The brain mechanism of attention consists of three neural networks that constitute cognitive systems of attention and control three sets of attentional functions. An influential theory proposed by researcher Michael Posner and his colleagues defines these functions as alerting, orienting, and executive attention. Alerting network controls achieving a state of readiness to process and respond to external stimuli. Orienting network directs our attention to relevant sensory or mental events and inhibits the irrelevant ones. Executive network controls our behavior and other mind "outcomes" like our thoughts through suppressing interference or resolving conflicts between alternative competing responses or thoughts. The brain consists of many simultaneously active neural networks that often compete with each other, thus, regulation of output with respect to current goals is a central issue.

A large number of behavioral, lesion, imaging, electrophysiological, pharmacological, and even genetic studies have supported this framework of attentional networks and shown that the three networks are indeed relatively independent from each other both functionally and neuroanatomically. Nevertheless, this does not imply that these networks work completely independently from each other. On the contrary, the networks have been shown to interact and to work together in accomplishing various cognitive tasks and actions. However, as Posner states, "how these networks function together in a coordinate fashion during the complex natural tasks of daily life is still largely a mystery". This question on interrelations and interactions of attentional networks thus remains amongst the main issues in the current research on attention. The present project aims to investigate the brain mechanisms of those interrelations and interactions between attentional networks. Specifically, we focused on influences of alerting and orienting on the efficiency of executive network in resolution of conflicts, on influences of alerting on orienting, and on proactive modulations exerted by executive network on alerting and orienting networks.

To measure the functioning and interactions of alerting, orienting, and executive attention, we use several variations of an experimental task called the attention network test (ANT). When participants perform the ANT we measure the brain electrical activity with the electroencephalogram (EEG) and the brain neural activation with a new optical imaging technique called the functional near infrared spectroscopy (fNIRS). Next, to infer the cognitive and brain mechanisms of attention, we analyze behavioral indices of the three attentional networks (calculated from response times and error rates in different ANT conditions), event related electrophysiological potentials (ERPs), connectivity and information flow between different brain regions, and activations of brain areas involved in specific attentional operations.

Understanding of the cognitive and brain mechanisms of attention is of a great importance for understanding not only the attention itself, but also the role of attention in functioning and pathologies of many other aspects of the brain and the mind. Moreover, it is important for the applied science as well. For instance, better understanding of attention will help to develop new rehabilitation methods for patients with neurological disorders of attention like hemispatial neglect or interventions and treatment for children with attention deficit disorders like ADHD. Also, it may help to increase the safety on the streets. It is known that general lability and lapses of attention, as well as two specific attentional phenomena: inattentional blindness and change blindness are the frequent causes of road accidents.

An innovative, modern approach that combines behavioral, electrophysiology, and imaging methods is crucial for further development of research on attention. We believe that the results of this project may help to link those levels of analysis into an overall cumulative account of attention and make thereby a valuable contribution to the progress and development of this research field.