Journal of Education and Practice www.iiste.org
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol 2, No 4, 2011

Cognitive Processing Strategies in Reading

Manaswini Dash
P.G. Department of Psychology, Utkal University,
Bhubaneswar-751004, Orissa, India
E-mail: manaswinidash@ymail.com

U. N. Dash
P.G. Department of Psychology, Utkal University,
Bhubaneswar-751004, Orissa, India
E-mail: undash@yahoo.co.in

Abstract

The present study examined the cognitive processing strategies of good and poor readers from two different grades and attempted to make an information processing analysis of reading. The performance of twenty good and twenty poor readers each from Grade 3 and Grade 5 was compared on tasks of attention, simultaneous and successive processing as well as planning. 2 (Grade) × 2 (Reading Status) analyses of variance revealed a significant effect of grade suggesting that the processes were developmentally sensitive. While the simultaneous and successive processing measures could differentiate the good readers from the poor ones, the former group showed their superiority in terms of attention and planning only when the task characteristic was complex. The results were interpreted within the theoretical framework of the PASS model suggesting cyclical hierarchical involvement of the two coding processes in reading.

Key Words: Attention, Cognitive processing, PASS model, Planning, Reading, Simultaneous process, Successive process.

1. Introduction

Reading being a complex process involves multiple systems and thus, is affected by a number of factors. There has been a host of research on reading ability comparing good and poor readers which could find differences in tasks of general abilities like intelligence, memory as well as in task of specific linguistic abilities like verbal processing, phonological processing, metalinguistic awareness, reading awareness and knowledge of orthographic principles etc. favouring the former (Baddeley, Logie, Nimmo-smith, & Brereton, 1985; Das & Siu, 1989; Edwards, 1958; Joseph, McCachran & Naglieri, 2003; Prakash, 1999; Stanovich, Cunningham, & Feeman, 1984;). But most of these studies without being motivated by any theoretical model, compared the good and poor readers on standard cognitive measures. Though these researches are helpful in identifying behaviours that can distinguish between good and poor readers, it is important to explore why and how the former group is better than the latter one.

This issue has been addressed by a shift of interest from the study of abilities to an inquiry into processes which resulted in the emergence of several information processing models (Morton & Patterson, 1980; Naglieri & Das, 1988, 1990). The basic tenet of the information processing approach believes that the internal representation of stimulus goes through several stages and undergoes considerable processing before a response is being made. The study of reading within the framework of information processing models of cognition are helpful in comprehending the psychological mechanisms by which the differences between the good and poor readers on several measures come about. The present study attempts to make an information processing analysis of reading within the theoretical framework of PASS model (Naglieri & Das, 1988, 1990).

The PASS theory is a blend of neuropsychological, cognitive, and psychometric approaches and provides a model for conceptualizing human intellectual activities. Being defined by four processes namely planning, attention, simultaneous and successive, it has its basis in Luria's (1973, 1980) neuropsychological

model which conceived the brain to be comprising of three functional units whose participation is required for any type of cognitive activity. The functions of these units- attention, coding and planning constitute the components of the PASS model. The attention system being housed in the upper and lower brain stem, the reticular formation and the hippocampus, is responsible for maintaining the cortical tone and a proper state of arousal. The second system is concerned with the obtaining, processing and storing of information. The mode of information processing is either simultaneous or successive. Simultaneous process synthesizes separate units of information into a quasi-spatial and relational organization. Successive processes integrate separate information into a temporally ordered and organized sequence. This system is seated in the temporal, occipital and parietal lobes and the rear portion of the frontal lobes. The third unit is located in the pre-frontal areas of the brain and is responsible for generation, selection, execution of plans or programs, evaluation of one's own behaviour and that of others and the response tendency to act on the basis of such evaluation. This model of information processing has also gained support from psychophysiological studies involving EEG coherence. Different EEG coherent patterns were seen during simultaneous and successive processing tasks (Okuhata & Okazaki, 2007; Okuhata, Okazaki, & Maekawa, 2009).

Researchers have attempted to explain various learning and reading processes in terms of the PASS processes. Simultaneous, successive as well as planning processes have correlated significantly with reading decoding and reading comprehension (Dash & Dash, 1999; Georgiou, 2010; Kirby & Robinson, 1987). Attention was also found to correlate with achievement (Naglieri, Das, Stevens, & Ledbetter, 1990).

From the significant correlations obtained between the PASS processing and various achievement measures, one would expect significant differences between the low-achievers and the high-achievers on the measures of these processes. This expectation is confirmed by researchers (Chow & Skuy, 1999: Das, 1998; Kirby, Booth & Das, 1996; Kirby & Robinson, 1987: Naglieri, Satler, & Edwards, 2004) who found differences in successive processing as well as simultaneous processing between good and poor readers. Researchers have also documented poor performance in simultaneous processing among the poor readers than the good readers (Dash & Dash, 1989; Keat & Ismail, 2011). It seems that the simplest form of reading, i.e. decoding depends on successive processing, while reading comprehension involves both the successive and simultaneous processing of information. Involvement of PASS' processes in reading has also been supported by Rosadah (2004) who compared the average students and talented students and found overall performance on PASS cognitive processing to be lower for average than talented students.

Reading involves a hierarchy of levels of analysis. These levels are letter features, letters, syllables, words, phrases, ideas etc. Simultaneous and successive processes operate within and between these levels (Kirby, 1988; Kirby & Das, 1990; Kirby & Williams, 1991; Naglieri, 1999). At each level, a set of units are held in an arbitrary order (successive processing) so that a higher level code can be used to recode the set as a single unit (simultaneous processing) for the next higher level of analysis. In skilled reading, the lower levels must be operating automatically so that attention can be devoted to the higher levels. The more advanced levels of reading require planning. Without planning there would not be any efficient application of the coding processes and as a result reading would not be successful. In fact, reading disabled children are believed to be employing simultaneous processing in the reading tasks that normally require successive processing (Kirby & Robinson, 1987); the probable cause of which is a deficit in planning. Attention is a prerequisite for any cognitive task. It is obvious that a proper arousal level must be maintained in order to perform any cognitive task. Attention deficit would result in performance deficit.

The present study is designed to examine the involvement of attention, simultaneous, successive and planning processes in reading by comparing the performance of good and poor readers in two different age groups on various measures of these processes.

2. Method

2.1. *Subjects*

The sample consisted of 20 good and 20 poor readers from each of the Grades 3 and 5. The good and poor readers in respective grades were matched in terms of their age and intelligence. All the good and poor readers in each grade came from the same age bracket and were within 35^{th} to 65^{th} percentile of the intelligence distribution as measured by the RCPM. In respect of reading, the good and poor readers were

approximately 1 grade point above and below their grade level respectively. Thus, in spite of equality in age and intelligence, there was a two grade-point difference in the reading level of the good and poor readers. The subjects' reading grades were calculated on the basis of their performance on the Graded Reading Comprehension Test developed by Mohanty and Sahoo (1985). All the subjects were selected from six primary schools of Puri town which is situated at 60 Kilometers. south of Bhubaneswar, the state capital of Orissa, in India.

2.2. *Tests*

All the subjects selected on the basis of their performance in RCPM and the Graded Reading Comprehension Test were administered marker tests of attention, simultaneous and successive processing, and planning. The test of Selective Attention was used as the measure of attention. While simultaneous processing was measured by the tests of Tokens and Matrix Analogy, successive processing was tapped by Serial Word Recall and Successive Ordering. Planned Connection and Crack-the-code were used as the measures of planning. The tests have been described below.

Graded Reading Comprehension Test. This test being developed by Mohanty and Sahoo (1985) measures the reading efficiency of children in Oriya from Grade 1 to Grade 7. It consists of 14 short stories/paragraphs, each printed in a separate page. There are two stories meant for each grade. All the stories are arranged in increasing order of difficulty. The subjects were asked to read the stories/paragraphs carefully, and answer the questions appearing in a separate booklet.

Selective Attention-Receptive. This nonverbal task consists of two conditions: Physical Match and Name Match. In each condition, the subject is given a printed sheet consisting of 84 pairs of pictures. In the Physical Match condition, the subject's task is to locate the picture pairs that look the same from among distracter pairs. In the Name Match condition, the subject has to identify the picture pairs that belong to the same class (i.e., 2 flowers, 2 animals and so on). There is a time limit of 2 minutes for each condition. The number of correct responses made by the subject is recorded.

Tokens. This verbal measure of simultaneous processing requires the child to use the concept of shape, colour and left, right, top and bottom. There are 4 square chips and 4 round chips from each of the blue, black, yellow and white colours. The child was asked to arrange the chips according to the direction given by the examiner such as "Put a black round one on a yellow square that is to the left of a blue square." The subject's score is the number of items correctly responded.

Matrix Analogy. This task of simultaneous processing consists of 35 abstract patterns in the black, blue, yellow and white of the progressive matrices type, printed two per page. Below each of the main figures, there are six alternatives from which the subject has to choose the one which will best complete the figural matrix. For each correct alternative the subject gets a score of 1.

Serial Word Recall. This test of verbal successive processing consists of 12 lists of words which begin with a four-word series and progress to a six-word series. There are four lists for each of the four-, five-, and six-word series. Following oral presentation by the investigator, the subject is required to recall each series in correct serial order. The total number of words recalled in correct serial position constitutes the serial recall score of the subject.

Successive Ordering. This nonverbal marker test of successive processing requires the child to re-produce the specific order of an event. There are eight circular chips arranged linearly on a board. The child's task is to turn the chips on the board in the same sequence as demonstrated by the examiner.

Planned Connection. This is a nonverbal test of planning. The test consists of 10 cards on which numbers and/or letters are distributed randomly. Eight of the cards have numbers only, and the rest two have both numbers and letters. For the first eight cards, the subject's task is to connect the numbers in the correct numerical sequence. For the remaining two cards, the subject's task is to connect numbers and letters alternatively such as 1-A-2-B-3-C and so on. The time taken to connect the series is recorded.

Crack the Code. This measure of planning consists of 4 coloured chips. The chips are placed in the first row of circles and 3 or 4 arrangements of coloured chips and the number of errors associated with each are provided to the subject. On the basis of this information, the subject has to infer the code so as to

place the chips in correct positions. Each item is scored as pass (1) or fail (0). There is a time limit of 3 minutes per item.

2.3. *Procedure*

A sample of 275 Grade 3 and 256 Grade 5 children from six primary schools of Puri town were administered the RCPM. Those children who scored within 35th to 65th percentile points on the RCPM (RCPM score between 16 to 24 in Grade 3, and between 19 to 28 in Grade 5) were further administered the Graded Reading Comprehension Test (Mohanty & Sahoo, 1985). On the basis of their performance in the Graded Reading Comprehension Test, 20 good and 20 poor readers for each grade were selected. Thus, children who scored 1 grade point above and 1 grade point below their respective grade levels were selected. Thus the good and poor readers were having mean reading grades 3.96 and 1.85 respectively in Grade 3 and 5.94 and 3.87 respectively in Grade 5. All the eighty subjects, thus selected, were administered the tests of attention, simultaneous, successive processing as well as planning individually.

3. Results

The means and standard deviations of the various measures of attention, simultaneous, successive and planning processes are presented in Table 1.2 (Grade) x 2 (Reading Status) ANOVA was performed for each of the information-processing measures and the summary of ANOVA are presented in Table 2.

Insert Table 1 & 2 about here.

It may be seen from Table 2 that the main effects of grade were significant for all the information processing tasks except Serial Word Recall. The Grade 5 children were superior to the Grade 3 children on the tasks of attention, simultaneous, successive and planning processes except one successive processing measure which is a verbal task.

The main effects of reading status were found to be significant for all the measures of coding. So far as attention is concerned, the main effect of reading status was significant for the name match condition of the Selective Attention-Receptive task but not for the physical match condition of the task. In Selective Attention test, physical match condition requires the child to match the pictures on the basis of direct visual features of the stimuli whereas the name match condition requires the subject to match by categories which necessitates lexical access and verbal processing of information. Thus the task characteristic of the name match condition was somewhat complex requiring verbal mediation and could yield a difference between the two reading status groups.

2 (Grade) x 2 (Reading Status) ANOVA performed on the planning tasks revealed significant main effect of reading status for Crack the Code task but not for Planned Connection. The former which measures planning at conceptual level could differentiate the good readers from the poor ones but not the latter which taps planning at simple perceptual level.

The interaction of grade with reading status was found to be significant for none of the cognitive measures.

4. Discussion and Conclusion

The result revealed that all the cognitive processes were developmentally sensitive. That is, the performance of the subjects improved with increasing age and grade. The fact that Serial Word Recall could not yield a significant grade effect might be due to high familiarity of the words that were used in test. But though insignificant, the fifth graders were at higher level than the third graders. The mean score of the third and fifth graders were 74.25 and 79.85 respectively. The results are consistent with the findings of earlier investigations (Das, Cummins, Kirby & Jarman, 1979; Dash & Dash, 1989).

The results of this study are also in consonance with the findings of Das, 1988; Dash & Dash, 1989; Keat & Ismail, 2010; 2011; Kirby & Robinson, 1987) in that reading involves attention, simultaneous, successive processing and planning.

Attentional process as explained by the filtering out the extraneous or irrelevant stimuli and focusing selectively on a task is required for skilled reading. Attention involves registration of information

and communication to appropriate cortical area which is necessary prerequisite of any cognitive task. Reading being a higher-order linguistic task is affected by attention processes that require lexical access and verbal mediation.

The involvement of both the coding processes in reading has been found in the present study. Several studies (Das et al, 1979; Luria, 1980) have documented the importance of successive processing for contextual grammatical aspect of language and simultaneous processing for logical grammatical aspect of language. Both these linguistic skills are involved in reading comprehension. Reading requires a cycle of simultaneous and successive processing. For example, coding of letters in a sequence to form words and words to form sentences is facilitated by successive processing while simultaneous processing helps recognition of whole words and forming of text units for better comprehension. Thus both the coding processes are important for reading comprehension and operate in a cyclic fashion to help the reader master the component skills of reading.

Skilled reading also involves planning. The present study though could not find the difference between good and poor readers in simple perceptual planning measure, i.e., the Planned Connection test, it could register the difference in a more complex task requiring conceptual planning. The reading disabled though were found to be deficient in simultaneous and successive processes, these children may be suffering more from deficient planning process needed for applying the appropriate the appropriate information integration mode to the reading task. That is, these children may be using simultaneous mode of processing where successive mode would have been more appropriate (Kirby & Robinson,1987). Planning assumes increasingly important role in reading comprehension with increasing age.

The PASS processes being very basic and fundamental processes of cognition, can provide information regarding a relationship between cognitive processes and academic achievement for different subjects at different grade levels and can provide directions for identification and remediation of possible specific deficit in processing.

References

Baddeley, A., Logie, R., Nimmo-smith, I., & Brereton, N. (1985). Components of fluent reading. *Journal of Memory and Language, 24,* 119-131.

Chow, D. & Skuy, M. (1999). Simultaneous and successive cognitive processing in children with nonverbal learning disabilities. *School Psychology International, 20,* 219-231.

Das, J. P. (1988). Simultaneous-successive processing and planning: Implications for school learning. In Schemeck, R. R. (Ed.), *Learning styles and learning strategies.* New York: Plenum Press.

Das, J. P., Cummins, J., Kirby, J. R., & Jarman, R. F. (1979). Simultaneous and successive processes, language, and mental abilities. *Canadian Psychological Review, 20,* 1-11.

Das, J. P. & Siu, I. (1989). Good and poor readers' word naming time, memory span, and story recall. *Journal of Experimental Education, 57,* 101-114.

Dash, M. & Dash, U. N. (1989). Information processing and the poor reader: Evidence for the developmental lag hypothesis. *Indian Psychologist, 6,* 85-93.

Dash, M. & Dash, U. N. (1999). Information processing correlates of planning. In Dash, U.N. & Jain, U. (Eds.) *Perspectives on Psychology and Social Development.* New Delhi: Concept Publishing Company.

Edwards, D. L. (1958). Reading from the child's point of view. *Elementary English, 35,* 239-241.

Georgiou, G. K. (2010). PASS cognitive processes: Can they explain the RAN-reading relationship. *Psychological Science,* (Online Available) Doi: http://en.cnki.com.cn/Article_en/CJFDTOTAL-XLKX201006003.htm.

Joseph, L. M., McCachran, M. E., Naglieri, J. A. (2003). PASS cognitive processes, phonological processes, and basic reading performance for a sample of referred primary-grade children. *Journal of Research in Reading, ISSN 0141-0423, 26,* 304-314.

Keat, O. B. & Ismail, K.H. (2010). The PASS cognitive functions of children with reading difficulties: A Malaysian study. *Procedia Social and Behavioral Sciences Journal, 5,* 2182-2193.

Keat, O. B. & Ismail, K.H. (2011). PASS cognitive processing: Comparison between normal readers and children with Reading Difficulties. *International Journal of Humanities and Social Science, 1,* 53-60.

Kirby, J. R. (1988). Style, strategy, and skill in reading. In Schemeck, R. R. (Ed.), *Learning styles and learning strategies.* New York: Plenum Press.

Kirby, J. R. & Das, J. P. (1990). A cognitive approach to intelligence: Attention, coding, and planning. *Canadian Psychology, 31,* 320-339.

Kirby, J. R. & Robinson, G. L. (1987). Simultaneous and successive processing in reading disabled children. *Journal of Learning Disabilities, 20,* 243-252.

Kirby, J. R. & Williams, N. H. (1991). *Learning Problems: A Cognitive Approach.* Toronto: Kagan and Woo.

Luria, A. R. (1973). *The Working Brain,* London: Penguin.

Luria, A. R. (1980). *Higher Cortical Functions in Man.* New York: Basic Books.

Mohanty, A. K. & Sahoo, R. N. (1985). *Graded Reading Comprehension Test.* Department of Psychology, Utkal University.

Morton, J. & Patterson, K. E. (1980). Little Words – No. In Colthart, M., Patterson, K. E., & Marshall, J. C. (Eds.), *Deep Dyslexia*. London: Routledge & Kagan Paul.

Naglieri, J. A. (1999). *Essentials for CAS assessment.* New York: Wiley.

Naglieri, J. A. &Das, J. P. (1988). Planning – Arousal _ Simultaneous – Successive (PASS): A model of assessment. *Journal of School Psychology, 26,* 35-48.

Naglieri, J, A. & Das, J. P. (1990). Planning, Attention, Simultaneous, and Successive (PASS) cognitive processes as a model for intelligence. *Journal of Psychological Assessment, 8,* 303-337.

Naglieri, J. A. & Das, J. P., Stevens, J. J., & Ledbetter, M. L. (1990). Confirmatory factor analysis of planning, simultaneous, successive cognitive processes. *Journal of School Psychology, 20,* 1-18.

Naglieri, J. A., Satler, C. J., & Edwards, G. H. (2004). Assessment of children with attention and reading difficulties using the PASS theory and Cognitive Assessment System. *Journal of Psychoeducational Assessment, 22,* 93-105.

Okuhata, S. T., Okazaki, S., & Maekawa, H. (2007). Differential topographic pattern of EEG coherence between simultaneous and successive coding tasks. *International Journal of Psychophysiology, 66,* 60-80.

Okuhata, S. T., Okazaki, S., & Maekawa, H. (2009). EEG coherence pattern during simultaneous and successive coding tasks. *International Journal of Psychophysiology, 72,* 89-96.

Prakash, P. (1999). Reading disability and knowledge of orthographic principles. *Psychological Studies, 44,* 59-64.

Rosadah, B. A. M. (2004). *Satu Kajian Perbandingan Profil Pelajar Pintar Cerdas Akademik Dengan Pelajar Sederhana Akademik*. Ph.D. Thesis UKM.

Stanovich, K. E., Cunningham, A.E., Feeman, D. J. (1984). Intelligence, cognitive skills, and reading process. *Reading Research Quarterly, 19,* 278-300.

.

Table 1: Group Means and Standard Deviations of Attention, Simultaneous, Successive and Planning Measures (N= 20 in each group)

Test	Grade 3	Grade 5

		Poor Readers	Good Readers	Poor Readers	Good Readers
Selective Attention Physical Match	Mean	18.65	19.05	19.55	20.00
	SD	1.42	1.05	0.69	.00
Name Match	Mean	12.90	16.35	16.25	18.60
	SD	3.51	3.03	2.84	1.57
Tokens	Mean	5.35	8.85	7.15	12.65
	SD	2.50	2.66	2.50	2.37
Matrix Analogy	Mean	6.10	9.05	8.80	12.70
	SD	4.19	4.73	4.74	4.99
Serial Word Recall	Mean	31.60	42.65	36.75	43.10
	SD	7.88	7.65	8.70	6.77
Successive Ordering	Mean	5.55	6.40	6.65	8.35
	SD	1.32	1.14	1.53	1.69
Planned Connection	Mean	46.07	46.75	41.84	37.75
	SD	8.50	6.08	12.58	8.96
Crack the Code	Mean	0.30	0.70	0.95	1.50
	SD	0.47	0.73	0.76	0.83

Table 2: Summary of ANOVA for Measures of Attention, Simultaneous, Successive and Planning Measures

Test	Sources	SS	df	MS	F
Selective Attention	Grade (A)	17.11	1	17.11	10.00**
	Reading Status(B)	3.61	1	3.61	3.01
Physical Match	A × B	0.01	1	0.01	0.01
	Within	68.45	76	0.90	
Selective Attention	Grade(A)	156.80	1	156.80	19.57***
	Reading Status(B)	168.20	1	168.20	20.99***
Name Match	A × B	6.05	1	6.05	0.76
	Within	608.90	76	8.01	
	Grade(A)	156.80	1	156.80	24.92***
Tokens	Reading Status(B)	405.00	1	405.00	64.37***
	A × B	20.00	1	20.00	3.18
	Within	478.20	76	6.29	
	Grade(A)	201.61	1	201.61	9.24**
Matrix Analogy	Reading Status(B)	234.61	1	234.61	10.75**
	A × B	4.51	1	4.51	0.21
	Within	1658.15	76	21.82	

Serial Word Recall	Grade(A)	156.80	1	156.80	2.59
	Reading Status(B)	1513.80	1	1513.80	15.01***
	A × B	110.45	1	110.45	1.82
	Within	4600.90	76	60.54	
Successive Ordering	Grade(A)	46.51	1	46.51	22.54***
	Reading Status(B)	32.51	1	46.51	15.75***
	A × B	3.61	1	3.61	1.75
	Within	156.85	76	2.06	
Planned Connection	Grade(A)	522.75	1	522.75	6.01*
	Reading Status(B)	0.82	1	0.82	0.01
	A × B	302.25	1	302.25	3.48
	Within	6605.08	76	86.91	
Crack the Code	Grade(A)	10.51	1	10.51	20.83***
	Reading Status(B)	4.51	1	4.51	8.94**
	A × B	0.11	1	0.11	0.22
	Within	38.55	76	0.50	

* $p < .05$, ** $p < .01$, *** $p < .001$