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Research Article

EFFECT OF *SANKHAPUSHPI* (*CLITORIA TERNATEA* LINN.) *CHOORNA* IN THE WORKING MEMORY OF CHILDREN

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ABSTRACT

The term "Working memory" refers to the ability of a person to hold information in mind and to manipulate it over short periods of time. Its deficit creates a high risk factor for educational underachievement as it is a better predictor of school performance than IQ. A clinical study was conducted to find out the effect of *Sankhapushpi* (*Clitoria ternatea* Linn.) *choorna* in the working memory of children. The study was conducted as therapeutic, interventional, non randomized, single group assignment, pre and post test and was carried out at the OPD of Dept. of *Kaumarabhritya*, Government Ayurveda College, Thiruvananthapuram. The study population included children in the age group 7 to 11years of both sexes with working memory deficit for their age when assessed by a clinical psychologist, selected from a population who presented with poor scholastic performance. The tools used were N back tasks for Verbal and Visuospatial Working Memory from NIMHANS Neuropsychological Battery and Visuospatial working memory span task and Working Memory Index tests in Wechsler's Intelligence Scale. The trial drug, *Sankhapushpichoorna* was given twice daily in empty stomach in the dose 1-2 gm with plain ghee and honey for 2 months. They were assessed before and after intervention and after 1 month of follow up period and the difference in scores were assessed. Analysis of the data using the most appropriate statistical tests showed significant response ($P<0.001$). The trial drug sustained its potential action during the follow-up period also and thus its efficacy was proved.

KEYWORDS: Working memory, *Sankhapushpichoorna, Medhya Rasayanas, Clitoria ternatea*.

INTRODUCTION

Education is the most important wealth one acquires in his life time. Learning is not a unitary process involving student and teacher. It depends on the harmonial interplay of familial, psychological, educational, social, and economical atmospheres in and around a child. Burt, the British Educational Psychologist,[1] described a scholastically backward child as one who in mid school career, is unable to do the work of the class next below that which is normal for his age.[2] Factors associated with scholastic backwardness include physical illnesses, below average intelligence, learning disorders, Attention Deficit Hyperactivity Disorder, psychiatric disorders, familial and school factors. In an otherwise normal child, sustained scholastic backwardness seems to be mostly associated with below average intelligence. David Wechsler, an expert in the field of psychology and learning, defines intelligence as "the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment". [3] A good part of intelligence rely on the ability to hold ideas in mind i.e., memory, especially working memory. Recently researches have revealed that academic underachievement is intimately related to poor performance of components of Working Memory.

The term "Working Memory" is used to describe the ability of a person to hold information in mind and to mentally manipulate it over short periods of time.[4] Children with working memory problems will have difficulty in remembering their teacher's instructions, recalling rules to a game, completing tasks involving actively calling up important information, following multistep directions, taking down notes in classroom, doing complex mathematical calculations and reading a comprehension. [5]

Working memory is found to be a better predictor of school performance than IQ. Studies have shown that many children recognized as having learning difficulties in the areas of reading and mathematics have marked impairments in working memory. Therefore it is important to address working memory at an early age as scope of

improving working memory is very compromised as the age advances and deficiencies in working memory will continue to compromise a child's chance of academic success. Various researches were done in the concept of working memory but no remediation is still proven to enhance it effectively. Working memory deficits are not properly recognized and treated nowadays as it is difficult to identify it unless consequent symptoms like less attention span arise. In a world overrun by stress where storage demands exceeds the capacity of working memory, it will be very difficult for a child with working memory deficit to adjust with this current scenario and excel academically and socially. Identification and early remediation of the deficit will support children's learning over the school years and beyond that into their adulthood. Thus it could improve the quality of life of children thereby causing betterment of society.

Apart from other systems of medicine, Ayurveda provides the concept of "*Medhya Rasayanas*" which include special herbs which help in improving the functional capacity of brain by increasing attention span, improving communication skill, enhancing grasping power, recollection speed and memory, directly influencing the performance IQ. The drug "*Sankhapushpi*" (*Clitoria ternatea* Linn., Fabaceae family) was selected for the study as it is the best among the *Medhya Rasayanas* told by Acharya Caraka.[6] Research works are available proving *Clitoria ternatea* cognitive effect which could substantiate the effect of drug.[7] *Clitoria ternatea* aqueous root extract was found to have the potential of being a neurogenic growth promoter which can be used to treat disorders of learning and memory.

Methodology

Objective of the study was to assess the effect of "*Sankhapushpi* (*Clitoria ternatea* Linn.*) Choorna",* in the working memory of children. Children of the age group 7 to 11 years with poor working memory as per the scoring in N Back test in NIMHANS Neuropsychological Battery for Children – manual [8] were included in the study and those who were having Mental retardation, Learning disability, Attention deficit hyperactivity disorder, Autism spectrum disorder, Developmental delay, Visual and auditory impairments and other causes of school backwardness were excluded from the study.

The raw trial drug, *Svethasankhapushpi* root, was collected from reputed sources of genuine raw drug stores in Thiruvananthapuram and the authenticity was confirmed by experts. The drug was well cleaned before preparation. Plain ghee and honey was obtained from authentic sources. The drug was washed well and shade dried for 3-4 days. Then it was crushed and finely powdered in a micro-pulverizer. The finely powdered *Svetha Sankhapushpichoorna* was stored in airtight plastic bottles. The selected children as per the inclusion criteria received internal administration of *Svetha Sankhapushpi Choorna* in the dosage of 1-2 gm/day according to the specific age group, as two divided doses before food, mixed with four times honey and double quantity *Ghritha* as *Anupana,* for a period of 2 months. Subjects were assessed before and after treatment and after a follow up period of 1 month.

Research Design

The study design was interventional, pre and post test. The children satisfying the inclusion criteria, who attended the OPD of Dept. of *Kaumarabhritya*, Govt. Ayurveda College Hospital for Women and Children, Poojappura and were willing for the study, were screened for Working Memory deficit. The eligible subjects were assessed before and after the intervention by a clinical Psychologist, for the change in working memory scores in N-Back test and Visuospatial working memory span task from NIMHANS Neuropsychological Battery for Children and Working memory index from Wechsler's Intelligence Scale for Children.[9] Consecutive cases satisfying the inclusion criteria were recruited until attaining the sample size of 30. The response to treatment was assessed after 2 months of treatment and after a follow up period of 1 month using all the above mentioned tasks**.**

Observation, Analysis & Interpretation

Those children who scored below the 25th percentile rank, especially in the 2 back test, according to the norms in the NIMHANS manual and who were satisfying the inclusion criteria were selected for the trial. The scoring in these screening tests were also taken as the before treatment score during the further study. The children included in the trial were then assessed for scores in visuospatial working memory span task in NIMHANS Neuropsychological Battery for Children and working memory index (Digit Span task and Letter Number Sequencing task) in Wechsler's Intelligence Scale for Children 4th (India Edition). From the scores obtained, the effectiveness of the drug was analyzed using Wilcoxon's signed rank test and descriptive statistics such as Mean, Standard Deviation, Median and Interquartile range were used to describe the characteristics of the subjects.

Data related to scores in screening tests

Table 1: Screening tests: N Back Test

	Verbal N Back test			Visuospatial N Back test		
	N	Mean	Sd	N	Mean	Sd
1 Back hits	30	6.0	2.4	30	5.9	2.5
2 back hits	30	4.6	3.3	30	1.1	1.3

Table 2: 25th Percentile score-NIMHANS Neuropsychological battery for children manual[10]

	Verbal N Back test					Visuospatial N Back test				
	7yrs	8yrs	9yrs	10yrs	11yrs	7yrs	8yrs	9yrs	10yrs	11yrs
1 Back hits	8	8	9	9	9	6	7	7	7	7
2 Back hits	11	11	12	13	13	1	2	2	2	2

1 Back test is more of a short term memory score even though it measures working memory also. At the same time 2 back task is the most precise measurement of working memory. Those have one or both working memory deficit (scores below the 25th percentile) were selected and assessed for improved scores after treatment and after follow up period.

Data showing the effectiveness of the drug

Table 3: Effectiveness of treatment on verbal working memory 1 back hits

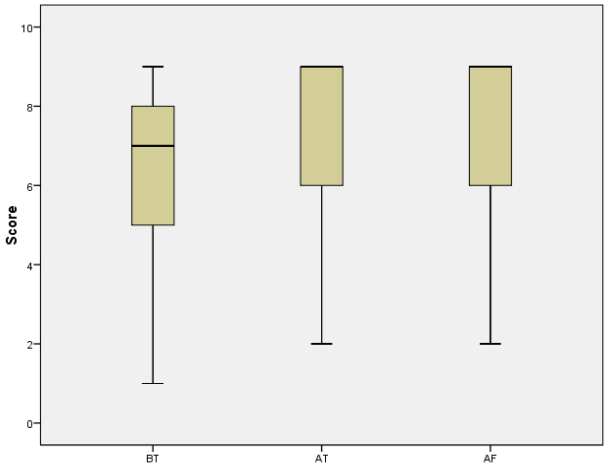
	N	Mean	Sd	Median	Inter quartile range	Paired comparison	Wilcoxon signed rank test	
							Z	P
BT	30	6.0	2.4	7.0	4.8-8.0	BT-AT	4.432	<0.001
AT	30	7.7	1.9	9.0	6.0-9.0	AT-AF	2.121	0.034
AF	30	7.9	1.9	9.0	6.0-9.0	BT-AF	4.412	<0.001

Table 4: Effectiveness of treatment on verbal working memory 2 back hits

	N	Mean	Sd	Median	Inter quartile range	Paired comparison	Wilcoxon signed rank test	
							Z	P
BT	30	4.6	3.3	4.0	1.8-8.0	BT-AT	3.545	<0.001
AT	30	6.2	3.8	6.0	2.8-10.0	AT-AF	0.302	0.763
AF	30	6.1	3.6	6.0	2.8-10.0	BT-AF	3.639	<0.001

The difference between the verbal working memory 1 back hit and 2 back hit scores before treatment, after treatment and after follow up period were statistically analyzed using Wilcoxon Signed Rank test and it was revealed that there were significant improvement in scores after treatment which was maintained during the follow up period also. Thus Verbal Working Memory task which involves mainly the function of the phonological loop (storage and rehearsal) and central executive was found to be improved on taking the trial drug.

Graph 1: Verbal 1 back hits



Graph 2: Verbal 2 back hits

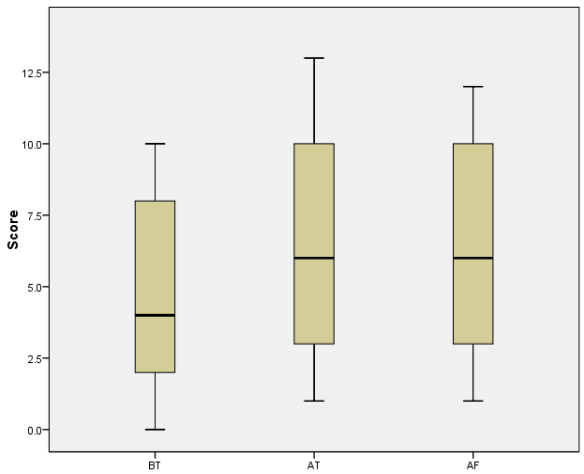


Table 5: Effectiveness of treatment on Visuospatial working memory 1 back hits

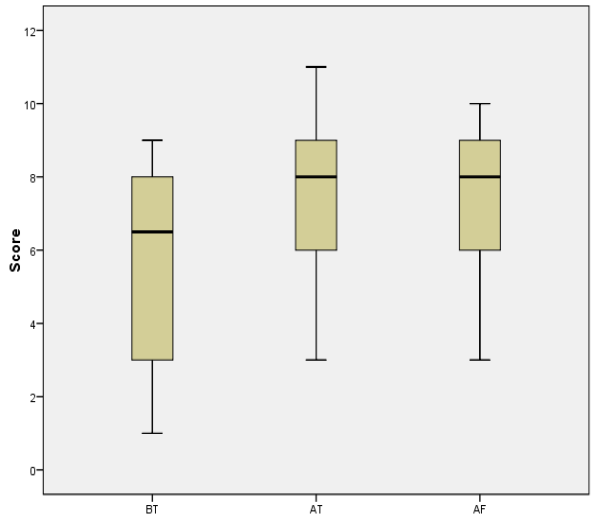
	N	Mean	Sd	Median	Inter quartile range	Paired comparison	Wilcoxon signed rank test	
							Z	P
BT	30	5.9	2.5	6.5	3.0-8.0	BT-AT	4.066	<0.001
AT	30	7.4	2.1	8.0	6.0-9.0	AT-AF	1.134	0.257
AF	30	7.3	1.9	8.0	6.0-9.0	BT-AF	3.758	<0.001

Table 6: Effectiveness of treatment Visuospatial Working Memory 2 back Hits

	N	Mean	sd	Median	Inter quartile range	Paired comparison	Wilcoxon signed rank test	
							Z	P
BT	30	1.1	1.3	1.0	0.0-2.0	BT-AT	4.183	<0.001
AT	30	2.3	1.3	2.0	1.8-3.0	AT-AF	1.000	0.317
AF	30	2.4	1.3	2.0	1.8-3.0	BT-AF	4.28	<0.001

When statistically analyzed using Wilcoxon Signed Rank test and it was revealed that there were significant improvement in scores of visuospatial 1 back and 2 back hits after treatment which was maintained during the follow up period also.

Graph 3: Visuospatial WM 1 back hits



Graph 4: Visuospatial WM 2 back hits

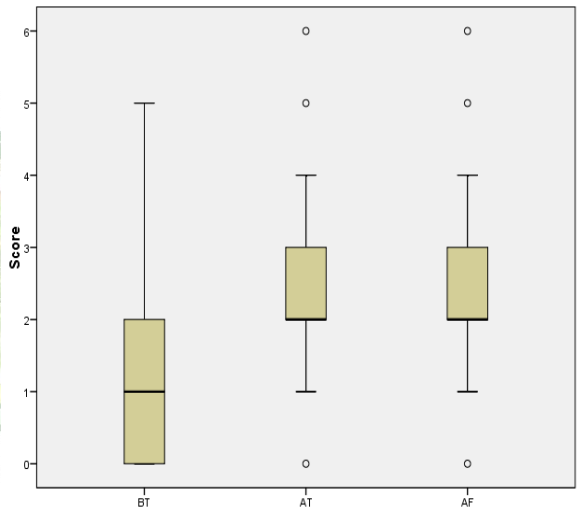


Table 7: Effectiveness of treatment on Visuospatial WM Span Task Forward

	N	Mean	Sd	Median	Inter quartile range	Paired comparison	Wilcoxon signed rank test	
							Z	P
BT	30	3.8	0.9	4.0	3.0-4.3	BT-AT	4.185	<0.001
AT	30	4.5	0.8	5.0	4.0-5.0	AT-AF	1.000	0.317
AF	30	4.6	0.7	5.0	4.0-5.0	BT-AF	3.957	<0.001

Table 8: Effectiveness of treatment on Visuospatial WM Span Task Backward

	N	Mean	Sd	Median	Inter quartile range	Paired comparison	Wilcoxon signed rank test	
							Z	P
BT	30	0.7	1.0	0.0	0.0-1.0	BT-AT	3.9	<0.001
AT	30	1.5	1.0	1.0	1.0-2.0	AT-AF	2	0.046
AF	30	1.6	1.0	2.0	1.0-2.0	BT-AF	4.064	<0.001

When statistically analyzed using Wilcoxon Signed Rank test and it was revealed that there were significant improvement in scores after treatment which was maintained during the follow up period also. Thus Visuospatial Working Memory task and Visuospatial Working Memory Span task which involves mainly the function of the visuospatial sketch pad and central executive was found to be improved on taking the trial drug.

Graph 5: Visuospatial Span Task Forward Graph 6: Visuospatial Span Task Backward

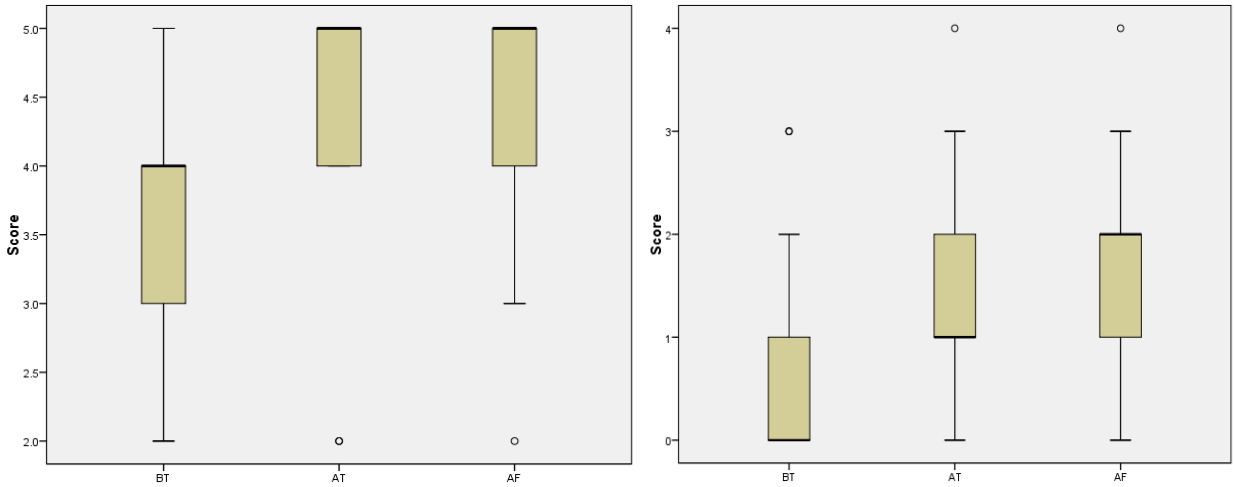


Table 9: Effectiveness of treatment on Digit span forward scores

	N	Mean	Sd	Median	Inter quartile range	Paired comparison	Wilcoxon signed rank test	
							Z	P
BT	30	5.5	1.5	5.0	4.0-7.0	BT-AT	4.716	<0.001
AT	30	6.5	1.5	6.0	5.8-7.3	AT-AF	0.378	0.705
AF	30	6.5	1.5	6.0	5.8-7.3	BT-AF	4.524	<0.001

Table 10: Effectiveness of treatment on Digit span backward score

	N	Mean	sd	Median	Inter quartile range	Paired comparison	Wilcoxon signed rank test	
							Z	P
BT	30	4.1	1.2	4.0	4.0-5.0	BT-AT	3.823	<0.001
AT	30	4.9	1.1	5.0	4.0-6.0	AT-AF	1.414	0.157
AF	30	4.9	1.1	5.0	4.0-6.0	BT-AF	3.898	<0.001

When statistically analyzed using Wilcoxon Signed Rank test and it was revealed that there were significant improvement in scores after treatment which was maintained during the follow up period also.

Graph 7: Digit span forward score **Graph 8: Digit span backward score**

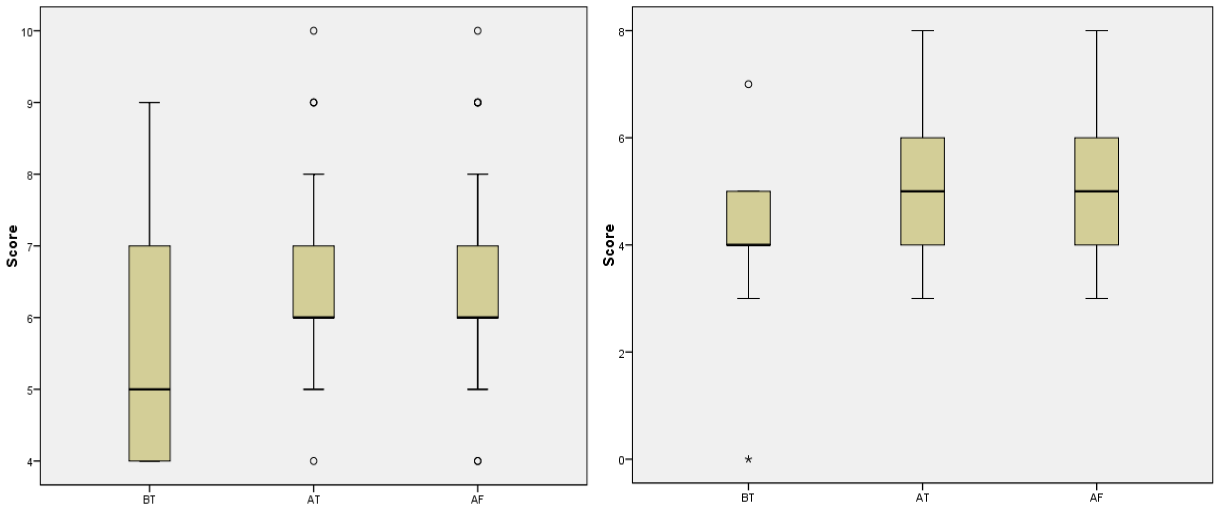
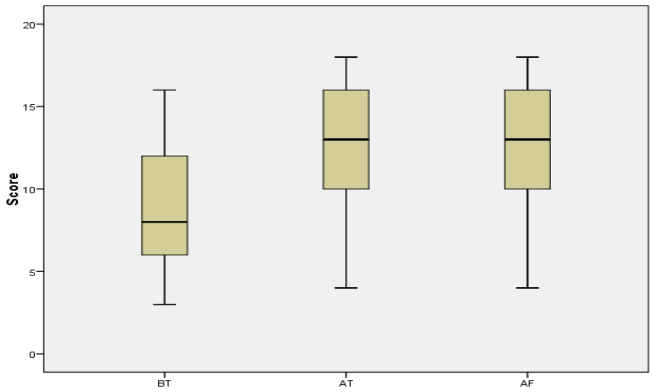


Table 11: Effectiveness of treatment on Letter Number Sequencing Task

	N	Mean	sd	Median	Inter quartile range	Paired comparison	Wilcoxon signed rank test	
							Z	P
BT	30	8.5	3.6	8.0	6.0-12.0	BT-AT	4.738	<0.001
AT	30	12.3	3.7	13.0	9.8-16.0	AT-AF	0.447	0.655
AF	30	12.4	3.8	13.0	9.8-16.0	BT-AF	4.733	<0.001

When statistically analyzed using Wilcoxon Signed Rank test and it was revealed that there were significant improvement in scores after treatment which was maintained during the follow up period also. On taking the percentage comparison considering the mean scores, it was found that there was 45% increase in the BT-AT comparison of Letter number sequencing task. Of all the tests performed the scores of letter number sequencing task showed marked improvement. This test process involves a good amount of storage, attention, processing and retrieval of information. As such it is a very good measure of working memory.

Graph 9: Letter Number Sequencing Task



Discussion on the study drug and its mode of action:

Medhyarasayanas (brain tonics) which have their direct action on perception, mind and intellect are the unique contribution of Ayurvedic science to the medical field. *Sankhapushpi* is the best *Medhya* drug told by our Acharyas. *Sankhapushpi* is a very widely used drug for its wide spectrum of action. Among the varieties used in different part of India, *Clitoria ternatea* was selected for the trial as it was easily available in the locality and cost effective and has been known for its neurorejuvenative and memory enhancing properties. [10,11]

The root of the drug, which is the most potential part was made into fine powder form for better storage, easy administration and also powders or *Choornas* have better penetrating power and faster action. Due to the increased potency and rapid action, the daily dose needed was also less. Ghee and honey was selected as *Anupanas*. Ghee was chosen, as a lipid medium would aid better transmission of the potency of medicines across the blood brain barrier and it also promotes the action of the trial drug through its *Medhya* effect. Honey was chosen to make the drug more palatable for children and also it supports the action of *Sankhapushpi*. The amount ghee taken was twice the amount of drug and honey was twice the amount of ghee as both ghee and honey can't be taken in equal quantity.

The *Sankhapushpichoorna* dosage as in Ayurvedic pharmacopoeia of India [12] is 1-3 gm. Taking 3 gm as the maximum adult dose and on calculating the dose for children according to their age, the dose ranged from1-2gm for 7-11 year old. It was administered twice daily in divided doses as it was thought to cause more sustained action of the drug.

Sankhapushpi has *Tridoshahara* (normalizes the three bodily humours) property and its *Medhya* action is due to its *Prabhava*. The *Katu, Tiktha, Kashaya rasa* and *Laghurukshaguna* of the drug decreased the *Tamoguna* and normalizes *Kapha*. The decrease in *Kapha* caused unobstructed action of *Vata* mainly *Prana, Udana* and *Vyanavayu* aiding the proper perception of objects by sense organs and mind.[13,14] Due to its *Prabhava* the action mainly occurs in the *Pranasthana* i.e., *Siras*. The unobstructed *Vata* and decreased *Kapha* augments *Pitta* mainly *Sadhakapitta* and helped in carrying out its function of *Medha*/intelligence. [15] The *Sitavirya*/ cold potency of the drug keeps a control on the action of *Pitta* and soothes the sense organs causing *Indriyaprasadana.* Even though the formulation has also a *Kaphahara* action, since it is *Kaphasthana*, controlled action of *Kapha* occurs causing *Dharana* (concentration or retention power).

So the unobstructed action and normalcy of *Vata* causes proper sense perception and functions of mind i.e. *Manobodhana* (alertness of mind) [16], *Indrayabhigraha* and *Svasyanigraha* (proper action and inhibition of sense organs) and *Uha* (imagination). Stability of mind occurs (*Manoanavasthana* disappear). The normalcy of *Pitta* causes proper intellectual functioning (*Medha, dhruthi*). Also the normalized *Kapha* controls the action of *Vata* and *Pitta* and causes proper retention of memory (*Dharana*) which could be later recollected.

CONCLUSION

The study was successfully completed and the conclusions drawn from the study were:

- Working memory deficit was found to be a major reason causing poor scholastic performance in children which is not frequently diagnosed and addressed timely.
- The effect of *Sankhapushpichoorna* was sustained even after the treatment and follow up period.
- The drug was safe since no adverse effect of the therapy was observed during the study and follow up period.
- The trial drug produced a significant improvement ($p<0.001$) in verbal working memory, visuospatial working memory and working memory index scores which proved its effect on Working memory.

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