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EVALUATION OF MEMORY IN ABACUS LEARNERS

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Abstract : Abacus is a method used by Chinese, Japanese and Koreans to improve mathematical skills. This system has now invaded our country. The improvement in mathematical skills is said to be due to a coordinated functioning of both right and left hemisphere. As learning and memory in any field is achieved by coordinating and analyzing the different sensory inputs, whether an abacus trainee would also improve the short term memory as a whole was evaluated in our study.

50 children of average IQ between 5 and 12 years from 2 regular schools and 50 from an abacus institute were evaluated for short term memory before and after a period of one and two years. The memory tests were taken from Wechsler memory scale, Mini mental state examination, Mann – Buitar visual memory screen for objects.

The results showed that the abacus learners at the end of one and two years had a better visual and auditory memory when compared to non-abacus learners.

Key words : abacus right and left hemispheres learning memory

INTRODUCTION

Abacus is a method used by Chinese, Japanese and Koreans since ancient times to improve the mathematical skills. Abacus is a calculating instrument, a mechanical aid which is performed by moving beads along rods, using both hands. At the end of the training, Abacus learners try to solve mathematical problems without physically using the hands and abacus beads but by visualization of beads by the brain. It has been well documented that mathematical skills improved in Abacus learners when compared to Non-Abacus learners of the same age.

Use of Abacus requires co-ordination of sight, sound and finger movements which induces increase in the synaptic connections. The abacus learner tries to coordinate visual, auditory and sensory inputs, analyses the problems and solves them. It has also been reported by Chinese workers that Abacus

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learners coordinate right and left hemispheres to solve problems (1). The action of the (R) hand helps in developing the logical thinking and language function of the (L) hemisphere and the action of the (L) hand in developing creative, imaginary and 3 dimensional skills of (R) brain. Since the (R) & (L) hemisphere transmit messages to each other, function of the whole brain is said to be developed with this system.

Learning is acquisition of the information and memory is the retention and storage of that information which is recalled and used for further learning. So learning leads to memory and learning becomes better by association with memory. The abacus learners are trained to co-ordinate visual, auditory and sensory inputs and solve problems by analyzing these repeatedly. Though a number of studies have proved the influence of abacus in improving mathematical skills, its influence on memory and overall learning ability has not been evaluated so far.

AIM

The aim of our study is to assess the short term memory in children between age of 5 and 12 years who have been trained in abacus for 1 and 2 years.

MATERIAL AND METHODS

Children between 5–12 years and between standard II-VI were selected for the study from

1) Don Bosco Matriculation School and St. Dominic Xavier School who were the control.
2) Gel Abacus School who had undergone training in Abacus for 1 and 2 years.

The Children enrolled in all these above schools belong to the upper middle class families. Parents of 60% of the children were Graduates. Among the others, one of them was a Graduate.

Tests for IQ were done using Binet Kamet Scale and students with average IQ were included in the study.

This study was done between May 2002 and May 2004.

The children included in the study had undergone 4 & 6 levels of training in the first and second year of abacus training. Each level consisted of 3 months, in which the children had classes twice weekly during weekends (Saturday and Sunday). Each class extended for a period of one hour. After every level there was a break of one month during which the children were asked to practice abacus at home before they pass on to the next level.

In the Is & II level, children were taught addition and subtraction using Abacus. In the III & IV level, multiplication and division & in the V & VI level, addition and subtraction of decimal numbers were taught using Abacus.

At all these levels, children were trained to solve mathematical problems using Abacus beads and then by imagining the bead movements.

Inclusion criteria

1) Age 5–12 years

2) A preliminary test for intelligence was conducted and children with average IQ were selected.

3) Students who underwent abacus training regularly for a period of 1 & 2 years.

Exclusion criteria

1) Children with IQ above or below average

2) Drop cuts from schools during the 1st and 2nd year of study.

3) Subjects with visual, hearing or other neurological problems.

This study was done between May 2002 and May 2004.

The children were divided into 4 groups.

Group I: (n=50) 5–12 years of age of non abacus learners of average IQ acted as control (May 2002–2003).

Group II: (n=50) Children between 5–12 years of age of average IQ who had undergone training in abacus for 1 year (between May 2002–2003).

Group III: (n=20) 20 from the Group I children who were followed up to 2 years and acted as control for the extended period of study.

Group IV: (n=20) From the Group II students, children who continued their abacus training for a period of 2 years.

The numbers in Group III & IV (n=20) were less than in Group I & II (n=50) because there were dropouts after 1 year in both the groups.

The children belonging to the study and control group were subjected to the tests for memory. Written consent of the parents and the heads of both schools and the Gel abacus institute were obtained before carrying out the tests.

This project was passed in the ethics committee of the college.

Tests for IQ

Tests for IQ are done for Children between 3 and 20 years. These tests are age specific. We use the Binet Kamet scale to assess the IQ of all the children enrolled in our study. The student should start answering from the tests designed for 3 years of age and goes up to the maximum that he is able to achieve. If he fails to answer all the questions in that test, he is considered to have an IQ of that particular age and he cannot pass to the next age. The formula to calculate IQ was given as

$$IQ = MA/CA \times 100$$

Where MA stands for mental age and CA stands for chronological age of the individual whose intelligence is being tested.

Tests for memory

6 tests were selected which were generated from different sources including.

Wechsler memory scale (Wechsler 1945), mini mental state examination (Shrub J Black 1977) Brown Peterson test (Peterson 1959), Mann – Buitar Visual Memory screen

for objects (Mann – Buitor 1984), picture screening (Kamat 1967).

All the Students were subjected to all the 6 tests on a 1:1 basis which lasted for one and a half hours for a student at the beginning of the study and at the end of 1 and 2 years.

Our tests for memory included:

1) Digit span forward – The subject is instructed to recite digit sequences of increasing length in the order presented.

2) Digit span backward – The subject is instructed to recite digit sequences of increasing length in the reverse order.

3) Sentence repetition – Five sentences are presented one by one to the subject for immediate reproduction.

4) Story telling – The examiner reads the story to the child and the child is asked for immediate recall after hearing the story

5) Picture recall – A row of pictures are shown, the pictures are then covered by the examiner. The subject is then asked to list the picture exactly in the same order they had seen starting at one end of row each time.

6) Benton visual retention test – 10 complex and unfamiliar geometrical figures on 10 cards are shown and each design is expound for 10 seconds and the subject is asked to reproduce the design immediately from memory.

RESULTS

On analyzing the results.

TABLE I: Digit Forward.

	No. of students	*Mean±SD (%)*	*SE of Mean*	*T*	*P*	*Significance*
Group I Vs Group II at zero time	50	30.80±13.90	1.97	0.28	0.782	NS
	50	31.60±14.86	2.10			
Group I Vs Group II (after one yr)	50	42.80±14.86	2.04	2.31	0.023	S
	50	51.60±22.71	3.21			
Group III Vs Group IV (after 2 yrs)	20	47.00±15.25	3.411	2.38	0.024	S
	20	66.00±28.75	9.092			
Group II before & after training for 1 yr	50	31.60±14.86	2.10	5.21	0.000	HS
	50	51.60±22.71	3.21			
Group IV before & after training for 2 yrs	20	37.50±15.14	4.79	2.77	0.013	S
	20	66.00±28.75	9.09			
Group I before & after 1 year	50	30.80±13.90	1.97	4.23	0.000	HS
	50	42.80±14.43	2.04			
Group III before & after 2 yrs	20	34.00±12.31	2.78	2.97	0.005	HS
	20	47.00±15.25	3.41			

TABLE II: Digit Backward.

	No. of students	*Mean±SD (%)*	*SE of Mean*	*T*	*P*	*Significance*
Group I Vs Group II at zero time	50	36.80±24.37	3.45	2.72	0.008	S
	50	24.60±20.22	2.86			
Group I Vs Group II (after one yr)	50	30.80±19.778	2.79	2.71	0.008	HS
	50	42.20±22.24	3.14			
Group III Vs Group IV (after 2 yrs)	20	41.00±23.15	5.18	2.74	0.011	S
	20	69.00±32.13	10.16			
Group II before & after training for 1 yr	50	24.60±20.22	2.86	4.14	0.000	HS
	50	42.20±22.23	3.14			
Group IV before & after training for 2 yrs	20	27.00±21.11	6.68	3.45	0.003	HS
	20	69.00±32.13	10.68			
Group I before & after 1 year	50	36.80±24.37	3.45	1.35	0.0180	NS
	50	30.80±19.78	2.79			
Group III before & after 2 yrs	20	29.00±16.83	3.77	1.88	0.068	NS
	20	41.00±23.15	5.18			

TABLE III: Story Telling.

	No. of students	*Mean±SD (%)*	*SE of Mean*	*T*	*P*	*Significance*
Group I Vs Group II at zero time	50	57.40±22.46	3.18	0.28	0.783	NS
	50	56.20±20.96	2.96			
Group I Vs Group II (after one yr)	50	54.40±20.82	2.94	6.40	0.000	HS
	50	77.80±15.33	2.17			
Group III Vs Group IV (after 2 yrs)	20	61.00±14.11	3.15	0.05	0.000	HS
	20	84.00±15.78	4.99			
Group II before & after training for 1 yr	50	61.00±14.11	3.15	0.05	0.000	HS
	50	77.80±15.33	2.17			
Group IV before & after training for 2 yrs	20	56.50±17.65	5.58	3.67	0.002	HS
	20	84.00±15.78	4.99			
Group I before & after 1 year	50	57.40±22.40	3.18	0.69	0.490	NS
	50	54.40±20.82	2.94			
Group III before & after 2 yrs	20	69.00±14.83	3.32	1.075	0.089	NS
	20	61.00±14.11	3.15			

TABLE IV: Sentence Repetition.

	No. of students	*Mean±SD (%)*	*SE of Mean*	*T*	*P*	*Significance*
Group I Vs Group II at zero time	50	44.80±26.78	3.79	2.49	1.015	NS
	50	57.40±23.80	3.37			
Group I Vs Group II (after one yr)	50	40.80±24.06	3.40	8.72	0.000	HS
	50	80.80±21.24	3.08			
Group III Vs Group IV (after 2 yrs)	20	56.00±17.89	4.00	6.67	0.000	HS
	20	96.00±8.43	2.67			
Group II before & after training for 1 yr	50	57.40±23.80	3.37	5.13	0.000	HS
	50	80.80±21.74	2.67			
Group IV before & after training for 2 yrs	20	60.00±23.09	7.30	4.63	0.000	HS
	20	96.00±8.43	2.67			
Group I before & after 1 year	50	44.80±26.78	3.79	0.79	0.434	NS
	50	40.80±24.06	3.40			
Group III before & after 2 yrs	20	46.80±25.35	5.67	1.37	0.179	NS
	20	56.00±17.89	4.00			

TABLE V: Picture Recall.

	No. of students	*Mean±SD (%)*	*SE of Mean*	*T*	*P*	*Significance*
Group I Vs Group II at zero time	50	82.80±23.13	3.27	1.37	0.173	NS
	50	88.20±15.48	2.19			
Group I Vs Group II (after one yr)	50	84.00±21.19	2.99	3.84	0.000	HS
	50	96.80±10.39	1.47			
Group III Vs Group IV (after 2 yrs)	20	90.00±13.77	3.08	2.16	0.04	S
	20	99.00±3.16	1.00			
Group II before & after training for 1 yr	50	88.20±15.48	2.19	3.26	0.002	HS
	50	96.80±10.39	1.47			
Group IV before & after training for 2 yrs	20	85.00±15.09	4.77	2.87	0.010	S
	20	99.00±3.16	1.00			
Group I before & after 1 year	50	82.80±2313	3.27	0.27	0.787	NS
	50	84.80±21.19	2.99			
Group III before & after 2 yrs	20	85.00±23.51	5.26	0.82	0.417	NS
	20	90.00±13.77	3.08			

TABLE V: Benton Visual Retention Test.

	No. of students	*Mean±SD (%)*	*SE of Mean*	*T*	*P*	*Significance*
Group I Vs Group II at zero time	50	76.00±18.74	2.65	1.16	0.247	NS
	50	71.00±19.07	2.69			
Group I Vs Group II (after one yr)	50	73.60±21.36	3.02	5.91	0.000	HS
	50	93.00±9.05	1.29			
Group III Vs Group IV (after 2 yrs)	20	74.00±13.14	2.94	5.07	0.000	HS
	20	96.00±5.16	1.63			
Group II before & after training for 1 yr	50	71.60±19.07	2.69	7.16	0.000	HS
	50	93.00±9.09	1.29			
Group IV before & after training for 2 yrs	20	70.00±11.55	3.65	6.50	0.000	HS
	20	96.00±5.16	1.63			
Group I before & after 1 year	50	76.00±18.74	2.65	0.60	0.552	NS
	50	73.60±21.36	3.02			
Group III before & after 2 yrs	20	72.00±19.89	4.45	0.38	0.710	NS
	20	74.00±13.14	2.94			

Multiple comparison significance (among Abacus learners)

	F	P
Digit forward	18.9406	0.0000(HS)
Digit backward	19.2571	0.0000(HS)
Story telling	21.6743	0.0000(HS)
Sentence repetition	5.9529	0.0037(HS)
Picture recall	4.0101	0.0209(S)
Benton visual retention test	31.8292	0.0000(HS)

Multiple comparison studies show that there is a highly significant increase in scores among Abacus learners at the end of 1 and 2 years.

DISCUSSION

Digit span includes digit forward and digit backward. Digit span forward is a test of immediate auditory memory. It is a relatively unchallenging, structured test of attention, requiring the subject to attend to the digit list as it is presented and to maintain that list in short term memory in order to repeat it back to the examiner.

In contrast, backward digit span places greater demands on attention. It requires not only that the subject hold the digit list in short term memory, but also that the information be mentally manipulated, so that it can be repeated in an order reverse to that of the initial presentation. Although, backward span requires comprehension of verbally presented material, the mental processes involved in reversing the digits may reflect the use of visual imaging and visuo spatial abilities.

Grand experts of Abacus can recall 13–20 digits in both forward and backward reproduction because Abacus learners place numbers on the Abacus image as they mentally calculate with the abacus method (2, 3). A test was given by calling out digits to the abacus learners before they took lessons in abacus and again after the completion of the course. It was found that abacus experts have a greater memory span for auditorily presented digits (4). Our results also show a highly significant increase in scores among the abacus learners in the above two tests.

The other tests used to evaluate auditory memory including sentence repetition; story telling also showed better scoring among the abacus learners than the control.

In the above two tests, the subject is asked to repeat the items in exactly the same order as was previously presented to him. Both these tests are a measure of serial recall and evaluate the comprehension of auditory inputs. The process of memory begins with an input of sensation into the organism according to its focus of attention and this in turn is immediately placed into a very brief sensory register called sensory memory (5). Increase in scores show skill in memory retention and recall.

However, it has to be noted that the above tests do not involve numbers and the abacus learners by increasing their scores in these tests do not reflect their increase in memory in numbers but an improvement in short term memory as a whole. The abacus learners show a tremendous improvement in visual retention memory. Benton visual retention test contributes to the evaluation of immediate visual memory, since the subject draws designs immediately from memory, Visual spatial and constructional abilities are all considered together and all these are related to the right hemisphere functions. The abacus learners by scoring over the Non abacus learners in Benton Visual retention test prove that they are trained to use the right hemisphere more than Non abacus learners, when required.

It has been known that subjects concentrating on 2 attributes of a visual stimulus show activation of the right angular cortex only and subjects carrying out visual and somatosensory tasks that require sustained attention show activation of areas in both the right prefrontal and superior parietal cortex. This activation is the same regardless of the modality or laterally of the input. These and other observations indicate that sustained attention in humans is a function of the representational hemisphere. Picture recall is again a test of visual scanning and it measures attentional ability.

The Right hemisphere is superior to the left in discriminating and remembering

spatial patterns (6, 7). Larry et al (8) studied regional cerebral blood flow using H_2O method. Prior to each test, the subjects studied a list of 15 words. Local blood flow was then monitored during a 40 second period. He concluded that performance is driven by the visual characteristics of the words. The results also provide evidence for selective activation of the Right hippocampal region in association with memory function.

Both these tests prove that the abacus learners have improved their visual memory (by discriminating and learning spatial patterns), as they are trained to use their Right Hemisphere.

Memory does improve with growth in a normal child. As children grow they use their experience to establish, elaborate meaningful relations in the information to be remembered, as a consequence, to remember more accurately.

The children belonging to the control group have been undergoing learning programme in the school during the 2-year period of our study. Therefore all these tests do show a slight improvement in control group as well. However the scores in abacus learners were significantly higher when compared with subjects of control group (not only in tests involving numbers but also in other tests which do not do so).

Various studies have been done to show improvement in mathematical skills among abacus learners (9, 10, 11, 12). *However, their improvement in memory both visual and auditory has not been evaluated so for.* Our results show that both visual and auditory memory is much better in abacus learners, which should help them perform better in subjects other than mathematics, as their ability to retain visual and auditory inputs has improved. Matsumoto K(13) in his study has reported psychosomatic problems in Japanese elementary school children attending abacus learning, calligraphy and music frequently in the same sitting on an intense learning schedule (more than 5 times a week). However in our study, the children were exposed only to abacus and they attended the training only twice a week apart from attending the school. Neither the teachers nor the parents complained of any behavioral problem or physical problem during the 2 years of our study. An intense concentration in 3 areas might have led to psychosomatic problems in the Children studied by Matsumoto K. The work by no other authors in the later years have mentioned such behavioral problems in the abacus learners.

A questionnaire given to parents and the teachers (listing the abilities in performance and concentration) and by going through the marks obtained by the abacus learners in various tests conducted in regular school showed a marked improvement not only in mathematics but also in other non-mathematical subjects.

Based on our results, we recommend abacus training for all children in a spaced manner not only to improve their mathematical skills but also to better themselves in other subjects.

Conclusion

Our study conducted over a period of two years show that the abacus trainees had a

better visual and auditory memory when compared to non abacus learners. We therefore believe that a student of abacus will perform better in his environment or in his study of subjects other than mathematics which requires concentration of auditory and visual inputs.

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