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Role of Medium of Instruction on the Development of Cognitive Processes

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Abstract

The present study was designed to examine the effect of medium of instruction on the development of cognitive processes. For this purpose, a sample of 80 children, 40 each from grade IV (aged 8-9 years) and grade VI (aged 10-11 years) were selected. In each age group, 20 children were studying in an English medium school and the other 20 in an Odia(a regional language of India) medium school. All the children were administered two tests each of planning, attention, simultaneous, and successive processing. The data were statistically analyzed with the help of 2 (medium of instruction) X 2 (grade) Analyses of Variance. The results revealed significant main effects of medium of instruction for almost all the measures of cognitive processes suggesting higher performance level of the English medium school children in comparison to their Odia medium counterparts. The cognitive processes were found to be developmentally sensitive as evident from significant main effects of grade. The results were discussed within the framework of PASS model.

Key Words: Attention, Bilingual education, English medium education, Odia medium education, Planning, Simultaneous processing, Successive processing

1. Introduction

There has been plenty of research on the effects of bilingual education that is education through a language other than the mother tongue of the child, the results of which reveal an important divide. Policy makers (UNESCO, 1953) as well as researchers (Mohanty, 1989; Mwamwenda,1996; Pattanayak, 1991) worry that learning and living in two languages will slow the cognitive development and consequently have long term negative effects on the educational achievements of children. Until early 80's, negative outcomes of bilingualism dominated the literature. Speaking two languages in general, and being exposed to bilingual education in particular, was viewed as a source of developmental problems or delays. Recent researchers working in a variety of disciplines including education, psycholinguistic, psychology, speech and hearing sciences as well as neurosciences, however, present a different view emphasizing the positive consequences of bilingualism.

Children who learn through their mother tongue (L_1) are at an advantage compared to the children who learn through a second language(Macnamara,1973; Miti,1995; Mwamwenda,1996; Ngara,1982; Pattanayak, 1991; Wallwork,1985). Chaudron (1998) holds that in a situation where the learner learns through a language other than the mother tongue (L_2), faces problems because his task is three-fold. Firstly, the student has to make sense of the instructional tasks, which are presented in the second language. Secondly, he has to attain linguistic competence that is required for effective learning to take place. And finally, he has to master the content itself. A poor grasp of L_2 results in a feeling of incompetence and loss of confidence on the part of the student (Roy-Campbell,1996).

In the context of benefits of mother tongue as the medium of education, Cummins' (1974, 79) views on cognitive academic language proficiency(CALP) is relevant. CALP requires sound literacy skills and a broad vocabulary in L_1 in order to facilitate subject-matter mastery, concept development and skills in formal oral and written expression in the second language (L_2). In fact, first language acquisition must develop strongly in the early years to achieve success in cognitive functioning.

On the other hand, more recent studies have found bilingual education to be a great asset to the child. It has been noted that the bilingual child has a better awareness of language differences, is better at learning new languages and possesses important advantages in intelligence and cognitive growth (Coneau, Geneasee & Mendelson, 2007; Diaz & Klinger, 1991; Diesendruck, 2004; Hawson,1997; Kirkici, 2004; Patra & Babu, 1999, Roseberry-Mackibbin & Brice,2000; Siegal, Iozzi & Surian,2009; Srivastava & Khatoon, 1980; Varkuti,2009). Researchers have also discovered that the cognitive systems of bilingually educated children differ from those of monolingually educated children (i.e., educated through mother tongue) in some remarkable ways. Learning , speaking and using two languages may affect fundamental aspects of cognitive and neural development, potentially influencing the way those systems learn and represent information (Bialystok,1999; Bialystok, Craik, Klein & Viswanathan, 2004; Bialystok & Martin,2004; Mechelli et al,2004; Yoshida,2008).

Peal and Lambert (1962) claimed that the bilingual child has the mental flexibility, a superiority in concept formation and a more diversified set of mental abilities. They are better able to dissociate concepts from the words with which they are verbalized. Since they have already developed a syntactic orientation to language, they are more aware of the dichotomy between form and meaning in language. Recent studies showing bilingual advantage in working memory (Feng, Bialystok & Diamond,2009) and executive functions (Yoshida,2008) suggest that bilingualism's demand on executive functions for constantly switching languages and exerting inhibitory control to suppress the mother tongue in class room context might be contributing to cognitive flexibilities.

In view of the conflicting issues relating to the effects of the bilingual educations, that is education through a medium other than the mother tongue, the present study is designed to ascertain the effects of mother tongue vis-à-vis other tongue as the medium of instruction on the cognitive development of children.

In the present study cognitive development was examined within the framework of the PASS model of Naglieri and Das (1988, 1997). Based on the neuropsychological theory of brain functions advanced by Luria (1973) the model provides an information processing explanation of human cognition. It defines human cognition in terms of four processes- planning, attention, simultaneous and successive. Planning is the ability to formulate and execute a strategy as well as to verify its effectiveness for solving a problem. Attention is the ability to selectively attend to relevant stimuli while inhibiting the distracting or irrelevant stimuli. The last two processes are responsible for storage and processing of information. While the simultaneous processing involves organization of information in a quasi-spatial and relational manner, the successive processing organizes separate bits of information in a temporally based sequential manner. The four processes have been operationalized in the Cognitive Assessment System (CAS: Naglieri & Das, 1997).

2. Method

2.1. Subjects

The sample consisted of eighty children, 40 each from grade IV and grade VI. In each grade twenty children were selected from an English medium school and the other twenty from an Odia medium school. The children studying in English medium school were selected from DAV school, Bhubaneswar and those studying in Odia medium school were from Saraswati Sishu Mandir, Bhubaneswar, the state capital of Odisha. Both the schools were comparable in terms of infrastructural facilities as well as quality of education. The children studying in grade IV were from the age group of (8-9 years) and those studying in grade VI were from (10-11years). All the children belonged to middle socio-economic background. The mother tongue of all the children was Odia.

2.2. Tests

The tests administered to examine the cognitive development of children were taken from the Cognitive Assessment System of Naglieri and Das(1997). A brief description of the tests is given below.

Matching Numbers. This is a measure of planning. The test comprises rows of numbers. Each row contains six numbers. The child's task is to find and underline the two numbers that are the same in

each row within a specified time limit. Each correct pair of matching numbers gets a score of '1'. The raw scores are transformed to a ratio score using the score conversion table.

Planned Connection. This is a measure of planning. In this test, the child's task is to connect a series of boxes containing numbers or letters in correct sequence. Some items involve a sequence of numbers only, while others involve a sequence of both numbers and letters (that is 1-a-2-b-3-c, etc.).Time taken to complete each item is recorded. The sum of the time taken for each item is the raw score.

Non-verbal Matrices. This test of simultaneous processing requires the child to select one of the options that best completes the matrix. The subtest uses the standard progressive matrix format and varies from completion of a simple pattern to completion of a 3×3 matrix of stimuli. A score of '1' is given to each item passed.

Figure Memory. This is a test of simultaneous processing which requires the child to identify a geometric figure that is embedded within a more complex design. The stimulus figure is exposed for five seconds. The child is required to reproduce the same figure within a more complex design presented on a separate page. Each correct response obtains a score of '1'.

Expressive Attention. This is a measure of attention. The child's task is to read colour names such as 'blue' and 'yellow' (item -1), to identify the colours of a series of rectangles(item -2) and then to identify the colour of the ink in which colour words are printed rather than to read the words (item 3). Basing on the correct number of responses in the item-3 and the time taken to complete it, the score is obtained using the conversion table.

Receptive Attention. This test of attention requires the child to find and underline pairs of letters that are the same from among rows of letters which contain both targets (pairs that match) and distracters (pairs that do not match). The child has to underline pairs of letters that are physically the same and have the same name. The raw score constitute the sum of ratio scores for both the physical as well as name match condition which are obtained from number of correct as well as the false detections and the time taken to complete each item using the ratio score conversion table.

Word Series. This test measures successive processing. Here the child's task is to repeat a series of words in the same order in which the examiner says them. A score of '1' is given for correct recall of the words in their correct order.

Sentence Repetition. This is a test of successive processing in which the child's task is to repeat a series of sentences spoken by the examiner. The sentences contain colour names in place of content words. Perfect repetition of the sentence obtains a score of '1'.

2.3 Procedure

Prior to the collection of data, permission was obtained from the Principal/Headmaster of the respective schools. Test administration was carried out after establishing adequate rapport with the children. The children were tested individually in a separate room of their respective schools. The tests were administered in English to the English medium children and in Odia to the Odia medium children. Moreover, the Odia medium children were administered the Odia translated version of those tests which were verbal in nature.

3. Results

Keeping the objective of the study in mind, the performance of twenty children studying in class IV and twenty in class VI, each from an English medium school and an Odia medium school was assessed. The data were analyzed by 2(medium of instruction) X 2(grade) ANOVA. The group means and standard deviations of all the measures as well as the results of ANOVA are presented in Table 1 and 2 respectively.

Insert Table 1 & 2 about here

From Table 1, it can be seen that the sixth graders scored higher than the fourth graders in almost all the measures studied as evident from higher mean scores of the former group than the latter group in both the English and Odia medium schools. However, the sixth grade children scored less than the fourth grade children in Planned Connection for which the score was the time taken to complete the test and lesser time taken implies superior performance. One exception is Expressive Attention which will be discussed later.

Results of ANOVA in Table 2 reveals significant main effects of grade for almost all the PASS cognitive measures except Figure Memory and Sentence Repetition. However, for Figure Memory, it was found to be marginally significant ($F_{1,76}=3.027$; $p=.086$) suggesting higher performance of grade VI children. Thus, the cognitive processes studied were found to be developmentally sensitive.

With respect to the effects of medium of instruction, it can be noticed in table 2 that it is significant for all the measures of cognitive processes except Planned Connection and Sentence Repetition. Considering the results of ANOVA together with the group means of the English Medium and Odia Medium children in both the classes as presented in table 1, it can be said that English Medium children performed significantly better on the cognitive tasks than their Odia Medium counterparts. To put in other words, English Medium schooling has been found to facilitate the development of the cognitive processes studied.

So far as Sentence Repetition is concerned, since colour names were used in place of content words, the sentences appeared meaningful while actually they are meaningless. While trying to hold a group of words in the form of a sentence in short-term memory and then reproduce the sentence, children have a tendency to accomplish it easily by processing the meaning of it. But in sentence repetition test, probably this strategy is not so effective as the meaning of sentences to be reproduced are confusing. This might be the reason that this test could register neither a significant developmental increase nor a significant difference as a function of medium of instruction.

A significant grade X medium of instruction interaction effect was obtained for none of the measures other than Expressive Attention.

Findings relating to Expressive Attention require special mention. From table 1 and table 2, it can be noticed that the performance of Odia medium children were significantly better than the English medium children. Moreover, interestingly, while the English medium grade IV and grade VI children were comparable, there was a significant grade difference obtained among their counterparts in the Odia medium school favouring the younger children. Expressive Attention test requires the children to identify the colour of the ink in which colour words are printed rather than to read the words. Automaticity in word identification develops with increased educational experience (Dash,1994; Dash &Dash, 1999). Probably due to automaticity in word decoding, the English medium children and older Odia medium children found it difficult to inhibit themselves from reading the words and to identify the colour of the print.

4. Discussion and Conclusion

The results revealed that the cognitive processes studied were found to be developmentally sensitive. That is, the performance of the children improved with increasing age and grade. The results are consistent with Dash (1994); Dash & Dash (1989; 2011); Kar, Mishra & Patnaik (1990); Patnaik (2009).

The results are also in conformity with the findings of earlier studies (Patra & Babu, 1999; Srivastava & Khatoon,1980; Mohanty,2007; Mishra,2011) in that children taught through a language other than their mother tongue performed significantly better than their counterparts who were receiving their education through their mother tongue. Researchers (Bialystok,1999; Bialystok & Martin,2004; Feng, Bialystok & Diamond,2009; Yoshida,2008) are of the opinion that using two languages for speaking and learning, that is, constantly switching languages requires executive functions that exert inhibitory control to suppress mother tongue in class room context. This demand on the executive functions affect the fundamental aspects of cognitive and neural development putting the English medium school children in a cognitively advantageous position.

PASS processes have been found to be subject to developmental and experiential changes. Earlier studies (Kirby & Williams,1998; Dash & Dash,1999, 2011; Kirby & Robinson,1987; Georgiou,2010; Keat & Ismail,2011) have linked cognitive processes to reading, spelling, comprehension and arithmetic as well as overall academic achievements (Reid,2001; Reid, Kok & Vander Merwe,2002). Children who lag behind the normal development of these processes are likely to experience academic failure (Dash & Dash, 1989). On the other hand, children who are academically talented performed at a higher level on these processes than average children (Rosadah, 2004) ascertaining further the link between these processes and academics-related skills.

Das et al. (1979) have documented the importance of successive processing for contextual grammatical aspect of language and simultaneous processing for logical grammatical aspect of language. That is, these two coding processes underlie the ability to integrate words for constructing sentences following grammatical rules as well as logical relations and to learn a language as a whole. Attentional processes as explained by the filtering out the irrelevant stimuli and focusing selectively on the task required, corresponds to alertness to discrete sounds, letters, spellings, and parts of the speech, that is an essential pre-requisite for comprehending the sentences. The ultimate achievement is dependent on planning which is required for determining and utilizing an efficient way to deal with the task at hand through the application of attention, simultaneous and successive processes in conjunction with the knowledge base. In fact, vocabulary, comprehension and coding skills are of little use if one is not equipped with the skill of adopting the appropriate strategy to utilize them optimally. Getting education through English involves differential curricular pressure and cognitive demands on the part of the students. The student has to understand the instructions presented in English which is not his mother tongue, to develop linguistic competence in it and simultaneously master the course content. For Odia medium children the task is much simpler as they have to master the course content only using a language already acquired earlier at home. However, this tougher task demand at an early age helps in faster development of cognitive processes in the children being educated through English medium.

In essence, instruction through English, i.e., $_{L2}$, provides opportunity to exercise linguistic and cognitive flexibility which facilitates the development of cognitive processes.

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

Cognitive Measures		English Medium		Odia Medium	
		Grade IV	Grade VI	Grade IV	Grade VI
Matching Numbers	Mean	4.85	5.85	4.30	5.40
	SD	0.67	0.81	0.92	0.82
Planned Connections	Mean	669.60	656.85	681.05	656.65
	SD	23.03	16.41	17.87	13.23
Nonverbal Matrices	Mean	20.25	22.00	18.10	20.45
	SD	1.55	1.45	1.97	1.73
Figure Memory	Mean	15.35	16.55	14.80	15.10
	SD	1.50	1.60	1.47	2.81
Expressive Attention	Mean	6.35	6.35	10.45	7.00
	SD	0.81	0.87	2.30	0.72
Receptive Attention	Mean	15.80	16.35	10.80	13.80
	SD	4.37	4.47	2.57	1.70
Word Series	Mean	17.10	18.45	14.55	16.15
	SD	2.36	1.60	2.48	2.60
Sentence Repetition	Mean	10.85	11.10	10.65	10.55
	SD	1.38	1.25	2.15	1.23

Table 2. Summary of Analyses of Variance for the Cognitive measures

Cognitive Tests	Source	Sum of squares	df	Mean squre	F	Sig.
Matching Numbers	Medium	5.00	1	5.00	7.58	0.007
	Grade	22.05	1	22.05	33.45	0.000
	Medium X Grade	5.00	1	5.00	0.076	0.784
	Error	50.10	76	0.659	-	-
	Total	2158.00	80	-	-	-
Planned Connection	Medium	632.81	1	632.81	1.96	0.166
	Grade	6900.61	1	6900.61	21.34	0.000
	Medium X Grade	678.61	1	678.61	2.098	0.152
	Error	24578.85	76	323.41	-	-
	Total	35521267.0	80	-	-	-
Nonverbal Matrices	Medium	68.45	1	68.45	24.03	0.000
	Grade	84.05	1	84.05	29.50	0.000
	Medium X Grade	1.80	1	1.80	0.632	0.429
	Error	216.50	76	2.85	-	-
	Total	33014.00	80	-	-	-
Figure Memory	Medium	20.00	1	20.00	5.38	0.023
	Grade	11.25	1	11.25	3.03	0.086
	Medium X Grade	4.05	1	4.05	1.09	0.300
	Error	282.50	76	3.72	-	-
	Total	19414.00	80	-	-	-
Expressive Attention	Medium	112.81	1	112.81	62.12	0.000
	Grade	59.51	1	59.51	32.76	0.000
	Medium X Grade	59.51	1	59.51	32.76	0.000
	Error	138.05	76	1.82	-	-
	Total	4915.00	80	-	-	-
Receptive Attention	Medium	285.01	1	285.01	23.44	0.000
	Grade	63.01	1	63.01	5.18	0.026
	Medium X Grade	30.01	1	30.01	2.47	0.120
	Error	924.15	76	12.16	-	-
	Total	17405.00	80	-	-	-
Word Series	Medium	117.61	1	117.61	22.33	0.000
	Grade	43.51	1	43.51	8.26	0.005
	Medium X Grade	0.313	1	0.313	0.059	0.808
	Error	400.25	76	5.27	-	-
	Total	22507.00	80	-	-	-
Sentence Repetition	Medium	2.81	1	2.81	1.16	0.284
	Grade	0.113	1	0.113	0.047	0.830
	Medium X Grade	0.613	1	0.613	0.253	0.616
	Error	183.85	76	2.42	-	-
	Total	9497.00	80	-	-	-