

# VU Research Portal

## Criticality theory applied to the wandering mind and meditation

Irrmischer, M.

2018

### **document version**

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

### **citation for published version (APA)**

Irrmischer, M. (2018). *Criticality theory applied to the wandering mind and meditation*. [PhD-Thesis - Research and graduation internal, Vrije Universiteit Amsterdam].

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

### **E-mail address:**

[vuresearchportal.ub@vu.nl](mailto:vuresearchportal.ub@vu.nl)

## Summary

Interruption of attentional focus by task-unrelated thoughts is a frequent, spontaneous and intermittent phenomenon known as “mind wandering”, which has the potential to impair learning, behavior, and emotional regulation. Until recently, the quantitative temporal dynamics—and its underlying neural correlates—were not known. We hypothesized that mind wandering and the underlying neuronal systems can be understood within the framework of so-called “critical dynamics”—a quantitative framework for understanding fluctuations in complex systems. We applied analytical tools from criticality theory in combination with attention tasks and mental training to understand the dynamics of attention and mind wandering in healthy volunteers, expert meditators, and in patients with major depressive disorder.

Behaviorally, we found that distracting thoughts indeed occurred in highly nonrandom sequences and that the temporal structure of these interruptions became more “patterned” when healthy volunteers had been subjected to a negative mood induction. The ability to focus attention was also reflected at the level of brain dynamics: the more people succeed in suppressing complex fluctuations in brain oscillations, the better they perform. Interestingly, a related phenomenon was observed during so-called focused attention meditation: experienced meditators strongly suppressed the temporal complexity of brain-activity fluctuations, whereas meditation-naïve healthy volunteers were unable to achieve this brain state when given the same instruction to focus on their breath. Further, we showed that these brain dynamics are subjective to changes after prolonged meditation practice in healthy volunteers, and also in depressed patients after an intervention. Last, we showed that temporal dynamics in neuronal oscillations are not only important for attention, but also for perception as we observed that task-related neuronal dynamics are related to the perception during a bi-stable visual experiment.

Together, our research has indicated that the proposed measurement of complex fluctuations in behavior and brain activity offer a reliable biomarker to quantify states of attentional focus, meditation, mood and visual perception suggesting that these measures