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Dynamic modulation of spontaneous firing rate and pattern of striatal neuron subtypes by cortical oscillations

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ABSTRACT OF THE TALK

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The striatum, as the computational hub of the basal ganglia is a key structure in the selection of actions in the mammalian brain. In addition, damage to this area or its connections underlies many common neurological and psychiatric disorders. It has been proposed that oscillations at the population level have a role in the functional connectivity between the cerebral cortex and striatum. Here we investigated the influence of cortical oscillations on the spontaneous rate and temporal properties of the spike trains of different striatal neuron subtypes to gain a greater understanding of striatal microcircuits and there interaction with the cortex. Microelectrodes were used to record single neurons and LFPs in the dorsal striatum with coincident ECoG, bilaterally, in halothane anaesthetized rats. Following spike sorting, over 140 single striatal neurons could be convincingly separated, based on waveform parameters alone into three clusters, corresponding to putative medium spiny neurons (MSNs), parvalbumin positive GABAergic interneurons (FSIs), cholinergic tonically active interneurons (TANs). In addition, by looking for neurons displaying low threshold spike bursts, we could disseminate parvalbumin negative GABAergic interneurons (LTS). It was then possible to analyse the interactions between these cells and with the cortical population activity provided by the ECoG. Under halothane anesthesia, power and coherence of ECoG and striatal LFPs was dominated by low frequency delta/theta oscillations that alternated between peak frequencies of 2-4Hz and 5-8Hz, and high frequency gamma oscillations that alternated between peak frequencies of 40-55 and 60-70Hz, over periods of tens-hundreds of seconds. The temporal properties and rate of individual neurons was strongly related to dynamic changes in these activities. All neuron subtypes phase locked to low delta frequency oscillations in the ECoG (2-4Hz) at different phases, but only FSIs locked strongly to 5-8Hz oscillations. In the gamma range, FSIs had the strongest tendency to phase lock to the ECoG and around 40% of FSI pairs displayed coherence in the low gamma range. In contrast, gamma coherence was relatively rarely observed between putative FSIs and

TANs or MSNs. In addition, the rate of individual neurons in all classes was significantly correlated with the power and coherence of high frequency ECoG/LFP oscillations over time. When the rate of a neuron positively correlated with low gamma activity (40-55Hz), it tended to be negatively correlated with high gamma activity (60-75Hz) and vice versa. Oscillations at the population level therefore have the potential to organize striatal activity through modulation of specific neuron subtypes. Specifically, coherent gamma oscillations, which are prominent in the awake animal, may be the result of synchronous activity of GABAergic interneurons entrained by the cortex, and modulate the rate of other neuron subtypes.