Reward system localised in the mammalian brain is an evolutionally conservative group of brain structures which are associated with control of motivation oriented behaviors. Thanks to this system one is able to increase the possibility of obtaining goals crucial for survival of the specimen and spiecies (food, reproductive behaviors). This system also allows to associate stimuli which precede receiving of the reward, allowing in future to anticipate occurance of the reward basing on these associated, previously neutral stimuli. The important part of the reward system are neurons synthesizing dopamine which are located within the ventral midbrain – in the ventral tegmental area (VTA) and substantia nigra pars compacta (SNc). Their activity is elevated when the unexpected reward or conditined stimuli announcing the occurance of the reward apears in the environment. There are many potential brain regions which may elicit such activity of dopaminergic neurons, however the sensory innervation seems to be delievered mainly from superior colliculi of the midbrain. It is a bilaterally located region engaged in processing of sensory stimuli, mainly visual, from contralateral visual hemifield, which attention and motor functions targeted towards an object have been well documented. Taking into consideration the similarity of function and the projections sent towards the dopaminergic neurons, it was shown that these projections indeed take part in regulating the reward system.

Nevertheless, it turns out that collicular neurons also send dense innervation to rostromedial tegmental nucleus (RMTg) located in the contralateral hemisphere. According to the fact, that this is the main region inhibiting the activity of dopaminergic neurons, it is possible that dopaminergic system located in the left and right hemisphere is controlled in the opposite way depending on the position of the rewarding stimuli in the visual field. That in turn could be responsible for eliciting apetitive behaviors towards the hemifield where this object is located. Therefore, the key goal is to fill the gap in knowledge concerning the difference in anatomy and physiology of ipsilateral projection (to the VTA/SNc) and contralateral (to the RMTg) of the superior colliculi.

In order to fill this gap the most up-to-date techniques for visualisation of neuronal projections and manipulation of neuronal activity will be used. Viruses which allow to introduce genes into the neurons (of superior colliculus) sending projections to the particular brain region (VTA/SNc or RMTg) will be used. Thanks to that approach it will be possible to induce expression of light-sensitive ion channels allowing to selectively active these neurons with light and to induce expression of fluorescent proteins visualising the axons of these neurons. That in turn, in combination with immunostaining will allow thorough inverstigation of anatomical connections from superior colliculi to the VTA/SNc or RMTg. In addition, in combination with electrophysiological techniques, these manipulations will allow to investigate the impact of activity of collicular neurons on electrical activity of cells within the VTA/SNc and RMTg.

In summary, the results obtained during realisation of the project will allow to precisely demonstrate the control of dopaminergic system by brain regions processing sensory information, with regard to the lateralisation of these connections. Anatomical and physiological description of descending connections from superior colliculi to dopaminergic system and brain structures controlling its activity will allow to expand our hitherto knowledge about the reward system. Taking under consideration the wide spectrum of nervous system disorders emerging from malfunction of dopaminergic system (such as addiction, schizophrenia, ADHD, Parkinson’s disease or some of the symptoms of depresion) getting to know the control mechanisms of this system will contribute to our better understanding of these disorders.