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Our brain has switch board to guide behavior in response to external stimuli

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How do our brains combine information from the external world (sensory stimulation) with information on our internal state such as hunger, fear or stress? NERF scientists demonstrate that the habenula, a specific part in our brain consisting of neural circuits, acts as a gate for sensory information, thus regulating behavior in response to external stimuli.

Emre Yaksi (NERF – VIB/imec/KU Leuven): "Our brain has high levels of spontaneous activity, even in the absence of sensory stimulation. We think that this spontaneous neural activity in combination with sensory stimulation results in a particular internal state of the habenula. By this functional organization the habenula acts as a kind of switch board, selecting certain sensory information and sending it to the downstream brainstem areas. Thus the habenula regulats our behavior. It will be interesting to test whether experience or learning can alter the functional organization of these circuits."

Unraveling neural circuits

Neuroscientists all over the world are gradually unraveling the processes in our brain. However our brain still remains a mystery. The activity of single neurons and the functioning of 'one-to-one' interactions have been examined in detail. Yet, the information processing at the level of neural circuits is less well-understood. Emre Yaksi and his NERF-colleagues integrate neurobiology and nano-scale engineering to study brain

function at multiple levels of detail. This multidisciplinary approach enables the researchers to look beyond the brain cells, and it provides them with great tools to study neural circuits and their link with behavior.

Exploring brain structures in zebrafish

Zebrafish is a useful model organism for neurological research. To find out how brains combine external and internal stimuli, Suresh Kumar Jetti, Nuria Vendrell Llopis and Emre Yaksi focused on the dorsal habenula (dHb) in zebrafish. The dHb is an equivalent of the habenula in mammals and relays information from the sensory areas to the brain region that regulates animal behavior under stress conditions. In zebrafish, the dHb receives input from cells of the olfactory bulbthus odors can trigger distinct behaviors (e.g. feeding, courtship, alarm).

Spontaneous activity is highly organized

The ongoing spontaneous activity in neurons was thought to be associated with several neurological phenomenons, such as sleep, or the learning and sensory process. The researchers observed that dHb is highly active even in the absence of any sensory stimulation. Moreover they showed that the spontaneous activity of dHb is not random but highly structured in the spatial clusters of neurons. Later the team showed that this spontaneous activity is very prominent during sensory stimulation and governs the odor responses in the dHb. The scientists their conclusion is that dHb acts like a switch board for the sensory information and is controlled by spontaneous activity.

More information: Spontaneous Activity Governs Olfactory Representations in Spatially Organized Habenular Microcircuits, Jetti et al, *Current Biology* 2014.

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