of Mind

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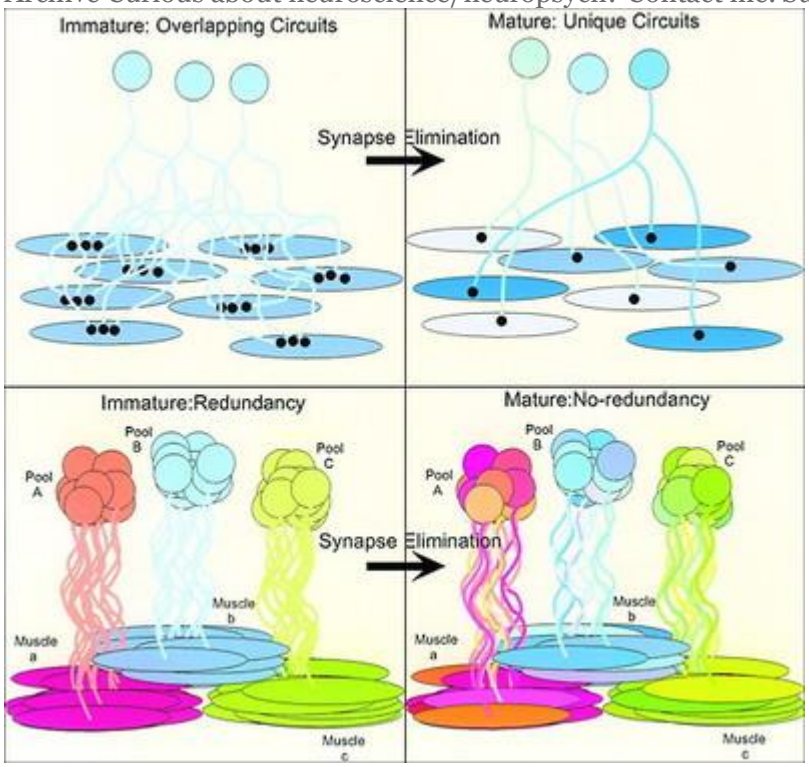

Synapse Elimination

The basic circuit plan of the neuromuscular junction, a model that has been used extensively in studies of neural pruning, is a series of highly overlapping circuits that result from simultaneous divergence/convergence between redundant neurons and redundant postsynaptic targets. In this system, each target cell can receive convergent innervation from multiple neurons and each input can diverge to many target cells. **In vertebrate neuromuscular systems, the number of inputs innervating each muscle fiber is reduced through synapse elimination or loss.** Synapse elimination is thus a mechanism that creates large numbers of specific circuits out of initially more diffuse and redundant connections.

Synapse elimination is a competitive process between axons. In this competition, relatively inactive or less active synapses are removed through the activity elicited by more active inputs (stronger, higher activity synapses) innervating the same targets. Areas occupied by competing axons at the same junction are nearly equal at birth but as development goes on the innervation of junctions skews in favor of one axon.

The implication for synapse elimination in learning is that learning requires selection of synaptic pathways instead of the construction of new ones. This selection is believed to occur by increasing the strength of one set of synaptic interconnections while weakening or eliminating others. Once an axon is removed, it no longer has any influence on the remaining synaptic connections. In the case of memories, they are characterized by a certain indelibility that prevents newer memories from

“overwriting” older ones. Input (or synaptic) elimination could be thought of as a way of assuring indelibility because by eliminating competing (asynchronously firing) inputs, the remaining circuit gains a certain protection from disruption by different neural activity patterns. The strength and number of synaptic connections undergo quick and extensive changes after learning experiences. These “plastic” synaptic connections also serve as neural substrates for long-term information storage.

This topic was one of my developmental neuroscience final. It is also one of the most interesting topics I have learned about all semester. Truly fascinating work done in this field.

Source:

Lichtman, Jeff W., and Howard Colman. 2000. Synapse elimination and indelible memory. *Neuron*. 25 (2): 269-78.

Yang, Guang, Pan Feng, and Wen-Biao Gan. 2009. Stably maintained dendritic spines are associated with lifelong memories. *Nature*. 462: 920-4.