe the minute details in the pictures and the essential elements in the passages and matched them accordingly.

Thus, comprehension skill developed in these children through abstraction, perception of interrelationship among the obtained information, strategic thinking, and the ability to focus

on relevant information to the exclusion of the irrelevant one. The children were also encouraged to become aware of their use of strategies through verbalization and showed improvement with increasing experience of the tasks. These facilitated the development of three of the cognitive processes, namely, simultaneous processing, planning, and attention—all of which are involved in reading comprehension.

The second objective of the study 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. This would indeed be a far transfer. 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 \times Time interaction for simultaneous processing; this was tentatively confirmed by the results. Not only did the PREP treatment group improve more in comprehension compared to the nontreated group, it did so in a basic cognitive processing component theoretically linked to comprehension (e.g., Naglieri & Das, 1988). We discuss briefly the observations of the facilitator that further confirm the influence of PREP on comprehension of verbal-spatial tasks.

The first author (SM), who observed each child during CAS, remarked that before PREP training, poor readers comprehended the text by processing the information at the surface level. In the present study, PREP seems to have facilitated their development of logical-analytical and inferential thinking (as observed by the facilitator), leading to a deeper level of processing text as they progressed through remediation. The cognitive-based remediation program thus seems to have the potential to facilitate the growth of reflective knowledge of the language while reading.

The correlations between the two reading measures and the CAS tasks at pretest reconfirm 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 the average and the children are not beginning but advanced readers, successive processing may not contribute significantly to individual differences in word reading.

Limitations and Future Directions

Though our findings suggest that PREP training enhanced comprehension, they are limited by the small sample size, lack of equivalent control group receiving alternative training, and the selection procedure for entrance into English-medium schools in India that may not admit obviously reading-disabled children. As a result, we cannot completely rule out alternative explanations, such as improved motivation and regression to the mean, and our study may best be viewed as a pilot study that needs to be followed by a larger study with alternative treatment control group, random assignment of participants, and follow-up testing to establish the long-term effect of the remediation. In addition, a microgenetic study (Kuhn, 1995) would be highly useful in potentially pinpointing the 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, would also avoid complications that are introduced as children are taught to read and write in their mother tongue and other languages (see Mishra & Stainthorp, 2007).

Conclusions

The present study is unique in two ways. First, the cognitive-based remediation program substantially enhanced the treated group's reading comprehension. The program also had a beneficial effect on word reading even when this group of readers had close to average scores at pretest. Second, the cognitive-based remediation program resulted in an improvement in simultaneous processing, which was at sub-average level at the beginning of the study. 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 the strategies and skill and likely benefit more from regular classroom instruction.

In spite of the study's limitations, the current study has introduced evidence that PREP as a *cognitive remediation* program has potential for substantially improving comprehension and, to a lesser extent, simultaneous processing scores for children who do not speak English as their first language as it has been shown to do among native speakers of English.

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