How do Meditation and other Activities affect the Human Mind & Body?

Assessing psychophysiological coherence during different activities via heart rate variability measurements and the coherence ratio

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1. Introduction

Psychophysiological coherence (PC) has been extensively studied over the past decades (McCraty et al., 2009; Shaffer & Ginsberg, 2017) and has allowed us to gain valuable insights into psychological and physiological states via heart rate variability (HRV) measurements. HRV captures the change in time intervals between adjacent heartbeats, called RR or inter-beat-intervals (IBIs). Increased PC is associated with a distinct rhythm of heart activity that can be described as a sine wave-like pattern. When such a physiological coherence mode is driven by a positive psychological state, we generally speak of PC, which has been linked to increased synchronization between several physiological systems. HRV measurements together with the coherence ratio (McCraty, Atkinson & Tomasino, 2001), allow us to learn how to improve cognitive clarity and decision making (Childre & Cryer, 2008), stress reduction (McCraty & Tomasino, 2004), health (Radin et al., 2008), inner peace (Davis, Schübeler & Kozma, 2019) and general physical and mental wellbeing, amongst others.

The study presented here is built upon previous work (Davis, Schübeler & Kozma, 2019), where a variety of daily activities have been analyzed. This paper, however, mainly focuses on the participants' coherence ratio (CR) during different types of meditation and a baseline. Additional to the meditations, one of the three group activities is presented, since it provides some additional contrast to the other results. The reader will be provided with a brief description of the experimental setting, the data acquisition and processing, followed by the presentation of the results based on 2 hypotheses regarding the relationship between meditation practices and baseline.

Finally, conclusions are drawn, and future perspectives are raised in order to stimulate further research to understand better what type of practices are most suitable to improve PC.

[1] This article is based on the presentation Florian gave on 'Psychophysiological Coherence in Community Dynamics - A Comparative Analysis between Meditation and Other Activities'. Florian is an Ambassador of Peace, with an academic background in political science and a research interest in Social Dynamics, as well as Heart Rate Variability and Neuroscience.

2. Experimental Setting and Data Acquisition

The study presented here was conducted at The Embassy of Peace (EoP) in Whitianga, New Zealand in 2015 as part of the International Heart Rate Variability Synchronization Study (IHRVSS), where a total of 6 groups from 5 different countries participated. The IHRVSS was comprised of a set of 4 individual and 2 global group meditations, while the participants otherwise continued with their normal daily activities. The study at EoP, however, included 3 additional daily group meditations, as well as 3 daily group activities that all the 20 participants performed together, 11 male and 9 female between 25 and 57 years of age.

The experiment was conducted during summertime, in a rural setting, surrounded by native bush, a very pleasant and peaceful environment. The group meditations (Meditation 1 and 3) and activities were held inside a house, mostly in a very spacious living room, where the participants were seated in a circular arrangement, sitting comfortably, either on a chair, a couch or on the floor, dependent on the choice of the participant. For Meditation 2 participants could choose freely the location and posture, some meditated outside and some lay down.

There are several events of interest that were analyzed and the CR calculated for, as follows:

(1) Baseline – Randomly chosen 30-minute periods outside the daily planned activities, meditations and sleep times. It is important to note that creating an arbitrary baseline activity is different from allowing each individual to go about their day doing their own random activities.

(2) Meditation 1 – Heart Lock-in Meditation (McCraty et al., 2018), daily from 10 am to 10:30 am.

(3) Meditation 2 – Individual participant's meditation style and position of choice with closed eyes, daily from 2 pm to 2:30 pm.

(4) Meditation 3 – Paradise Landing Meditation (PLM): (a) sitting down with closed eyes and listening to a piece of poetry about spiritual values from Paradise Landing (Paradise Landing, 2000), followed by (b) chanting the sounds of the associated Hebrew letters to each value and (c) the syllable 'OM', daily from 6 pm to 6:30 pm.

(5) Group Activity 'Gibberish' – Comprised of 2 components: (a) Gibberish Talk, a 30 minute period of talking gibberish with a partner and (b) a 30 minute meditation (akin to Meditation 2) in close physical proximity to the same partner.

Measurements were obtained via a *FIRSTBEAT Bodyguard 2* HRV recorder. The device was attached to the skin with two chest electrodes that once connected, started recording data automatically with a sampling frequency of 1000 Hz. We recorded for 23 hours daily, and each participant was disconnected for 1 hour to shower and recharge the device. The recorded data was pre-processed by the HeartMath Institute and .txt files with the IBIs were provided.

From the IBIs, after interpolation and the application of the Fast Fourier Transform, the power spectrum was derived, from which the CR can be calculated, as follows:

$$CR = \frac{LFP}{TP - LFP}$$

In **Table 1** an example of such a calculation is given for Participant 8 during Baseline, based on the power spectrum displayed in **Figure 1**.

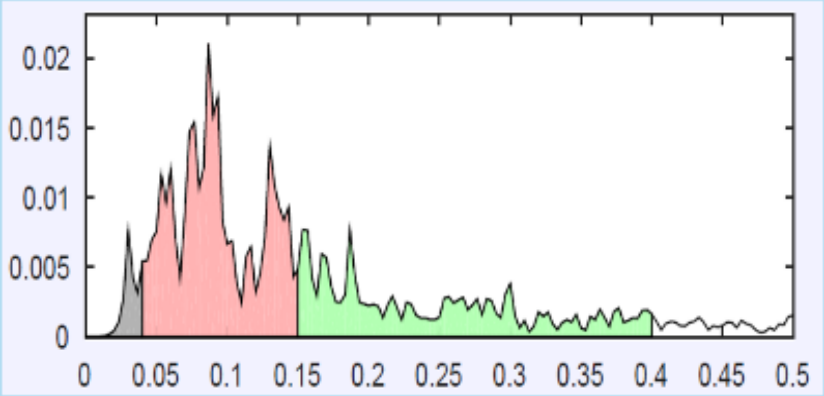

Figure 1. Shows the power spectrum for HRV measurements of Participant 8 during a Baseline period. The very low frequency band (VLF) is displayed in grey, the low frequency band (LF) in red and the high frequency band (HF) in green. The power spectrum shown was derived with the Kubios software.

Table 1. Displays the frequency bands and their associated power for Participant 8 during a Baseline period.

Frequency Band	VLF (0-0.04 Hz)	LF (0.04-0.15 Hz)	HF (0.15-0.4 Hz)	Total	**CR** (LFP/(TP-LFP))
Power (ms^2)	74	987	559	1623	**1.56**

3. Results

The CR mean values for all 20 participants per day were computed and displayed in **Figure 2(a)**, where an interestingly consistent highest CR mean value corresponds with the times of the Paradise Landing Meditation (PLM). While we also can observe higher CR mean values during most times of Meditation 1 and 2, they do lack the consistency displayed during the PLM.

This initial observation becomes even clearer, when we calculate the CR mean value for all participants and all days, as shown in **Figure 2(b)**, where we can easily see the 3 peak CR mean values associated to the 3 daily meditations and the highest of the 3 being during the PLM.

Based on these initial findings, two working hypotheses were formed, as follows:

- Hypothesis 1: The Paradise Landing Meditation (PLM) recording period should show significantly **higher CR** mean values than other activities and Baseline periods.

- Hypothesis 2: Baseline periods are expected to show **lower or similar CR** mean values than Gibberish Talk (GT) and Gibberish Meditation (GM) recording periods.

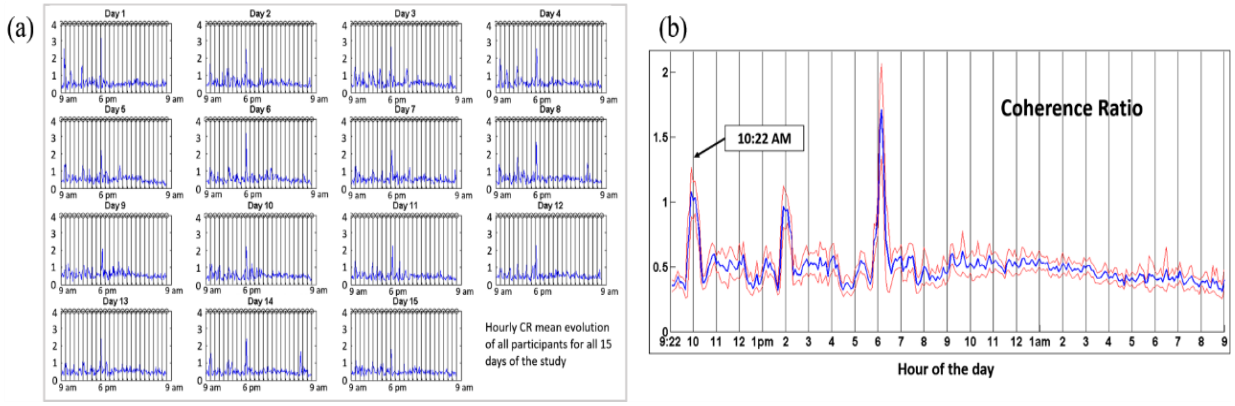

Figure 2 **(a)**. Shows the daily CR mean value evolution for all participants for each of the 15 days. **(b)**. Illustrates the CR mean values evolution for all 15 days and 20 participants, with the 3 peak values for Meditation 1, Meditation 2 and PLM at their set daily times.

In order to gain further insights into the CR development, a movie was created that displays each individual participants' CR every 5 minutes throughout the 15 days of the experiment. **Figure 3(b)** provides example frames for 6 significant daily periods. It can be clearly observed that several participants display high to very high CR mean values during the PLM, while no participants display such high values during the evening and night period. The reader is encouraged to watch the movie, where **Figure 3(a)**, as well as the paper by (Davis, Schübeler & Kozma, 2019), provide an explanation of what is shown in the movie. Note that the movie includes 2 additional participants to the 20 analyzed in this study. These additional 2 participants were located elsewhere in New Zealand and only performed some of the group meditations and general activities.

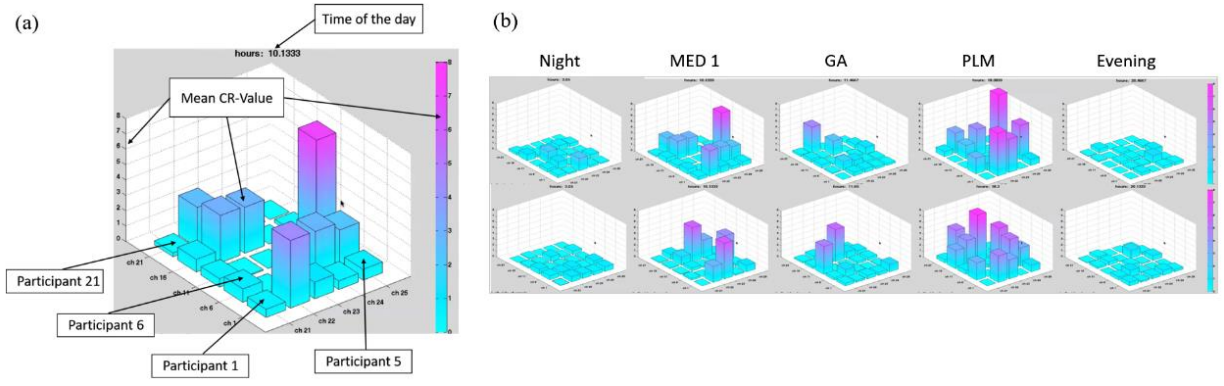

Figure 3. Shows example frames taken from the 'Heart Coherence Ratio per Participant' movie, where **(a)** provides an explanation of what is shown in the movie and **(b)** displays frames from different periods throughout the day. The movie can be found here: https://youtu.be/UAd_GUgsYFU.

From **Figure 4** several relevant observations can be made. PLM displays significantly higher CR mean values than GT, GM and Baseline, as shown in **Figure 4(a)**, **Figure 4(b)** and **Figure 4(c)** respectively. Only 3 participants display CR mean values less than 2 during PLM, while 8 do so during GT, 13 during GM and 9 in Baseline. It is also important to note that 19 participants displayed a higher CR mean value during PLM than GM and only Participant 10 had a significantly higher CR mean value during GM than PLM.

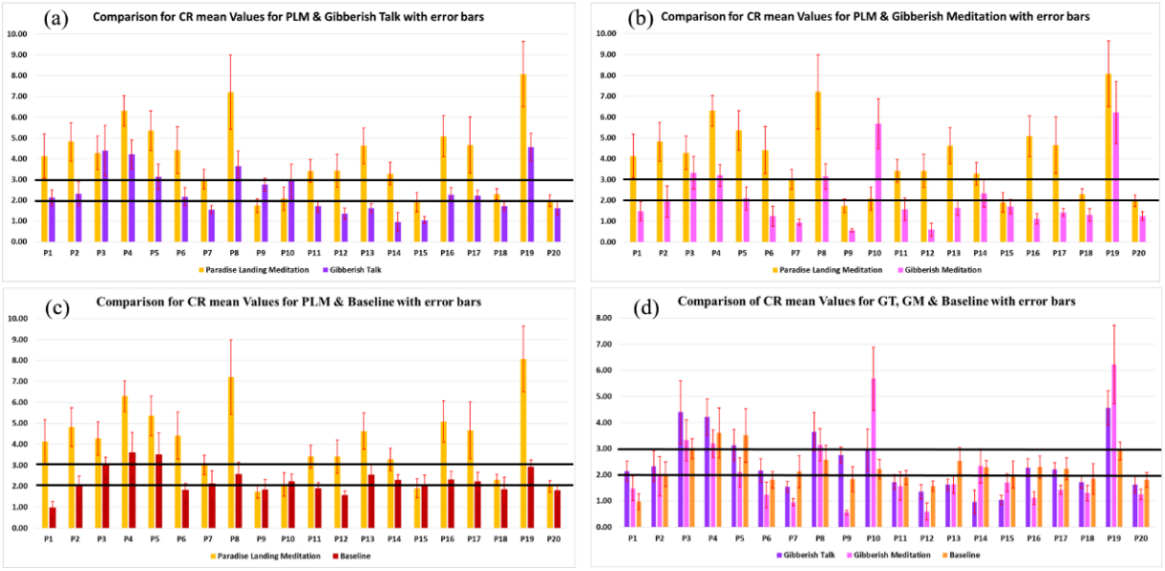

Figure 4. Displays the CR mean values and error bars with a 95% confidence limit, for all participants during **(a)** PLM in yellow and GT in purple, **(b)** PLM in yellow and GM in pink, **(c)** PLM in yellow and Baseline in red, **(d)** GT in purple, GM in pink and Baseline in orange. The black lines indicate the boundary between low, medium and high CR mean values.

When comparing GT, GM and Baseline periods, no homogenous observation can be made and while several participants (P1 & P3 for example) show a GT-GM-Baseline order, where GT is associated with the highest and Baseline with the lowest CR mean values, many participants show the lowest CR mean values for GM, most combined with higher Baseline than GT CR mean values, such as P7 and P20.

This is somewhat surprising, since our initial analysis suggested Baseline periods to result in the lowest CR mean values and meditation periods in significantly higher CR mean values.

While PLM confirmed this impression, GM results failed to do so.

When we revisit the 2 hypotheses, we find that Hypothesis 1 holds, since the PLM period certainly shows significantly higher CR mean values than the GT, GM and Baseline periods for most participants. For Hypothesis 2, however, we found that the Baseline period showed CR mean values that were often between the GT and GM CR mean values for most participants, indicating that some activities, generally speaking, may create a better than baseline result, while other activities may manifest a worse than baseline condition. Also surprising is the fact that for many participants the GM resulted in the lowest CR mean values of those 3 periods.

It is important to note that PLM periods show substantially and significantly higher values in coherence ratios for most people who practice PLM regularly, as well as for those who were unfamiliar with the PLM previous to the study.

Hypothesis testing for equal means was performed for the above results, however, it is outside the scope of this paper and can be reviewed in (Davis, Schübeler & Kozma, 2019).

4. Conclusions and Future Perspectives

This study showed how different activities affect PC, measured via the CR. This is especially relevant, since different forms of meditation result in significantly different CR mean values.

Figure 5 shows a comparison between Meditation 1, 2 & 3 (PLM), which confirms this observation. While GM had a significantly different setting to the PLM, Meditation 1 was performed by all participants in the exact same setting as the PLM, and Meditation 2 by most. Still, the results differ for many participants significantly.

This poses the question, 'which type of meditation is the most conducive to improve PC' a good candidate for further research.

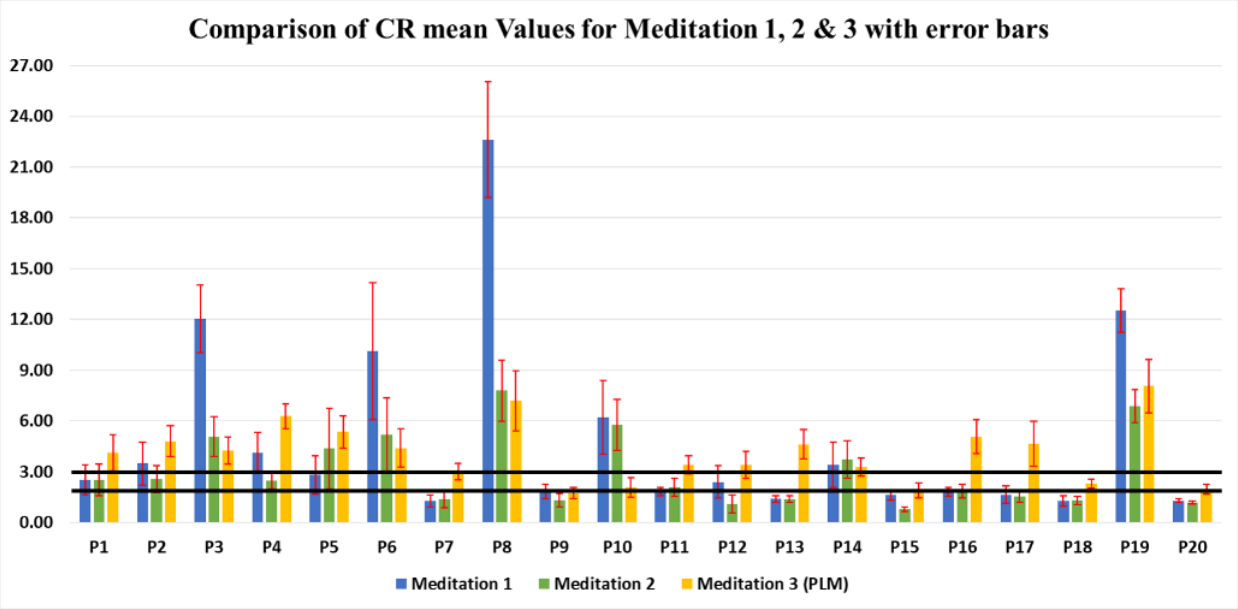

Figure 5. Displays the CR mean values for Meditation 1 (blue), Meditation 2 (green) and Meditation 3 (PLM, yellow) with their associated error bars with a 95% confidence limit, for all participants.

The results obtained for GM strongly suggest that the environment, including people around us (Flory et al., 2023) (Davis & Schübeler, 2019), can effect HRV measures, where the environment may enhance or diminish the positive effects of meditation and other potentially beneficial activities on PC. One possible explanation for the low CR mean values for most participants during

GM may be found in the fact that GT was experienced as stressful by many participants, while for others this same activity was neutral or enjoyable, something that may be reflected in lower or higher CR values and potentially carry over to the time and activity afterwards, in our case GM.

In summary, certain meditative practices may contribute to an increased resilience towards potentially stressful environments and activities and, over time, increase PC and inner peace.

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