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Effect of Yoga Practice on Recalled Image Orientation

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Abstract

Background: The accuracy and precession of image orientation in spatial memory performance is essential for skilled personals.

Aim: To test efficacy of yoga practice to enhance the Angle of Recalled Image Orientation precession performance.

Methods and Material: The study was conducted on six Navodaya Vidhyala residential schools of India. Schools were divided into yoga group (YG) and non yoga group (NYG). Each group consists of three Navodaya schools. The participants were tested for pre-post Recall Angle of Image Orientation (RAIO) performance error after the 45 days of yoga intervention.

Results: One out of three YG schools showed significant decrease in error score ($p<0.05$) and others had similar decreasing trend as compared to NYG. However, one NYG school showed significant increase in recall image orientation error as compared to YG ($p<0.05$), while other two NYG schools had non-significant increase in RAIO error scores.

Conclusion: The yoga practice significantly reduces recall image orientation error in YG as compared to NYG.

Key words: Yoga, Image Orientation, Performance error.

Introduction:

The phenomenon of spatial memory is an internal homogenous unitary construct [1]. The ability to retain object's identity and process of spatial aspect information of visual–spatial working memory is essential to perform routine visual task [2]. This spatial motor memory task performance may be improved over the consistent practice trails in the typical learning process [3]. However, it is observed that the decline in memory performance seem due to minimum stimulus exposure time, attention span, inadequate learning threshold, etc. The spatial memory performance, in general, is influenced by exogenous [4] and endogenous factors [5, 6, 7] to generate mental animation [8] .The endogenous process depends on stimulus fixation duration, fixation timing and transition probabilities, etc [9]. These endogenous factors influence the two major aspects of spatial memory functions:-1) Perfection in retrieved memory content and 2) Precise image orientation [10] and accuracy to matched retrieved information with limited memory resources [11,12] to execute an efficient motor function like perfectly reproducible recalled drawn figures on paper etc.

Therefore, for perfect retrieval functions the review of literature amply suggests that certain yoga asanas and conventional breathing techniques enhance memory in general; such as improved immediate memory through yoga practice [13]. Enhanced spatial memory by left nostril breathing [14], spatial memory improvement by yogic way of breathing through particular nostril [15], breathing through particular nostril improves spatial memory without the lateralized effects [16]. Besides, mere natural nostril breathing induced cerebral hemispheres functions, memory and cognition [17,18] and also a differences in memory performances between Cyclic Meditation and Shavasana practice [19]. The above review suggests a link between cognitive functions and breathing effects of relaxation techniques on over all memory performance. However, a significant discrepancy ($P<0.001$) between orientation at presentation and recall suggests that

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for a perfect retrieval function, it depends on the geometric determinants of human spatial memory such as geometric determination response localization, cue location, direction from the cues to the corners of display area, etc., [20]. The performance of spatial working memory system for static and mechanical component of spatial memory content requires diagrammatic reasoning that operates on complex spatial inferences with the limited capacity of spatial working memory [21]. This may limit the recall ability of entire image details. However, earlier reports on yoga training enhances memory scores [16] etc., suggests to test the efficacy of yoga practice in enhancing accuracy of recalled image orientation as the study objective.. This is a geometric determinant aspect of psycho-physiological aspect of perception [10] and spatial memory [20]. The selected geometric determinant is to match the accuracy of recalled image (angular) orientation with stimulus image orientation of test apparatus. The objective of verbal recall performance accuracy includes letter sequence of correct remembered words with respect to correct and incorrect spelt test words.

Methods

Participants

The normal male healthy school student's of age group range 13 to 18 years were selected for this study. The three states of India were chosen for the study and each states represents two Navodaya Vidhyalaya Schools as yoga (YG) and non yoga group (NYG) (table 1). The geographical location of two schools does not exceed beyond 40 kms. Hence there will not be any influence of confounding factor.

The inclusion criteria include healthy school children of Navodaya Vidyalaya from the selected India states. The exclusion criteria include mental and physical impairments such as dyslexic, aphasia and severe health problems. The YG is treated as experiment group and NYG as control.

Table 1: Details of District wise Navodaya Vidyalaya schools in Selected Indian States

School / Group	Code	Sample size	Selected Indian states
A-YG		103	Maharashtra
B-NYG		74	Maharashtra
C-YG		135	Andhra Pradesh
D-NYG		133	Andhra Pradesh
E-YG		38	Jammu
F-NYG		40	Jammu

A= Solapur, B= Tulajapur, C= Anantpur, D= Doddaballapur, E= Samba F= Udhampur
The selected schools are alphabetically labeled with varying district wise sample sizes.

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Design

The participants performed delayed recall task for Visuo-Spatial information for testing both spatial and verbal memory function [16] in the 1st day and the last day of the yoga intervention. They were assessed for the overall recalled image orientation for pre-post with and without yoga training (combination of physical postures, breathing exercises and meditation) intervention for daily an hour twice a day for 45 days as per Kaivalydhama tradition [22] by the competent yoga instructor.

Apparatus

We used "Delayed recall task for visuo-spatial information" [13] test by power point slide for presenting the spatial memory task performance. The exposure time for each slide lasted for 10 seconds. The each test includes ten items to remember.

Stimuli and Procedure

The visual -spatial tests were given as per the procedure adopted by earlier researchers [13]. The verbal memory includes words of non-sense syllables with three letters e.g., REL, etc followed by a mathematical equations. The spatial memory test includes simple line diagram, various shapes related to geometric features. The method of recording subjects' response was performed by administering paper-pencil test, wherein, they were instructed to write down the recalled items of displayed test stimuli. They were free to reproduce as it is according to their recall sequence in both the tests. However, investigator deliberately did not instruct the subjects to cover the minute details of the image such as angle of image orientation of displayed test objects/drawings, which is the key variable in this study, in order to reflect the quality of recalled motor image. Therefore, the assessment of this variable would reveal the degree of motor memory performance with respect to magnitude of calibration and precession errors before and after yoga practices.

Analysis

The spatial test includes identification of recalled visual items with respect to the orientation angle of presented visual stimuli. The correct spatial score variable is operationally defined as Angle of Recalled Image Orientation (ARIO) that were separated from incorrect visually drawn items which is identified as Angle of Recalled Image Orientation Error (ARIOE) scores. This study analyzed only the (incorrect) scores of spatial ARIOE data. The data was analyzed for Product Moment Correlation Coefficient to ascertain relationship between yoga practice and spatial ARIOE performance. The test of significance asses the performance error through the image orientation recall calibration error measured through the precession error (Pe) scores. The precession error score estimates the extent of precession error is derived as reciprocal of standard deviation of error scores [11]. This gives underlying calibrated precision error of recalled image orientation angle for spatial memory. However, the varying sample size has no impact on attention resource, has it is not dependent on number of items recalled [11]. Therefore, number of recalled items is independent of recalled motor calibration precession.

Results:

The YG showed significant magnitude change in decreasing trend of errors scores after the 45 days of yoga practices (table 2). The non -yoga group also showed significant decreasing trend except school B. but magnitude change was very less as compared to YG. The school E showed

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significant decrease ($p<0.05$) in error score. This could be due to variation in baseline as result of unequal error sample size.

The between group within condition pre-pre and post-post in YG & NYG indicated increased post performance error in NYG as compared to YG. Particularly in comparison in two schools (Ananthpur - YG & Doddaballapur - NYG) showed significant increase in post performance error in NYG. However other schools also showed magnitude wise similar trend although not statistically significant. This observed enhance performance error in NYG attributes to the lack of yoga training. Hence, mere innate typical learning ability may not enhance accuracy and precession of spatial memory performance. Therefore, it infers that yoga practice may enhance spatial memory performance.

Table 2: Recall Angle of Image Orientation Performance Error Scores of RAIO- Within Group

Navodaya Vidyalaya School regions	**Pre Test**		**Post Test**			
	Mean & SD	Total no. of errors	Mean & SD	Total no. of errors	σ_D	"t"
YG- A	1.461 ±0.830	65	1.322 ± 1.166	31	±0.233	-0.596
NYG -B	1.28 ±0.496	49	1.529 ± 0.856	40	±0.159	+0.654
YG –C	1.263 ±0.966	73	1.027 ± 1.019	46	±0.188	-1.255
NYG – D	1.68 ±0.799	97	1.59 ± 0.659	85	±0.107	-0.841
YG –E	1.18 ±0.588	21	0.657 ± 0.534	13	±0.195	-2.68 *
NYG –F	1.391 ±1.157	23	1.111 ± 1.250	27	±0.340	-0.823

*P<0.05, σ_D: Standard error of the mean, t: significance difference between mean. This table depicts significant differences in RAIO error scores in within group.

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Table 3: Recall Angle of Image Orientation Performance Error Scores of RAIO- Between Group

Navodaya School regions	Yoga group Performance Error Score			Non Yoga group Performance Error Scores				
	Mean	SD	n_1	Mean	SD	n_2	σ_D	"t"
YG-A & NYG-B (Pre-Pre)	1.461	± 0.830	65	1.28	±0.496	49	0.124	-1.459
YG-A & NYG-B (Post –Post)	1.322	± 1.166	31	1.529	±0.856	41	0.249	+0.831
YG-C & NYG-D (Pre-Pre)	1.263	±0.966	73	1.68	± 0.799	97	0.138	+3.021**
YG-C & NYG-D (Post-Post)	1.027	±1.019	46	1.59	± 0.659	85	0.271	+2.077*
YG-E & NYG-F (Pre-Pre)	1.391	±1.157	21	1.18	± 0.588	23	0.774	+0.272
YG-E & NYG-F (Post –Post)	1.111	± 1.250	13	0.657	± 0.534	27	0.282	+1.609

*P<0.05, **p<0.01, $\sigma_{D:}$ Standard error of the mean, t: significance difference between mean, n_1 & n_2 : total no. of subjects committing RAIO performance error. This table depicts significant differences in RAIO error scores in between group.

Discussion

The memory is a global cognitive phenomenon, but learnt and unlearnt memory responses bear a sharp distinction. The unlearnt memory has limited stimulus exposure; time constraint to integrate stimulus information, unlike learnt memory improves over consistent practice trails. Hence, role of yoga may improve unlearnt memory performance through complex faster retinal sensory information transmission by neural mismatch process using specific sensory-perceptual template [23]. This aspect includes focused attention initiated by interconnected straite cortex (area17) , prestraite cortex (area 18 & 19) and cortex (area 20 & 21) of infero-temproal region [22, 24, 25] of the secondary visual field of the primary visual cortex [26] of posterior parietal lobe via primary geniculostraite cortex, pulvinar-tectal cortical projections systems [25,27, 28, 29] as well as lateral Geniculate Nucleus at primary geniculostraite visual and secondary-colliculus-pulvinar – Parietal pathways [28,30,31].

The image orientation error also reduces drastically as confirmed from the Table 2 with a non-significant decrease image orientation error in YG schools Viz; A,C (t=-0.596 & p>0.05, ; t= -1.255 & p>0.05) and significant decrease in school E (t=-2.68* & p<0.05 level). However, all YG are showing significant improvement in magnitude of change.

The above results reflect that yoga effects may generates an appropriate motor command by sub-cortical priming function. This suggests better accuracy in image orientation dependence of recall function as inferred from the results (table 4 is table 3) showing less performance error scores in post-post condition of YG as compared to NYG with reference to pre-pre condition.

The restoration of precise image orientation through yoga effects is mostly due to the computation of half-bandwidth and half-amplitude sensory channel functions. This sensory channel computation outcome must match the attended differential bandwidth component with

respect to analysis of perceived sensory size channel and modulated attended as well as checked channel sizes of Colliculus-Pulvinar –Parietal secondary pathways [21] . This underlying mechanism is mostly responsible for a better recall image orientation performance. The above results also suggests possible yogic effects in modulating the neural mechanism for eliciting precise calibrated motor memory response is mostly due to the differential bandwidth feedback response effect. The exact precision performance in terms of precession error score is computed by taking reciprocal value of its standard deviation [6] .This observed improvement in precision could be attributed to the neural channel modulation index (NCMI) triggered by fine tuned modulation of neural channel [5,32, 33, 34] .This NCMI may contribute to larger retinal receptive field [34] to enhance visual response through the sub cortical prime function [32,34,35,36,37] . Therefore, it is proposed that the observed decease in the precession error score is mostly due to the underlying differential bandwidth feedback response proportional to evoked sensory output of Colliculus –Pulvinary –Parietal cortex [28,,30,31] . This is modulated by a specific occipital channels oriented to exert sensory control on selective spatial information [32] .

The above proposed neurophysiological mechanism suggests that the yoga practices exert a complete control of sensory information flow [39] with a long lasting optimum unlearnt slow motor memory response [40] and also enhances attentional resource to increase speed and accuracy in any task response [41] . This results in resource conservation and minimum attentional resource utilization [42,43,44] due to yoga practices as opposed to increased resource allocation and consumption in the typical memory recall function [12]. The study concludes that the yoga practice significantly reduce recall image orientation errors though unknown cortical functions of complex attention mechanism and enhance accuracy of recall motor performance.

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