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Title: Activity-dependent increase of intrinsic oscillatory frequency in rat hippocampal neurons

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Abstract: Certain neurons in the central nervous system exhibit intrinsic membrane potential oscillations (MPOs) that have been suggested to play a role in different behavioral states. Pyramidal cells in hippocampal subregion CA1 exhibit MPOs in the theta frequency range (2-7Hz), and can be assessed by measuring their resonance characteristics [1]. Given that these MPOs are dependent on the hyperpolarization-activated cation current, Ih [1], and that Ih can be modulated by activity [2], we hypothesized that activity would produce changes in the internal oscillatory dynamics of these cells. To directly test this hypothesis, we performed whole cell patch-clamp recordings of visually identified CA1 pyramidal cells from 5-7 week old Sprague-Dawley rats. Employing the impedance amplitude profile as a tool to measure resonance properties [1], we show that theta-burst firing (TBF; [2]) elicits a significant, 20% increase in membrane resonance frequency, as observed at 40 minutes after TBF. This increase is accompanied by a significant 13% reduction in input resistance, a rightward shift in the f-I curve, a significant 10% increase in hyperpolarization-induced sag and a 3mV depolarizing shift in the resting membrane potential [2]. There was also a linear relationship between the time courses of changes in resonance frequency and input resistance, suggesting that this plasticity is due to changes in Ih [2]. The mechanisms underlying such plasticity will be presented. We are also characterizing and assessing plasticity in the oscillatory dynamics of CA1 pyramidal cell dendrites. Such activity-dependent plasticity of intrinsic oscillatory dynamics has implications for neural coding of behavioral states.

1. Hu et al. J. Phys. 545.5. 2002.
2. Fan et al. Nat. Neurosci. 8(11). 2005.

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