Anticipated Synchronization Between Neuronal Populations

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Two identical autonomous dynamical systems coupled in a master-slave configuration can exhibit anticipated synchronization (AS) if the slave is subjected to a delayed negative self-feedback [1]. One of the prototypical examples of AS is described by the equations [1]

$$\dot{x} = f(x(t)), \quad (1)$$

$$\dot{y} = f(y(t)) + K[x(t) - y(t - t_d)]. \quad (2)$$

$f(x)$ is a function which defines the autonomous dynamical system. The solution $y(t) = x(t + t_d)$, which characterizes AS, shown to be stable in a variety of scenarios, including FitzHugh-Nagumo models driven by white noise [2] as well as experimental studies of semiconductor lasers [3] and electronic circuits [4]. Recently, we have shown that AS occurs in systems of Hodgkin-Huxley neurons, where the delayed inhibition is provided by an interneuron [5].
Here we show that AS can also occurs between large-scale populations of interconnected neurons. We propose a mechanism in which two different brain areas coupled in a master-slave configuration can oscillates in a delayed synchronization regime (DS) as well as in a AS regime. The phenomenon seems to be robust when model parameters are varied within physiological range. Moreover, the transition from DS to AS is smooth and typically depends on the inhibitory synaptic conductance in the slave population, which works as the delayed negative self-feedback in Eq. 2.

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