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The Development of the Hedonic Nose in Health and Disease

Our laboratory has largely contributed to the identification of molecular and cellular mechanisms that contribute to a group of neurodevelopmental disorders called “synaptopathies” such as autism spectrum disorder (ASD) and Fragile X Syndrome (FXS). We aim at understanding and developing therapies for those neurodevelopmental disorders, as well as identifying biomarkers for a future personalized medicine.

Dysfunctions in the olfactory system are associated with multiple neurological and psychiatric pathologies including Alzheimer's and Parkinson's disease, schizophrenia, and neurodevelopmental disorders. A monogenetic form of autism spectrum disorder (ASD) is the Fragile X Syndrome (FXS), the most frequent form of single gene inherited intellectual disability. Clinical evidence indicates abnormal sensory processing in individuals with FXS and ASD. In addition, FXS mice exhibit an impairment in the dendritic pruning of olfactory bulb mitral cells and a deficit in odor sensitivity.

Olfaction is crucial for proper development and survival (food intake, social interactions, and danger avoidance) from birth to adulthood. Odors represent a valuable source of information for decision-making and behavioral guidance and have the capacity to elicit strong emotions in humans and across different species. How specific odors affect brain development, wiring and behavior is still largely unknown. One of the interests in our laboratory is understanding how different ability to smell during development enables the generation of emotions, memories and ultimately affects behavior in adult stages in health and disease conditions.

This project will contribute to identifying how the sense of olfaction develops during the early postnatal stages in mammals - specifically rodents – in healthy and pathological conditions using an established portfolio of different state of the art techniques spanning from behavior to in vivo circuitry and identification of molecular signatures. Specifically, we will study the anatomy and the molecular composition of the developing olfactory bulb, perform odor-based behavioral tests to identify the hedonic value in rodent models of ASD and FXS. Finally, to reveal the spatiotemporal dynamics of identified dysregulated mRNAs we will use spatial transcriptomic (MERFISH technology) and electrophysiology on an array with > 25.000 electrodes (CMOS).

This project will provide insights into the brain-behavioral axis controlled by the sense of smell through the identification of the mechanisms involved in neuromodulation in the olfactory bulb. The PhD candidate will be exposed to and acquire various techniques to develop an innovative project and be supervised by senior researchers and collaborate with clinicians - receiving therefore an exceptional training. Commitment to science, proactivity and curiosity are mandatory requirements to develop this project.