Institute: Institute of Zoology and Biomedical Research

Topic: Neurophysiological, anatomical and behavioural analysis of the reciprocal connection between Lateral Habenula and Nucleus Incertus: implications for aversion processing, stress response and adaptive behaviours.

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Background information:
The reciprocal connection between the Lateral Habenula (LHb) and Nucleus Incertus (NI) is a topic of growing interest in the field of neuroscience due to its potential implications for aversion processing, stress response, and adaptive behaviours. The LHb has been shown to play a critical role in aversion processing and stress response, while the NI has been implicated in stress-induced behaviours and behavioural flexibility. Anatomical studies have revealed that the LHb and NI are closely interconnected via a reciprocal connection, which may allow for a coordinated response to aversive stimuli and stressors. Behavioural analyses of both structures have also supported the potentially important role of the LHb-NI circuit in aversion processing, stress response, and adaptive behaviours [1]. However, while there has been significant progress in our understanding of how both structures function separately in animal brains, there is still much to be learned about the electrophysiology, anatomy, and exact function of their interconnection, and further research is needed to fully characterize its role in aversion processing, stress response, and adaptive behaviours.

The main question and tasks:
What is the anatomy, electrophysiology and function of LHb-NI circuit. In particular: 1) what are the neurotransmitter content, efferent targets and electrophysiological characteristics [2] of the neurons forming LHb-NI loop?; 2) how activation of the loop influences activity of the specific neuronal populations within the LHb and NI?; 3) how the manipulation of the elements of LHb-NI neuronal loop affects the behaviour of animals.

Information on the methods:
The studies will be performed on adult male rats. The following experimental techniques are planned to be used: 1) Neuroanatomy: neuronal tract-tracing with the use of anterograde, retrograde and transsynaptic viral vectors and classical chemical markers; 2) Electrophysiology: single unit and multiple-unit, using MEAs, extracellular recordings of neuronal activity *in vivo*; 3) Behaviour: testing of animal behaviours during optogenetic manipulation of the elements of Lhb-NI neuronal loop.

Special requirements from the student:
The student should have experience in the following research techniques: injections of viral vectors into the selected structures of the rodent brain; experience in fibre photometry measurements of neurotransmitter release; behavioural testing of laboratory animals (rats); preparation and microscopic analysis of the histological material of immunocytochemically stained nerve tissue. In addition, the student should have the following skills, training and qualities: training to perform procedures and experiments and to kill animals (in accordance with the applicable Act on the protection of animals used for scientific or educational purposes, of January 15, 2015); good command of the English language.

References:

[1] Zahm DS, Root DH (2017) Review of the cytology and connections of the lateral habenula, an avatar of adaptive behaving. Pharmacol Biochem Behav, 162:3-21. doi: 10.1016/j.pbb.2017.06.004.
[2] Trenk A, Walczak M, Szlaga A, Pradel K, Blasiak A, Blasiak T (2022) Bidirectional Communication between the Pontine Nucleus Incertus and the Medial Septum Is Carried Out by Electrophysiologically-Distinct Neuronal Populations. J Neurosci, 42(11):2234-2252. doi: 10.1523/JNEUROSCI.0230-21.2022.