

ABSTRACT

BACKGROUND

In ancient yoga texts, there are two meditative states described. One is *dhāraṇā*, which requires focusing, the second is *dhyāna*, during which there is no focusing, but an expansive mental state is reached. The earlier study on changes in brainstem auditory evoked potentials following four mental states described in yoga texts viz., *cañcalatā* (random thinking), *ekāgratā* (focusing without meditation), *dhāraṇā* (focused meditation) and *dhyāna* (meditative defocussing or effortless meditation) showed significant increase in wave V peak latency during *cañcalatā*, *ekāgratā* and *dhāraṇā* but not in *dhyāna* (Kumar et al., 2010). The results suggest that *dhyāna* practice alone does not delay auditory information transmission at the brainstem level, whereas *cañcalatā*, *ekāgratā* and *dhāraṇā* showed delay in auditory information processing at the inferior collicular level since the wave V corresponds to that level. Another study assessed the performance in a cancellation task at the beginning and end of the four types of session viz., *cañcalatā*, *ekāgratā*, *dhāraṇā*, and *dhyāna* (Kumar & Telles, 2009). The performance in cancellation task improved significantly after *dhāraṇā* and was worse after *cañcalatā*, suggesting better attention after *dhāraṇā*. The changes in mid-latency auditory evoked potentials during these four mental states have not been studied.

AIM AND OBJECTIVES

The present study was intended to study psychophysiological changes following two meditative states described in yoga texts. The objectives of the study were to investigate the effect of *cañcalatā*, *ekāgratā*, *dhāraṇā* and *dhyāna* on: (i) Mid-latency auditory evoked potentials (MLAEPs), (ii) Performance in the d2 test of attention, (iii) Performance in the digit symbol substitution test (DSST), and (iv) Subjective assessment of following the guided instructions for *cañcalatā*, *ekāgratā*, *dhāraṇā* and *dhyāna* using visual analog scale.

METHODS

Participants

Sixty male volunteers with ages ranging from 17 to 38 years were studied. They were all students at a yoga University in South India. They had a minimum of 6 months of experience in meditation on Om (group average experience \pm SD, 20.95 \pm 14.21 months).

Design

For Mid-latency auditory evoked potentials, each participant was assessed in four sessions. Two of them were meditation sessions (*dhāraṇā* and *dhyāna*) and two of them were non-meditation sessions (*ekāgratā* and *cañcalatā*). All four sessions consisted of 3 states: pre (5 minutes), during (20 minutes), and post (5 minutes). Assessments were made on four different days, which were not necessarily on consecutive days, but at the same time of the day. The allocation of participants to the four sessions was random using a standard random number table. For Performance in

attentional tasks [i.e., (a) d2 test of attention and (b) digit symbol substitution test], each participant was assessed before and after the practice of *dhāraṇā* and *ekāgratā*. A visual analog scale was given immediately after the practice of *cañcalatā*, *ekāgratā*, *dhāraṇā* and *dhyāna* session.

Assessments

- (i) Mid-latency auditory evoked potentials (MLAEPs) recorded at Cz electrode site referenced to linked earlobes (A1-A2), using the Nicolet Bravo system (Nicolet Biomedicals, U.S.A.)

MLAEPs have been used to assess cortical and subcortical changes.

- (ii) D2 test of attention

The d2 test is a timed test of selective attention and concentration.

- (iii) Digit symbol substitution test

The digit symbol substitution test is a subset of the Wechsler Adult Intelligence Scale-Revised (WAISR) administered using paper and pencil. It measures sustained attention, response speed, and visuo-motor coordination.

- (iv) Visual analog scale

*The ability to follow the guided instructions for *cañcalatā*, *ekāgratā*, *dhāraṇā* and *dhyāna* was measured using the visual analog scale.*

Intervention

Throughout all the sessions, participants sat cross-legged and kept their eyes closed and followed the prerecorded instructions.

Cañcalatā (Random thinking)

Participants were asked to allow their thoughts to wander freely as they listened to a compiled audio CD consisting of brief periods of conversation, announcements, advertisements, and talks on multiple topics recorded from a local radio station transmission. All these conversations were unconnected and were believed to induce a state of random thinking.

Ekāgratā (Focusing without meditation)

Participants listened to a prerecorded lecture on meditation. This was not about meditation, on the Sanskrit syllable Om, but about meditation, in general. It was speculated that listening to a lecture on a particular topic could induce the state of non-meditative focused thinking.

Dhāraṇā (Focused meditation)

Participants were asked to follow the audio instructions for the practice of *dhāraṇā*. The meditative focusing on the Sanskrit syllable Om consisted of mental visualization of the symbol Om. *Dhāraṇā* involves conscious effort to keep the thoughts restricted to those given in the instructions.

Dhyāna (Meditative defocusing or effortless meditation)

Participants were asked to follow the audio instruction for the practice of *dhyāna*. They were supposed to absorb with the object of meditation without any effort. *Dhyāna* involves effortless defocusing induced by mental chanting of Om.

Data analysis

(i) Mid-latency auditory evoked potentials (MLAEPs)

Statistical analysis was done using SPSS (version 16.0). Data were tested for normality by the Kolmogorov-Smirnov test. Since the same individuals were assessed in repeat sessions on separate days (ie, *cañicalatā*, *ekāgratā*, *dhāraṇā* and *dhyāna*), repeated measures analyses of variance (ANOVAs) were performed with 2 within-participant factors, that is factor 1: sessions; *cañicalatā*, *ekāgratā*, *dhāraṇā* and *dhyāna* and factor 2: states; “pre,” “during” (Dur1 to Dur4), and “Post.” Repeated measures ANOVAs were carried out for each wave of MLAEPs separately, for both peak latencies and peak amplitudes. This was followed by post hoc analyses with Bonferroni adjustment for multiple comparisons between the mean values of different states (during and post), and all comparisons were made with the respective pre state.

(ii) Performance in attentional tasks [i.e., (a) d2 test of attention and (b) Digit symbol substitution test]

Since the same individuals were assessed in repeat sessions on separate days (i.e., *ekāgratā* and *dhāraṇā*), repeated measures analysis of variance was used (ANOVA). Repeated measures analysis of variance (ANOVA) were performed with two 'within subjects' factors, i.e., Factor 1: Sessions; *ekāgratā* and *dhāraṇā* and Factor 2: States; “Pre”, and “Post”. This was followed by a post-hoc analyses with Bonferroni adjustment comparing ‘pre’ with ‘post’ values.

(iii) Visual analog scale

Repeated measured analysis of variance (ANOVA) was performed with one 'within subjects' factor, i.e., sessions: *cañcalatā*, *ekāgratā*, *dhāraṇā*, and *dhyāna*.

This was followed by a *post-hoc* analysis with a Bonferroni adjustment for multiple comparisons between the mean values of different sessions.

RESULTS AND DISCUSSIONS

(i) Mid-latency auditory evoked potentials [MLAEPs]

Mid-latency auditory evoked potentials were assessed in 60 participants during *cañcalatā*, *ekāgratā*, *dhāraṇā*, and *dhyāna*. During *dhyāna*, latencies of 2 MLAEPs components, the Na and Pa waves were prolonged, suggesting that auditory information transmission at the level of the medial geniculate and primary auditory cortex (i.e., the neural generators corresponding to the Na and Pa waves) was delayed. Hence, meditation influenced MLAEPs, while meditative focusing did not.

(ii) Performance in attentional tasks [i.e., (a) d2 test of attention and (b) digit symbol substitution test]

In the present study, sixty male volunteers were assessed in the d2 test of attention and digit symbol substitution test after *dhāraṇā* and *ekāgratā*. After both types of focusing, there was a significant improvement in all measures of the d2 test of attention (TN, E, TN-E, E%, and CP). However, the performance in the digit symbol substitution test was better after *dhāraṇā* but did not change after *ekāgratā*.

(iii) Visual analog scale

The study was conducted to assess the self-rated ability to follow the instructions to achieve the four mental state's viz., *cañcalatā*, *ekāgratā*, *dhāraṇā*, and *dhyāna* using a visual analog scale. The results showed that following *dhāraṇā*, scores on the visual analog scale were significantly lower compared to those for *cañcalatā*, *ekāgratā* and *dhyāna*.

CONCLUSION

The present study showed an increase in the peak latency of Na and Pa waves during *dhyāna* which suggests an increase in information processing time at the level of medial geniculate and primary auditory cortex. Following *dhāraṇā*, there was an improvement in performance on all measures of the d2 test of attention (TN, E, TN-E, E%, and CP) and in the digit symbol substitution test. The results suggest that, *dhāraṇā* is associated with better attention, incidental learning, and better accuracy. Subjective assessment about the ability to follow guided instructions showed that *dhāraṇā* is the most difficult state compared to the *cañcalatā*, *ekāgratā* and *dhyāna* states.