# Inhibitory Synaptic Conductances Mediate Transition From Delayed Synchronization to 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]

$$\begin{aligned} \dot{x} &= f(x(t)), \\ \dot{y} &= f(y(t)) + K[x(t) - y(t - t_d)]. \end{aligned} \tag{1}$$

$f(x)$ is a function which defines the autonomous dynamical system. The solution $y(t) = x(t + t_d)$, which characterizes AS, has been shown to be stable in a variety of scenarios, including theoretical studies of autonomous chaotic systems[1], delayed-coupled maps[2] and non-autonomous dynamical system as FitzHugh-Nagumo models driven by white noise[3].

Recently, AS was shown to occur in systems of simplified neuron models, where the delayed inhibition is provided by an interneuron[4]. In this biologically plausible scenario, a smooth transition from delayed synchronization (DS) to AS typically occurs when the inhibitory synaptic conductance is increased.

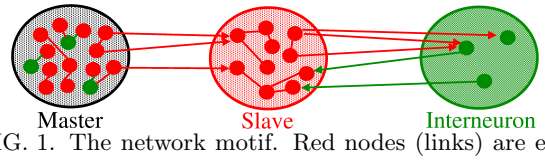


FIG. 1. The network motif. Red nodes (links) are excitatory neurons (synapses), green ones are inhibitory.

Here we investigate the synchronization of 3 large populations[5] of interconnected neurons. The master population contains both excitatory and inhibitory neurons. The slave population contains excitatory neurons and receives feedback from an interneuron population (see Fig. 1). Each neuron is modeled by the Izhikevich[6] model with parameters that reproduce firing patterns observed in the cortex. The links are unidirectional dynamical synapses mediated by $AMPA$ and $GABA_A$[7]. We find that this nework motif exhibits a transition from DS to AS. The mean time lag $\tau$ between the master population and the slave population is a function of the inhibitory synaptic conductance $g_{GABA_A}$ as shown in Fig. 2. By definition if $\tau < 0$ ($\tau > 0$) the system is in the DS (AS) regime. As occurs in the 3-neurons motif[4], here the anticipation time is not hard-wired in the dynamical equations, but rather emerges from the system's dynamics.

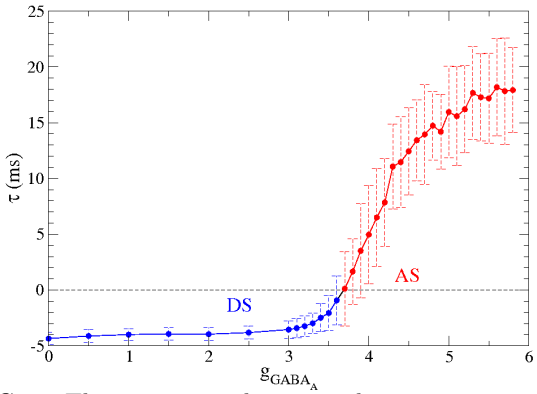


FIG. 2. The mean time lag $\tau$ synchronization *versus* inhibitory synaptic conductances. $\tau = 0$ is where the transition from DS (blue) to AS (red) regime occurs

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