

answer the second question, i.e., whether mirror star tracing is influenced by re-testing. Hence this is not a randomized controlled trial and the control group served solely to understand the re-test effect.

METHODS

Subjects

There were two groups, Yoga and Control. The yoga group consisted of 26 subjects (12 female) who had elected to join a one-month residential yoga training program. Their ages ranged between 18 and 45 years (group average age \pm S.D., 25.7 ± 7.1 years). The control group of 26 subjects (11 female), were within the same age range as the yoga group. All subjects had normal health based on a routine clinical examination and were right hand dominant based on the Edinburgh handedness inventory (6). The two groups were not matched in any other way. Hence the control group served to assess the re-test effect on performance in the task. The volunteers of both groups had all completed their graduation (minimum) and were all office ('white collar') workers.

Design

Assessments were made at the beginning (initial) and end (final) of a thirty day period during which the yoga group received training in yoga while the control group carried on with their routine activities. For both groups the testing (pre and post) was between 10.00 a.m. and 12 noon. The project was reviewed and approved by the Institutional Ethics Committee.

Assessment

The task involved filling in the outline

of a six-pointed star while looking in a mirror to observe the movements of the hand (7). A shield prevented the subject from looking directly at the pattern which was placed on a board and was visible in the mirror (Anand Agencies, Pune, India). The outline of the star consisted of 60 circles, each circle approximately 4 mm in diameter. The star was placed so that two points faced up or down and one point faced right or left. Alternate subjects were asked to begin tracing with either the right hand or with the left hand. This order was kept the same at the final assessment. Tracing with either hand began from mid-way between the two lower points, and then proceeded either clockwise (with the left hand) or anti-clockwise (with the right hand).

The volunteers were asked to trace the outline of the star passing through as many circles as possible within one minute. Hence the total number of circles crossed in one minute need not be 60, i.e., they may not have been able to pass through all the circles in one minute. The numbers of circles crossed and left out were calculated from the point of starting till the end-point, i.e., the circle reached at the end of one minute. In the process of moving along the outline volunteers would (i) cross circles which is what they are meant to do, and (ii) leave out circles - which is considered as an error. The variables noted were: (i) number of circles crossed, and (ii) number of circles left out.

Training in yoga

The yoga group received training in physical postures (*asanas*, 90 minutes), cleansing practices (*kriyas*, 30 minutes), yoga voluntarily controlled breathing (*pranayama*, 60 minutes), meditation (60 minutes), devotional sessions (90 minutes)

and lectures on the theory of yoga (60 minutes).

The asanas which were practiced every day included: *ardhacati cakrasana*, *ardha cakrasana*, *padahastasana*, *ardha matsyendrasana*, *paschimottanasana*, *ustrasana*, *matsyasana*, *salabhasana*, and *cakrasana*. The *kriyas* were: *trataka* (daily) and *jala neti* and *vaman dhauti* (twice in a week). The *pranayama* practices included *brahmari*, *nadisuddhi*, *sitali*, *sitkari*, and *sadanta pranyamas*, as well as sectional breathing (with attention shifting from the abdomen, to the chest, and to the clavicular (upper) part).

Data analysis

The non-parametric Wilcoxon paired signed ranks test was used for Initial-Final comparisons of the data of the two groups. This test was selected as the data did not have equal variance and a normal distribution.

RESULTS

The Yoga group showed a significant increase in number of circles crossed for both the right and the left hands at the final assessment compared to the initial values ($P < 0.001$, in both cases). The Yoga group also

showed a significant decrease in the number of circles left out when using the right hand, at the final assessment ($P < 0.05$). The Control group showed a significant increase in the number of circles crossed using the left hand at final assessment compared to the initial assessment ($P < 0.05$). There was no change for the right hand or for the number of circles missed (for both hands) at the final assessment compared to the initial values. There was no significant difference between the initial values of the two groups ($P > 0.05$, for all comparisons, Mann-Whitney U test). The group average values \pm S.D. are given in Table I.

DISCUSSION

The Yoga group showed a significant improvement in the performance in a mirror tracing task at the end of a one-month program, in terms of an increase in the number of circles crossed (when using either hand) and a decrease in the number of circles left out using the right hand. The control group showed an increase in the number of circles crossed using the left hand at the end of thirty days.

There has been no study on the effect of

TABLE I: Number of circles traced and missed in one minute during a mirror star tracing task before and after a month in yoga and control groups. Values are group Mean \pm S.D.

Groups	Number of circles traced				Number of circles missed			
	Right hand		Left hand		Right hand		Left hand	
	Before	After	Before	After	Before	After	Before	After
Yoga (n=26)	18.7 \pm 12.4	36.2 \pm 15.5***	22.7 \pm 13.4	42.7 \pm 18.8***	0.4 \pm 0.7	0.1 \pm 0.3*	1.0 \pm 1.4	0.9 \pm 1.2
Control (n=26)	19.3 \pm 10.2	23.1 \pm 9.6	21.9 \pm 12.5	27.3 \pm 12.6*	1.5 \pm 3.6	1.0 \pm 1.3	1.7 \pm 3.3	2.0 \pm 2.0

* $P < 0.05$, *** $P < 0.001$, Wilcoxon paired signed ranks test, for 'After' values compared to 'Before'.

yoga practice on performance in a mirror tracing task. However mirror tracing was used not as a motor task but as one of three laboratory stressors in practitioners of transcendental meditation (TM), and the salivary cortisol levels were measured (8). The practice of TM was associated with lower plasma cortisol suggesting that meditation reduced the 'stress' associated with performing the mirror tracing task.

The fact that the control group also showed an improvement (though of a lesser magnitude) in the task performance can be explained as a beneficial effect of practice on testing. This was also shown in an earlier study where the improvement seen in a mirror tracing task over twelve repeat sessions was retained four months later (9). Also, the initial improvement (i.e., after 1 or 2 trials) was greater for the non-dominant hand. The fact that the non-dominant hand improves with re-testing may explain why the left hand performance showed an improvement in the control group. The control group consisted of office workers in offices and factories close to the yoga center. There is no reason to expect that their routine activities at work or at home could

have influenced their performance in the mirror star tracing task. However it has to be emphasized that since a detailed account of their activities was not noted hence this possibility cannot be ruled out.

The yoga group showed an increase in the number of circles traversed in a minute suggesting an improvement in speed. The other change following yoga was a decrease in the number of circles left out during the one-minute traverse. This reduction suggests an improvement in accuracy.

In a previous study the motivation to learn yoga was found to influence the performance in a tweezer dexterity task (5). Hence higher motivation levels in yoga-learners may have also contributed to the improved performance in the mirror tracing task.

In summary, the present results suggest that a month of yoga training brings about an improvement in a mirror tracing task. The motivation to learn yoga may have also influenced the results. However further studies using a randomized controlled design could substantiate these preliminary findings.

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