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Improved information processing under attention is explained by phase transitions in cortical dynamics

Nergis Tomen[1], Udo Ernst[1]

Institute for Theoretical Physics, University of Bremen, Germany

Attention improves processing of visual stimuli and is required for perceiving complex shapes and objects (e.g. [1]). Electrophysiological studies investigating the neural correlates of selective visual attention revealed a strong increase of oscillations in the gamma frequency band (35-90 Hz) in visual cortical neurons [2]. This indicates that gamma oscillations are relevant for optimizing information processing under attention, but their functional role is currently not understood. Here we explore the relationship between increased synchrony and stimulus representation in a network of integrate-and-fire neurons. By increasing the efficacy of recurrent couplings, attention enhances spontaneous synchronization and renders activation patterns for different external stimuli more distinct. This result is in good agreement with recent experimental evidence [3]. Combining mathematical analysis of the network dynamics with parametric simulations reveals that the effect is particularly strong at the phase transition from a state of irregular activity towards a synchronized state. At this point, power-law distributions of synchronous events (avalanches) occur, which are characteristic for so-called 'critical' states previously observed in cortical cultures [4]. If cortical networks indeed operate at such a critical point, fine modulations of synaptic strengths lead to dramatic enhancements of stimulus representations, suggesting a functional role for synchronization and criticality in cortical information processing.

References

[1] Posner MI, Snyder CR, Davidson BJ (1980) Journal of Experimental Psychology: General 109:160-174.
[2] Fries P, Reynolds JH, Rorie AE, Desimone R (2001) Science 291:1560-1563.
[3] Rotermund D, Taylor K, Ernst UA, Kreiter AK, Pawelzik KR (2009) The Journal of

Neuroscience 29:10120-10130.
[4] Beggs JM, Plenz D (2003) The Journal of Neuroscience 23:11167-11177.

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