Sparse and reliable cortical representations emerge naturally in networks with adapting neurons.

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Action potential induced adaptation is an ubiquitous phenomenon in spiking neurons, both in peripheral and central nervous systems (Wark, Lundstrom & Fairhall, 2007). How cellular adaptation affects neural processing at the network level remained largely unexplored. Here, we investigate the role of adaptation on the progressive stimulus representation from peripheral to central stages in the sensory pathway. We report two important results. (1) Neuron-intrinsic adaptation causes a *transient reduction of the trial-by-trial variability* of cortical neurons (under balanced network conditions) and thus provides a qualitative and quantitative explanation for a wide-spread and yet unexplained phenomenon that has been experimentally verified in sensory and central areas (Churchland et al., 2010) as well as in motor areas (e.g. Churchland et al., 2006; Rickert et al., 2009). This reduction in variability in single neuron output transfers to the population activity, which implies reliable input to downstream neurons (Farkhooi, Müller & Nawrot, 2011). (2) The effect of cellular adaptation accumulates across successive network stages. Each transmission step *increases the temporal sparseness of the response*. An adaptive cortical ensemble receiving input from a sub-cortical group of adaptive neurons responds with a single or only very few spikes to the onset of a constant stimulus with high precision. We hypothesize that his mechanisms facilitates assembly formation and could be used by the system for transforming a rate code into a temporal code.

This research is funded by the German Federal Ministry of Education and Research (BMBF) within the Bernstein Focus Neuronal Basis of Learning through grant 01GQ0941.

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