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Auto-structure of spike trains matters for testing on synchronous activity

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Coordinated neuronal activity across many neurons, *i.e.* synchronous or spatiotemporal pattern, had been believed to be a major component of neuronal activity. However, the discussion if coordinated activity really exists remained heated and controversial. A major uncertainty was that many analysis approaches either ignored the auto-structure of the spiking activity, assumed a very simplified model (poissonian firing), or changed the auto-structure by spike jittering. We studied whether a statistical inference that tests whether coordinated activity is occurring beyond chance can be made false if one ignores or changes the real auto-structure of recorded data. To this end, we investigated the distribution of coincident spikes in mutually independent spike-trains modeled as renewal processes. We considered Gamma processes with different shape parameters as well as renewal processes in which the ISI distribution is log-normal. For Gamma processes of integer order, we calculated the mean number of coincident spikes, as well as the Fano factor of the coincidences, analytically. We determined how these measures depend on the bin width and also investigated how they depend on the firing rate, and on rate difference between the neurons. We used Monte-Carlo simulations to estimate the whole distribution for these parameters and also for other values of gamma. Moreover, we considered the effect of dithering for both of these processes and saw that while dithering does not change the average number of coincidences, it does change the shape of the coincidence distribution.

Our major findings are: 1) the width of the coincidence count distribution depends very critically and in a non-trivial way on the detailed properties of the inter-spike interval distribution, 2) the dependencies of the Fano factor on the coefficient of variation of the ISI distribution are complex and mostly non-monotonic. Moreover, the Fano factor depends on the very detailed properties of the individual point processes, and cannot be predicted by the CV alone. Hence, given a recorded data set, the estimated value of CV of the ISI distribution is not sufficient to predict the Fano factor of the coincidence count distribution, and 3) spike jittering, even if it is as small as a fraction of the expected ISI, can falsify the inference on coordinated firing. In most of the tested cases and especially for complex synchronous and spatiotemporal pattern across many neurons, spike jittering increased the likelihood of false positive finding very strongly. Last, we discuss a procedure [1] that considers the complete auto-structure of each individual spike-train for testing whether synchrony firing occurs at chance and therefore overcomes the danger of an increased level of false positives.

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References

1. Pipa G, Wheeler DW, Singer W, Nikolic D: **NeuroXidence: Reliable and efficient analysis of an excess or deficiency of joint-spike events.** *J Comp Neuroscience* 2008, **25:**64-88.