NASCIC
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Module 9 – Neuroplasticity

Synaptic Plasticity

Synaptic plasticity refers to adaptations made at the location where one neuron connects to another, which also occurs after SCI and can affect neuronal circuits in both positive and negative ways. In order for neurons to communicate with one another, a pre-synaptic neuron must release neurotransmitters into the space between neurons called the synaptic cleft. The transmitter then interacts with the post-synaptic neuron.

Neurons can modulate their communication with one another by either A) changing the amount or frequency that neurotransmitters are being released, B) changing the duration that neurotransmitters remain in the synaptic cleft, and C) changing the magnitude of response to neurotransmitters in the post-synaptic neuron.

The mechanisms associated with changes in synaptic plasticity are very complex and are still being elucidated. They may include combinations of the following:

- For A) changing the amount or frequency that neurotransmitters are being released, a neuron can either
    - 1) synthesize more neurotransmitters
    - 2) conduct more frequent action potentials leading to neurotransmitter release
    - 3) change the sensitivity of machinery inside of a pre-synaptic neuron that leads to neurotransmitter release.
- For B) changing the duration that neurotransmitters remain in the synaptic cleft, neurons and glial cells can either
    - 1 produce more or less enzymes that actively break down neurotransmitters in the synaptic cleft
    - 2) modulate the re-uptake and removal of neurotransmitters from the synaptic cleft.
- For C) changing the magnitude of response to neurotransmitters in the post-synaptic neuron, neurons can either

    1) synthesize more receptors that can respond to neurotransmitters

    2) make receptors and ion channels more sensitive and activate longer in response to neurotransmitters

    3) increase the surface area between the pre- and post-synaptic neuron

    4) suppress the ability for specific neurotransmitters to exert an effect

    5) change the responsiveness of the neuron to input.

While the examples depicted in the figures show a change in a direction that would implicate a larger post-synaptic response, plasticity can work in both directions. Plasticity can change the response to be either more, or less, sensitive by modulating all of the mentioned mechanisms.

Not all forms of synaptic plasticity result in beneficial adaptations. Affecting neuro-transmission in a pathway that amplifies or suppresses the signals to and from the brain can be either beneficial or detrimental to our ability to function or our sensory perceptions.