A Computational Approach to Meditation

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Introduction

Meditation is a form of complementary alternative medicine and has been defined clinically. Since 1957 there has been numerous studies to understand the physiology of meditation. These include EEG, ERP, PET, SPECT and more recently fMRI studies (Cahn & Polich, 2006). Some of these studies have shown that meditation can have positive health effects e.g., reduction of depression, emotion regulation, etc. To our knowledge, no study has focused on understanding the neural basis for meditation using computational modeling although such an approach has been used to investigate related cognitive behaviors such as visual attention (Koch & Itti, 2001) and consciousness (Miranker, 2000). A similar approach can be used to simulate meditation mechanisms. In preliminary work, such a model was developed and tested, based on controlling the dynamics of a single computational element.

Model

Meditation techniques can be divided into two main categories – Mindfulness and Concentrative (Cahn & Polich, 2006). This paper focuses on the concentrative approach, in particular modeling the 'Surat-Shabad-Yoga' method. In this technique, meditator sits in a quite place turning all five senses inwards. He focuses his attention on a point defined located between and behind the intersection of eyebrows (the so-called sixth chakra). To facilitate this regulation of mind he repeats the 'mantra' provided by his Master. The model consists of four components, depicting the various aspects of such meditation (Figure 1a). The model is trained to represent three different states of consciousness (Figure 1b-d). The first of these is the sleep state, in which there is no input from the external world and no regulatory mechanism. Thus in this state only 'Filter' and 'Think Tank' are online, generating a chaotic sequence of thoughts. The second is the alert state: there is still no specific control mechanism for thoughts, however, there is input from the external world that drives these thoughts. In the third, meditative state, there is no input from the outside world, however the meditator is trying to regulate his thoughts using the control component, reducing its complexity from chaotic to periodic dynamics.

Implementation

Two different types of neural networks are used to implement the components of the model. The Think Tank is a chaotic neural network; in the current implementation it is represented as a single chaotic neuron (Aihara, 1990). The sequence of states of this neuron represents the sequence of thoughts. The control component is implemented using a modified DSANE algorithm (Burgess & Weeks, 2001), which is a neuro-evolution learning technique. This algorithm is used to control the chaotic behavior of Think Tank neurons and making them periodic. Results of this implementation are shown in Figure 1(b,c,d).

Future Study

In the future, the model will be scaled up and matched with fMRI and EEG data. Such simulations should eventually lead to a computational theory of meditation, providing insights to neuroscientists and clinicians and possibly suggesting how meditation can be used in treating of depression and emotion regulation disorders.

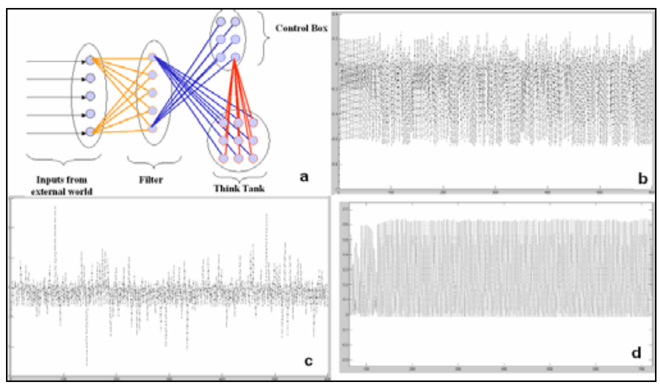

Figure 1. Meditation model and its behavior. (a) The model architecture. (b) Sleep state (chaotic). (c) Alert state (driven by input). (d) Meditative state (periodic, driven by control).

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