Tracking Functional Connectivity using Dynamic Independent Component Analysis During the Meditative State

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Background

- Meditation enhances emotional and mental clarity.
- Focused attention (FA) meditation is the practice of gaining internal awareness of mental states. Focused attention states are downregulated within the Default Mode Network (DMN), which is responsible for mind wandering, working memory, and self-reference.
- Functional magnetic resonance imaging (fMRI) is a noninvasive tool used to study brain activity through changes in blood flow.

Introduction

- We plan to extract data from fourteen fMRI-scanned meditation practitioners[1] . The meditation process was modeled into four intervals of component states: focused attention, mind wandering, awareness of mind wandering, and shifted attention.

- Our **hypothesis** is that we will decode a unique neural network to be activated within the focused attention states

Methods and Materials

- Our plan is to accurately assess the decomposed brain model, using dynamic ICA, to trace patterns of connectivity within the whole brain.
- 20% of sample population were male, 80% of subjects were female; 28-66 years old.
- We will utilize various computational tools and software to assist in the statistical analysis of the neuroimaging data:
  - GIFT toolbox in MATLAB[2]
  - Statistical Parametric Mapping (SPM)
  - CONN; functional connectivity toolbox in MATLAB

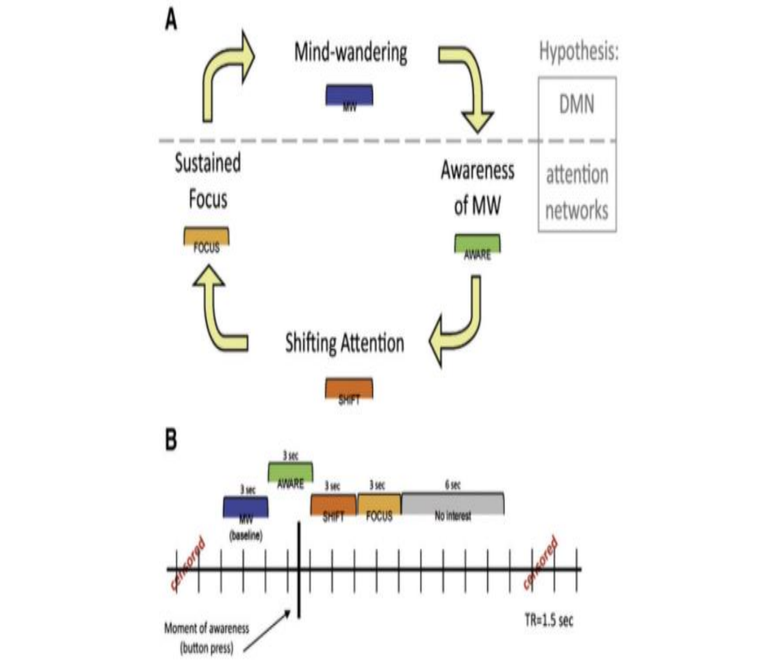
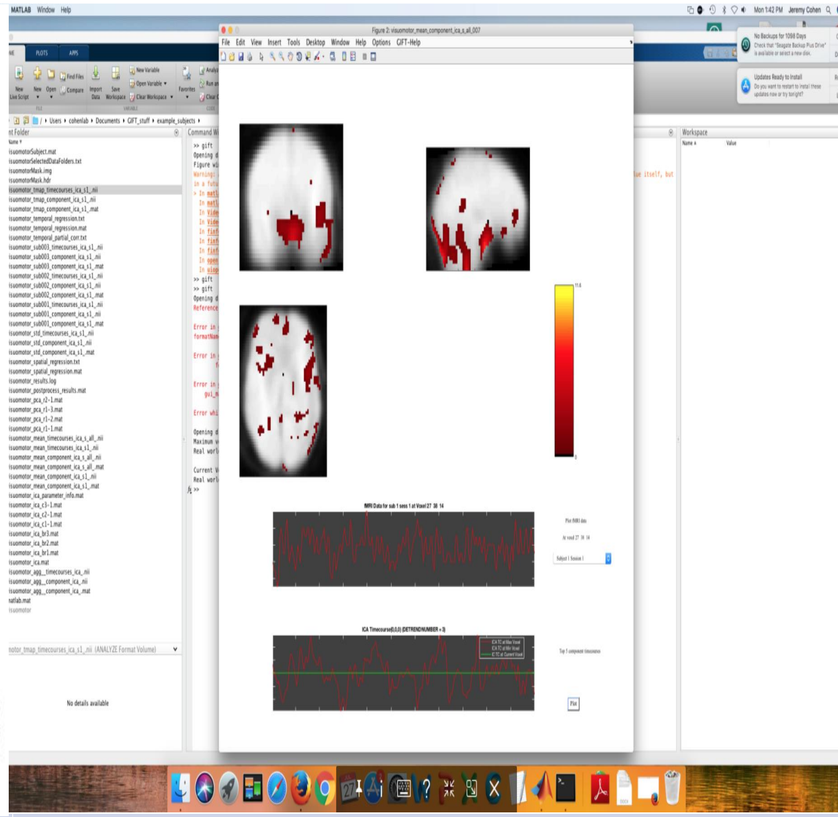


Fig. 1. Theoretical and analytical models of FA meditation. A) Theoretical model of dynamic cognitive states experienced during a session of FA meditation. A detailed description of this cognitive cycle is presented in the Introduction. The gray dashed line represents our hypothesized division between DMN and task-positive attention network activity during these states. B) Analytical model for construction of phases surrounding each button press (represented by the heavy black vertical line). While the button press is represented here in the middle of a TR, note that the timing of the button press within a TR will be variable. A detailed description of the phases is presented in Materials and methods.



A visualization of the cyclical process of FA meditation. Attention is focused on a breathing exercise, following an event that causes the mind to wander. Meditators acknowledge the event, and shifts attention back to the task based breathing exercise[1].

A spatial component map of task related component No. 7 using the Orthogonal viewer method. The upper plot is the Blood-oxygen-level-dependent (BOLD) fMRI time course at the current voxel position 27 38 14 [x y z]; The lower plot is an ICA time course [2].

Future Plans

- Analyze preprocessing steps used in GIFT tutorial data
- Create clinical trials of real time neurofeedback to train individuals with no prior meditation experience under decomposed model
- Expand experiment to areas that are disproportionately affected by high levels of stress and lack resources to treat mental health issues

Acknowledgments and Sources

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