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Burst structure can code different stimulus features in thalamic neuron models

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Bursting behaviour in the neural response has recently been found to be relevant for the coding of information about a stimulus [1]. In this study, multi conductance (MC) [2] and a simple integrate and fire or burst (IFB) [3] thalamic cell models, capable of producing realistic bursting, were analyzed and found to be responsive to stimulus features not encoded by individual spikes. The models were driven by a naturalistic correlated noisy stimulus representing synaptic input [4]. We then computed spike/burst-triggered averages (S/BTAs).

BTAs from both models contained strong negative deflections that were not observed in STAs (Figure 1A), a finding consistent with previous results [5] that was robust across a range of stimulus parameters. The detailed structure of bursts also reveals a more specific burst code that strongly relates burst size (measured by the number of spikes they contain) to the value of the area enclosed by the negative (hyperpolarizing) BTA range (Figure 1B). Thus, bursts size in these models are related to the total negative charge entering the neuron. Preliminary analysis implicates the dynamics of the transient Ca^{2+} current (IT). The activation and amplitude of this current requires membrane voltage be above a certain threshold (Eh) just prior to bursting and that previous voltages reach a value lower than Eh. We also tested the significance of these bursting coding properties by performing stimulus reconstruction using the different S/BTAs and by applying information theory to quantify the information conveyed by the different types of bursts and single spikes.

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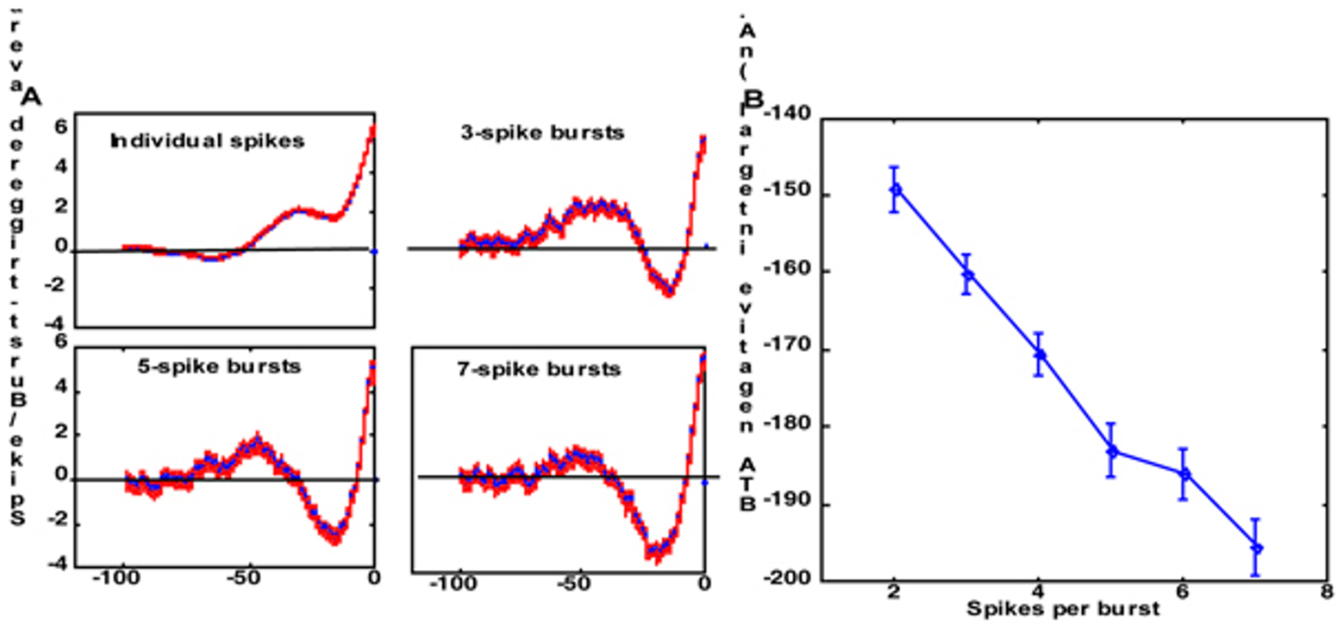

Figure 1

Coding properties of spikes and bursts. A) Spike and burst triggered averages for the MC model; B) Integral of the negative BTA range (negative charge), as a function of burst size.