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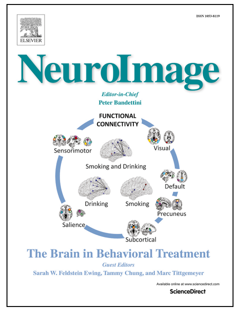

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Andreas Daffertshofer, Robert Ton, Bastian Pietras, Morten L. Kringelbach, Gustavo Deco

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Scale-freeness or partial synchronization in neural mass phase oscillator networks: pick one of two?

Andreas Daffertshofer[a,*], Robert Ton[a,b], Bastian Pietras[a,c], Morten L. Kringelbach[d,e], Gustavo Deco[b,f]

[a]*Institute for Brain and Behavior Amsterdam & Amsterdam Movement Sciences, Faculty of Behavioural and Movement Sciences, Vrije Universiteit Amsterdam, van der Boechorststraat 9, 1081BT Amsterdam, The Netherlands.*
[b]*Center for Brain and Cognition, Computational Neuroscience Group, Universitat Pompeu Fabra, Carrer Tanger 122-140, 08018 Barcelona, Spain.*
[c]*Department of Physics, Lancaster University, Lancaster LA1 4YB, UK.*
[d]*University Department of Psychiatry, University of Oxford, Oxford, OX3 7JX, UK.*
[e]*Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Denmark.*
[f]*Institució Catalana de la Recerca i Estudis Avanats (ICREA), Universitat Pompeu Fabra, Carrer Tanger 122-140, 08018 Barcelona, Spain.*

Abstract

Modeling and interpreting (partial) synchronous neural activity can be a challenge. We illustrate this by deriving the phase dynamics of two seminal neural mass models: the Wilson-Cowan firing rate model and the voltage-based Freeman model. We established that the phase dynamics of these models differed qualitatively due to an attractive coupling in the first and a repulsive coupling in the latter. Using empirical structural connectivity matrices, we determined that the two dynamics cover the functional connectivity observed in resting state activity. We further searched for two pivotal dynamical features that have been reported in many experimental studies: (1) a partial phase synchrony with a possibility of a transition towards either a desynchronized or a (fully) synchronized state; (2) long-term autocorrelations indicative of a scale-free temporal dynamics of phase synchronization. Only the Freeman phase model exhibited scale-free behavior. Its repulsive coupling, however, let the individual phases disperse and does not allow for a transition into a synchronized state. The Wilson-Cowan phase model, by contrast, could switch into a (partially) synchronized state, but it did not generate long-term correlations although being located close to the onset of synchronization, i.e. in its critical regime. That is,

*Corresponding author
Email address: a.daffertshofer@vu.nl (Andreas Daffertshofer)