# Central amygdala mediates socially transferred positive and negative emotions

Ewelina Knapska[1],
Karolina Rokosz[1], Kacper Kondrakiewicz[1], Karolina Ziegart-Sadowska[1], Adam Hamed[1],

[1] Nencki Institute of Experimental Biology, Polish Academy of Sciences, Warsaw, Poland

In its simplest form empathy can be characterized as the capacity to share the emotional state of another being. Tuning one's emotional state to that of another increases the probability of similar behavior, which thereby allows for a rapid adaptation to environmental challenges. Emotional contagion, commonly observed in animals, including rodents, is well described at the behavioral level, but the neuronal circuits necessary for sharing emotions are not well understood. The neuronal circuits in the central nucleus of the amygdala (CeA) are crucial for both appetitively and aversively motivated non-social behaviors. In the latter case the CeA mediates both active and passive defensive responses. To test the hypothesis that the neuronal circuits of the CeA are necessary for socially transferred emotions of different valence we used three behavioral rat models of adult, same-sex social interactions that induce positive emotions, active fear and passive fear. Using c-fos-driven targeting of channelrhodopsin and halorhodopsin in these models we were able to activate or inhibit neurons involved in social interactions. We show that activation of the CeA neurons involved in social interactions of different emotional valence in a novel environment resulted in distinct behavioral patterns. Activation of the CeA "positive" neurons increased exploration of the environment, activation of the "passive fear" neurons motivated rats to hide and activation of the "active fear" neurons enhanced risk assessment behavior. Inhibiting the CeA neurons led to opposite effects. We also showed that when the "social" CeA neurons are activated in social context, the rats exhibit the behavioral repertoire characteristic to social interaction with an emotionally aroused conspecific. In order to further characterize the neuronal pathways underlying social emotions of different valence, we identified, by functional mapping methods, the neurons activated by the same three types of social interactions in the brain structures targeted by the CeA. Most of the identified activated neurons received projections from the CeA and the pattern of activation depended on the emotional valence of social interaction. Taken together, our results show that the neural circuits within the CeA control socially transmitted emotions and that social emotions of different valence involve subpopulations of neurons that are, at least partially, distinct.