Original Article

Effect of 12 Weeks of Yogic Training on Neurocognitive Variables: A Quasi-Experimental Study

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Abstract

Background: Neurocognitive abilities are the brain-mind skills needed to initiate any task from the simplest to the most complex, decreases with advancing age. Attention, alertness, and memory are the basic neurocognitive functions most affected by age. There are potential benefits of yoga on neurocognitive functions because this ancient Indian technique positively nurtures the mind-body systems. **Aim of the Study:** The present study was aimed to evaluate the effect of 12 weeks of yogic training on neurocognitive abilities in a middle-aged group. **Methods:** A total of 86 volunteers (46 male and 40 females, age group of 35–55 years), with no prior experience of yoga were participated in this study. Five male and 4 female participants were excluded from the study. All participants divided into yoga training group (male = 21 and female = 18) and control group (male = 20 and female = 18). The yoga training group underwent yoga practices, including *kriya, surya namaskar, asana, pranayama, and dhyana* daily in the morning, for 6 days/week, for 12 weeks. Standing height, body weight, body mass index, visual reaction time (RT), auditory RT (attention and alertness), and short-term memory were assessed day 1 (pre), 6th week (mid), and 12th weeks (post) of intervention. **Results:** Repeated-measures analysis of variance showed that a statistically significant increased ($P < 0.05$) in attention-alertness and short-term memory after 12 weeks of yogic practices. **Conclusion:** Integrated approach of yogic intervention may have promising effect on neurocognitive abilities that concomitantly promote successful aging.

Keywords: Healthy aging, mind-body medicine, neurocognition

Introduction

Neurocognition is a sub-discipline of neuroscience. Neurocognitive abilities include learning, memory, perception, attention, alertness, and problem-solving. These abilities are the brain-mind skills needed to initiate any task from the simplest to the most complex. The process of normal aging is associated with substantial declines in cognitive abilities, which include speed and accuracy of perception, decision-making, task-switching, working memory, and multitasking. The basic neurocognitive functions mainly attention-alertness and memory are markedly affected by age.[1,2] Last three decades investigations on mind body interventions signify on neurocognitive functions suggested promising effect in slowing or reversing the cognitive decline associated with aging process.[3,4] Further, research investigations in the field of exercise science clearly indicated that regular moderate exercise habit reduces the risk factor associated with neurocognitive decline in healthy individuals.[1-4] Yoga is considered a mind-body practice of Indian origin, which confirms its potential benefits on the functional ability of neurocognitive aspects. There are studies on the effect of yoga (single or multiple interventions) and the improvement of neuropsychological or psychophysiological functions.[5,6] However, there is no study found on the effect of combined graded yogic training on neurocognitive abilities among middle-aged population, although it is a vulnerable phase of life from where every person may start the normal aging process. Therefore, the present study was conducted to see the effect of Six and twelve weeks of yogic training on neurocognitive abilities among the middle-aged group.

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Methods

Study location

The present study was carried out in the city of Bolpur, West Bengal, India.

Population

The target population was middle-aged men and women.

Subjects

To meet the specific objective of the study and to find out the motivated participants, a workshop on "Healthy aging through Yoga" was organized in the locality of Bolpur city, District–Birbhum, State–West Bengal, India. There was total 86 adult men (n = 46) and women (n = 40) aged between 35 and 55 years willingly enrolled their names to join this yoga and healthy aging workshop. The sample size calculation was not done before the study. However, the *post hoc* analysis of auditory reaction time (RT) of male in the yoga group showed that with the sample size 86, the calculated effect size is 0.96 and power is 0.99 of the study.[7] All participants were from almost similar in socioeconomical background, recreationally active but they have no prior experience any form of yoga before the commencement of specific yoga training. Based on a routine clinical examination, nine participants (5 male and 4 female) were excluded from the study due to major injury and illness. The participants who were (n = 77; male 41 and female 36) found in normal health and none of them taking any medication were considered for the study. All the participants were living in Bolpur city and following a similar lifestyle pattern. All of them were nonvegetarian.

Study designed

Quasiexperimental research design and convenient sampling method were considered to enroll subjects. All participants were divided into two groups in respect to their serial of registration for the workshop. First 39 participants were served (male 21; age 39.81 ± 9.13 years; female 18, age 41.75 ± 8.70 years) as the yoga training group and remaining others (n = 38) were served as a nonyoga practicing group (male 20, age 40.17 ± 8.37 years; female 18, age 42.33 ± 8.23 years). The University Research Review Board approved the study and signed informed consent form was obtained from each subject. All participants were tested-three times, i.e., day 1 (pre), after 6th week (mid), and after 12th week (post) assessment, under similar laboratory condition. Participants were free to withdraw themselves from the yoga training or assessments at any point of time during the study. The final number of each group completed the study is shown in the flow diagram of quasi-experimental trials [Figure 1].

Assessments

Demographic information, including age, gender, socioeconomic status, education, and anthropometric measurements, was taken on the day of enrolment. Further, participants were assessed for neurocognitive abilities by using visual RT (VRT), auditory RT (ART), and short-term memory. RT is an interval time between stimulus (S) and response (R) in a given situation. RT was used as an index of cognitive performance change, was considered as it correlates with many central nervous system conditions. Digital reaction timer (Lafayette Instrument Multi-Operational Apparatus for RT, Model No. 35600) was used for the collection of data. Two modes were used to measure the RT, i.e., VRT using "Light" stimulus; ART using "Audio" stimulus. RT was recorded in term of milliseconds unit. Each subject was given 10 trials, and then, average of these trials was considered as the RT of that subject. It was regarded as lesser the time is better the cognitive ability (Manual, Lafayette Instrument, 3700 Sagamore Parkway North, P.O. Box 5729, Lafayette, In 47903 USA). The short-term memory is holding small amount of information for the short period of time. The short-term memory was measured through "serial learning" test by using "Digital Memory Scope" instrument (Medicaid System, 389, Ind. Area, Phase-II, Chandigarh - 160 002, India). Serial Learning was recorded in terms of the right attempt made by the subject out of 10 numbers accordingly.

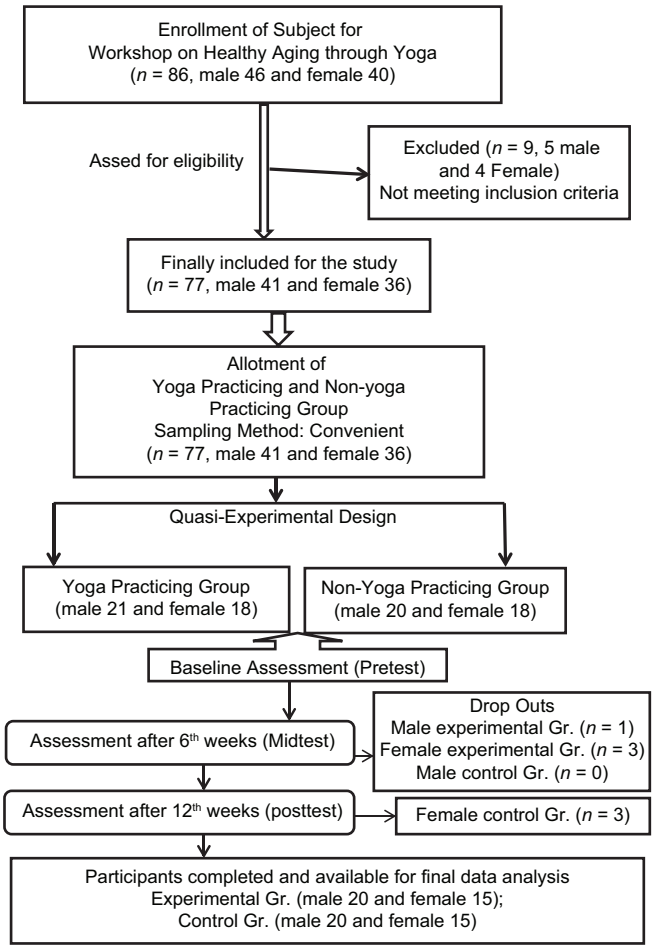

Figure 1: Flow diagram of quasi-experimental trial (n = 86)

Intervention

Yoga practicing group (experimental group)

The yoga group practiced *suryanamaskar* (dynamic form of physical posture), *asanas* (static type of physical posture),

kriyas (cleansing practices), *pranayamas* (manipulation of breathing), and *dhyana* (meditation) for a period of 12 weeks. Training lode in the form of execution time, repetitions, and degree of difficulty increased gradually from the 1st week to 12 weeks. Total practice time for the 1st week was 45 min and reach 90 min at the end of 6 weeks. Finally, 1 h 45 min practice times were fixed in the beginning of 8th week and continue till 12–weeks. The detailed yogic practices were reported elsewhere.[8,9] Furthermore, a general record was maintained of the subjects' activities, diet, and lifestyle during the study period.

Non-Yoga practicing group (control group)

The subjects of the waitlist control group following their usual routine activities. They are instructed to report in the laboratory once in a week. Researcher kept a detail history of their daily lifestyles during these 12 weeks.

Statistical analysis

Data obtained through different tests and measurements were processed for data analysis. Mean and standard deviation as descriptive statistic, repeated measures analysis of variance (RM ANOVA) as inferential statistic were used for the data analysis. The RM ANOVA was utilized for two factors, i.e., factor 1 within groups-time points (pre, mid, and post) measurements and factor 2 between Groups-differences between the groups (yoga practicing group and nonyoga practicing group). *Post hoc* test was followed with within and between groups' factors. Significant level was set at 0.05 levels ($P < 0.05$).

Results

Baseline status

An insignificant baseline difference was found between yoga practicing group and nonyoga practicing group for both male and female participants separately [Table 1].

Effect of yoga on physical characteristics

In yoga practicing group for both male and female, body weight and body mass index were fall significantly ($P < 0.001$) after 12 weeks of yogic practices compare to baseline; however, in the nonyoga practicing group, no such changes were found ($P > 0.05$).

Table 1: Baseline status (independent *t*-test)

Variables	Male ($n=40$) yoga group ($n=20$) versus non-yoga group ($n=20$) (P)	Female ($n=30$) yoga group ($n=15$) versus non-yoga group ($n=15$) (P)
Body weight (kg)	0.34	0.54
Body mass index (kg/mt^2)	0.47	0.46
Visual reaction time (ms)	0.55	0.38
Auditory reaction time (ms)	0.70	0.24
Short-term memory	0.67	0.43

Effect of yoga on neurocognitive variables

Attention and alertness

Following 6-week and 12-week of combined yoga practices showed a significant improvement in auditory and visual reaction time compared to baseline data, in male and female yoga-practicing group [Table 2], whereas no such changes were found in the non-yoga practicing group [Figure 2]. Similarly, the short-term memory was measured through serial learning test showed a significant improvement after 12-week yogic practices [Table 2 and Figure 3].

Discussion

It is evident that regular exercise or physical activity of mild to moderate intensity, i.e., walking, freehand exercises, stretching exercises, moderate strength exercises, obviously reduces the risk of neurocognitive decline compared to sedentary lifestyle.[2,10,11] However, this probably the first quasi-experimental study in which, 12 weeks combined yoga practice regimen was applied to observe the neurocognitive response in a middle-aged group with normal health status. The results of the present study showed a significant decrease in ART and VRT following 6-week and 12-week practice of yoga. This outcome clearly indicates improvement of one's attention and alertness. The outcomes are in line with previous reports that yogasana can produce a significant reduction in the RT of ART and VRT.[12] It was reported that voluntary control on the time period of inspiratory breathing positively correlated with the changes in RT.[13] Another study reported that the RT was improved after the practice of Mukh Bhastrika.[14] Further, 12 weeks of yoga training (asana and pranayama) decrease RT[15] and also reported shortening of RT after pranayama practice.[16] In a study, Borker and Pednekar[17] reported that ART and VRT reduced significantly after 4 weeks of pranayamic breathing exercises. In a recent study, Telles *et al*.[15] reported that RT was decreased significantly after the session of breath awareness and quite sitting, whereas no change was observed immediately after 18 min of Bhastrika pranayama. RT has been considered an indirect index for the measurement of the processing ability of the central nervous system and also a method used to determine sensory-motor

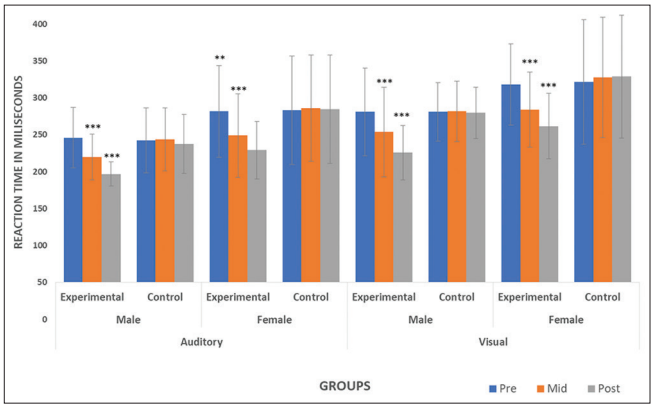

Figure 2: Reaction time of auditory and visual tasks

Table 2: Results (mean±standard deviation) of neurocognitive variables between yoga (experimental) and nonyoga (control) training group

Neurocognitive variables	Yoga training group, mean±SD			Non-yoga training group, mean±SD		
	Pretest	Midtest (pre versus mid)	Posttest (pre versus post)	Pretest	Midtest (pre versus mid)	Postest (pre versus post)
Auditory reaction time (ms) (male) (*n*=20)	245.81±40.97	219.80±30.76***	196.95±16.62***	242.50±44.07	243.72±42.66	237.73±39.90
Auditory reaction time (ms) (female) (*n*=15)	281.65±62.33	249.03±56.58**	229.18±38.88***	283.15±73.45	286.05±72.16	284.71±73.35
Visual reaction time (ms) (male) (*n*=20)	281.11±59.29	253.66±60.57***	225.84±36.74***	280.97±39.76	281.65±41.20	279.74±34.84
Visual reaction time (ms) (female) (*n*=15)	317.92±54.83	284.28±50.82	261.54±54.30	321.66±84.27	327.50±81.66	328.97±83.22
Short term memory (counts) (male) (*n*=20)	6.93±1.75	7.40±1.47	8.93±0.88***	6.67±1.14	6.63±1.42	6.80±1.28
Short term memory (counts) (female) (*n*=15)	7.12±1.25	8.00±0.92	8.62±1.06***	7.35±1.28	7.14±1.65	7.50±1.14

*P<0.01, **P<0.01 and ***P<0.001, RMANOVA, with a *post hoc* analysis comparing the values at baseline (pretest), 6 weeks (midtest) and 12 weeks (posttest). SD: Standard deviation, RMANOVA: Repeated-measures analysis of variance

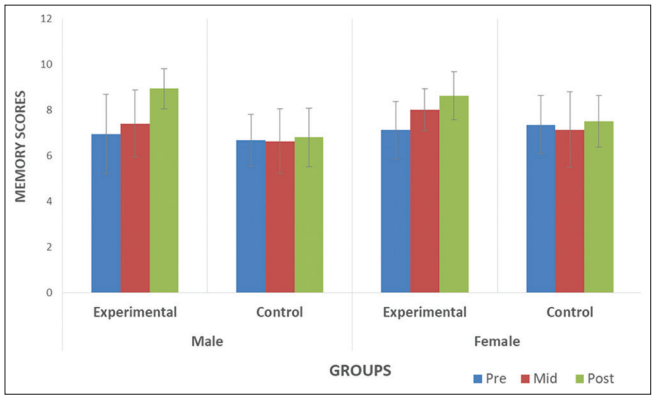

Figure 3: Short-term memory

association and performance.[18] It involves a central neural mechanism and also an index of cortical arousal.[18] A decrease in RT indicates improved sensory-motor performance and enhanced processing ability of the central nervous system. Finally, a decrease in ART and VRT clearly expresses a positive improvement in the sensory-motor processing ability that may broadly interpret as the development of central nervous system functions. Therefore, from the findings of the present study, it may be concluded that yogic intervention for a period of 12 weeks positively improved this processing ability by (i) the higher rate of information processing, (ii) improving the power of concentration and the ability to ignore extraneous stimuli factors, (iii) higher arousal and the ability of faster information processing could be understood as the alterations in afferent inputs and efferent outputs, which may further control the activity of ascending and descending activity of the reticular system in thalamo-cortical levels, and (iv) a decrease in sympathetic activity and increased parasympathetic activity may enhance the concentration ability and bring deep psychosomatic relaxation and decrease in oxygen consumption. All these above possible mechanisms may be attributed to the decrease of visual and ART. From the above discussion, it may be concluded that a combined yoga regimen in the middle-aged group may improve attention and alertness as reflected through the RT results.

In the present study, researcher evaluates the effect of yogic training on short-term memory in a middle-aged group. It was found that short-term memory was improved significantly in the form of the serial learning score after 6th and 12th weeks of yoga training. From the evidence, it could be observed that aging may disrupt old memory and the processing of new memory. Yoga is a type of mind-body intervention, regular practice of which helps to improve individual memory, which includes perception, concentration, and attention span.[19] Naveen *et al*. studied the impact of uninostril breathing on verbal and spatial memory tests in school children. On the basis of different breathing practices, all the students were randomly categorized into four groups, i.e., (a) right nostril breathing, (b) left nostril breathing, (c) alternate nostril breathing, or (d) breath awareness without manipulation of nostrils. They found a significant increase in spatial memory scores in all four experimental groups after 10 days of yoga breathing practice, but no such change was observed in the control group.[20] Sahaj yoga practice can lead to an improvement in verbal working memory[21] and breathing through the left nostril able to increase the spatial cognitive task.[22] In a study, Subramanya and Telles reported that memory scores were improved immediately after the practice of cyclic meditation.[23] The yogic education system improves visual and verbal memory scores in school boys compared to the modern education system.[24]

In the present study, short-term memory in the form of serial learning scores significantly improved after yogic practices in the middle-aged group. It can be interpreted as (i) Anxiety inhibit memory development, whereas yoga practice reduced anxiety may improve memory scores;[25] (ii) Right hemispheric (nonverbal, spatial memory) and left hemispheric (verbal memory) improvement after yogic training may have a positive effect on memory development;[24] (iii) Yogic practices decrease psychophysiological scores of arousals, and sympathetic activity may alter hypothalamic functions, which is considered the highest center for autonomic regulations;[22-24] (iv) Regular Yoga practice positively improves the concentration, attention span, and visuomotor speed, which may influence memory by large; and (v) some practices of yogic technique modulate the function of

hypothalamic-hypophyseal adrenal axis, thereby may bring an efficient neural effector communication, thus affecting the expression of neurotrophic factors that may influence the neurotransmitter like serotonin, norepinephrine and produce an effective improvement in different cognitive domains like memory[22]

Limitations of the study

i. Not a randomized control trial
ii. The study participants did not attend any residential camp.

Conclusion

On the basis of an elaborate discussion of the present research findings, now it may be concluded that combined yoga module (*surya namaskar, kriya, asana, pranayama, and dhyana*) has a positive influence on the neurocognitive function in middle-aged group that concomitantly promote healthy aging.

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Conflicts of interest

There are no conflicts of interest.

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