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INCREASE IN VOLUNTARY PULSE RATE REDUCTION ACHIEVED FOLLOWING YOGA TRAINING

To the Editor:

Visceral and glandular responses, which were initially believed to be 'involuntary,' were later shown to be operantly conditioned (Leukel, 1985). Biofeedback uses external visual or auditory cues to learn voluntary control over what was, before learning, an 'involuntary' function. Ancient Indian texts say that through the practice of yoga it is possible to gain mastery over the mind and body (Taimini, 1986).

Scientific studies have attempted to investigate whether yoga practitioners really can control various functions thought to be mainly, if not entirely, involuntary. For example, there have been investigations on claims of yogis to stop the heart beating at will. In one study (Wenger, Bagchi, & Anand, 1961), a decrease in the amplitude of the QRS complex in the electrocardiogram (EKG) was associated with maintained inspiration and there were signs of raised intrathoracic pressure. This suggested that the yogis carried out breath maneuvers, which were responsible for the cardiovascular changes in them. However, an investigation on a single yogi, who remained in an underground pit for eight days, with an absence of electrical activity in the EKG during the period, remained inexplicable to scientists (Kothari, Bordia, & Gupta, 1973). Similarly, it was difficult to explain the extraordinary ability of yoga practitioners of the Tibetan Buddhist meditation, g-Tum-mo yoga, to increase the temperature of their digits by 5–15°C (Benson et al., 1982).

However, in all reports cited above, the participants were experienced practitioners of yoga, who had a long duration of serious commitment to the practice. Hence the present study was planned to assess the effect of yoga on the ability to reduce the pulse rate voluntarily, based on external cues, in participants who were novices to yoga practice.

There were two groups (i.e., yoga and non-yoga, control), with 17 participants in each group. The yoga group group mean was 37.6 ($S.D.$ = 6.3) years, range 22 to 44 years, with four females in the group. These participants were volunteers for a one-month residential yoga-training program. The participants in the non-yoga control group were selected from volunteers working in a factory close to the yoga center and none of them had experience in yoga. They were selected to match the yoga group for gender (i.e., four female participants) and age (±2 years). Hence the age range for this group was between 22 and 45 years, while the group mean age was 38.0 (*S.D.* = 6.3) years. The participants in each group had comparable educational backgrounds. An EKG recording (Standard limb lead II) showed that none of the participants had extra systolic/skipped beats.

Both groups were assessed at the beginning, middle, and end of a month. During the month the yoga group received training in yoga, while the control group carried on with their regular activities. Since the two groups were not matched for other factors (e.g., motivation to learn yoga), assessments made on the non-yoga control group were used exclusively to study the retest effect.

A pulse rate biofeedback apparatus (Recorders & Medicare, Chandigarh, India) with visual cues (i.e., green or red light) was used for participants to voluntarily regulate their pulse rate. A photoplethysmogram transducer was worn on the dorsal side of the distal segment of the right index finger, which was kept immobile. At the start of the experiment, in order to obtain a baseline pulse rate, participants were asked to sit for 15 minutes while the experiment was explained to them. Pulse rates were noted at the end of 15 minutes. The equipment was designed to give beat-to-beat pulse rates based on the inter-beat interval as an electronic display. The initial pulse rate reading was taken as the reference or baseline pulse rate. Subsequently, participants were allowed to view the colored light cues, which were explained to them that a red light corresponded to an increase in pulse rate, while a green light corresponded to a decrease. During a 6-minute session, participants were asked to attempt to voluntarily reduce their pulse rates, aided by the visual, colored light cues. A digital display showed the change in pulse rate, which was available to the experimenter alone. Hence, every 30 seconds actual pulse rates (PR) and the difference (reference PR minus actual PR) were noted. Since the test sessions lasted 6 minutes, there were 12 values for each participant at each assessment. Not all 12 values indicated a decrease in pulse rate (i.e., that the actual PR was less than the reference PR). However, in all sessions there were some reductions in the pulse rate. The reduction of maximum magnitude was noted.

The session duration was fixed at 6 minutes as preliminary studies showed that some participants required at least 5 minutes to be able to reduce their pulse rate. Hence the biofeedback session was used as a means of assessing the pulse rate reduction (and not as therapy). Assessments were carried out on Days 1, 15, and 30.

The yoga group received 30 days training in yoga. The daily program consisted of: postures (*asanas*) for 90 minutes, yoga voluntarily regulated breathing (*pranayama*) for 60 minutes, cleansing practices (*kriyas*) for 30 minutes, meditation on the syllable 'OM' (*Omkara dhyana*) for 20 minutes, devotional sessions for 60 minutes, guided relaxation for 60 minutes, and lectures on the theory and philosophy of yoga, also for 60 minutes.

Two measurements were statistically analyzed. These were: One, the maximum pulse rate reduction (MPRR) obtained during the test period of 6 minutes and, two, the baseline pulse rate (BPR) at the start of the session. A repeated measures analyses of variance (ANOVA) was conducted, with the within-subjects factor being Days (or Trials 1, 2, 3 on Days 1, 15, and 30, respectively) and the between-subjects factor, Groups (i.e., Yoga and Control). The level of significance was set at .05 for the ANOVAs and other tests. A statistical analysis package, SPSS (Version 10), was used.

For MPRR, there was a significant interaction effect for Days and Groups, $F(2, 64) = 24.5$. A significant linear (but not quadratic) day × group interaction also was obtained in a follow-up repeated measures ANOVA, $F(1, 32) = 42.90$, reflecting a significant trend towards a reduction of post- minus pre-MPRR for the yoga group relative to the control group, whose levels showed no change. The specific values were for the yoga group were, Day 1, 7.1; Day 15, 15.9; Day 30, 23.1; for the control group, Day 1, 6.0; Day 15, 5.2; Day 30, 5.2. Several t tests for unpaired data also showed a significant difference between the groups at Day 15 and at Day 30.

For Baseline Pulse Rate (BPR) values, there was no significant interaction effect for Days vs. Groups. However, a follow-up contrast on the two groups showed a significant linear (but not quadratic) effect in the trends across Days, $F(1, 32) = 4.65$. Again, in these data this effect reflected a significant trend toward a reduction of BPR for the yoga group from Day 1 (81.1 bpm) to Day 15 (73.9 bpm) and again to Day 30 (71.2 bpm) relative to the control group, which showed no such reduction (Day 1, 88.0 bpm; Day 15, 86.4 bpm; Day 30, 85.1 bpm). For the BPR values, again there were significant differences in post- minus pre-BPR unpaired t test comparisons between the two groups at 15 days and 30 days.

The absence of change in the control group suggests that differences between the groups in the trends of effects was related to the practice of yoga and not to repeating the sessions. However, it should be noted that motivation to learn yoga has been shown to influence the outcome of yoga practice (in terms of improved performance in a motor skill task; Manjunath & Telles, 1999). Since the yoga group had all chosen to be trained, the two groups were not comparable in their motivation (to learn yoga). Hence, assessments on the control group allowed the retest effect to be studied, but did not assess the impact of motivation to learn yoga.

Yoga practice has been shown to improve the regularity of breathing (Telles & Srinivas, 1999), relaxation (Telles, Narendran, Raghuraj, Nagarathna, & Nagendra, 1997), and concentration (Telles, Hanumanthaiah, Nagarathna, & Nagendra, 1993). Thus, the practice of yoga may facilitate the conditioning of visceral responses to instrumental cues. The present results suggest that yoga practice may have an "augmenting effect" in pulse rate biofeedback treatments if practiced simultaneously. While this study found an improvement in the ability of participants to reduce their pulse rate in response to external cues following yoga training, it would also be useful to investigate if the practice of yoga can help to reduce the heart rate at will, in the absence of external cues. These findings have implications for the use of yoga therapy in the management of stress-related ailments.

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