Reg. No: 2015/18/E/HS6/00399; Principal Investigator: dr Monika Lewandowska

For most people a sense of the passage of time is something natural and obvious. Despite that time experience has always intrigued scientists and was an object of many studies, the nature of this phenomenon still remains unclear. A term: “time” is difficult to define, we can feel as time passes, but we cannot describe it. Not many people realize that there are complex brain mechanisms underlying the feeling of the passage of time. Several contemporary theories postulate the existence of the” internal clock” which is located in the brain. Such mechanism operates in its own rate which varies in different persons and is determined by the features of the neural networks. There are also theories indicating that time is perceived in a discontinuous manner, and a sense of passing is achieved by the function of special mechanism that integrate such different elements into single unit. One of the aforementioned elementary temporal phenomena is perception of the order of two events presented in rapid succession. An ability to recognize the order of incoming stimuli appears to be crucial for humans to survive. It is needed for motion perception or speech understanding. It is well documented that two events have to be separated by an interval of at least 20-50-msec. to be recognized as one being after another (however, there are individual differences in the length of this inter-stimulus-interval). Up to date, it is unknown where exactly the mechanism responsible for temporal order perception is located in the brain. Furthermore, a question whether there is one central supramodal mechanism or more modality-specific systems is still open. Therefore, one of major objectives of the presented project is to elucidate the brain mechanism underlying temporal order perception.
To address this issue, functional magnetic resonance imaging (fMRI) technique was used to measure hemodynamic brain response. About 200 high school students (half males) will be asked to report the order of either two auditory or two visual events. Some of these persons will also perform additional task inside an MRI scanner in which Temporal Order Judgment (TOJ) of two stimuli from different sensory modalities (auditory and visual) is required. These two fMRI protocols allows to answer the question whether there are the same brain areas involved in TOJ ability regardless of the sensory modality of the stimuli.
Previous studies indicate a relationship between temporal information processing and intelligence defined as a global ability to reasoning, planning, problem solving, abstract thinking, fast learning and learning from experience. The shorter interval between two stimuli needed to correct identification of their order, the higher intelligence tests scores. It is not clear whether higher intellectual abilities cause fast rate of the internal clock or higher temporal resolution of the clock entails better performance on tests for intellectual abilities. It seems that the relation between temporal processing and general intelligence is affected by other factors such as attention (vigilance, concentration), working memory (information processing in a short time period), some personality and temperamental traits (extraversion, openness for experience).
In this project we would like to clarify the relationship between the TOJ ability and general intelligence using advanced statistical methods. Subjects will be asked to take part in psychological assessment of attention, working memory and general intelligence. Prior to the fMRI studies, Temporal Order Threshold (TOT), defined as the shortest interval between two consecutive stimuli needed to establish their before – after relation will be also measured individually in each subject. This experimental procedure helps to evaluate an individual rate of the internal clock (the lower TOT value, the higher temporal resolution of the clock). The brain activity of persons who achieved the lowest and highest TOTs could be different. Such a difference may be reflected in fMRI resting state condition when a subject is at rest, not involved in any task, as well as in the cerebral blood flow (CBF) and the white matter microstructure. The higher internal clock rate can be associated with higher oxygenation of the brain tissue, globally or in only some parts of the brain. Therefore, persons who achieve lower TOTs may also show increased CBF. As the white matter is responsible for information transition in neural networks, individuals who obtain higher TOTs may also have increased white matter volume.
We also plan electrophysiological (EEG) studies to test the hypothesis of higher information content in EEG signal recorded in a particular time period in persons who achieve lower TOT values. The higher resolution of the internal clock could be linked with more effective information processing.