

## Letter to the Editor

Changes in heart rate variability during concentration meditation<sup>☆</sup>Sukanya Phongsuphap<sup>a,\*</sup>, Yongyuth Pongsupap<sup>b</sup>,  
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**Abstract**

This study aims at investigating changes in heart rate variability (HRV) measured during meditation. The statistical and spectral measures of HRV from the RR intervals were analyzed. Results indicate that meditation may have different effects on health depending on frequency of the resonant peak that each meditator can achieve. The possible effects may concern resetting baroreflex sensitivity, increasing the parasympathetic tone, and improving efficiency of gas exchange in the lung.

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**1. Introduction**

Originally, meditation is a spiritual practice in many religions. Nowadays, it can be practiced by anyone regardless of their religions to facilitate a greater sense of calmness or awareness. There are many types of meditation techniques. The one adopted here is concentration meditation. The terms “meditation” and “Samadhi” used throughout this paper are defined as follows. *Meditation* is a practice of concentrated focus upon the breath in order to still the mind. *Samadhi* is the state of one-pointed concentration which is a product of successful meditation. In this study, we investigate changes in heart rate variability during concentration meditation to understand more its effects on health. Finally, we discuss and compare our results with those of the other meditation techniques [1–5] such as Qigong (Chinese style), Kundalini Yoga (Indian style), and Zazen (Japanese style).

**2. Materials and methods****2.1. Subjects**

Thirty-five experimental subjects were recruited on a voluntary basis (mean age 33.40 years, mean weight 58.69 kg, mean height 165.63 cm). These thirty-five subjects are meditation practitioners who have experienced in achieving the Samadhi state and most of them are meditation masters. And seventy age-matched subjects who did not have any experience in meditation practice were recruited as a control group (mean age 33.56 years, mean weight 57.44 kg, mean height 162.56 cm). At the time of enrolment, all subjects were in good general health, free of any history of cardiac or vascular disease, did not follow any specific exercise routines, did not take any form of medication, and did not drink coffee or tea before meditation practices or data recording. They were non-smokers and none of them were habitual drinkers. The overall general health conditions for the meditation group and the non-meditating control group were comparable. Informed written consent was obtained from each subject after the experimental procedures had been explained.

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## 2.2. Data collection

RR interval data were collected from subjects by using Polar 810/810i (Polar Electro Oy, Kempele, Finland). For the meditation group, the subjects sat in a cross-legged position and kept their eyes closed as they were accustomed to doing during their meditation practice. Subjects were first instructed to sit quietly for 5 min. After that, they performed concentration meditation by focusing on the breath in order to achieve the Samadhi state. The subjects were asked to meditate everyday for about 4 weeks. The RR interval data were collected during the practices. For the control group, the subjects were also instructed to sit quietly in a cross-legged position during data recording for about 10 min per time. Totally, data were recorded 3–4 times for about 4 weeks in each subject. There are totally 1677 and 654 segments (256-second period) of RR interval data from the experimental group and the control group respectively.

## 2.3. Data analysis

The RR interval data were analyzed in terms of HRV parameters both in time domain and frequency domain. Then, the HRV measures in the Samadhi state and the Non-Samadhi state were compared. The spectral parameters are used to gain insight into the autonomic nervous system (ANS) response induced by meditation. We considered two measures in time domain including the mean heart rate and the autocorrelation coefficient. The spectral HRV measures for each segment were calculated by using Fast Fourier transform [6]. According to the Task Force [7], the power

spectrum for short time series can be classified into 3 ranges as follows: (i) power in the very low frequency range (VLF), 0.003–0.04 Hz, (ii) power in the low frequency range (LF), 0.04–0.15 Hz, and (iii) power in the high frequency range (HF), 0.15–0.4 Hz.

## 2.4. Data clustering

All of the data will be classified into  $K$  groups by  $K$ -means clustering method [8]. After that, the data in each cluster are investigated to summarize the characteristics of HRV measures in the Samadhi state and compare differences to those of the Non-Samadhi state.

## 3. Results

We use the following features: mean heart rate, auto-correlation coefficient, normalized VLF, LF and HF power spectra, width of the highest spectral peak, and frequency of the highest spectral peak for grouping the RR interval data. By using  $K$ -means clustering algorithm and investigating data in each cluster, we can summarize that there are 3 categories of data corresponding to states of mind including Normal state, Samadhi state, and Intermediate state (meditating but cannot achieve the Samadhi state yet). The prominent feature of the Samadhi state is the appearance of the single narrow peak with high amplitude called the resonant peak. The peak may appear in the LF, HF, or VLF ranges called the LF-, HF-, and VLF-resonant peaks respectively. Results show that HRV in the Samadhi state and the Non-Samadhi state are remarkably different.

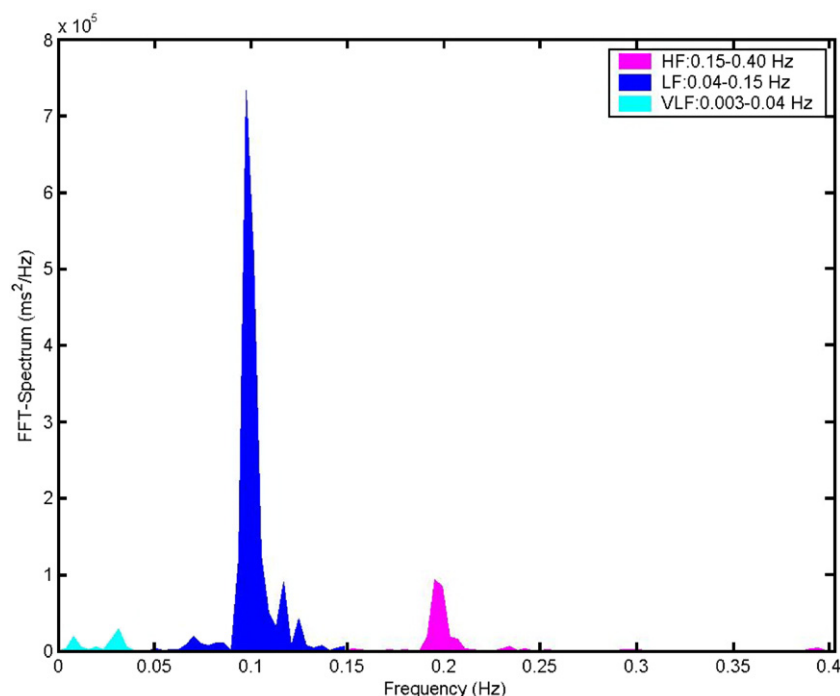


Fig. 1. Power spectrum of RR interval time series during the Samadhi State (during meditation).

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