**Abstract**

**How Brain Oscillations Provide Sampling-Rates for our Perception & Memory.**

George Parish1,2, Sebastian Michelmann3, Simon Hanslmayr1, Howard Bowman1,2

1University of Birmingham, Department of Psychology, U.K.; 2University of Kent, Department of Computer Science, U.K., 3Princeton University, Department of Psychology, U.S.

E-mail for correspondence: g.parish@bham.ac.uk

**Background**

Neural oscillations have provided us with a language with which to understand the mechanisms within the brain. One review of these findings has argued that cortical oscillations regulate our attention and perception by providing shared up-states of neuronal activity1. Here, neural desynchronisations are thought to signify the flow of information2, which has been demonstrated in a previous computational model3. As well as detecting ‘when’ you are thinking about something, new research has indicated that one can also detect ‘what’ you are thinking about4. It is the purpose of the modelling project presented here to understand the processes behind this novel mind-reading capability, as well as to hypothesise about the utility of underlying nested frequencies in providing a hierarchical sampling-rate for temporal memory.

**Methods**

We simulate a neural-network model to explore how the interactions between disparate, intrinsically oscillating brain regions provide temporal windows that regulate our perception and allow us to encode sequences of discrete events.

**Results**

Through a complex and computationally demanding analysis of oscillatory phase, we show through our model that one can identify the encoding and subsequent re-instantiation of unique sequences.

**Conclusions**

Here, we have created a neural-network model that defines a hierarchical architecture of perception and memory, theorising the roles that distinct brain oscillations might play in regulating our online experience and encoding memories. As such, we hope to provide a testable framework for future experiments in understanding how consciousness can emerge from a complex biological system.

References

# [1] EEG Alpha Oscillations: The Inhibition-Timing Hypothesis. 2007. Klimesch, W, et al., Brain Res. Rev. 53(1), 63-68.

# [2] Oscillatory Power Decreases and Long-Term Memory: The Information via Desynchronisation Hypothesis. 2012. Hanslmayr, S, et al., Frontiers in Human Neuroscience. 6(74), 1-12.

# [3] The Sync/deSync Model: How a Synchronised Hippocampus and a Desynchronised Neocortex Code Memories. 2018. Parish, G, et al., Journal of Neuroscience. 38(14), 3428-3440.

# [4] The Temporal Signature of Memories: Identification of a General Mechanism for Dynamic Memory Replay in Humans. 2016. Michelmann, S, et al., PLoS Biology. 14(8).

# Keywords:

# neuroscience, oscillations, neural-networks