# Spike Frequency Adaption Reduces Noise in Neural Ensemble Activity

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A spontanoeus spiking pattern of negatively serially correlated intervals has been reported for a range of different neuron types and in various systems - in the periphery as well as in central brain regions, both in invertebrtates and vertebrates (for review see [1]). This phenomenon has been linked to neuron-intrinsic physiological mechanisms of spike-frequency adaptation (SFA) which exist in many different types of spiking neurons.

Here, we studied the causal relation between SFA and serial interval correlation (SIC) in different computational models. We show that (1) the negative serial correlation of ISIs is a direct consequence of SFA, (2) negative correlation reduces the noise level in single neurons as well as (3) in the merged activity of a neural ensemble which is representative of the integrated input to post-synaptic neurons.

We studied three different models. First, a biophysical model with slow AHP currents. In the presence of white noise current injection this model produces negative SICs which are most pronounced for neghbouring intervals but generally extend over several lags. This result is robust throughout the physiological spike frequency range. Second, we investigated the generality of this effect in two different phenomenological Integrate-and-Fire (I&F) models with SFA that had been proposed by Brette & Gerstner (2005) [2], and Muller et. al. (2007) [3], respectively. Both models captured the short-lived negative SIC. In both models we describe the relationship of the input statistics with SIC in the output spike train. In particular we confirm the expectation that the strength of the observed correlation is rate dependent. As a control, we compare our results to the leaky I&F model without SFA which produces a renewal output.

Independent of the detailed model we find that the observed negative serial correlation lead to a reduced single neuron variability by up to 50%, as measured by the Fano factor of the spike count. We have previously shown that this phenomenon also exists in in vivo recordings from single cortical neurons where the noise was reduced by abot 30% [4].

Interestingly, this reduction of the count variance carries over to the ensemble activity of SFA neurons. This activity shows the very same amount of reduction when observed on the same time scale. We may interpret this as a reduced noise in the fluctuating ensemble rate signal. The read-out of this signal in a receiving cell will be more accurate than in the case of serially uncorrelated single neuron activity of the presynaptic ensemble.

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