Coming together - neural dynamics of transition from out-group reserve to in-group fellowship

Social polarization is a serious threat to the stability and economic progress of societies. This alarming global trend not only jeopardizes financial stability and impedes societal ability to compromise on vital issues but also exacerbates the already existing problems such as income inequality and fragmentation of social fabric, leading to conflicts and sometimes even social unrest. Now more than ever, investigating brain mechanisms underlying the development of stable social bonds, is crucial for our ability to understand and counteract the negative consequences of the increasingly divided societies.

Classifying individuals as members of an in-group, that is social circles with whom we identify, is a rapid and unconscious process. Consequently, very little is required to discriminate against the ones we identify as out-group, which happens on a similarly prompt and arbitrary basis, and oftentimes results in an unconscious bias. Arguably, it is because classifying individuals as either "us" or "them" is a hard-wired neuronal mechanism. Since studying brain underpinnings of social categorization in humans poses significant experimental limitations, in the proposed research we will use laboratory mice, a species known to be a relevant model of mammalian social behavior. As the neural background of sociability is highly evolutionarily-conserved, although obviously less complex in mice than humans, we will investigate the role of the brain structure known to be key for encoding social familiarity in all tested mammalian species – prefrontal cortex (PFC).

The PFC is located at the very front of the brain. In humans it is crucial for so-called executive function, meaning our ability to select and manifest behaviors needed for obtaining set goals. Notably, the role of the PFC in navigating social aspects of our lives has been well-documented. Research indicates that neural circuits, that is groups of functionally interconnected brain cells (neurons), of the PFC, might be central for developing attachment and expressing affiliative behavior. Neurons communicate with one another by sending electrical signals. Interestingly, the neural circuits of the PFC are composed of many different types of cells. Most importantly, some of them send signals to other neurons to activate them, others to inhibit their activity. Further, we can categorize neurons based not only on their function but also on their physiology, morphology, and genetic profile. In this project, we investigate the contribution of major classes of PFC neurons to social bonding between previously unfamiliar individuals. The studies show that although all prominent types of neurons are necessary for maintaining the proper functioning of the PFC, their activity plays different roles in the emergence of behavioral patterns relevant for social interactions. In this light, investigation of both excitatory and inhibitory cells composing the PFC is essential for elucidating neural correlates of developing familiarity.

Here we propose research focused on the brain processes underpinning overcoming reserve towards unknown conspecifics, in order to compose an amicable social group. We plan to apply a combination of cutting-edge techniques of systems neuroscience, including automated behavioral assessment in genetically-modified mouse strains and in-vivo two-photon microscopy in behaving animals to discover how changes in the activity of the main cell types composing the neuronal circuits of the PFC involved in encoding social familiarity reflect the transition from out-group reserve to in-group fellowship. Behavioral testing will be conducted with the use of Eco-HAB, a system for computerized measurement of social interactions in group-housed mice, which closely follows murine ethology, thus allowing to measure natural behavioral patterns. Moreover, we aim to use advanced methods of brain manipulation (chemo- and optogenetics) to test how the processes of social familiarization can be facilitated by changing the activity of the prefrontal cortex.

We argue, that the proposed experimental plan will bring critical insights into the brain mechanisms implicated in the dynamic development of social familiarity. The fusion of advanced methodologies is highly innovative and due to the implementation of automation will be a step towards research reproducibility. Moreover, we expect that our original conceptual approach will constitute a significant contribution to the field of social neuroscience.