**Supplementary material 1**

The power spectrum may be defined as the Fourier transform of the auto-correlation function (Wiener-Khinchin theorem), and thus the firing rate induced bias that is illustrated by the power spectrum of the spike train (Fig. S1A-C), could be visualized by the corresponding auto-correlation function of the spike trains (Fig. S1D-F). As the firing rate increases – the oscillatory nature of the spike train is more evident in the auto-correlation function, while much like the power spectrum, the oscillation cannot readily be seen during low rate activity. The SNR of the peak in the auto-correlation of these simulated neurons varies linearly as a function of the base firing rate of the neuron (Fig. S1G). The oscillation frequency cannot typically be assessed using the first-order ISI histogram, regardless the firing rate (Fig S1H-J), as the oscillation relies on ISIs of higher order.

