Electrical coupling regulates layer 1 interneuron microcircuit formation in the neocortex

With the support by the National Natural Science Foundation of China, the research team led by Prof. Yu Yongchun (禹永春) at the Institutes of Brain Science, Fudan University, revealed the vital roles of electrical coupling in chemical synapse formation between interneurons, which was published in *Nature Communications* (2016, 7: 12229, DOI: 10.1038).

Although the excitatory neurons in the neocortex are electrically coupled only during early development, it is well established that interneurons maintain their functional gap junctions into adulthood in the neocortex. It has long been postulated that the formation of electrically coupled neuronal domains might help to guide the emergence of chemically transmitting neuronal circuits in the developing neocortex. However, whether electrical coupling can modulate chemical synapse formation between interneurons has rarely been reported.

In this study, Yao et al. showed that electrical coupling between layer 1 interneurons regulates the formation of specific chemical synapses. Multiple-electrode whole-cell recordings revealed that electrical and chemical synapses between neocortical layer 1 interneurons have a parallel developmental time course. Moreover, Yao et al. observed that layer 1 interneurons exhibit robust synchronous GABA-A receptor-mediated synaptic activity, which preferentially develops between electrically coupled pairs. More importantly, this study demonstrated that disruption of Cx36-mediated electrical coupling between layer 1 interneurons can severely impair bidirectional GABAergic connections and excitatory synaptic inputs.

The developmental period when interneurons form GABAergic and electrical connections remains elusive. Correspondingly, there are few reports on whether electrical coupling can modulate chemical synapse formation in interneurons. The present study, for the first time, not only systematically characterized the development of GABAergic and electrical connections between layer 1 interneurons, but also revealed that layer 1 interneurons exhibit robust GABA-A receptor-mediated synchronous synaptic activity. More importantly, this study clearly evidenced the functional role of gap junction-mediated electrical coupling in regulating precise interneuronal circuit assembly at the individual cell resolution.

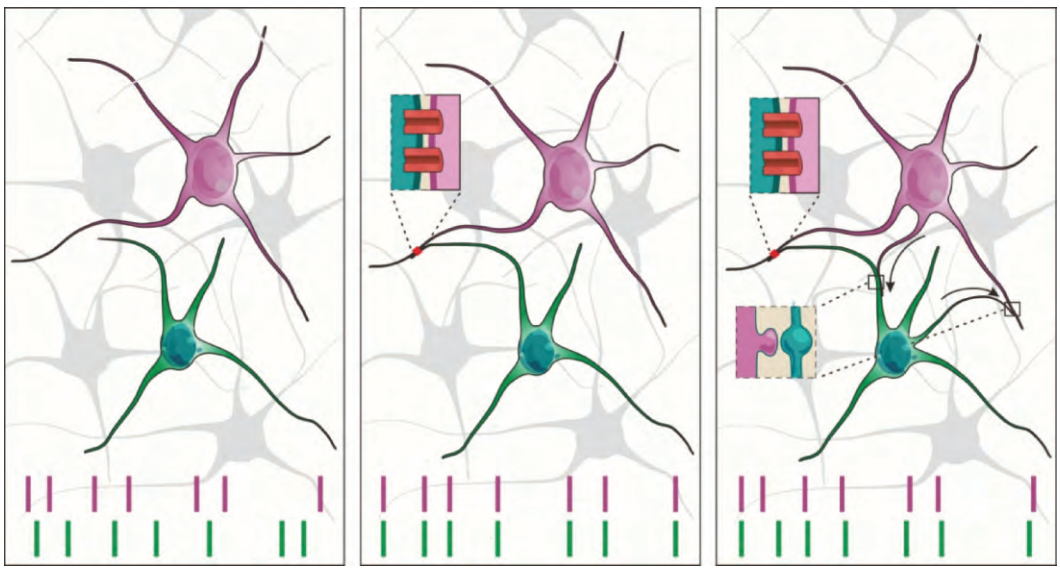

Figure Electrical coupling in the early postnatal stage facilitates synchronized activity, which in turn promotes bidirectional chemical synapse formation, between neocortical interneurons.