PoM
PAPER OF THE MONTH

UKE Paper of the Month October 2023

Olfactory bulb activity shapes the development of entorhinal-hippocampal coupling and associated cognitive abilities

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ABSTRACT:

The interplay between olfaction and higher cognitive processing has been documented in the adult brain; however, its development is poorly understood. In mice, shortly after birth, endogenous and stimulus-evoked activity in the olfactory bulb (OB) boosts the oscillatory entrainment of downstream lateral entorhinal cortex (LEC) and hippocampus (HP). However, it is unclear whether early OB activity has a long-lasting impact on entorhinal-hippocampal function and cognitive processing. Here, we chemogenetically silenced the synaptic outputs of mitral/tufted cells, the main projection neurons in the OB, during postnatal days 8-10. The transient manipulation leads to a long-lasting reduction of oscillatory coupling and weaker responsiveness to stimuli within developing entorhinal-hippocampal circuits accompanied by dendritic sparsification of LEC pyramidal neurons. Moreover, the transient silencing reduces the performance in behavioral tests involving entorhinal-hippocampal circuits later in life. Thus, neonatal OB activity is critical for the functional LEC-HP development and maturation of cognitive abilities.

STATEMENT:

The study combines state-of-the-art in vivo electrophysiology, chemo- and optogenetics with behavioral testing and demonstrates the developmental interplay between olfaction and higher-order cognitive processing. It provides experimental evidence that olfaction during a defined developmental period is necessary for the maturation of neuronal networks and cognitive performance. We revealed that early in life, when most senses are underdeveloped, olfaction not only accounts for the communication with the environment and sensory activation but also boosts the cognitive processing.

BACKGROUND:

This work was performed at Institute of Developmental Neurophysiology (director: Prof. Dr. Ileana L. Hanganu-Opatz), Center for Molecular Neurobiology. It is part of the PhD thesis of Yu-Nan Chen. All authors have strong interests in how the sensory inputs early in life influence the development of neuronal networks and cognitive functions by combining *in vivo* electrophysiology, chemogenetics, optogenetics and behavioral tests. The project was funded by grants from the German Research Foundation (Ha4466/11-1, Ha4466/20-1, Ha4466/22-1, and SFB 936 178316478), European Research Council (ERC-2015-CoG 681577), Horizon 2020 DEEPER (101016787), MSCA-ITN (860563), and Landesforschungsförderung Hamburg (LFF73 and LFF76).