Model: Model of spontaneous activity in developing networks

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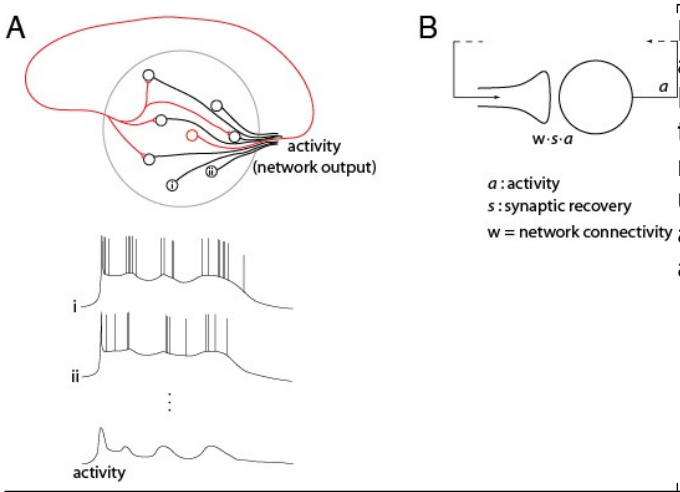
Brief Description *	This is a mean field model of spontaneous episodic activity in the embryonic chick spinal cord. Episodes of activity are created by the interplay between excitatory connectivity (positive feedback) and activity-dependent synaptic depression (slow negative feedback).
Narrative *	This is a minimal model of episodic activity in the developing chick spinal cord. Early in development, all fast neurotransmitter synapses are functionally excitatory, so developing networks generate intense episodes of electrical activity involving a large number of neurons. In the chick spinal cord, the activity comprises episodes of rhythmic discharge (duration 5â€“90 sec; cycle rate 0.1â€“2 Hz) that recur every 2â€“30 min. The activity does not depend on specific connectivity. It is modeled using a mean field approach, with network activity feeding back onto itself due to recurrent excitatory connectivity. This positive feedback creates episodes of high activity. These episodes of activity are terminated by an activity-dependent synaptic depression that operate on a slow time scale (up to minutes). In addition, a fast synaptic depression process (timescale up to seconds) creates oscillations during the activity episodes. The model shows that rhythmic behavior can be generated in the absence of inhibitory synapses and pacemaker neurons. The model also explains two key experimental observations. First, when glutamatergic or gabaergic synapses are blocked pharmacologically, episodic activity initially stops, but eventually reappears, with similar characteristics to the control activity. Second, there is a positive correlation between the duration of activity episodes and the length of the preceding -- but not following -- interepisode interval. This indicates that episodes are triggered in a stochastic manner, but terminate in a deterministic way. This characteristic of the developing chick spinal cord is also observed in other developing networks, suggesting a common mechanism of operation in widely different neuronal networks.
Tags	development, recurrent network, synaptic depression, Wilson-Cowan

Architecture

Diagrams



Mean field model of excitatory network with activity-dependent synaptic depression. A, Recurrent excitatory connectivity ensures that all neurons feel the same averaged network activity as input. B, This justifies using a mean field model with a (activity averaged over time and space) reinjected as input with feedback gain w*s.

Inputs		
Name	**Data Type**	**Description**
a		activity (injected back into the network by the recurrent connectivity)
Outputs		
Name	**Data Type**	**Description**
a		activity
States		
Name	**Data Type**	**Description**
a		activity, the average population firing rate in the network, varies between 0 and 1.a = 0 means the network is silent;a = 1 means all neurons fire at their maximal frequency.
d		fast synaptic depression variable, responsible for cycling during episodes. d varies between 0 and 1.d = 0 means synapses in the network a fully depressed;d = 1 means synapses in the network are fully recovered.
s		slow synaptic depression variable, responsible for episodic activity. s varies between 0 and 1.s = 0 means synapses in the network a fully depressed;s = 1 means synapses in the network are fully recovered.