

RESEARCH ARTICLE

A comparative study of the effects of superbrain yoga and aerobic exercise on cognitive functions

Joseph Ivin Thomas, Venkatesh D

Department of Physiology, MS Ramaiah Medical College, Bengaluru, Karnataka, India

Correspondence to: Venkatesh D, E-mail: venkatesh40@gmail.com

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ABSTRACT


Background: Superbrain yoga is an ancient oriental exercise which is claimed to boost overall physical and mental well-being. **Aims and Objectives:** The aim of this study was to assess the effects of superbrain yoga and simple squats on cognitive functions and to compare the effects of these interventions on attentional control and working memory. **Materials and Methods:** This is an interventional study. A total of 40 healthy, medical students from MS Ramaiah Medical College, Bengaluru, were recruited and randomly assigned to superbrain yoga and simple squats groups. Audio-visual reaction time for attentional control and n-back task for working memory was assessed over a 4-week period. **Results:** The reaction time and n-back scores in both groups improved over the sessions. The improvement was more pronounced for the n-back task scores in the superbrain yoga group (baseline: $83.75 \pm 7.65\%$, week-4: $94.50 \pm 6.42\%$) than the simple squats group (baseline: $84.80 \pm 7.53\%$, week-4: $88.75 \pm 7.60\%$). **Conclusion:** The present study demonstrates that superbrain yoga has a positive impact on both attentional control and working memory components of cognition. The effect was more pronounced on working memory than attentional control in the superbrain yoga group compared to simple squats group.

KEY WORDS: Reaction Time; Superbrain Yoga; Working Memory; N-Back Task

INTRODUCTION

There is a recent surge of interest in the West for the practice of an ancient oriental exercise, which has come to be known there as superbrain yoga. It was first popularized by Master Choa as a form of regular exercise to boost overall physical and mental well-being.^[1] In India, this exercise constitutes a traditional form of worship of the elephant-headed deity Lord Ganapati, more commonly known by the Sanskrit term Thoppukaranam.^[2] Chinese acupuncture and Indian

Ayurveda subscribe to the view that the earlobes possess life energy corresponding to the head. Auriculotherapy holds that the entire ear corresponds to the shape of an inverted fetus and that the earlobe specifically corresponds to the head region.^[3] Studies done in the recent past lend plausibility to the claimed effects of superbrain yoga.^[4] It, therefore, merits further objective investigation. Superbrain yoga practised over several months has a positive impact on social behavior in children with autism and attention deficit hyperactivity disorder.^[5] Earlier studies have shown that the academic performance of students improved significantly with regular practice of superbrain yoga and also boosts emotional intelligence in adolescent females.^[6,7] Another study showed its positive impact on children of alcoholics, who are addicted to drugs.^[8] Two important components of cognition that can be readily assessed are attentional control and working memory. They form a part of the central executive functions, along with planning, abstract thinking, and task

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coordination. Both single bout of exercise and prolonged physical activity have been found to impact cognition and executive functions.^[9,10] An Indian study by Chandrasekeran et al. (2014) on Thoppukaranam, which is a close variant of superbrain yoga, has shown to have a significant effect on selective attention and psychological states in young adults.^[2] However, the current scientific literature documenting the comparative effects of superbrain yoga versus aerobic exercise on cognition is still lacking.

Reaction time is defined as the time interval between the delivery of a sensory stimulus and motor response. It is a measure of sensory-motor coordination as well as internal processing speed in the brain.^[11,12] It may also be considered as an index of cortical arousal (alertness) and is a simple non-invasive assessment of peripheral and central neural structures. Exercise is known to improve reaction time.^[13] A greater degree of alertness and better muscular coordination are the reasons attributed to the superior performance of the athletic group.

Working memory forms a core component of the executive function of the brain. It acts as a short-term memory buffer, temporarily holding the information, facilitating its processing.^[14,15] Performance of tasks that engage working memory may be increased by means of high-intensity exercise.^[16] A variety of different tests exists in the literature to measure working memory. The n-back task is a valid measure of working memory as it involves dynamic rehearsals while responding to each item.^[17]

The primary aim of this proposed study was to assess the impact of short-term practice of superbrain yoga and simple squats on the components of human cognition, namely, attentional control and working memory. The secondary aim was to compare the effects of these interventions on human cognition.

MATERIALS AND METHODS

An interventional study was carried out at MS Ramaiah Medical College, Bengaluru. This study was granted approval by the Ethics Committee of MS Ramaiah Medical College. In this study, 40 healthy students were recruited and randomly assigned to superbrain yoga and simple squats groups with the help of a random number table. Based on Chandrasekeran et al. study, a sample size of 15 was arrived at for each group. A sample size of 15 for each group achieves a power of 80%, set at the desired confidence level of 95% with an effect size of 0.78.^[2] In this study, students were divided into 2 groups, each comprised 20 students. They were all highly motivated individuals, and informed consent was obtained from them after the experimental protocol was explained in detail. The students with following inclusion criteria were included in the study: (i) Male; (ii)

right handed; and (iii) age 18-21 years. While students with color blindness or hearing problems or neurological deficits or H/O any regular medication intake were excluded from the study.

Assessment of visual reaction time (VRT) and auditory reaction time (ART) was done using an indigenously designed portable response analyzer device, with a least count of 1/1000 s and powered by two rechargeable AA batteries. Auditory and visual cues consisted of clicks and a flash of green light, respectively. Subjects were first familiarized to the equipment with a practice session. The least of three successive recordings was taken as the reaction time.

Assessment of visual working memory was done using the n-back task. In this computer-based test, a randomized series of picture frames were presented on a screen, one at a time in close succession. The subjects were instructed to respond with a left mouse click as quickly and accurately as possible, on a picture if it had previously appeared n-frames before. For instance, in a 2-back test, the subject is required to click on a particular picture if it had previously appeared two frames before. Hence, if the picture of a fish is followed by a picture of cake, which is then followed by the picture of a fish again, the subject is required to click on this last frame because it had previously appeared two frames before. The subjects were tested for 2-back, 3-back, and 4-back loads. Subjects were first familiarized to the task with a practice session. Each trial began with a center fixation cross on the screen for 500 ms, followed by the picture stimulus in that location for 500 ms, followed by a 2000 ms interstimulus interval. The number of correct responses made was automatically calculated (in percentage) at the end of each trial. The average score for three successive trials at a given task load was taken as the working memory score.

Members of the superbrain yoga and simple squats group were required to practice their prescribed exercise protocols at a fixed time each morning for a total of 4 weeks, for at least 5 days a week. Compliance was ensured by means of daily electronic reminders sent to the students, which was then followed up orally by the investigator in the class that day. The recordings taken on the first day of testing constituted the baseline for either group. Subsequent recordings were taken at the end of the 1st, 2nd, 3rd, and 4th weeks.

The superbrain yoga regimen adopted is described in the book by Master Sui^[2]: The subject stands facing East, with the feet shoulder width apart and the tongue touching the roof of the mouth. The right ear lobe is squeezed between the left thumb and the left index finger. The left ear lobe is squeezed between the right thumb and right index finger. While squeezing the ear lobes, the thumbs are on the outside and the index fingers inside. In the process of holding the ear, the limbs are crossed with the right forearm in front of the

left forearm. The subject inhales while squatting down and exhales while rising back up. 3 sets of 21 repetitions of this exercise were done at least 5 days a week for 4 weeks. The attention and memory parameters were recorded at the end of each successive week.

The control exercise regimen required the subjects to perform simple, repetitive squats with arms folded across the chest. Again, 3 sets of 21 repetitions of this exercise were done at least 5 days a week for 4 weeks. The attention and memory parameters were recorded at the end of each successive week.

Statistical Analysis

All the quantitative variables such as age, body mass index, reaction time, and working memory are summarized using descriptive statistics such as mean and standard deviation. Repeated measures of ANOVA were employed to test for any significant difference in attention and memory-related parameters from baseline to session-4 in both superbrain yoga and simple squat groups. Paired *t*-test was carried out to assess the difference in reaction times between left and right hands and the effect of increasing load in the n-back task. Finally, between group, comparisons were carried out using independent (unpaired) *t*-test.

RESULTS

Analysis for Baseline Parameters of Both Groups

Data were subjected to non-parametric, normality testing using Kolmogorov Smirnov's test, and normal distribution was observed for each parameter. Group means were compared using appropriate *t*-tests. All data are expressed as mean \pm standard deviation. The two-tailed independent *t*-test for equality of means reveals that both groups are age and anthropometrically matched since $P > 0.005$ for each parameter (Table 1).

Similarly, the group means for VRT, ART, 2-back, 3-back, and 4-back task performance scores calculated for baseline, sessions-1, session-2, session-3, and session-4 are also compared using independent *t*-test (Tables 2 and 3). The data are pictorially presented as bar diagrams, and the *p*-values corresponding to the difference between group means for each session are given in the last column of Table 2. The two-tailed *t*-test for equality of group means reveals the following: (i) The difference in mean VRTs between Groups 1 and 2 is not statistically significant for any of the five measurement sessions, (ii) the difference in mean ARTs between Groups 1 and 2 is not statistically significant for any of the five measurement sessions, (iii) the difference in mean 2-back task scores between Groups 1 and 2 is statistically significant for sessions 2, 3, and 4, (iv) the difference in mean 3-back task scores between Groups 1 and 2 is statistically significant for sessions 1, 2, 3, and 4,

Table 1: Baseline parameters

Parameter	Group 1	Group 2	<i>P</i> value
Age (years)	18.95 \pm 0.0826	19.40 \pm 0.754	0.080
Height (cm)	172.85 \pm 5.264	174.40 \pm 4.838	0.338
Weight (kg)	74.50 \pm 13.30	78.10 \pm 8.322	0.311
BMI (kg/m ²)	24.82 \pm 3.59	25.71 \pm 2.75	0.382
MUAC (cm)	27.35 \pm 4.196	28.30 \pm 3.466	0.440
ULL (cm)	75.75 \pm 2.731	75.15 \pm 3.864	0.581

Group 1: Superbrain yoga, Group 2: Simple squat, BMI: Body mass index, MUAC: Mid-upper arm circumference, ULL: Upper limb length

Table 2: Session-wise comparison of effect of superbrain squats and simple squats on reaction time in Groups 1 and 2

Reaction time	Group 1	Group 2	Difference of means
VRT (ms)			
Baseline	210.80 \pm 8.115	208.15 \pm 10.762	2.650
Session-1	205.90 \pm 15.427	208.10 \pm 15.138	-2.200
Session-2	200.40 \pm 4.435	207.10 \pm 14.279	-6.700
Session-3	196.75 \pm 12.174	203.10 \pm 11.457	-6.350
Session-4	194.90 \pm 14.977	202.00 \pm 8.944	-7.100
ART (ms)			
Baseline	172.25 \pm 17.553	169.45 \pm 6.245	2.800
Session-1	167.60 \pm 14.295	167.00 \pm 9.989	0.600
Session-2	165.50 \pm 11.241	167.75 \pm 7.738	-2.250
Session-3	164.35 \pm 6.691	163.60 \pm 12.331	0.750
Session-4	164.45 \pm 9.528	163.55 \pm 14.845	0.900

Group 1: Superbrain yoga; Group 2: Simple squat

and (v) the difference in mean 4-back task scores between Groups 1 and 2 is statistically significant for sessions 1, 2, 3, and 4.

Within Group Analysis using Repeated Measures

There is an improvement in mean VRT and ART which is statistically significant from baseline to sessions-4 in Group 1. There is an improvement in mean 2-back, 3-back, and 4-back task scores which is statistically significant from baseline to sessions-4 in Group 1 (Tables 4 and 5).

There is an improvement in mean VRT and ART which is statistically significant from baseline to sessions-4 in Group 2. There is an improvement in mean 2-back, 3-back, and 4-back task scores which is statistically significant from baseline to sessions-4 in Group 2 (Tables 6 and 7).

DISCUSSION

In this study, the impact of practising superbrain yoga for approximately 1 month, on attentional control and working

Table 3: Session-wise comparison of effect of superbrain squats and simple squats on working memory performance in Groups 1 and 2, respectively, VRT and ART are expressed in ms

N-back task scores	2-back task		Difference of means	3-back task		Difference of means	4-back task		Difference of means
	Group 1	Group 2		Group 1	Group 2		Group 1	Group 2	
Baseline	83.75±7.656	84.80±7.537	-1.050	57.10±8.620	59.20±7.488	-2.100	47.85±9.472	46.00±9.857	1.850
Session-1	92.05±8.338	88.05±7.430	4.000	68.05±12.237	58.60±8.678	9.450*	55.80±9.589	48.45±9.698	7.350*
Session-2	95.35±6.218	89.00±8.627	6.350*	74.30±13.685	60.05±9.439	14.250*	61.35±10.703	49.65±9.789	11.700*
Session-3	94.85±5.833	88.85±8.677	6.000*	73.10±12.969	62.90±5.467	10.200*	62.80±11.998	53.90±7.433	8.900*
Session-4	94.50±6.420	88.75±7.608	5.750*	73.20±12.378	63.25±7.840	9.950*	61.50±12.133	52.35±7.177	9.150*

N-back task scores are expressed in percentage, (*Level of significance $P<0.05$)

Table 4: Session-wise effect of exercise on reaction times in Group 1

Session i-Session j	Difference of mean VRT	Difference of mean ART
Baseline-Session-1	4.900	4.650
Baseline-Session-2	10.400*	6.750
Baseline-Session-3	14.050*	7.900
Baseline-Session-4	15.900*	7.800*
Session-1-Session-2	5.500*	2.100
Session-1-Session-3	9.150*	3.250
Session-1-Session-4	11.000*	3.150
Session-2-Session-3	3.650*	1.150
Session-2-Session-4	5.500*	1.050
Session-3-Session-4	1.850	-0.100

*Level of significance $P<0.05$

Table 6: Session-wise effect of exercise on reaction times in Group 2

Session i-Session j	Difference of mean VRT	Difference of mean ART
Baseline-Session-1	0.050	2.450
Baseline-Session-2	1.050	1.700
Baseline-Session-3	5.050	5.850
Baseline-Session-4	6.150*	5.900
Session-1-Session-2	1.000	-0.750
Session-1-Session-3	5.000	3.400
Session-1-Session-4	6.100*	3.450
Session-2-Session-3	4.000	4.150
Session-2-Session-4	5.100*	4.200
Session-3-Session-4	1.100	0.050

*Level of significance $P<0.05$, VRT: Visual reaction time, ART: Auditory reaction time

Table 5: Session-wise effect of exercise on n-back performance in Group 1

Session i-Session j	Difference of mean scores		
	2-back task	3-back task	4-back task
Baseline-Session-1	-8.300*	-10.950*	-7.950*
Baseline-Session-2	-11.600*	-17.200*	-13.500*
Baseline-Session-3	-11.100*	-16.000*	-14.950*
Baseline-Session-4	-10.750*	-16.100*	-13.650*
Session-1-Session-2	-3.300*	-6.250*	-5.550*
Session-1-Session-3	-2.800	-5.050*	-7.000*
Session-1-Session-4	-2.450	-5.150*	-5.700*
Session-2-Session-3	0.500	1.200	-1.450
Session-2-Session-4	0.850	1.100	-0.150
Session-3-Session-4	0.350	-0.100	1.300

*Level of significance $P<0.05$

Table 7: Session-wise effect of exercise on n-back performance in Group 1

Session i-Session j	Difference of mean scores		
	2-back task	3-back task	4-back task
Baseline-Session-1	-3.250*	0.600	-2.450*
Baseline-Session-2	-4.200*	-0.850	-3.650
Baseline-Session-3	-4.050*	-3.700	-7.900*
Baseline-Session-4	-5.350*	-4.050*	-6.350*
Session-1-Session-2	-0.950	-1.450	-1.200
Session-1-Session-3	-0.800	-4.300*	-5.450*
Session-1-Session-4	-2.100*	-4.650*	-3.900*
Session-2-Session-3	0.150	-2.850	-4.250
Session-2-Session-4	-1.150	-3.200	-2.700
Session-3-Session-4	-1.300	-0.350	1.550

*Level of significance $P<0.05$

memory function, was assessed. These effects were compared to aerobic exercise consisting of simple squats practised over the same span of time.

A comparative analysis between the superbrain yoga group and the simple squats group shows that there was

no significant difference in the mean ART-VRTs for any of the weekly sessions. However, the superbrain yoga group had significantly higher mean 2-back, 3-back, and 4-back task performance scores compared to the simple squats group. This differential effect was observed to occur as

early as the 1st week itself for the 3-back and 4-back tasks, and only by the 2nd week for the 2-back task. An analysis within each of the respective groups reveals that superbrain yoga significantly improved the mean VRTs from the baseline readings by as early as the 2nd week. A similar effect was also observed regarding the mean ARTs, though it was delayed to the 3rd and 4th weeks. On the n-back task, superbrain yoga had significantly improved performance across the board, regardless of load (i.e., 2-back, 3-back, and 4-back) from the baseline reading to each subsequent measurement session. In the case of the simple squats group, the mean VRT improved from the baseline reading by the final week, but the mean ARTs showed no such change from the baseline. There was, however, significant improvement in the n-back task performance scores from baseline to the final measurement session. These findings confirm the previous studies that demonstrate aerobic exercise training as associated with modest improvements in neurocognitive performance, which encompasses both attention and memory components.^[18-20] A study by Chandrasekaran et al. found that Thoppukaranam, which is very similar to superbrain yoga, has a significant enhancing effect on attentional control and psychological states compared to the control simple squats group.^[2]

It is proposed, here, that the observed improvement over the sessions can be attributed to the activation of dedicated neural pathways with enhanced formation and release of neurotransmitters. The increased sensitivity of the postsynaptic membrane and the effective inhibition of the distracting signals also could be responsible for the improved cognitive performance.

These important results must be considered in the light of some study limitations, such as the fact that only males were recruited for the assessment and that the sample size may not be of sufficient size to allow for generalization to a larger population. Also, we did not investigate into whether the observed positive effects of exercise on cognition decline without regular practice. Finally, it is difficult to rule out the possibility that other forms of physical activity could have concomitantly played an influencing role during the period of the study.

Future studies can be directed to studying the effects of superbrain yoga on attention and memory parameters with the help of more sophisticated neuroimaging techniques such as functional magnetic resonance imaging and electrophysiological attentional parameters such as P300 wave characteristics of event-related potentials. This would in turn help establish the neurovascular and electrophysiological basis for the observed superiority of superbrain yoga over simple squats in influencing the key components of human cognition.

CONCLUSION

The present study demonstrates that superbrain yoga has a positive impact on both attentional control and working memory function. When compared to simple squats, the effects are more pronounced on working memory than for ART-VRT. Considering the positive benefits of regularly practising superbrain yoga on improving cognition, the authors recommend that this regimen be integrated into the physical education system of school going pre-adolescents and adolescents.

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