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Higher theta and alpha1 coherence when listening to Vedic recitation compared to coherence during Transcendental Meditation practice



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ABSTRACT

This study compared subjective experiences and EEG patterns in 37 subjects when listening to live Vedic recitation and when practicing Transcendental Meditation (TM).

Content analysis of experiences when listening to Vedic recitation yielded three higher-order codes. Experiences during Vedic recitation were: (1) deeper than during TM practice; (2) experienced as an inner process; and (3) characterized by lively silence. EEG patterns support these higher-order codes. Theta2 and alpha1 frontal, parietal, and fronto-parietal coherence were significantly higher when listening to Vedic recitation, than during TM practice. Theta2 coherence is seen when attending to internal mental processes. Higher theta2 coherence supports subjects' descriptions that the Vedic recitations were "not external sounds but internal vibrations." Alpha1 coherence is reported during pure consciousness experiences during TM practice. Higher alpha1 coherence supports subjects' descriptions that they "experienced a depth of experience, rarely experienced even during deep TM practice." These data support the utility of listening to Vedic recitation to culture deep inner experiences.

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1. Introduction

Research has described two features of consciousness: the *level* of consciousness (tonic wakefulness) and the *contents* of consciousness (specific thoughts, feelings, and perceptions of outer objects and experiences) (Koch & Tsuchiya, 2007). These two features of consciousness are intertwined during ordinary waking experiences. Consequently, most scientists, beginning with William James, have concluded that consciousness cannot exist without an object (James, 1890/1951; Natsoulas, 1997). These two features of consciousness can be disentangled, however, during meditation practices, which are techniques to explore the relation between the levels and contents of consciousness.

Meditation techniques involve different procedures to investigate conscious experiences and so fall into different categories (Travis & Shear, 2010). Meditation practices in the *Focused Attention* and *Open Monitoring* categories keep individual awareness engaged in experiencing objects—such as focusing on breath in the first category or passively observing ongoing experiences in the second category. Meditation practices in the *Automatic Self-Transcending* category, such as Transcendental Meditation, transcendental activity to reveal a state of silent self-awareness underlying thinking (Travis & Shear, 2010). This is a state of *being* rather than a state of thinking or doing. This state experienced during Transcendental Meditation practice is called "pure consciousness" (Maharishi Mahesh Yogi, 1969; Travis & Pearson, 2000). Pure consciousness is "pure" in that it is a state

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of consciousness—self-awareness—free from changing mental content. It is defined as the simplest form of human awareness or the ground state of consciousness, the basis of all thoughts, feelings, and actions (Maharishi Mahesh Yogi, 1986).

Physiologically, experiences of pure consciousness during TM practice have been characterized by higher frontal alpha1 coherence (Dillbeck & Bronson, 1981; Travis & Arenander, 2006; Travis et al., 2010), higher frontal and lower brainstem blood flow (Ludwig, Gevirtz, Hubbard, & Travis, 2011), MEG source localization in medial prefrontal and anterior cingulate cortices (Yamamoto, Kitamura, Yamada, Nakashima, & Kuroda, 2006), and higher eLORETA source localization in midline frontal and parietal cortices that are part of the default mode network (Travis et al., 2010). In a meta-analysis, TM subjects had lower sympathetic activation than eyes-closed rest, as indicated by lower breath rate, lower skin conductance levels, and lower plasma lactate (Dillbeck & Orme-Johnson, 1987).

Phenomenologically, a content analysis of descriptions of pure consciousness during TM practice yielded three themes: absence of time, absence of space, and absence of body sense (Travis & Pearson, 2000). Time, space, and body sense are the framework that give meaning to waking experience. Note that pure consciousness was not described in terms of distorted content—strong emotions, vivid sensations, or distorted sense-of-self. Rather, it was described as the state that is experienced when the customary framework that defines everyday waking experiences is transcended.

The experience of pure consciousness is fundamentally different from ordinary waking experiences. In ordinary waking experiences, changing thoughts and perceptions define the experience. Changing mental content move through awareness, forming a “stream of consciousness” (James, 1890/1951). In contrast, the experience of pure consciousness is “bigger” than the individual. Pure consciousness is defined as being outside the boundaries of time, space and body sense and outside of individual characteristics, such as age, height, gender, and style of thinking. The individual “experiences” pure consciousness by transcending active thinking levels—experiencing more subtle levels of a thought and then transcending even the most subtle level of thinking (Maharishi Mahesh Yogi, 1969). Then the mind is silent and awake with nothing to experience. It is like a wave settling down to the ocean, and becoming the ocean.

This discussion admittedly takes us outside of the modern scientific paradigm. We ask readers to view this argument as a conceptual framework to understand the study hypothesis and to interpret effects of listening to recitation of the Vedic literature.

There is a similarity between individual consciousness and pure consciousness. Individuals are conscious of changing experiences—indeed, the ability to report ongoing experience is the criterion used in research to establish that one is conscious. Maharishi Mahesh Yogi who brought Transcendental Meditation to the West explains that pure consciousness is also, by its nature, conscious. Yet, there is no content in pure consciousness. So, pure consciousness is awake to itself and interacts with itself. This creates as if waves or sequences of transformations—reverberations—within pure consciousness. These reverberations have been experienced as phonetic sequences by individuals with very clear awareness (Maharishi Mahesh Yogi, 1994; Nader, 2000). These sequences were passed down through an oral tradition and have been recorded as the Vedic literature of India. Thus, in this understanding, the Vedic literature are not texts on defense, grammar or architecture, but rather they are the sequences of transformation within pure consciousness.

1.1. Hypothesis

If the sounds of the Vedic literature reflect processes going on in the deepest aspect of silent pure consciousness, then listening to traditional Vedic recitation would enliven these sequences within the consciousness of the listener. This hypothesis will be tested by comparing EEG patterns recorded when listening to Vedic recitation and when practicing Transcendental Meditation. A semi-structured interview will also probe inner experiences when listening to Vedic recitation. TM practice was used as the benchmark in this study since extensive research has documented qualitative and quantitative characteristics of the experiences of pure consciousness during TM practice (Dillbeck & Orme-Johnson, 1987; Farrow & Hebert, 1982; Travis & Arenander, 2006; Travis & Pearson, 2000; Travis et al., 2010; Yamamoto et al., 2006).

2. Material and method

2.1. Subjects

Thirty-seven subjects volunteered for this study, 20 women and 17 men. They were an average age of 57.6 ± 9.3 years, and had been practicing the TM technique for 34.0 ± 11.4 years. They had also been practicing an advanced program, the TM-Sidhi program for 28.6 ± 9.3 years. None of the subjects were fluent in Sanskrit or were able to translate Sanskrit into English. Subjects signed consent forms before beginning the study, which had been approved by the University Institution Review Board.

2.2. Procedure

Each subject came in for EEG measurement in the early afternoon. Thirty-two sensors were applied to the scalp according to the 10/10 system. Sensors were also applied to the left and right ear lobes for later re-referencing before analysis. Impedances were below 10 k Ω at all sensors.

EEG was recorded at 256 samples/s during 15-min TM practice and a one-hour live recitation of Vedic literature using BIOSEMI ActiveTwo amplifiers and software (www.biosemi.com). The first five minutes of the Vedic recitation was the Swasti Path, which is recited for the well-being of the world. The next 10 min was recitation to Ganesh to remove obstacles. The next 45 min were different each day and contained recitation to the laws of nature most lively during that day, such as Surya or Vishnu. After the recitation, subjects were given a semi-structured interview with one question: What did you experience when listening to Vedic Recitation?

Subjects sat with eyes closed both during TM practice and when listening to Vedic recitation. They were asked to press a button during periods of inner silence and expansion during each condition. These button presses were used to select 2-min periods for analysis.

2.3. Data analyses

EEG around button presses were selected during the 15-min TM session and within the first 15 min of the hour session of listening to Vedic Recitation. These time periods were selected because: (1) they involved similar length of times sitting with eyes closed, and (2) as explained above, the Vedic chanting was the same during the first 15 min each day. Two minutes of EEG were selected around each button press, beginning one min before and continuing one min after the button press. During post-processing, the four sec before and after the button press were deleted to remove effects of becoming aware of the experience and the muscle movements associated with the button press.

The EEG was analyzed with Brain Vision Analyzer. First, the data were visually inspected and any body movement, electrode, or eye artifacts were marked and removed from the analysis. Raw data were re-referenced to averaged linked ears to compare with previous TM research, digitally filtered in a 2.0–50 Hz band pass filter with a 48 dB roll off, and fast Fourier transformed in 2-s epochs using a Hanning window with 10% onset and offset. EEG coherence, the absolute value of the cross-correlation function in the frequency domain, was calculated for the 496 possible combinations of 32 recording sites.

2.3.1. Coherence analysis

Coherence estimates were averaged into frontal, parietal and frontal-parietal spatial averages. The frontal coherence averages included 36 coherence pairs between nine frontal sensors—AF3, AF4, F3, F4, F7, F8, Fz, FC1, FC2. The parietal coherence averages included 36 coherence pairs between nine parietal sensors—PO3, PO4, P3, P4, P7, P8, Pz, CP1, and CP2. The frontal-parietal coherence averages included 45 coherence pairs between 10 anterior-posterior sensors—AF3, AF4, PO3, PO4, F3, F4, P3, P4, Fz, Pz. Data were analyzed in six frequency bands: delta: 1–4.5 Hz, theta2: 5–7.0 Hz, alpha1: 7.5–10.5 Hz, alpha2/sigma: 11–15.5, beta1: 16.5–20 Hz, and gamma: 20.5–50 Hz.

In the analysis, alpha2 EEG estimates was combined with sigma because alpha2 covaries with higher frequency bands and alpha1 covaries with lower frequency bands (Aftanas & Golocheikine, 2002). Other research reports that alpha2 EEG estimates desynchronize after a target, when the subject begins task processing; and alpha1 EEG desynchronizes after the warning stimuli, when the subject switches attention from internal processing to outer tasks (Klimesch, Doppelmayr, Russegger, Pachinger, & Schwaiger, 1998). In general, alpha2 EEG activity is correlated with the task paradigm (eyes open/ eyes closed), while alpha1 EEG activity is unrelated to the task condition (Ben-Simon, Podlipsky, Arieli, Zhdanov, & Hendlar, 2008).

2.3.2. Content analysis

Content analysis was conducted using the ATLAS.ti 4.2 software. This program allows the researcher to read through the transcriptions and highlight “units of meaning” – words or phrases that express a coherent idea. In Atlas-Ti, these phrases are called “quotations.” Once quotations have been highlighted, each is assigned a code. For example, an individual said: “These sounds coax the silent, immovable nature of pure consciousness to begin to move.” This was coded as “consciousness moving in itself.” After coding of quotations was completed, codes with three or fewer quotations were reviewed to see if they fit into a more general code. Next, codes were grouped by common themes into higher-order codes.

2.4. Statistical analysis

SPSS 13.0 was used for statistical analysis. A 2-way repeated-measures MANOVA was conducted with the two conditions as the repeated measures (TM/Vedic Recitation), three brain areas (frontal, parietal and frontal-parietal coherence pairs) and coherence in six frequency bands as the variates (delta: 1–4.5 Hz, theta2: 5–7.0 Hz, alpha1: 7.5–10.5 Hz, alpha2/sigma: 11–15.5, beta1: 16.5–20 Hz, and gamma: 20.5–50 Hz). If significant interactions were found, then repeated measure MANOVAs were conducted to determine main effects of condition within each frequency band collapsing across brain areas. To control for multiple tests, a significance level of $p = 0.01$ was used in the second analysis.

3. Results

3.1. Condition differences in EEG coherence

The 2-way repeated-measures MANOVA yielded significant condition \times frequency interactions ($F(5, 28) = 2.6, p = 0.045$) and significant brain areas \times frequency interactions ($F(10, 23) = 43.5, p < 0.0001$). Thus, six repeated measure MANOVAs

were conducted with TM/Vedic recitation as the repeated measures and coherence in each frequency band as variates, collapsing across brain areas. These repeated measure MANOVAs revealed significant condition differences only for theta2 and alpha1 coherence across all brain areas ($F(1,35) = 11.6, p = 0.002$; $F(1,35) = 12.9, p = 0.001$, respectively).

Fig. 1 presents coherence averaged across frontal, parietal and frontal-parietal coherence pairs in six frequency bands. The average and standard errors are presented. While coherence when listening to Vedic recitation was higher in all frequency bands, these differences only reached significance for theta2 and alpha1 bands.

3.2. Content analysis

Content analysis yielded three major higher-order codes. Experiences during Vedic recitation were: (1) Deeper than during TM practice (two codes), (2) Experienced as an inner process (three codes), and (3) Characterized by lively Silence (three codes). Table 1 presents the output from the content analysis. In this table, the three higher-order codes are presented in the left column. The middle column presents the codes used in the higher-order code. The right column includes sample quotations for that code.

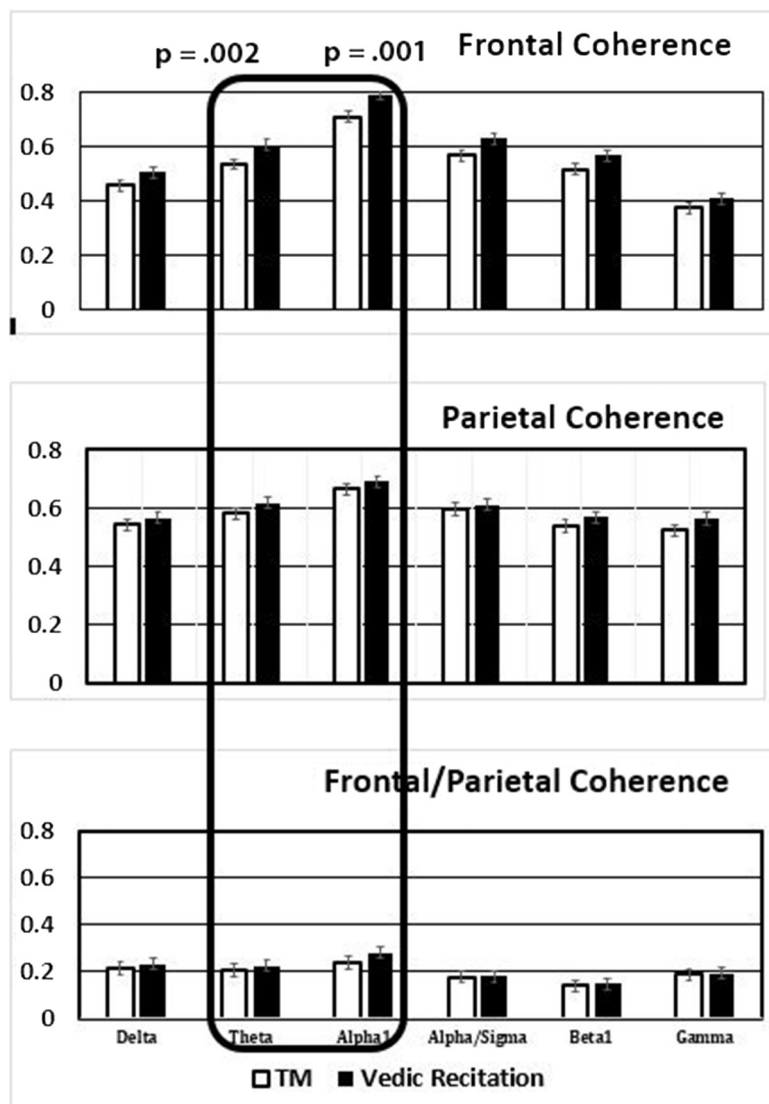


Fig. 1. Coherence is presented in frontal (top), parietal (middle), and frontal/parietal pairs (bottom) when listening to Vedic recitation (dark bars) and when practicing Transcendental Meditation (light bars) in six frequency bands: delta through gamma. Coherence when listening to Vedic recitation was higher in all frequency bands. These differences only reached significance for theta2 and alpha1 bands.

Table 1

Output from the content analysis: the higher-order code, the codes included in the higher-order code with the number of times mentioned and sample quotations in that code are presented.

Higher-order code	Codes (number of times used)	Sample quotations
Deeper than during TM practice	Very deep (16)	<ul style="list-style-type: none"> • I experience a depth, rarely experienced even during deep meditations and Yogic Flying • I was so relaxed and was able to transcend for very long periods of time. The experiences were calming, cleansing and left me feeling incredible amounts of bliss • I felt like in a very deep meditation
	Unbounded (21)	<ul style="list-style-type: none"> • Previous fluctuations in consciousness seem to be like little ripples in the vastness of peace and stillness of the mind • I had the feeling of “I am” and everything ceases to be around me • A sense of no limits • When the chanting ends, it takes time to be able to talk and move again • A sweetness invaded my being and my consciousness was gathered (collected) in a point as suspended in the space • Time was often flying or not existing at all
Experienced as an inner process	Chanting in me (11)	<ul style="list-style-type: none"> • The recitation was in me, permeating my being. There were no thoughts in my head, only the sounds • The sequence of Vedic sounds are inside me. They are not external sounds but inner vibrations • I was completely immersed in these sounds—as if they were inside and around me • These sounds coax the silent, immovable nature of pure consciousness to begin to move
	Consciousness Moving in itself (6) Inner Transformations (14)	<ul style="list-style-type: none"> • The individual threads of inner Being are infused with the liveliness of the Vedic sounds and they swell up and move apart • The Vedic recitation creates space within silence • All the activity and fluctuations emerge from this silent source within me
Characterized by lively Silence	Lively Silence (8)	<ul style="list-style-type: none"> • Silence was very lively • Extremely profound sensation of happiness, which seemed at times to radiate from me into the surrounding space
	Contentment (12)	<ul style="list-style-type: none"> • Settled into a state of very agreeable silence • Pleasant feeling like being in the mother’s womb. A deep state of ease and peace • I felt more awake to my innermost self and being more at home
	Clarity (4)	<ul style="list-style-type: none"> • Transcending in the gaps between the hymns. Like a refreshing blissful crystal clear wave then I was coming back to myself

4. Discussion

Coherence between frontal, parietal and frontal-parietal theta2 and alpha1 coherence pairs was significantly higher when listening to live Vedic recitation compared to TM practice. Also, the subjective descriptions of inner experiences when listening to Vedic recitation yielded three higher-order codes that parallel the changes in brain patterns.

4.1. Relation of content analysis higher-order codes and EEG patterns

4.1.1. First theme: deeper than during TM practice

When listening to Vedic recitation, subjects reported “... a depth of experience, rarely experienced even during deep meditation.” And that they “... were able to transcend for very long periods of time.” In terms of the brain, alpha1 frontal, parietal and frontal-parietal coherence was significantly higher when listening to Vedic recitation. Alpha1 frontal coherence is reported during the experience of pure consciousness during TM practice (Dillbeck & Bronson, 1981; Travis et al., 2010). Listening to Vedic recitation appeared to cultivate and sustain the experience of pure consciousness.

4.1.2. Second theme: experienced as an inner process

When listening to Vedic recitation, subjects reported: “... The recitation was in me, permeating my being. There were no thoughts in my head, only the sounds.” Another commented: “The sequence of Vedic sounds are inside me. They are not external sounds but inner vibrations.” In terms of the brain, theta2 frontal, parietal and frontal-parietal coherence was higher when listening to Vedic recitation. Frontal theta coherence is associated with attention to inner mental processes (Vinogradova, 2001). It is reported during tasks requiring internal timing (Ishii et al., 1999; Ishii et al., 2012), during working memory tasks (von Stein & Sarnthein, 2000) and during tasks requiring memory retention and mental imagery (Sarnthein, Morel, von Stein, & Jeanmonod, 2005). Vedic recitation appears to be appreciated by these subjects as an *inner* process. This is an important point, since the Vedic literature is proposed to comprise reverberations within pure consciousness, which are cognized as such within ones own pure consciousness, rather than being poetry or prose composed by individuals to tell a story.

4.1.3. Third theme: lively silence

The last theme appears to summarize the state gained when listening to Vedic recitation. This state is different from a conscious experience that is dominated by changing content—colors, sounds, sensations. The state resulting from listening to Vedic recitation is dominated by silence. This state of silence is not passive or inert. One person said: It is a “Pleasant feeling, like being in the mother’s womb. A deep state of ease and peace.” Another says: It is an “Extremely profound sensation of happiness, which seemed at times to radiate from me into the surrounding space.” This lively silence may result when the Vedic recitation is experienced as inner transformations of consciousness, as described above.

4.2. Future research

Although this research on Vedic recitation is new, it has produced interesting results that add to our scientific understanding of conditions under which pure consciousness can be experienced. William James and most scientists today do not recognize the existence of a state of consciousness such as pure consciousness, which is free from changing content and which underlies thinking. In terms of an analogy, James identified a stream of consciousness—changing experiences—but missed the water that underlies and connects changing experiences. The paper has demonstrated two conditions, under which pure consciousness may occur, Transcendental Meditation practice and listening to Vedic recitation. This represents a fundamentally *new* area for phenomenological research and a new direction for research in consciousness studies.

Future research could extend these findings by comparing effects of listening to live Vedic recitation versus recordings of the same chanting. It could also compare effects of listening to Vedic recitation in meditating and non-meditating populations, and in those who only practice the TM technique compared to those who also practice the TM-Sidhi program.

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