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Research Paper

Development and Use of Alphabet Vigilance Test - Based on Indian Norms

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ABSTRACT

Sustained attention refers to the attention process that allows us to focus on a particular stimulus long enough to complete a particular task. This study attempted to design and standardize a test to measure sustained attention and response inhibition in children – Alphabet Vigilance Test. For the purpose of this study, children were divided into three age categories, 5-7 years, 8-11 years and 12-15 years (age mean and SD). A minimum sample of 30 boys and 30 girls for each age category were administered this test. The time taken to complete the test (vigilance) and errors committed (response inhibition) was noted down. The data was statistically analysed with descriptive means and percentile analysis to develop norms of performance ranging from the 5th percentile to the 95th percentile, along with't' test to check for performance difference between boys and girls of all age categories. The scores and norms are discussed and elaborated upon, with limitations of study and suggestions for future research.

Keywords: *Alphabet Vigilance, Sustained attention, Response Inhibition, Children, Indian Norms.*

Attention is a cognitive process that allows living organisms to focus on a specific aspect within themselves or outside of them from the other stimuli in the environment. Different stimuli in the environment compete for our attention. However, certain features of a stimulus can increase our focus on it –features like the size, colour, novelty and location of stimuli. There are three different types of attention processes – focused attention, divided attention and sustained attention. Focused attention is the type of attention that allows you to concentrate on a particular stimulus in the environment and perform a task among the various stimuli in the environment. The second parameter of attention, divided attention refers to a process of handling two or multiple tasks simultaneously. The focus is divided among the different tasks that are being controlled at the same time. The third parameter, sustained attention refers to the ability to hold one's concentration or focus on a particular object or stimulus for a long period of time in order to be able to learn or finish a particular task. This is the type of attention that allows us to concentrate in class during lectures as well as help us in reading a newspaper. The degree of sustained attention in a particular task depends on task

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difficulty or task complexity. It is often seen that sustained attention is higher in simpler tasks as compared to complex ones.

Different brain structures are linked to the function of different attention processes. Focused attention is largely seen to be controlled by orbito-frontal areas in the prefrontal cortex. Any lesion to this area is usually seen to result in distractibility. Anterior cingulate and the dorso-lateral prefrontal cortex are seen to be closely working in the process of divided attention. A right fronto-parietal network is found to be associated with sustained attention and vigilance. Any damage to this region results in poor vigilance and reduced response inhibition.

Neuropsychological assessment batteries have standardized tests to measure focused, divided and sustained attention. The test used to measure sustained attention in adults is the Digit Vigilance Test. This test consists of numbers randomly ordered from 1 to 9. The subject must cancel only numbers 6 and 9. For children, the test for sustained attention is the Colour Cancellation Test. The Alphabet Vigilance Test was developed which the sole purpose of measuring sustained attention in literate children completely based on the norms of the Indian population. This test takes into account the sustained attention and response inhibition of children.

Response inhibition refers to the ability of refraining from engaging in a particular behaviour as it is either inappropriate or not goal-directed. The subject decides and segregates useful behaviour from non-useful behaviour and consciously refrains or inhibits himself from engaging in that behaviour. Research studies with patients of Parkinson and Stroke indicate that they exhibit reduced sustained attention and response inhibition rates as compared to unaffected people in the population.

The Alphabet Vigilance test measures vigilance and response inhibition in children of the age group of 5-15 years. It is one of its kind where the performance of the Indian population is studied and norms have been developed accordingly. It aims at presenting the norms of performance on test of children of three different age categories, 5-7 years, 8-11 years and 12-15 years. The test has been standardized using urban child sample which is predominantly right-handed. This test can be used to measure vigilance and response inhibition in children and provide suitable diagnosis of ADHD and other learning disabilities with deficits in sustained attention.

REVIEW OF LITERATURE

The literature available in the field of sustained attention is rich and includes information on various concepts associated with it. For the purpose of this study, I have divided the literature available in three different categories –

Development of sustained attention

Many research studies have attempted to trace the development of sustained attention in toddlers and pre-schoolers, and how it develops over the years. A study conducted analysed the growth of sustained attention in children from toodlerhood and pre-school period. It was found that positive, empathetic and warm maternal behaviour along with positive emotion-seeking behaviour indicated a greater growth in the level of sustained attention (Graziano, P. A., Calkins, S. D., & Keane, S. P., 2011). Another study which studied sustained attention in pre-school children reported that increase in child's ability to exercise choice resulted in higher sustained attention in classrooms (DiCarlo, C. F., Baumgartner, J. J., Ota, C., & Geary, K., 2016).

Influences on the development of sustained attention

The development of sustained attention takes its full course, and is influenced by many factors along the way. A study conducted attempted to understand if variable event rate and display time varied the amount of sustained attention exhibited by a child. This hypothesis was refuted with the establishment that practice on a particular task highly influences the sustained attention on that task (Chee, P., Logan, G. & al, 1989). A recent study conducted compared the sustained attention in pre-term and term babies. It was found that pre-term babies performed more poorly on sustained attention tasks as compared to term babies (Sun, J. & Buys, N., 2012). This understanding presents us with the picture that the development of sustained attention is influenced by biological factors (time of birth) as well as situational factors (practice).

Sustained attention in children with psychological health concerns

Sustained attention varies in children with no learning disabilities, children with ADHD, autism and in children with anxiety. A study measured the sustained attention and response inhibition in children at risk of ADHD. It was found that children at risk performed poorer on these tests, taking more time to complete the test and committing more errors that those children at no risk of ADHD (Berwid, O. G., Curko Kera, E.,A., Marks, D. J., Santra, A., Bender, H. A., & Halperin, J. M., 2005). Another study attempted to demonstrate the differences between the impairment in attention in children with ADHD and those with anxiety disorders. It was found that children with ADHD have poor sustained attention while children with anxiety disorders show greater biases in attention (Weissman, A. S., Chu, B. C., Reddy, L. A., & Mohlman, J., 2012). Another study conducted with children with autism and their parents established the importance of parental cues in improving the child's sustained attention. Parental cues that guided the child to sustain attention on a particular task resulted in major developments in the levels of sustained attention, as compared to those parental cues that indicated to the child a change in focus (Brigham, N. B., Yoder, P. J., Jarzynka, M. A., & Tapp, J., 2010).

The current literature helps us understand the development and potential influences on sustained attention. Basing my study on this literature, the Alphabet Vigilance Test has been developed to measure vigilance and response inhibition of children and providing them with suitable diagnosis and adequate training.

Need for study

The available test to measure sustained attention in children (Colour Cancellation Test) does not have norms specifically for the Indian population. It also does not include varying factors which are found to be sensitive to the child's performance on tests of sustained attention. Keeping these findings in mind, the Alphabet Vigilance Test was developed and standardized for children solely based in the Indian setting. It also includes various factors such as font and colour which are found to be sensitive to the child's performance.

Inclusion criteria were age 5-15 years healthy children, understanding language skills (kannada/Hindi/English). Exclusion criteria were severe physical or mental retardation or psychological problems which excluded in the study (i.e., incompetent to follow instructions), severe neurological disorders, severe and uncorrectable vision, or hearing problems.

METHOD

Table 1: Sample Characteristics

Age category	N	Minimum	Maximum	Mean	SD
5-7 years (boys)	30	5	7	6.20	0.81
5-7 years (girls)	30	5	7	6.23	0.77
8-11 years (boys)	34	8	11	9.76	1.20
8-11 years (girls)	35	8	11	9.66	1.07
12-15 years (boys)	32	12	15	13.03	1.15
12-15 years (girls)	32	11	15	12.84	0.88

The sample chosen for the test consisted of children ranging from 5 to 15 years of age. There were three age categories – 5-7 years, 8-11 years and 12-15 years. For each age category, a minimum of 30 boys and 30 girls were selected and administered the test. They belong to the Indian urban literate population, and hail from a middle socio-economic background. All the children go to schools and are currently studying in classes ranging from Upper KG (UKG) to 10^{th} grade. The mean age of boys of 5-7 years category is 6.20 years while that of girls is 6.23 years. The mean age of boys of 8-11 years category is 9.76 years while that of girls is 9.66 years. The mean age of boys in the 12-15 years category is 13.03 years while that of girls is 12.84 years. Each child's parents were explained the purpose and procedure of the study, and their consent was taken before administering the test to their child.

Tool

The Alphabet Vigilance Test consists of three categories (Categories A, B and C) based on the age of the child. Children from age 5-7 form the first category, 8-11 years form the second category and children of 12 – 15 years form the third category. The different categories of the test include various factors that are found to be sensitive to the child's performance on a sustained attention task.

5-7 years. The Alphabet Vigilance Test (A) contains a total of 35 lines and 42 alphabet characters in each line, resulting in a total of 1470 characters. It is administered to children of this age category and consists of random alphabets present in a sheet, where the child is required to strike out the alphabets 'b' and 'p' only. The test is administered and the time taken to complete the test as well as the errors committed is noted down.

8-11 years. The Alphabet Vigilance Test (B) contains a total of 35 lines and 42 alphabet characters in each line, resulting in a total of 1470 characters. It is administered to children of this age category and consists of a moderate variation to the previous category. The children are required to strike out alphabets 'b' and 'p' among other alphabets. However, there exist alphabets 'b' and 'p' in a different font than the usual font. The children must pay attention to this variation and not strike out 'b' and 'p' if they are presented in a different font.

12-15 years. Alphabet Vigilance Test (C) administered to children of this age consists of two sections. Both the sections consist of 16 lines, 44 characters each. Therefore, there are 704 characters in each section. In the first section, alphabets are presented in a random order. The children are required to strike out 'b' and 'p'. However, they should refrain from striking these alphabets out if they are presented in either a different font or a colour other than black.

In the second section, the children are required to strike out the alphabets 'b' and 'p' when they are presented in the usual font as well as in a different colour. They must refrain from striking out these alphabets when presented in a different font than usual.
The alphabets 'b' and 'p' were selected based on trial and error method. The child's sensitivity to alphabets was measured. The child was presented with various alphabet combination such as 'a' and 'e', 'c' and 'o', 'p' and 'q', 'b' and 'd', 'b' and 'p' and 'w' and 'm'. It was seen that the children's performance was most sensitive to the alphabets 'b' and 'p'. Furthermore, the factors such as changing font and changing font colours were found to increase the child's sensitivity to the test.

Procedure

The children were made to sit in a quiet place in groups of 5 for easy and effective administration of the test. They were made to sit in three different categories according to their age, ranging from 5-7 years, 8-11 years and 12-15 years. The test was handed over to them along with stationery items. Each group was educated about the process of the test with everything explained in detail. They were also encouraged to ask the administrator in case of any doubts or confusions. They were then signalled to start the test along with the start of a stop-watch. Once the children completed the test, they would hand over the test sheets to the administrator and the time taken to complete the test was noted down. Later, these test sheets were corrected to compute the number of errors committed by the child.

Instructions

The instructions given to the children of the three age categories differed in their content. They were given in the local language for easy comprehension. The following are the instructions –

5-7 years. "In the sheet given to you, alphabets are placed in a random order. You must cancel two alphabets – b and p, wherever you find them. Proceed to cancel these alphabets line by line. Try to cancel all b's and p's in the sheet. There is no time limit but finish the test as soon as possible."

8-11 years. "In the sheet given to you, alphabets are placed in a random order. You must cancel two alphabets – b and p, wherever you find them. Proceed to cancel these alphabets line by line. You will also find 'b' and 'p' present in a different font. Do not cancel them. Try to cancel all b's and p's which are present in the usual font. There is no time limit but finish the test as soon as possible."

12-15. "The following sheet contains two sections. In the first section, you must cancel all the 'b's and 'p's that you find. There are b's and p's present in this section that are written in a different font or in a different font colour. Do not cancel these alphabets. Proceed to only cancel b's and p's if they are present in the usual font and black font colour. In the second section of the test, proceed to cancel all the b's and p's present in the usual font and black font colour. Along with this, cancel all the b's and p's also present in another font colour. Do not cancel the alphabets present in a different font. Proceed with the second section of the test as soon as you finish the first section. There is no time limit but finish the test as soon as possible."

Scoring

The scoring of the test consists of noting down the time taken by the child to complete the test, as well as calculating errors of commission and errors of omission. Errors of

commissions refer to those errors where the child has cancelled alphabets other than 'b and 'p'. For example, if the child has cancelled alphabets such as'd' and 'q' in places, this is known as error of commission. On the other hand, errors of omission refer to those errors where the child has skipped few 'b's and/or 'p's while cancelling them in the sheet. For example, if a particular line contains 5 b's but the child fails to cancel 2 of them, this is an error of omission. The time taken and errors committed are then tallied with the norms of the suitable age population.

Statistical Analyses

Statistical analysis was conducted using the IBM-SPSS statistical software package version 17. Descriptive means, percentile analysis and 't' were computed to understand the characteristics of the sample, generate norms of performance for each age category and also compute any mean differences between the groups.

RESULTS

Table 2: Means, SDs and percentiles of the scores obtained by the junior student group (5-7-years)

		5-7-years Boys		5-7- years - Girls	
		Total Time taken	**Total Errors**	**Total Time taken**	**Total Errors**
N		**35**	**35**	**35**	**35**
Mean		20.98	22.95	20.37	20.32
Std. Deviation		3.66	4.54	3.33	7.21
Range		16	22.0	15	45.0
Minimum		11	9.0	11	1.0
Maximum		26	31.0	25	46.0
	5	26.3	29.4	25.2	30.8
	10	26.16	28	24.14	26
Cut-off	**15**	**25.83**	**27.6**	**23.42**	**25**
Percentiles	20	25.13	26.8	23.23	24.8
	25	23.08	24.2	22.19	22.2
	30	20.98	23	21.06	20.72
	40	20.98	22.95	20.37	20.32
	50	20.98	22.95	20.37	20.32
	60	19.06	22.95	20.37	19.8
	70	18.5	22.95	19.35	19
	80	18.29	22	17.83	17.4
	85	17.48	19.8	17.17	16
	90	16.31	15.2	15.32	11
	95	13.68	11.4	11.75	3.4

The mean time taken by boys of age 5-7 years to complete this test is 22.98 minutes, while the mean errors committed by them are 22.95. On the other hand, mean time taken by girls to complete this test is 20.37 while mean errors committed by them are 20.32.

Percentile scores are also presented from the 5^{th} percentile to 95^{th} percentile. The scores of time and error are placed on the percentile score they correspond to. The 15^{th} percentile is the cut-off percentile, any score that falls below the range of the 15^{th} percentile is considered to be impaired. The value corresponding to the 5^{th} percentile is as follows – time taken by boys

to complete this test is 26.3 minutes while time taken by girls is 25.2 minutes. On the other hand, the errors committed that relate to the 5th percentile score is as follows – errors committed by boys is 29.4 and that by girls is 30.8. The 15th percentile score for time taken for boys of this age category is 25.83 minutes and the corresponding error is 27.6. Likewise, the 15th percentile score for time taken by girls of this age is 23.42 minutes and the corresponding error score is 25. If the amount of time taken or errors committed by both boys and girls of this age is above the scores corresponding to the 15th percentile, then the sustained attention of the child is said to be impaired for his age.

The normal distribution curves and histogram were also computed for the following data. They correspond to the distribution of time taken and errors committed by boys and girls of the age category 5-7 years. Any outlier data from the sample has been removed to avoid any drastic fluctuations in the scores. The time taken by boys to complete this test ranges from 11 minutes to 26 minutes. The errors committed by boys range from 9 to 31. On the other hand, the time taken by girls of this age to complete this test ranges from 11 to 25 minutes, while the errors committed ranges from 1 to 46.

Table 3: Means, SDs and percentiles of the scores obtained by the junior student group (8-11-years)

		8-11-years Boys		**8-11-years Girls**	
		Total Time taken	**Total Errors**	**Total Time taken**	**Total Errors**
N		**35**	**35**	**35**	**35**
Mean		14.72	19.71	14.42	18.41
Std. Deviation		3.84	10.02	4.52	7.84
Range		13	55.0	17	31.0
Minimum		9	1.0	6	2.0
Maximum		22	56.0	23	33.0
	5	22.2	40.8	22.43	32.2
	10	20.24	33	21.55	30
Cut-off	**15**	**18.9**	**27**	**20.29**	**27.6**
Percentiles	20	17.86	25	18.14	23.8
	25	17.21	19.97	17.1	22
	30	15.48	19.71	15.73	19.96
	40	14.72	19.70	13.45	18.40
	50	14.23	18.68	12.36	18.40
	60	11.86	15.8	11.43	16
	70	11.1	13	11.3	15
	80	10.5	12.2	11.12	11.8
	85	9.73	9.4	9.95	8.8
	90	9.42	8.6	8.34	5.6
	95	9	4.2	6.47	2

The mean time taken by boys of this age to complete this test is 14.72 minutes while the mean time taken by girls to complete this test is 14.42 minutes. When it comes to response inhibition, the mean error committed by boys of this age is 19.70 while mean error committed by girls is 18.40.

Percentile scores have also been corresponded based on the performance of boys and girls of this age. Percentile scores ranging from the 5th percentile to the 95th percentile are presented. Any score that falls below the corresponding value of the 15th percentile is considered to be impaired. The time taken value corresponding to the 5th percentile for boys is 22.2 minutes and for girls, it is 22.43 minutes. The 5th percentile value for errors committed for boys of this age is 40.8 while that of girls is 32.3. Based on the understanding of the 15th percentile scores, any value of time taken that is above 18.9 minutes for boys and 20.29 minutes percentile) for girls is considered to be impaired. On the other hand, any number of errors committed above 27 for boys and 27.6 for girls is said to be impaired (15th percentile values). The normal distribution curves and histograms were also computed for this data. They indicate the distribution of the time taken and the errors committed by both boys and girls of this age across all subjects. Any outliers in the data were removed to avoid any drastic fluctuations in the score. The range of time take by boys to complete this test is from 9 to 22 minutes, while the range of time taken by girls is from 6 to 23. The errors committed by boys ranges from 1 to 56 while that of girls ranges from 2 to 33.

Table 4: Means, SDs and percentiles of the scores obtained by the senior student group (12-15-years)

		12-15-years Boys		**12-15-years Girls**	
		Total Time taken	**Total Errors**	**Total Time taken**	**Total Errors**
N		**35**	**35**	**35**	**35**
Mean		9.82	14.815	8.58	15.926
Std. Deviation		1.838	6.9368	1.675	6.3056
Range		9	30.0	8	27.0
Minimum		5	0	5	2.0
Maximum		14	30.0	13	29.0
	5	13.66	27.6	11.51	27.4
	10	12.3	25.4	10.49	25.4
Cut-off	**15**	**11.44**	**23.4**	**10.27**	**23.6**
Percentiles	20	11.18	19.8	10.09	22
	25	10.38	17.2	9.4	17.6
	30	10.05	15.526	9.05	15.926
	40	9.82	14.815	8.58	15.926
	50	9.54	14.815	8.23	15.37
	60	9.28	12.6	7.46	12.8
	70	9.15	9	7.3	11
	80	8.3	8.2	7.17	11
	85	8.01	6	6.73	9.4
	90	7.39	5.6	6.42	7.8
	95	6	3.2	5.45	4.4

The mean time taken by boys of this age to complete this test is 9.82 minutes, while girls usually take 8.58 minutes to complete the test. On the other hand, mean errors committed by boys of this age are 14.81 and those committed by girls are 15.92.

Percentile scores are also presented with the corresponding values, ranging from the 5th percentile to the 95th percentile. Any score which is lesser than the value corresponding to the 15th percentile is considered to be impaired. The 5th percentile score corresponding to the time

taken by boys 13.66 minutes and time taken by girls to complete the test is 11.51 minutes. On the other hand, the 5th percentile score of the errors committed by boys is 27.6 and that of girls is 27.4. Based on the understanding of the 15th percentile score, the value of time corresponding to this score in boys is 11.44 minutes and it is 10.27 minutes in girls. Any amount of time taken which exceeds these values is considered to be impaired. The 15th percentile value for errors committed is 23.4 for boys and 23.6 in girls.

The normal distribution curves and histograms were also computed for the data. They represent the range of time taken and errors committed by boys and girls of this age category. Any outliers in the data were deleted so as to avoid drastic fluctuations in the scores. The range of time taken by boys to complete this test is 5 to 14 minutes and that by girls in 5 to 13 minutes. On the other hand, the range of errors committed by boys is from 0 to 30 and that of girls is from 2 to 29.

Table-5: Gender differences comparison of mean scores for Alphabet Cancellation performances, and the corresponding 't' values

	Groups Compared	**N**	**Mean**	**SD**	**Mean Difference**	**t**	**Level of sig.**
5-7-years Total Time taken	Boys	35	20.98	3.67	0.626	0.74	0.47
	Girls	35	20.37	3.33			
5-7-years Total Errors	Boys	35	22.96	4.54	2.65	1.83	0.07
	Girls	35	20.32	7.21			
8-11-years Total Time Taken	Boys	35	14.72	3.84	0.29	0.29	0.77
	Girls	35	14.42	4.52			
8-11-years Total Errors	Boys	35	19.71	10.02	1.30	0.66	0.56
	Girls	35	18.41	7.84			
12-15-years Total Time taken	Boys	35	9.82	1.84	1.24	2.97	0.01*
	Girls	35	8.58	1.68			
12-15-years Total Errors	Boys	35	14.86	6.94	1.11	0.70	0.49
	Girls	35	15.93	6.31			

*Significant at 0.01 level

Results of table-5 shows that senior grade girls (12-15-years) scored significantly low (M=8.58) as compared to boys (M=9.82) [t=2.97, p=0.01] on Alphabet Vigilance Test (ACT) in terms of time taken. The results of comparison bring to light a significant difference in performance on alphabet cancellation scores in the senior grade children of the present study, with their performance only on timing score.

Table 6: Number of Patients tested

Tests	**No. of patients tested (ADHD) and attention deficit**	**Accuracy of diagnosis**
Alphabet Vigilance Test	28	88%

The accuracy score of 88% indicates that the Alphabet Vigilance Test is a reliable tool for the diagnosis of cases of ADHD and other attention deficits in children from 5 to 15 years in the Indian population.

DISCUSSION

The primary aim of this study was to develop a test to measure the sustained attention of children ranging from 5-15 years, and standardize it. In order to create norms for this test, the test was constructed in three versions – version A, B and C to be administered to children of age category 5-7 years, 8-11 years and 12-15 years respectively. The test was administered to a minimum sample of 30 boys and 30 girls in each age category in order to check for normative performance. This test measures sustained attention and response inhibition of the child with response to the time taken and errors committed.

Statistical analysis of descriptive means and percentile analysis was computed so as to understand the mean time taken by boys and girls of all age categories to complete the test as well as the mean errors committed by them. Percentile analysis provided norms from the 5^{th} to 95^{th} percentile, any score falling below the score corresponding to the 15^{th} percentile indicating impairment in the sustained attention and response inhibition of the child. Along with this, normal distribution curves with histograms were created to understand the range of performance of boys and girls in terms of time taken and error committed. 't' test was also computed to check for dinner in performance between boys and girls of a particular age group. Finally, the sensitivity and specificity of the test was also checked by administering the test to children diagnosed with ADHD and other attention deficits. The test was found to be 88% accurate in diagnosing a child for the ADHD and other attention deficits in an Indian setting.

't' test scores indicated that there was a significant difference seen in the performance of boys and girls in terms of time take and errors committed, across all age groups. Girls of age group 12-15 years took much lesser time to complete the test of boys of the same age group [$t=2.97$, $p=0.01$]. This phenomenon can be further investigated to find out the underlying cause of better performance in future research.

The limited number of sample for each age category is a limitation of the current study. Future research must attempt to test the findings of this study with a larger sample size to improve accuracy of normative attention patterns in children. Another limitation of this study is the dominance of right-handed children in the sample. Left-handed children can be tested in future research in order to develop specific norms corresponding to their levels of sustained attention and response inhibition. To further enlarge the scope of this test, rural literate population of children can also be included in the study so as to develop norms corresponding to their performance level.

It is nevertheless important to mention that the development of this test is highly useful to measure the sustained attention and response inhibition of children of age 5-15 years. This test can be used to detect deficits in sustained attention in children with ADHD, learning disability, head injury, attention deficits, autism spectrum disorder, dyslexia and other developmental disorders. This test can be widely used to test literate children in an Indian setting as the performance norms as solely devised based on an Indian sample. However, it must be noted that the test scores of the child be interpreted with inputs on individual differences and cultural background in addition with correspondence to norms.

CONCLUSION

The Alphabet Vigilance Test can be a reliable measure of sustained attention and response inhibition in children of age 5-15 years. The time taken to complete the test and the errors committed by the child can be correlated and checked with the norms developed for their age

category and gender, any score below the 15th percentile indicating impairment. With further additions to the norms of the test which include norms for left-handed children and the rural literate population of children, this test will have a widespread applicability in the future.

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Conflict of Interest

There is no conflict of interest.

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