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A RANDOMIZED TRIAL COMPARING THE EFFECTS OF YOGA AND PHYSICAL ACTIVITY PROGRAMS ON DEPTH PERCEPTION IN SCHOOL CHILDREN

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Abstract: The present study was intended to compare the effects of two programs (yoga and physical activity), each of one-month duration on depth perception. Thirty two girls (aged between 10 and 11 years) in a residential school were matched as pairs for age and randomly assigned to the two groups. The groups practiced the assigned interventions as 75 minutes every day for 7 days a week. Depth perception was assessed using a standard apparatus measuring errors in 5 trials per subject. At the end of the month the yoga group showed a significant decrease in errors 26.5% (Kruskal-Wallis test for tied ranks), compared to the physical activity group, who showed no change. The significant improvement in the yoga group in depth perception compared to the physical training group, was speculated to be related to lower anxiety levels which have been proven to be associated with better visual perception.

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INTRODUCTION

Depth perception is an ability to judge the direction and the distance of an object relative to oneself (Sekuler & Blake, 1994). This process of reacting quickly and accurately requires knowing where the object is located in three-dimensional space. Depth perception is essential to carry out diverse daily activities (e.g., driving or sports). Depth perception is important for sports players and physical activity influences visual acuity and perception. Visual acuity was seen to improve following exercise on the Harvard Step Test in 5 subjects (Vlahov, 1977). In another study, psychological measures of mood and perceptual speed were administered to 64 subjects prior to and immediately after either vigorous exercise or as a contrast after a hobby class (Litchman & Poser, 1983). It was reported that physical activity was associated with incremental changes in mood, mental functioning and visual perceptual speed, of greater magnitude than the contrast activity.

Physical activity is one of the aspects of yoga, which is an ancient Indian science and way of life. Yoga includes several techniques: physical postures (*asanas*), voluntarily regulated breathing (*pranayama*), meditation, and philosophical concepts (Nagarathna & Nagendra, 1985). A mindfulness meditation derived from the Buddhist tradition, when practiced for long periods, produced definite changes in perception, attention, and cognition (Brown, 1977). Significant changes were reported in the visual perception of advanced meditators, who were able to distinguish subtle differences in color and shade, and were on the whole more perceptually sensitive than non-meditators (Brown & Engler, 1980). Another study described an increase in visual sensitivity following the practice of the mindfulness Buddhist meditation (Brown, Forte & Dysart, 1984). Subjects were able to detect shorter light flashes and they required a shorter interval to differentiate between successive flashes correctly after learning meditation. In contrast, a non-meditation group showed no change. Studies on the effects of various yoga practices including meditation showed that depth perception, improved following a 30 day yoga training camp in adults (Raghuraj & Telles, 2002).

Hence there is evidence that both physical activity and yoga (which includes physical postures) improves different aspects of visual perception. However the two types of practices were not studied simultaneously in the same population. Also, the effect of yoga on depth perception in children was not studied. The present study was designed to compare the effects of two interventions viz., yoga and physical training of the same duration on depth perception in children.

METHOD

Subjects

34 girls between the ages of 10 and 11 years in a residential school in the suburbs of Bangalore City, in South India, were considered for the study. Since this was a residential school, the children had similar living and studying conditions. The signed informed consent was obtained from the teachers as guardians of the children. Two girls who were unable to understand the test procedure were left out of the study hence the 'n' was 32. All the subjects had normal vision.

Design

The 32 subjects were considered as 16 pairs matched for age (± 6 months). Subjects of a pair were randomly assigned to two groups, viz. a yoga group with an average age ± SD, 10.25 ± 0.45 years, and a physical training group with an average age ± SD, 10.19 ± 0.40 years, using a standard random number table (Jones, 1996). The yoga group received training in yoga, which included physical postures, instructions to relax, and awareness of physical and other sensations (detailed below). The physical training group was given physical training, so that this group would also have physical activity, but without instructions about relaxation and awareness. Both groups were assessed at the beginning and end of a month, during which they carried on their respective practices. Different people were involved in (i) taking the assessments and (ii) in giving the interventions (i.e., yoga or physical activity).

Assessment

Depth perception was recorded using a standard electronic apparatus (Model DP 129, Medicaid, Chandigarh, India) (Weiss, Kimmel & Stein, 1993). The equipment consisted of three vertical rods mounted in a box, illuminated with two fluorescent tubes. The subjects viewed the rods through an aperture (4.0 cm X 8.1 cm). Assessments were carried out in a darkened room with no other illumination. Subjects were seated at a distance of 2.5 m from the center of the apparatus. The subjects were required to align the central moveable rod accurately between the two stationary rods on either side. They used a remote control device to align the rods. Each subject was assessed in 5 trials moving the central rod forward using the remote control device. The measurement obtained was error for distance in cm, which was the difference from that reading at which the three rods were accurately aligned. The minimal error which could be detected was 1 mm. The averages of the 5 values obtained were used for analysis. This reading was available to the experimenter alone, as a digital display on a panel on the apparatus.

Yoga

The yoga training included physical postures (*asanas* and loosening exercises, 20 minutes), voluntarily regulated breathing (*pranayama*, 15 minutes), internal cleansing practices including visual exercises (*kriyas*, 20 minutes), meditation and relaxation techniques (20 minutes). The yoga practices were two sessions, one in the morning (30 minutes) and another in the evening (45 minutes), for 7 days a week.

Physical training

Physical training consisted of standing exercises (e.g., bending forwards and backwards, sideways, twisting), sit-ups and sitting exercises, jogging, and lifting weights. This program also consisted of two sessions, one in the morning (30 minutes) and the other in the evening (45 minutes), for 7 days a week.

Analysis

(1) The average of 5 trials of Day 1 and the average of 5 trials of Day 30 of both groups were not normally distributed and were of unequal variance. Hence the Kruskal-Wallis test for tied ranks was used for analysis (Zar, 1984). The multiple-comparisons, non-parametric Tukey-test was used to compare the mean values of the groups in pre-post comparisons. (2) Further analysis was done using the Wilcoxon signed ranks test to compare the individual trials of Day 1 versus Day 30 for both groups (for e.g., Trial 1 on Day 1 vs Trial 1on Day 30). (3) To understand whether perceptual learning occurred with 5 repeat trials, comparisons were made between trials 1, 2, 3 or 4 versus the last trial i.e., Trial 5 separately on Day 1 and Day 30 for both groups using the Wilcoxon signed ranks test.

RESULTS

The group mean values (with 95% C.I.) of error for distance of depth perception for both groups on Day1 and Day 30 are given in Table 1.

1) The Kruskal-Wallis test using the data of average of 5 trials on Day1 and Day 30 for both groups:

The Kruskal-Wallis test for tied ranks showed a significant decrease in the error for distance in the yoga group (since $H = 9.54$, $\chi^2_{0.025,3} = 9.34$, hence $P<0.025$). There was no change in the physical training group. The multiple-comparison, non-parametric Tukey test revealed a significant difference between the mean rank of the error for distance of the yoga group on Day 30 compared to the mean rank on Day 30 of the physical training group ($q = 4.01$ where $q_{0.025,\infty,4} = 3.98$, hence $P<0.025$) (Wilcoxon & Wilcox, 1964). There was no significant difference between the yoga and physical training groups on Day 1 showing no difference at baseline and between the Day 1 and Day 30 values for either group.

2) The Wilcoxon signed ranks test comparing individual trials on Day 1 versus Day 30 (e.g., Trial 1 on Day 1 versus Trial 1 on Day 30):

The yoga group showed a significant reduction in the error for distance on Day 1 versus Day 30 for trials 3, 4, and 5 ($P<0.01$, $P<0.01$, and $P<0.01$, respectively) and for Trials 1 and 2 there were no significant changes. The physical training group did not produce any change.

3) The Wilcoxon signed ranks test comparing the changes between the last trial (i.e., Trial 5 versus Trials 1 to 4) separately on Day 1 and Day 30

The yoga group showed a significant reduction in the error for distance on Day 1 of Trial 1 vs Trial 5 ($P<0.05$). Comparisons between other trials on Day 1 in the yoga group did not show any significant changes. On Day 30 the yoga group showed a significant reduction in the error for distance between the following trials: Trial 1 versus Trial 2 ($P<0.02$), Trial 1 versus Trial 4 ($P<0.01$), and Trial 1 versus Trial 5 ($P<0.01$). The comparison between Trial 1 versus Trial 3 on Day 30 did not show any significant change. There were no changes observed in the physical training group.

Table 1: Error of Depth Perception in Yoga and Physical Training groups (n=16 each). Values are group mean (with 95% C.I.)

ERRORS (cm)				
	Yoga		Physical Training	
Trials	Day 1	Day 30	Day1	Day 30
Trial 1	0.90 (0.47 to 1.32)	1.14 (0.08 to2.19)	0.76 (0.34 to 1.18)	1.12 (0.28 to 1.96)
Trial 2	0.82 (0.33 to 1.31)	0.55# (0.02 to 1.08)	0.90 (0.49 to 1.30)	1.26 (0.64 to 1.88)
Trial 3	1.03 (0.48 to 1.53)	0.60† (0.06 to 1.27)	1.05 (0.47 to 1.64)	1.05 (0.43 to 1.66)
Trial 4	0.91 (0.49 to 1.34)	0.31†§ (0.00 to 0.61)	0.98 (0.50 to 1.45)	1.20 (0.46 to 1.94)
Trial 5	0.50♦ (0.30 to 0.70)	0.20†§ (0.04 to 0.35)	0.96 (0.49 to 1.46)	1.08 (0.31 to 1.86)
Average of 5 trials	0.83 (1.49 to 1.16)	0.61 * (1.17 to 1.09)	0.99 (0.59 to 1.38)	1.13 (0.70 to 1.56)

DISCUSSION

The present study compared the effects of a month of two interventions (yoga or physical training) on depth perception in school children. It was found that in the yoga group the error of depth perception following one month of practice was significantly less than that of the physical training group at the end of the same period.

An improvement in depth perception following yoga training has already been reported in adults following a one-month camp (Raghuraj & Telles, 2002). Other aspects of visual perception (viz., optical illusion and flicker fusion frequency) also improved after yoga training in adult volunteers (Ramanavani, Nagarathna, Nagendra & Telles, 1997; Telles, Nagarathna, & Nagendra, 1995). These results were similar to those reported earlier, with reference to other aspects of improved visual perception following yoga. For example, detection of a flickering stimulus was possible at a higher frequency following a month of yoga training compared to before (Ramanavani, Nagarathna, Nagendra & Telles, 1997; Telles, Nagarathna, & Nagendra, 1995). Repetition of the test as five successive trials appears to improve performance, as the number of errors for the distance of the yoga group decreased significantly between Trial 5 and Trial 1 recorded on Day 1. This trend was seen more clearly on Day 30. The physical training group did not show such a trend at all. The studies cited above were conducted on adult subjects with varying duration of yoga training. A similar study on children who practiced yoga for 10 days showed a significant improvement in both critical flicker fusion frequency and optical illusion following yoga practice (Manjunath & Telles, 1999).

In a correlation between the mental state and performance in visual perceptual tasks, it was found that experienced Zen meditators, with experience of one year or more, had lower scores on tests for anxiety and depression, than novices and non-meditators (Tloczynski, Santucci & Astor-Stetson, 2000). They also had lower

illusion levels in Müller-Lyer and Poggendorff illusions. These results suggest that meditation practice reduces anxiety and improves performance in visual perceptual tasks. This may explain the benefits observed in the present study, as the anxiety reducing effects of yoga are well known (Miller, Fletcher & Kabat-Zinn, 1995).

There were no previous studies on the effects of physical activity on depth perception, though accurate depth perception is an important pre-requisite for several physical activities and sports. A study which measured motor and perceptual abilities of three different age groups of elite rhythmic gymnasts showed that motor abilities as well as allied aspects of visual perception were the best in the most experienced group of the three gymnast groups (Kioumourtzoglou, Derri, Mertzanidou & Tzetzis, 1997). Another study examined psychological measures of mood and perceptual speed prior to and immediately after either vigorous exercise or a hobby class (Litchman & Poser, 1983). Physical activity was associated with several incremental changes, including changes in visual perceptual speed of greater magnitude than the contrast group. However, in the present study the physical activity group showed no change in depth perception.

While motivation has been shown to influence the benefits derived from a yoga program (Manjunath & Telles, 1999), it is unlikely that motivation alone influenced the present results, as both yoga and physical activity groups were given the same instructions before the test and had equal interaction with the instructor allotted to them. However it is important to note that while on Day 1 the yoga group showed a decrease in the error for distance at the fifth trial compared to the first trial, the physical training group showed no such decrement in the error for distance with repeat trials. This suggests that in spite of attempting to keep various factors between the groups similar and randomizing subjects of a pair, the yoga group had a higher level of motivation to begin with.

Finally, since yoga practice has been shown to improve different aspects of visual perception in this, and earlier cited studies, further research is needed to understand the mechanisms underlying the improvement.

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