

Short Communication

Mirror tracing task in yoga practitioners and non-yoga practitioners: A cross-sectional comparative study

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Received : 07 October 2020

Accepted : 13 June 2021

Published : 10 August 2021

DOI

10.25259/IJPP_293_2020

Quick Response Code:



ABSTRACT

Objectives: The present study compared yoga practitioners with age- and gender-matched yoga naïve persons on performance in a mirror tracing task which involved tracing a star pattern on a sheet of paper while looking at its reflection in a mirror.

Materials and Methods: The present cross-sectional study included twenty yoga practitioners of both sexes (15 females; group mean age \pm SD; 24.8 ± 3.4 years) and twenty yoga naïve persons (15 females; group mean age \pm SD; 24.2 ± 3.8 years) of the same age range. Both groups were assessed for performance in the mirror tracing task in three trials. The distance covered, total errors, and time taken to complete the task were noted.

Results: Yoga practitioners made significantly less errors ($P < 0.05$) in the third trial and covered greater distance in star tracing in the first ($P < 0.05$) and second ($P < 0.05$) trials compared to yoga naïve participants. Mann-Whitney U-test was used for all comparisons.

Conclusion: Yoga practice may be useful to facilitate learning in the tasks that require better perceptual and motor skills.

Keywords: Mirror tracing task, Yoga practitioners, Motor skill learning, Visuomotor adaptation, Hand coordination

INTRODUCTION

The mirror tracing task is used to assess motor skill learning and has been used in behavioral sciences since 1910.^[1] The task involves tracing a shape (usually a polygon, such as a star) on a sheet of paper by seeing its reflection in a mirror. A mirror flips the image by 180° about a vertical plane due to which the movements of the hand appear in the opposite direction. This creates confusion in perceiving and tracing the shape, hence the task requires optimal visuomotor adaptation to efficiently perceive aberrant visual information and facilitate tuned hand movements.^[2]

Previously, the practice of yoga has been shown to improve motor functions such as hand steadiness,^[3] finger dexterity,^[4] and the ability to repetitively move fingers.^[5] A subsequent study reported better performance in a mirror tracing task following 1 month of yoga breathing.^[6] In the study, 26 participants who were attending a residential yoga program were compared with an equal number of participants of the comparable age who carried out their routine activities. After 1 month, the yoga group showed an increase in the number of circles crossed for both hands

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(Cohen's $d = 1.25$ and 1.22 , respectively) and a decrease in the number of circles left out for the right hand (Cohen's $d = 0.56$), while the control group showed a significant increase in the number of circles crossed for the left hand alone (Cohen's $d = 0.43$). In another study on persons who had a history of substance abuse, 66 participants were randomized to yoga or physical exercise for a duration of 12 weeks and were assessed for motor performance including the mirror tracing task.^[7] The study reported a significant reduction in time taken in mirror tracing after both 12 weeks of yoga (Cohen's $d = 0.433$) and physical exercise (Cohen's $d = 0.446$) along with a significant median decrease in mirror error score after 12 weeks of yoga.

The present study is an attempt to see the long-term effects of yoga on visuomotor performance. To meet this aim, yoga practitioners with a long duration of experience of yoga were compared with persons naïve to yoga for performance in a mirror tracing task involving an age- and gender-matched sample.

MATERIALS AND METHODS

Participants

Forty participants (group average age \pm SD; 24.5 ± 3.6 years) who belonged to two categories: (i) Yoga practitioners ($n = 20$; 5 males; group average age \pm SD; 24.8 ± 3.4 years) and (ii) naïve to yoga persons ($n = 20$; 5 males; group average age \pm SD; 24.2 ± 3.8 years), took part in the study. The yoga practitioners had an average experience of 4.6 ± 3 years (ranged between 6 and 120 months) and were practicing yoga for an average of 84 ± 31.1 min/day (ranged between 30 and 120 min/day) for 5 days/week on an average. The participants of the yoga group were recruited from a yoga center located in North India where they were trained in the following aspects of traditional yoga: Postures (*asana*), voluntarily regulated breathing techniques (*pranayama*), guided relaxation, meditation, and philosophical principles of yoga such as *yama* and *niyama*. Naïve to yoga persons were from the same institution but had no experience of yoga. The sample size was calculated from an earlier study in which performance in a mirror tracing task was assessed at the beginning and end of 1 month of yoga training.^[6] The required sample size ($n = 12$ in each group) was obtained using Cohen's formula for the effect size 1.25, with an alpha of 0.05, powered at 0.99 using the G power program.^[8] The effect size was calculated from the mean and standard deviation of the number of circles traced for a mirror star tracing task from left hand which was significantly changed in the study.^[6]

The participants had to (i) be willing to take part in the study, (ii) have normal health based on a routine clinical checkup, (iii) be in the age range between 20 and 35 years, and (iv) have at least 6 months of yoga experience to be included in the

yoga group and no prior experience of yoga to be included in the naïve to yoga group. The criteria for exclusion were (i) left hand dominance based on the Edinburgh handedness inventory^[9] and (ii) impaired cognitive or motor functions. All the participants were individually explained about the study and their signed informed consent was obtained. The study had approval of the Institutional Ethics Committee of the Patanjali Research Foundation (approval number: YRD-017/035). The participation was voluntary and no incentive was given to participate in the study. [Table 1] shows the demographic details of the participants.

Design

This study was a single blind cross-sectional comparative trial carried out to compare the performance in a mirror tracing task of participants with and without prior experience in yoga. The assessor was blinded to the groups to which the participants belonged. The study was carried out in a physiology research lab in North India. The assessments were taken approximately 2 h after brief breakfast. The participants were first seated in a chair comfortably and were given a rest for 10 min. They were informed about the study in detail and the procedures and their queries were answered if any before the assessments. The assessment cabin was adequately lit, sound attenuated and the temperature was kept at 25°C .

The information about the yoga experience was based on these questions in the socio-demographic data sheet: (i) Do you have any experience of yoga practice? (ii) If your answer was yes for the previous question then please mention (a) the

Table 1: Demographic details of the participants.

S. No.	Information	Yoga group	Naïve to yoga
1.	Number of participants	20 (14 females)	20 (14 females)
2.	Age in years (mean \pm SD)	24.8 \pm 3.4	24.2 \pm 3.8
3.	Years of education (range)	12–17	12–18
4.	Marital status (married: unmarried)	1:19	4:16
5.	Experience of yoga practice (mean \pm SD in years)	4.6 \pm 3	Not applicable
6.	Type of diet (vegetarian: non-vegetarian)	20:0	17:3
7.	Consumption of alcohol (number)	0	0
8.	Consumption of tobacco including smoking (number)	0	0

duration of yoga experience in months, (b) frequency of yoga practice/week, and (c) duration of yoga practice/day.

Assessment of mirror tracing task

The mirror tracing task involved tracing a six-pointed star on a sheet of paper with a pencil while looking in a mirror to see the sheet and the movements of the hand. The star was printed in double lines with a distance of 0.4 cm between the inner and outer contour. The length of each edge of inner and outer star measured 5.6 cm and 6.6 cm, respectively; hence, the perimeter of inner and outer star was 33.6 cm and 39.6 cm, respectively. The apparatus (Anand Agencies, Pune, India) had an adjustable metal shield to prevent the participants from looking at the tracing sheet directly. The star was oriented one point faced down, one point faced up, two points faced left, and two points faced right sides. The participants were seated comfortably on a chair and were asked to trace the star within the boundaries of the double line by viewing it through the mirror. There were three trials, first tracing the star clockwise with the left hand followed by tracing the star anticlockwise with the right hand and finally tracing the star clockwise with the left hand. After each trial, there was a period of rest for 15 s.

Scoring and data extraction

Scoring was done by a person to whom the information about participants' group was not disclosed. Drawing outside the star pattern by more than 2 mm was counted as an error. The variables noted were (i) number of errors, (ii) time taken to trace the star, and (iii) total distance traced. The time taken to trace the star was noted using a stopwatch with precision up to 1/100 s. The distance traced was measured using a measuring scale with precision up to 1/10 centimeter.

Statistical analysis

Data were analyzed using SPSS (Version 24.0). Shapiro–Wilk test was performed to check the normality of the data.

Between groups comparisons

The two groups were compared with Mann–Whitney U-test for (i) number of errors, (ii) time taken to trace the star, and (iii) total distance traced.

Within groups comparisons

In both groups, trial 1 was compared with trial 2 and trial 2 was compared with trial 3 using Wilcoxon paired signed-ranks test to determine the practice effect in tracing the star.

Correlation analysis

The three variables, that is, (i) number of errors, (ii) time taken to trace the star, and (iii) total distance traced were

tested for correlation with (i) the months of yoga experience and (ii) frequency of yoga practice in the yoga group using the Spearman's rank correlation test.

RESULTS

The Shapiro–Wilk test showed that the data were not normally distributed. Therefore, a non-parametric test, namely, Mann–Whitney U-test was used to compare the two groups.

Between groups comparisons

Mann–Whitney U-test showed that yoga practitioners made significantly fewer errors in the third trial ($P < 0.05$) than yoga naïve participants. Furthermore, yoga practitioners covered significantly more distance in star tracing in the first ($P < 0.05$) and the second trials ($P < 0.05$), respectively, compared to yoga naïve participants. No other significant differences were found between the two groups. The group mean values \pm SD for the variables studied are given in [Table 2].

Within groups comparisons

Wilcoxon paired signed-ranks test showed that the time taken in trial 2 was significantly less than the time taken in trial 1 in the yoga group ($P < 0.05$, $Z = 1.99$). No other significant differences were found within groups.

Correlation analysis

Spearman's rank correlation test showed a significant positive correlation between the months of yoga experience and (i) the total distance traced in trial 1 ($P < 0.05$, $r = 0.477$), (ii) the total distance traced in trial 2 ($P < 0.01$, $r = 0.570$), and (iii) the total distance traced in trial 3 ($P < 0.05$, $r = 0.529$) in yoga group. Furthermore, the number of errors in trial 1 was negatively correlated with the yoga experience ($P < 0.05$, $r = -0.489$). No other significant correlations were found.

DISCUSSION

Yoga practitioners showed better performance than yoga naïve persons in a mirror tracing task. Yoga practitioners made 96.9% fewer errors in the third trial compared to yoga naïve persons. Yoga practitioners covered 14.5% more distance in the first trial and 7.1% more distance in the second trial compared to yoga naïve persons. In addition, there was a positive correlation between the experience of yoga in months and the distance traced in all three trials while the number of errors in trial 1 was negatively correlated with the experience of yoga. The time taken to complete mirror tracing was significantly reduced in trial 2 compared to trial 1 in yoga group while there was no significant difference in yoga naïve group. This indicates

Table 2: Comparison between yoga practitioners and yoga naïve participants for the mirror star tracing task using Mann–Whitney U-test.

Variables	Yoga practitioners	Yoga naïve	Z-values	U-values	P-values
Time taken in trial 1 (sec)	160.3±68.14	215.75±142.5	-0.879	167.5	0.38
Time taken in trial 2 (sec)	134.35±84.64	177.35±111.88	-1.15	157.5	0.25
Time taken in trial 3 (sec)	98.05±30.13	143.4±83.94	-1.583	141.5	0.11
Errors in trial 1 (counts)	2±3.55	3.1±2.92	-2.003	129	0.05
Errors in trial 2 (counts)	1.6±2.26	2.45±2.48	-1.295	154.5	0.2
Errors in trial 3 (counts)	0.85±1.84	2.45±2.35	-2.665	109	0.01
Distance covered in trial 1 (cm)	35.2±2.2	30.455±10.39	-2.612	114.5	0.01
Distance covered in trial 2 (cm)	35.03±3.23	32.635±4.88	-2.688	112	0.01
Distance covered in trial 3 (cm)	34.85±2.28	32.83±4.96	-1.756	142.5	0.08

that yoga experience may facilitate learning tasks requiring visuomotor coordination.

Mirror tracing involves drawing visually distorted patterns which requires specific perceptual and motor skills such as motor learning, eye hand coordination, fine-tuned hand movements, and re-orienting and drawing an object presented as a mirror image.^[2] Yoga practice comprises physical postures (*asana*), regulated breathing (*pranayama*), relaxation and meditation (*dhyana*), and a sense of inward-awareness.^[10,11]

Previously, yoga practice for 30 days improved motor learning based on a maze learning task in 31 adults of both sexes.^[12] The subjects underwent a residential yoga training program for 30 days and were compared with 31 adults who did not receive yoga training and served as control. After 30 days of yoga training, there was a decrease in time taken to complete the maze and number of errors.

A suggestion of eye hand co-ordination and fine-tuned hand movements following yoga is inferred from previous studies of improved hand steadiness^[3] and tweezer dexterity scores.^[4] Hand steadiness was tested in two groups of children ($n = 45$ each), of which one group was given yoga training for 10 days and another served as a control. Yoga group showed a decrease in errors following 10 days of yoga training while control group did not show any significant changes. In another study, 80 adults were divided into yoga and non-yoga groups and were assessed for tweezer dexterity task. One group underwent 30 days of yoga training and the other group continued their routine activities. The tweezer dexterity task scores were higher at the end of 30 days of yoga training while no significant changes were reported in non-yoga group.

The present results are comparable with the previous studies in which performance of mirror tracing was improved after 1 month of yoga training,^[6] as well as after 20 min of yoga based meditation.^[13] These studies along with the findings of the present study suggest that yoga practice for both short and long durations has similar effects on motor and learning task performance. However, a study on 6th grade students randomized to yoga or physical education for 15 weeks did

not find significant differences in physiological response to mental arithmetic and mirror tracing tasks.^[14] This suggests age to be a factor which might influence the motor skills learning effects of yoga.

A plausible explanation of the present results is that yoga practice helps facilitating a relaxed but alert mental state^[15] which might have contributed to better performance in the mirror tracing task. Higher levels of anxiety have been shown to deteriorate the ability to maintain attentional focus^[16] and motor learning.^[17] A meta analyses of 8 RCTs with 319 participants concluded that yoga can be effective for a reduction in anxiety suggesting its role in facilitating a relaxed mental state. Yoga practice for 30 days altered heart rate variability indices such as an increase in pNN50 and a reduction in LF power among other changes^[18] suggesting a shift in sympathovagal balance toward parasympathetic dominance. Yoga practice improved scores of digit span forward, digit span backward and letter number sequencing in 43 adults suggesting an improvement in attention and cognition.^[19] Separately, components of yoga practice such as meditation and yoga breathing (*pranayama*) showed improvement in tasks requiring attention along with a simultaneous decrease in measures of sympathetic arousal.^[20,21] Such physiological effects of yoga practices may be attributed to the changes seen in the present study.

The present study is limited with the possibility that some factors might have influenced the results which however would be associated with both groups. Such factors include baseline levels of anxiety and/or blood pressure since they can influence visuomotor coordination.^[22,23] These factors were not measured which is a limitation of the present study. Therefore, these observations should be considered as an affirmation of the earlier reports.

CONCLUSION

Yoga practice may be useful to facilitate learning in the tasks that require better perceptual and motor skills, such as motor learning, adapting to new visuomotor coordination, and fine-tuned hand movements.

Declaration of participants consent

Institutional Review Board (IRB) permission obtained for the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Kala N, Pal S, Sharma SK, Telles S, Balkrishna A. Mirror tracing task in yoga practitioners and non-yoga practitioners: A cross-sectional comparative study. *Indian J Physiol Pharmacol* 2021;65(2):127-31.