An Evaluation of the Ability to Voluntarily Reduce the Heart Rate after a Month of Yoga Practice

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The study aimed at determining whether novices to yoga would be able to reduce their heart rate voluntarily and whether the magnitude of reduction would be more after 30 days of yoga training. Two groups (yoga and control, $n = 12$ each) were assessed on Day 1 and on Day 30. During the intervening 30 days, the yoga group received training in yoga techniques while the control group carried on with their routine. At each assessment the baseline heart rate was recorded for one minute, this was followed by a six-minute period during which participants were asked to attempt to voluntarily reduce their heart rate, using any strategy. Both the baseline heart rate and the lowest heart rate achieved voluntarily during the six-minute period were significantly lower in the yoga group on Day 30 compared to Day 1 by a group average of 10.7 beats per minute (i.e., bpm) and 6.8 bpm, respectively ($p<.05$, Wilcoxon paired signed ranks test). In contrast, there was no significant change in either the baseline heart rate or the lowest heart rate achieved voluntarily in the control group on Day 30 compared to Day 1. The results suggest that yoga training can enable practitioners to use their own strategies to reduce the heart rate, which has possible therapeutic applications.

Key Words: voluntary heart rate reduction, yoga, visceral conditioning.

Introduction

IT HAS BEEN SHOWN that visceral and glandular responses, initially believed to be 'involuntary' can be operantly conditioned (Leukel, 1985). Biofeedback uses external visual or auditory cues to learn voluntary control over what was, before learning, an 'involuntary' function. The ancient Indian science, yoga is believed to help in gaining mastery over the mind and body (Taimini, 1986).

There have been attempts to investigate whether yoga practitioners can control various functions thought to be mainly involuntary. For example, there have been investigations on claims of yogis to stop the heart beating at will. Wenger, Bagchi, and Anand (1961), reported a decrease in the amplitude of the QRS complex in the electrocardiogram (EKG) associated with maintained inspiration and there were signs of raised intrathoracic pressure. This suggested that the yogis carried out breath maneuvers which caused 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, the

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extraordinary ability of practitioners of the Tibetan Buddhist meditation, g-Tum-mo yoga to increase the temperature of their digits by five to 15°C was also inexplicable (Benson, Lehman, Malhotra, Goldman, Hopkins, & Epstein, 1982).

However in the reports cited above, the subjects were experienced practitioners of yoga, who had a long duration of serious commitment to the practice. A recent study examined whether novices to yoga practice were able to reduce their pulse rate voluntarily with the help of colored light cues, after 30 days of yoga practice compared to a non-yoga group (Telles & Vani, 2002). At the end of the 30-day program the subjects were able to reduce their heart rate significantly more than at baseline, while a non-yoga group did not show any change. Since this reduction occurred based on visual feedback, in the form of colored light, the results suggested that yoga practice adds to the effect of biofeedback cues.

The present study was planned to assess the effect of yoga on the ability to reduce the heart rate voluntarily, without external cues, in subjects who were novices to yoga practice at the end of a 30-day yoga program, compared to their ability before learning yoga, and compared to a control group.

Methods

Subjects

There were two groups (i.e., yoga and non-yoga), with 12 volunteers in each group. The yoga group had group mean age ± S.D., 26.92 ± 5.84 years, age range 20 to 40 years, with two females in the group. The yoga group consisted of subjects who had joined for a 30-day yoga course and who were novices to yoga. Most of them had heard about the course from previous participants, while a few of them had seen advertisements of the course. The control group consisted of people working in an institution close to the yoga center, which was 30 km from the nearest city. None of them had experience in yoga. They were selected to match the yoga group for gender (i.e., two female subjects) and age (± 2 years). Hence the age range for this group was between 22 and 40 years, while their group mean age ± S.D. was 28.83 ± 5.90 years. The subjects of both groups had a comparable educational background. All of them agreed to participate in the trial and their informed consent was obtained. An EKG recording showed that none of the subjects had extra systolic beats or skipped beats and none of them were on any medication.

Both groups were given an oral briefing about the experiment by the experimenter. This briefing stated that "the ability to test voluntary control of the heart rate was being examined." The volunteers of both groups who wanted to participate in the trial were included, provided they fulfilled the other inclusion criteria (e.g., age range, gender, educational background).

Design of the Study

Both groups were assessed at the beginning 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. The fact that the control group did not receive training relevant to heart rate control is a limiting factor for this study.

Assessment

Prior to the assessment subjects were asked to remain seated for 15 minutes in a comfortable chair. During the recording subjects remained in the same position with their eyes closed. The EKG was recorded using standard limb lead I configuration on one of four channels of a polygraph with pen recorders (Medicaid, Chandigarh, India). The chart speed was kept at 25mm/sec, to make it easier to manually measure the R-R interval with a ruler graduated in millimeters. This was always done by the same person, who was not informed about the purpose of the study. The Heart Period (HP) or the interbeat interval represents time between two successive heart cycles and can be determined in milliseconds. In this study it was obtained from the R-R intervals. The heart rate (HR) is derived as a reciprocal of the heart period, the formula being HR = 1/HP × K (the scaling constant) (Papillo & Shapiro, 1990). With regard to the accuracy of the 'manual' method of assessing the R-R interval as compared with an analysis based on the digitized EKG signal, it has been shown that the computerized system and the traditional (manual) method, are comparable except for the fact that when the computerized method is used, subjectivity is eliminated (Neumann & Schmid, 1997). Hence subjectivity (which is a disadvantage of the manual method) was noted as a shortcoming of this study. However since the person making the measurements was not aware of the study design the subjectivity could be expected to contribute to all readings without differentiation.

The initial heart rate reading based on the R-R interval was taken at the end of a minute. This was the 'baseline' heart rate. This was followed by a six-minute session during which subjects were asked to attempt to voluntarily reduce their heart rate, without giving them any suggestions how to attempt to do it. During this six-minute period every 30 seconds the heart rate was calculated. This was the 'test heart rate.' The difference (i.e., 'baseline' HR minus 'test' HR) was noted. Since the test sessions lasted six minutes, there were 12 'test HR' values for each subject at the assessments on Day 1 and Day 30. Not all 12 values indicated a decrease in heart rate (i.e., that the test HR< baseline HR). However, in all sessions there were some reductions in the heart rate. The reduction of maximum magnitude (i.e., the lowest heart rate (LHR) achieved) was noted.

The session duration was fixed at six minutes as preliminary studies showed that some subjects required a minimum of five minutes to voluntarily reduce their pulse rate. Assessments were carried out on Day 1 and Day 30.

The subjects were also asked to fill in a questionnaire with four options to find out what strategy they used (if any) to reduce their heart rate. The options were: (1) consciously slowing breathing, (2) imagery, (3) consciously relaxing their muscles, and (4) any other strategy, which they were asked to specify.

Intervention

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.

Data Analysis

Two principal measurements were statistically analyzed, (1) the lowest heart rate obtained during the test period of six minutes and (2) the baseline heart rate at the start of each session, on both Day 1 and Day 30. Analyses were performed using the statistical analysis package, SPSS (Version 10). The Wilcoxon paired signed ranks test was used for 'Pre-Post' comparisons, and the Mann-Whitney U test was used for comparisons between groups. The level of significance (α level) was .05.

Based on the subjective questionnaire, the number of subjects in the Yoga and in the Control groups who used different strategies to voluntarily lower their heart rate was noted. These numbers were compared for significant difference using a 2 × 2 Chi-square test. Separate Chi-square tests were carried out for data obtained at Baseline and on Day 30. A 2 × 2 Chi-square test was also performed to compare the number of subjects who followed the different strategies at Baseline and Day 30 assessments. This was done for the Yoga and the Control groups, separately.

The lowest heart rate reduction achieved for both Yoga and Control groups at Baseline and Day 30 (final) assessments was tested for correlation with the strategy employed. For the analysis, the two strategies were given numbers, i.e., 'consciously slowing breathing' was designated as '1' and 'consciously relaxing the muscles' was designated as '2.' Since these values were nominal, correlation was tested using the Spearman rank correlation test.

Results

The data were not normally distributed (this was apparent graphically from the box-plot and the stem-and-leaf plot and also based on the Shapiro-Wilk test). Hence non-parametric statistical tests were used for analysis.

The yoga group showed a significant decrease in the 'baseline' heart rate on Day 30 compared to Day 1 ($Z = 2.535$, $n=12$, $p = .011$, Wilcoxon paired signed ranks test). There was also a significant decrease in the Lowest Heart Rate achieved (LHR) in the yoga group on Day 30 compared to Day 1 ($Z = 2.197$, $n=12$, $p = .028$). In contrast there were no significant changes in the control group, though there was a non-significant trend of increase in the 'baseline' heart rate on Day 30 as compared to Day 1 ($Z = 1.956$, $n=12$, $p = .050$).

There were no significant differences between the 'baseline' heart rate values or the LHR achieved of the two groups on Day 1 ($p > .05$, Mann-Whitney U test). The group mean values ± S.D. are given in Table 1.

In both groups at baseline assessment and at the 30-Day final assessment all subjects used two strategies out of the four options [the options were: (1) consciously slowing breathing, (2) imagery, (3) consciously relaxing their muscles, and (4) any other strategy, which they were asked to specify]. The two strategies used were (1) consciously slowing breathing and (2) consciously relaxing their muscles. In the yoga group the number of subjects who used the two strategies was as follows: (1) consciously slowing the breath (8 at Baseline; 5 at the 30-Day final assessment) and (2) consciously relaxing the muscles (4 at Baseline; 7 at the final assessment). Similarly, in the Control group the number of subjects who used the two strategies was as follows: (1) consciously slowing the breath (9 at Baseline; 9 at the 30-Day final assessment) and (2) consciously relaxing the muscles (3 at Baseline; 3 at the final assessment).

The number of subjects who adopted either of the two strategies were not significantly

TABLE 1
Lowest heart rate achieved and baseline heart rates in yoga and control groups on Days 1 and 30. Values are group mean ± S.D.

Groups	Days	Lowest Heart Rate Achieved	Baseline Heart Rates
Yoga n = 12	1	72.3 ± 14.6	80.7 ± 11.5
	30	63.3 ± 15.1*	70.1 ± 8.2*
Control n = 12	1	76.4 ± 6.2	77.2 ± 9.1
	30	77.9 ± 10.8	83.5 ± 14.1

*p<0.05, Day 30 versus Day 1, Wilcoxon paired signed ranks test

different for two groups at Baseline ($\chi^2 = 0.28$, p>.50, as $\chi^2 = 0.45$ for $df = 1$ at $p = .50$) or at the final assessment on Day 30 ($\chi^2 = 2.75$, $p > .05$, as $\chi^2 = 3.84$ for $df = 1$ at $p = .05$). Also, the number of subjects who adopted either of the two strategies were not significantly different at Baseline versus Day 30, for the Yoga group ($\chi^2 = 1.50$, $p > .10$, as $\chi^2 = 2.70$ for $df = 1$ at $p = .10$) or for the Control group ($\chi^2 = 0$, $p > .99$, as $\chi^2 = .0^3 15$ for $df = 1$ at $p = .99$).

With regard to correlation between the strategy used and the change in HR obtained, there was no correlation between the strategies used by the Yoga group and the Lowest Heart Rate achieved at Baseline ($\rho_S = .260$; $p > .10$, $df = 12$) or at the final assessment on Day 30 ($\rho_S = -.049$; $p > .10$, $df = 12$). Also there was no correlation between the strategies used by the Control group and the Lowest Heart Rate achieved at Baseline ($\rho_S = -.234$; $p > .10$, $df = 12$), and at the final assessment on Day 30 ($\rho_S = -.330$; $p > .10$, $df = 12$).

Discussion

A group of 12 novices who practiced yoga showed a significant decrease in both their 'baseline' heart rate and the lowest heart rate achieved (LHR) voluntarily, following a thirty day yoga program, compared to before. In contrast a non-yoga group showed no change.

These results are similar to those reported when novices to yoga practice were able to reduce both their 'baseline' heart rates and achieve a lower pulse rate voluntarily, compared to before, when guided by visual cues (Telles & Vani, 2002). In the present study however, subjects were not guided by external cues. The yoga programs given in the two studies were almost identical and both were for a 30-day period. The baseline heart rate values for both groups were higher than the average expected for a young population like the group evaluated here. The 'Control' group continued to show a higher than expected value at the final assessment. The reason for the higher values was not understood, but could be related to a 'white coat effect' (Siche, 1998).

In a comparison of the two studies, one using visual cues as an aid to voluntary heart rate reduction and the present study, without cues, a difference in the magnitude of the LHR achieved can be seen. For example when cues were used the heart rate was decreased by a group average of 23 beats per minute (bpm) on Day 30 (Telles & Vani, 2002). In the present study, the assessment method was different, with the LHR achieved in the test period being noted, instead of the maximum heart rate reduction. The latter was obtained directly from the biofeedback equipment used in the "With cues" study. When no cues were used the LHR achieved during the six-minute test period was a group average of 63.3 bpm, approximately 6.8 bpm less than the baseline value [i.e., on Day 30, a group average heart rate of 70.1 (at baseline) minus 63.3 (the LHR achieved)], and considerably less than when cues were used (i.e., 23 bpm).

In contrast the decrease in the 'baseline' heart rate, on Day 30 as compared with Day 1 was comparable for the present study (without cues; group mean of 10.7 bpm) as compared to the study with cues (group mean 9.9 bpm; Telles & Vani, 2002).

It is also to be noted in the present study on Day 1 the Yoga group subjects had achieved a decrease of 8.4 bpm [i.e., 80.7 (at baseline) minus 72.3 (the LHR achieved)]. This suggests that though this group consisted of novices to yoga, they were already able to achieve a heart rate reduction on Day 1, unlike the non-yoga group. A comparable magnitude of decrease in the heart rate was seen in the earlier study in both yoga (i.e., 7.1 bpm) and non-yoga groups (6.0 bpm), when visual cues were used (Telles & Vani, 2002).

The absence of change in the control group suggests that differences between the groups in the trend of effects appeared to be 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 in yoga, 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.

It was interesting to note that both yoga and control groups used similar strategies to attempt to voluntarily reduce their heart rate, like slowing breathing and consciously relaxing the muscles. This was seen on both Day 30 and on Day 1. In the yoga group the absence of correlation between the significant increase in Lowest Heart Rate achieved after 30 days of the intervention and the strategies used, may be related to the fact that both conscious slowing of the breathing and conscious relaxation of the muscles are essential parts of yoga practice (Mehta, 1990). Also, the numbers of subjects in the Yoga group who adopted either of the two strategies was not significantly different at Baseline versus Day 30. Hence it may be speculated that changing from one strategy to the other may not have been the factor that determined improvement. Instead, the use of the strategy may have been more effective following thirty days of training in yoga. Hence while the training in yoga made the use of the strategies more effective, since the LHR achieved by the yoga group on Day 30 was significantly more than that on Day 1, the strategies used did not change. These strategies were also used by the control group, but did not appear effective as the LHR achieved on both Day 1 and Day 30 were almost the same as the corresponding baseline heart rates.

It needs to be emphasized that the present study did not use conventional biofeedback (instrumental-conditioning) or Pavlovian conditioning to produce a HR deceleration a combination of the two approaches is effective. This is based on the idea that before trying to shape a response through feedback, one must establish it in the first place, a possible way being Pavlovian conditioning (Furedy, Shulhan, & Randall, 1989). For instrumental conditioning especially the only adequate control which has been described is a form of non-contingency, in which the unconditional stimulus is delivered after the conditional stimulus, independent of the conditional response (Furedy, 1987; Furedy and Riley, 1982). While the present study did not use either form of conditioning but attempted to examine voluntary control of the HR following yoga, a similar non-contingent control would have been ideal and its' absence is a limiting factor of this study. Hence the present results may be taken as preliminary support for the idea that training in yoga facilitates voluntary heart rate reduction, though further studies, preferably using a non-contingent control would be required.

Yoga practice has been shown to improve the regularity of breathing (Telles & Srinivas, 1999), reduce physiological arousal (Telles, Narendran, Raghuraj, Nagarathna, & Nagendra, 1997), and increase concentration (Telles, Hanumanthaiah, Nagarathna, & Nagendra, 1993). Hence the practice of yoga may facilitate the conditioning of visceral responses by autosuggestion. These findings have implications for the use of yoga practice in the management of stress.

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