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Research Paper: Quantitative Electroencephalogram-Informed Geometric Meditation: A Pilot Validation Study

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ABSTRACT

Objectives: The emerging neuroscience literature has provided some evidence that meditation may have measurable effects on the electrophysiological parameters in the nervous system. We hypothesized that a novel geometric meditation approach comprising Geometric Somatic-Breathing Based (GSBB) and Geometric Introspective Based (GIB) meditation yield favorable electrophysiological changes at brain's cortical level and autonomic nervous system upon deep meditative experience.

Materials & Methods: A multi-sensor digital sampling setup, including Electroencephalography (EEG), Galvanic Skin Response (GSR), and Heart Rate Variability (HRV) was used to obtain data and compare meditation and baseline epochs from 3 long-term geometric meditators.

Results: The analysis revealed a notable change in autonomic nervous response, including Root Mean Square of Successive Differences (RMSSD) in Heart Rate Variability (HRV) as well as GSR and Quantitative Electroencephalogram (QEEG) correlates across 10 practiced techniques in training and post-training as compared to the baseline state.

Conclusion: Such findings may serve as a pilot validation dataset to pursue further research on quantitative EEG-guided geometric meditation approach.

1. Introduction

Other than earlier established meditation approaches [1-10], geometric meditation is an innovative meditation protocol in which attention is focused upon geometric shapes and routs superposing on different parts of the body and moving through inhalation and exhalation. The anecdotal effects of geometric meditation prompted us to assess its physiological relaxation response in a case study through a polygraph setup [11].

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Farshad's Geometric (FG) meditation (introduced and developed by FN, the first author) is an innovative method comprising two components, including Geometric Somatic-Breathing Based (GSBB) and Geometric Introspective Based (GIB) meditation. The key substrates of FG meditation rest upon purposeful and self-induced manipulation of attention leading to the experience of an altered state of consciousness and concentration. The spotlighted attention is reflected through the brain capability and tendency to deal with a single subject or a phenomenon and to ignore surrounding subjects and phenomena at the same time.

In the practice of GSBB meditation, our attention is focused on subtle vibrations and effects produced by the breathing process in specific body parts, dismissing all other vibrations and effects from our attention [12-16]. These vibrations should be organized on various linear, surface, and solid directions in the form of specific geometric shapes superposing on different parts of the body. This would aim to manipulate, massage, and modulate our attention to reach the concentrative state and mental silence as well as to experience altered states of consciousness [11].

The GSBB meditation encompasses a group of techniques in which subtle and sensible effects caused by breathing are followed in light of form, route, and direction of respiratory muscles' movements, the entry and exit of the airflow or slight vibrations produced by both processes, both upon inhalation and exhalation stages. This process should be organized in some geometric shapes superposing on different parts of the body aiming to modulate our attention in order to reach the concentrative state and mental silence as well as to experience an altered states of consciousness. In this meditative approach, one of the unique features of FG meditation is to present the meditative process in the form of mathematical graphs and functions [11].

The practiced FG meditation techniques (Figure 1) include linear concentration, hyperbolic concentration techniques, expandable hyperbolic angle, spheral concentration, conical concentration, plantar concentration, and mixed geometric concentration [11]. FG meditation techniques show how the mind connects to the body and coordinates in a reciprocal way. In GIB meditation, our attention seems to drive to the frontal lobes in a deep meditative state. In order to reach deep concentration and penetration into the dark space, we use geometric forms as spiral, reverse spiral, spheres, cones, and circles to accelerate the process [11].

2. Materials and Methods

Baseline and meditation data were obtained from 3 long-term FG meditation practitioners using the multichannel polygraph setup. Each subject was asked to complete a 5-minute resting period during which they closed their eyes and let their mind wander (without meditating). This was followed by an 8-10 minutes training of a specific FG meditation technique. A f4-channel EEG (F3-A2, F4-A1, P3-A2 and P4-A1) montage, Galvanic Skin Conductance (GSC), Heart Rate Variability (HRV) and pulse-oximetry probes (Vilistus DSU, UK) were applied for real-time recording while subjects were going through 5 training phases in each technique; pre-test, pre-technique, core technique, post-technique, and post-test.

Study subjects were initially screened for their affective state by a cognitive neuroscientist and subsequently briefed about the process. They were then provided written informed consents. For all subjects, the power spectrum in 8 commonly-examined frequency bands was computed on a second-by- second basis, resulting in 31 datasets each composed of 8 vectors labeled as either "baseline" or "meditation". The number of 8 vectors in each dataset corresponded to the total number of seconds in both baseline and meditation epochs.

The comparative outcome measures across states were the spectral and spatial distribution of theta wave/theta power, GSR and HRV. Statistical differences were considered significant at $P<0.05$ cut-off. The Independent t test was used to determine the significance of differences between corresponding states. Mean and standard errors of mean (M±SEM) were calculated for all obtained values.

3. Results

Our findings including the EEG alpha-theta power ratio at F3 upon meditative experience, cortical brain maps for theta power, GSR by µS and RMSSD for HRV are summarized in Figure 2. This preliminary data suggested a pronounced deep-down relaxation response in FG meditation in all practiced techniques as compared to control condition. Our pilot trial and subsequent randomized clinical setup are expected to shed further light to the efficacy of FG meditation as a possibly preferred method in reducing stress response.

4. Discussion

In geometric meditation, our attention is organized through various paths; linear, surface, and solid directions, in relation to different body parts and in coor-

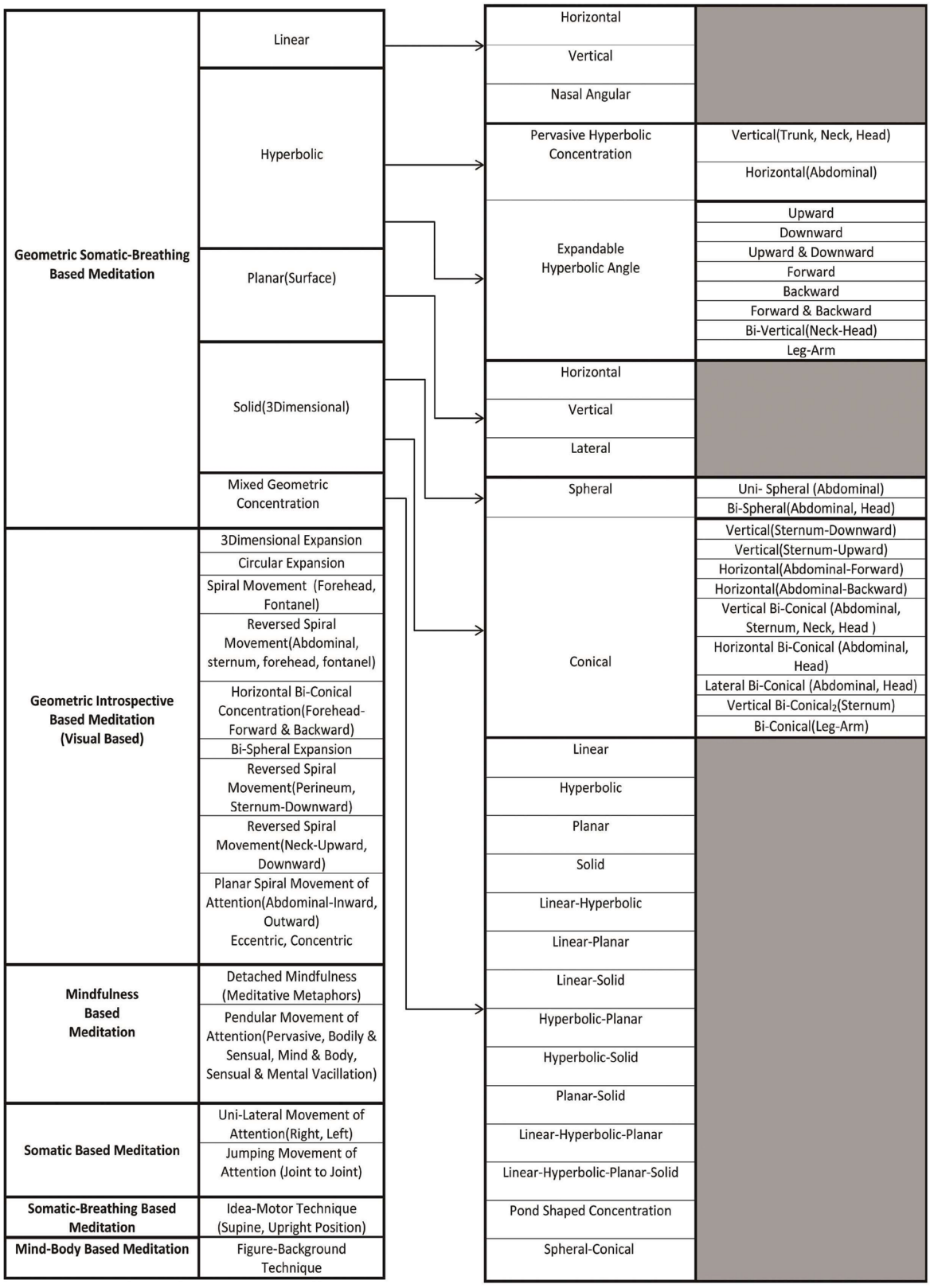

Figure 1. Overall clustering of various geometric meditations approaches

The main three clusters including geometric somatic breathing-based, introceptive and minfulness-based meditation approaches focus of a separate sets of elements for superposing attention to provide a deep conscious state

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dination with breathing it allows us to reach focused attentive stage. FG meditation is a method which uses linear, surface, solid and mixed concentrative techniques. FG meditation is a new comprehensive style of meditation, which includes concentrative, introspective, and mindfulness techniques. In this style of meditation, we focus our attention on breathing and breathing effects in a very different and new manner through the geometric forms. FG meditation also includes introspective methods based on inner visual experiences through the spiral, spheres, cones and other geometric forms. In FG meditation, the purpose of GSBB meditation and mindfulness based meditation is to reach

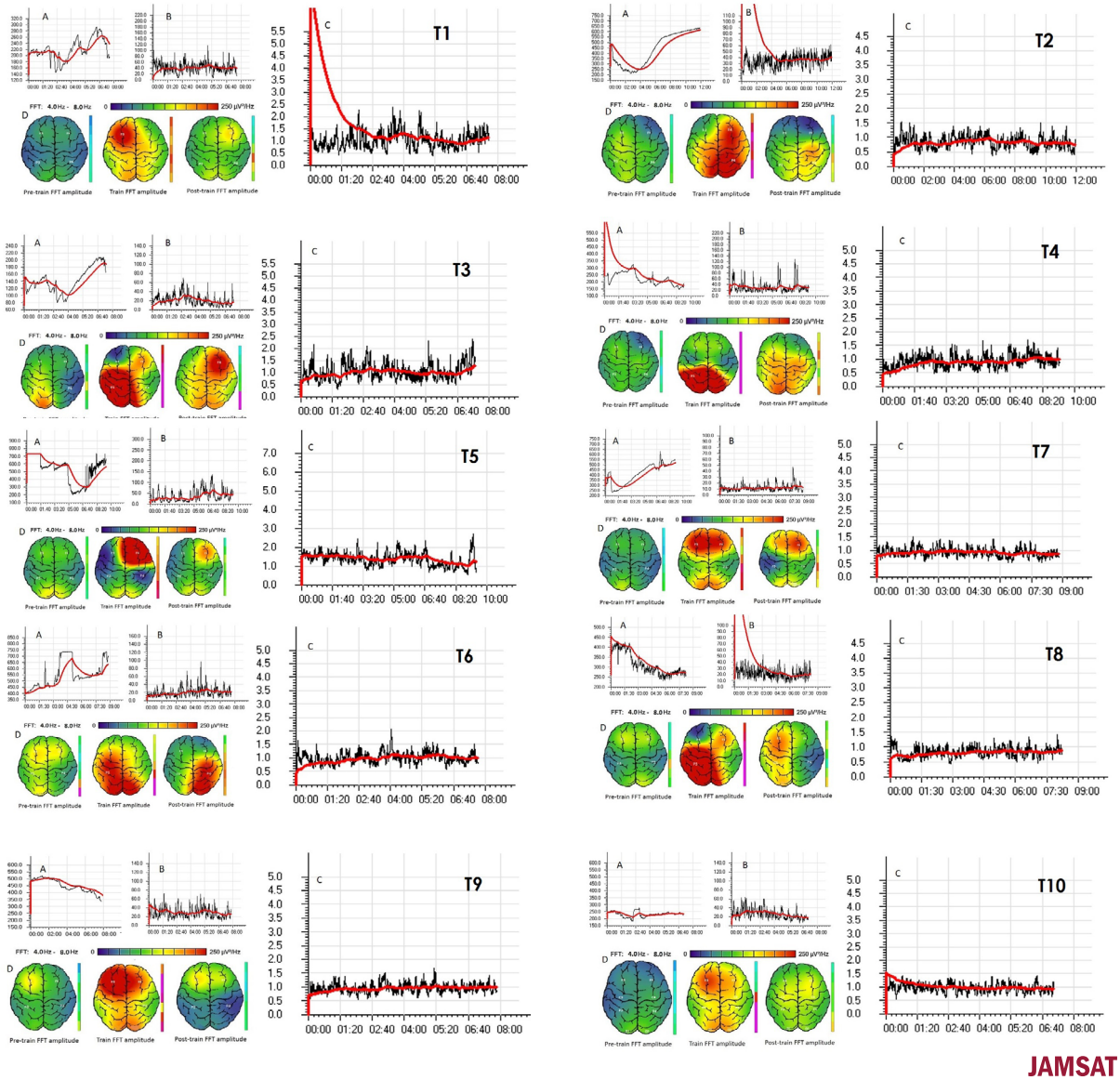

Figure 2. Outcome measures upon meditative training across subjects and techniques

Technique 1, Subject 1: Three-dimensional expansion of attention; Technique 2, Subject 1: Unilateral right; Technique 3, Subject 1: Mixed Biconical concentration; Technique 4, Subject 1: Jumping movement of attention; Technique 4, Subject 1: Jumping movement of attention; Technique 5, Subject 2: Reverse spiral fontanelle; Technique 6, Subject 2: Expanded hyperbolic leg and arm; Technique 7, Subject 2: Spiral forehead; Technique 8, Subject 3: Conical spherical; Technique 9, Subject 3: Expanded hyperbolic down; Technique 10, Subject 3: Idea-motor;

A: GSR µS; B: RMSSD; C: Alpha-theta ratio at F3; D: Cortical brain map showing theta power FFT

FFT: Fast Fourier Transform; GSR: Galvanic Skin Resistance; RMSSD: Root Mean Square of Successive Differences; T: Technique.

solidarity of self-conscious mind, whereas the aim of GIB meditation is to encounter unconscious mind.

5. Conclusion

Breathing in FG meditation is based on the spontaneous pattern across techniques, therefore breathing becomes tranquil and placid at the end, facilitating a harmony between mind, breathing, and body. As such, the element of attention aligns with the body and breath throughout the technique [11]. Questions about the generalizability of our results to novice and intermediate practitioners remain to be answered in future studies.

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Conflict of Interest

The authors declared no conflicts of interest.

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