Excitatory and inhibitory synaptic mechanisms at the first stage of integration in the electroreception system of the shark.

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Abstract:

High impulse rate in afferent nerves is a common feature in many sensory systems that serve to accommodate a wide dynamic range. However, the first stage of integration should be endowed with specific properties that enable efficient handling of the incoming information. In elasmobranches, the afferent nerve originating from the ampullae of Lorenzini targets specific neurons located at the Dorsal Octavolateral Nucleus (DON), the first stage of integration in the electroreception system. Using intracellular recordings in an isolated brainstem preparation from the shark we analyze the properties of this afferent pathway. We found that stimulating the afferent nerve activates a mixture of excitatory and inhibitory synapses mediated by AMPA-like and GABAA receptors, respectively. The excitatory synapses that are extremely efficient in activating the postsynaptic neurons display unusual voltage dependence, enabling them to operate as a current source. The inhibitory input is powerful enough to completely eliminate the excitatory action of the afferent nerve but is ineffective regarding other excitatory inputs. These observations can be explained by the location and efficiency of the synapses. We conclude that the afferent nerve provides powerful and reliable excitatory input as well as a feed-forward inhibitory input, which is partially presynaptic in origin. These results question the cellular location within the DON where cancelation of expected incoming signals occurs.

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