ABSTRACT

Background

Research on meditation in volunteers who were previous naïve to meditation began with studies on transcendental meditation (TM) in the early 1970 (Wallace 1970, Wallace, et al. 1971). Subsequently, there have been several studies on widely differing meditation techniques and practitioners for e.g., study done by Hirai (1960) on Japanese Zazen meditation showed that during the practice, meditators showed an increase in heart rate and increase in beta activity in EEG. However, another study on Zen meditators showed that this meditation was associated with decrease in breath rate (Kasamatsu & Hirai 1966). Hence the two studies on Zen meditation showed different trends. The study by Hirai (1960) suggested that Zen meditation is activating which was in contrast to study done by Kamatsu and Hirai (1970), which suggested that Zen meditation is physiologically relaxing. Another study done on a meditation technique called Änanda Märga meditation (based on principles from täntric yoga text) showed that the practitioners of this meditation had an increase in heart rate from a mean of 69.4 to 72.8 and an increased skin conductance (Corby, et al. 1978). In contrast, a study by another group showed that Änanda Märga meditators had reduced breath rate (Elson, et al. 1977). Here again like the two studies on Zen meditation, two studies on Änanda Märga meditation also had conflicting implication. While the study by Corby et al (1978) and others suggested that Änanda Märga meditation is physiologically activating. The study by Elson et al (1970) suggested that Änanda Märga meditation decreased physiological activation. All these studies compared meditators with non-meditators. A different research design was attempted to assess
whether this would reduce inter-subject variability. This is a self-as-control design, which required the same person to be assessed in yoga session and in a non-yoga session (Telles, et al. 1992). This approach also involved assessing each yoga practitioners in repeated yoga and non-yoga sessions and it was found that there was definite inter-subject variability as well as intra-subject variability (i.e., where each practitioners differed in their trends of results of different days).

Hence no clear picture emerged about the effect of meditation on autonomic and respiratory variables given the considerable intra and inter individual variability (Telles, & Desiraju, 1993a; Telles, & Desiraju, 1993b; Telles, et al. 1995; Telles, et al. 1998). Hence it was considered that practitioners may be showing different results because they practice meditation in different ways i.e., meditation on OM was found to be practiced by visualizing the syllable OM as it is written in Sanskrit while few other practitioners practiced by mentally repeating OM (Telles, et al. 1994). Thus an attempt was made to teach all practitioners to practice meditation in the same way and this resulted in group significant results (Telles, et al. 1994). However this may limit the individual’s experience and sense of fulfillment derived from meditation.

This gave rise to the idea of examining description of meditation from traditional yoga texts may give, common results across different subjects. Hence, the present study intended to examine the effects of meditation as described in Patañjali’s yoga Sūtras as well as two more mental states described in the Bhagavad Gétā. These mental states are Dhāraṇā (Patañjali’s Yoga Sūtras, Chapter 3: Verse 1) and Dhyāna (Patañjali’s Yoga Sūtras, Chapter 3: Verse 2) and
two other states, these are random thinking Caïcalatä (Bhagavad Gétä Chapter 6: Verse 34), and single pointed ekägratä (Bhagavad Gétä Chapter 6: Verse 12).

In order to understand the psycholphysiological effects the assessments comprised an attention task, autonomic and respiratory variables as well as brain stem auditory evoked potential. The last variable was selected to assess whether these practices influence sensory information processing as assessed by evoked potentials.

Aim

The present study aimed to assess the psycho-physiological changes during caïcalatä (random thinking), ekägratä (focusing), dhāraëä (meditative focusing), and dhyäna (meditation without focusing) on: (1) brainstem and auditory evoked potentials (2) autonomic and Respiratory variables (3) performance in a six letter cancellation task.

Methods

Thirty subjects from Svämé Vivekänanda Yoga Research Foundation, Bangalore, South India were selected with ages ranging from 20 to 45 years ($M = 29.1 \pm SD = 6.5$ years) who had a minimum of 6 months experience in ‘OM’ meditation.
Design

Each subject was assessed in four sessions i.e., two meditation (dhāraēä and dhyāna) and two control sessions (caïcalatā and ekāgratā) to record brainstem auditory evoked potentials, autonomic and respiratory variables separately. And for performance in a cancellation task, assessments were made immediately before and after each session. The two control sessions were: (i) Ekāgratā, i.e., single topic lecture and (ii) Caïcalatā, i.e., non-targeted thinking. The two meditation sessions were (i) Dhāraēä, i.e., focusing on the symbol ‘OM’ and (ii) Dhyāna, i.e., meditation with effortless focusing on OM, the object of meditation. All four sessions consisted of three states, i.e., ‘pre’ (5 minutes), ‘during’ (20 minutes), and ‘post’ (5 minutes).

The assessments were made on four different days, but at the same time of the day (i.e., the self-as-control design). The allocation of the subjects to the four sessions was randomized using a standard random number table. This was done to prevent the influence of being exposed to the laboratory for the first time, from influencing the results.

Assessments

I. BAEP were recorded using the Nicolet Bravo system (Nicolet Biomedicals, U.S.A.).

II. Autonomic and respiratory variables using 4-channel polygraph (Polyrite D, Recorders & Medicare Systems, Chandigarh, India)

a) Galvanic Skin Resistance (GSR)

b) Finger Plethysmogram Amplitude (FPA)

c) Electrocardiogram (EKG)
d) Respirogram

(i) Six letter cancellation task (SLCT)

**Intervention**

Throughout all sessions subjects kept their eyes closed and followed pre recorded instructions. The instructions emphasized carrying out the practice slowly, with awareness and relaxation. The meditators who participated in the study underwent a month of orientation sessions where they practiced two phases which formed a continuum in meditation (dhāraṇā and dhyāna) as two separate sessions and two control sessions, i.e., caïcalatā or non-target thinking and ekāgratā (by ‘listening to a lecture on meditation, with multiple, yet associated thoughts’).

These states are described in the traditional texts i.e., the Patañjali’s Yoga Sūtras and Bhagavad Gétā, (Bhagavad Gétā Chapter 6: Verse 34, Chapter 6: Verse 12; Patañjali’s Yoga Sūtras, Chapter 3: Verses 1-2) stating that when awake and in the absence of a specific task the mind is very distractible (caïcalatā), and has to be taken through the stages of ‘streamlining the thoughts’ (concentration or ekāgratā), before moving on to the stage of meditation. These are: one-pointed concentration, non-analytical focusing or dhāraṇā and a defocused, effortless single thought state or dhyāna.

During caïcalatā session (non-targeted thinking) the participants were directed to allow their thoughts to wander freely as they listened to a pre recorded general conversation of a local radio station transmission. During ekāgratā practice participants were listening to a lecture on meditation. The dhāraṇā session consisted of meditative focusing on the meaning of the Sanskrit syllable,
‘OM’, where OM is used as a symbol for the entire universe, representing that which sustains everything (Māṇḍūkya Upaniṣat; Cimmayānanda, 1984). The dhyāna session consisted of meditation with effortless absorption with the object of meditation. For the two meditation sessions (dhāraṇā and dhyāna) and the other two control sessions (caīcalatā & ekāgratā) participants were given guided instructions with a compiled audio CD relevant to the respective sessions. All sessions (dhāraṇā, dhyāna, caīcalatā, and ekāgratā) constituted a practice of 20 minutes duration.

Data analysis

Statistical analysis was done for all variables using SPSS (Version 10.0). The peak latencies and peak amplitudes of all seven waves and all autonomic variables were analyzed using repeated-measures analyses of variance (ANOVAs), and post-hoc analyses with Bonferroni adjustment was to compare ‘pre’ data with ‘during’ and ‘post’. Also six letter cancellation task scores were analyzed using repeated-measures analyses of variance (ANOVAs), and post-hoc analyses with Bonferroni adjustment was to compare ‘pre’ with ‘post’ scores.

The repeated measures analyses of variance (ANOVAs) were performed with two ‘Within Subjects’ factors, i.e., Factor 1: Sessions; with four levels, viz., caīcalatā, ekāgratā, dhāraṇā, and dhyāna, and Factor 2: States; with six levels, viz., Pre, During (D1 to D4), and Post. These repeated measures ANOVAs were carried out for the peak latency and peak amplitude of all levels as well as autonomic and respiratory variables. For letter cancellation task the repeated measures analyses of variance (ANOVAs) were performed with two
‘Within subjects’ factors, i.e., Factor 1: Sessions; with four levels, viz., caïcalatā, ekāgratā, dhāraēā, and dhyāna, and Factor 2: States; with two levels Pre and post. This was followed by a post-hoc analysis with Bonferroni adjustment for multiple comparisons between the mean values of different states (Pre, During 1 to During 4 and Post) and pre and post data analysis was done for letter cancellation task.

Results and Discussion

(i). Brainstem auditory evoked potential –There was a significant increase in the latency of Wave V during the caïcalatā session (Pre versus During), ekāgratā session (Pre versus During & post) and following the dhāraēā session (Pre versus Post).

Hence irrespective of whether meditators were in a state of random thinking (caïcalatā) or channelized thought in concentration (ekāgratā) there was a delay in sensory information processing, as mentioned above at the mid-brain, (possibly the inferior colliculus) level. The mental state was characterized by a lack of effort during dhyāna session, where as there was effort involved during dhāraēā session; in both the sessions, the latency of wave V did not show any significant delay in sensory information processing. In contrast, there was a significant delay seen post dhāraēā session while no such changes was observed post dhyāna session.

ii) Autonomic and respiratory variables-
• Galvanic Skin Resistance (GSR): There was a significant increase in the galvanic skin resistance during and after the *dhyāna* session in comparison to *caīcalatā, ekāgratā, and dhāraēā* sessions.

• Finger Plethysmogram Amplitude (FPA): There was a significant increase in the digit pulse volume in *dhyāna* session (pre versus during).

• Electrocardiogram (EKG): There was a significant decrease in the heart rate in *dhyāna* session (pre versus during & post).

• Respiratory rate: There was a significant increase in the respiratory rate in *caīcalatā* sessions (pre versus during & post). But in session *dhyāna* there was significant decrease in respiratory rate (pre versus during & post).

• HRV LF: There was a significant increase in low frequency in *caīcalatā* and *ekāgratā* sessions (*caīcalatā* (pre versus during & post), *ekāgratā* (pre versus during & post). But there was significant decrease in low frequency in *dhyāna* session (pre versus during & post).

• HF: There was a significant decrease in high frequency in *ekāgratā* session (pre versus during & post), while there was significant increase in high frequency in *dhyāna* session (pre versus during & post).

• LF/HF: There was a significant increase in low and high frequency ratio in *ekāgratā* session (pre versus during & post).

In the present study the LF power was higher during *caīcalatā, ekāgratā* and lower in *dhyāna* sessions. The HF power was lower during the *ekāgratā* practice and higher during the *dhyāna* practice. The LF/HF ratio
was higher during the ekāgratā practice. The changes in LF and HF power suggest that there was a shift towards the increased sympathetic activity during caīcalatā and ekāgratā, where as increased parasympathetic activity was observed during dhyāna sessions. Hence dhāraēa did not influence the HRV.

In the present study there was a significantly higher increase in skin resistance during dhyāna session in compare to other sessions. The rate of breathing is known to vary directly with the level of anxiety (Srinivas & Telles, 1999). A decreased breath rate is a well recognized correlate of reduced psychophysiological arousal. Hence for this variable also there were difference between dhāraēa and dhyāna. The heart rate was also lower during dhyāna in the present study there was a lowering of both breathing rate and heart rate during dhyāna suggestive of physiological relaxation.

- Six letter cancellation task (SLCT): Total and net scores were significantly higher after the dhāraēa session compared to the pre scores, whereas after the caīcalatā session they were significantly lower. No significant change was observed in other sessions for the letter cancellation task.

Conclusions

These results showed that information transmission along the auditory pathway is delayed during caīcalatā and ekāgratā with no change during dhāraēa and dhyāna.

In dhyāna there was a relative increase in wave V amplitude (relative to wave III) suggesting recruitment of more neurons at the inferior collicular level.
compared to before. This suggests that during dhyāna auditory information transmission was delayed at the inferior collicular level (the tectum) as the wave V corresponds to the tectum. Also the autonomic and respiratory variables suggested a higher magnitude of psycho-physiological relaxation during dhyāna as compared to other sessions. Performance in the six letter cancellation task also suggested that meditative focusing (dhāraṇā) may improve attention.

1.1 BACKGROUND

Meditation has become popular throughout the globe since 1960 while it has been in vogue for centuries. It is a systematic approach for an individual to become one with the object of meditation and ultimately the highest level of consciousness of which man is capable (Taimni, 1961). During meditation a state of mind is reached which is characterized by deep relaxation as well as increased internalized attention (Murata, et al. 1979).