As time is omnipresent in our life, it is observed an increasing interest of researchers to learn how we experience and perceive time. Psychological time does not correspond to the '*clock time'* which flow objectively in environment. Nowadays, it has been an explosion of research into the neural underpinnings of time, because *Temporal Information Processing (TIP)* constitutes an essential component of human cognition. Extensive research has clearly shown that many cognitive functions, like language, attention, memory, motor control or decision making are characterized by the specific temporal intervals, indicating that the brain incorporates dimension '*time*' into its computation. Understanding how different cognitive functions are temporally integrated to control our behaviour in milliseconds-to-seconds ranges is a fascinating problem, assuming that the basic neural network operates in this timescale. Therefore, the basic question in this project is *how* and *where* in our brains time is processed.

Previous studies indicated that TIP is not monolithic and several time ranges are controlled by neural mechanisms. This project focuses on milli- and supra-second TIP, as these two ranges reflect the complex TIP fundamental for human cognition. To data, neural mechanisms that would account for the representation of time constitute still an open question. Despite evidenced temporal dynamics of cognitive functions, only few literature studies linked directly the subjective time to other cognitive processes, but the nature of such relations remains unclear. Furthermore, existing evidence indicated that healthy individuals differ importantly in the efficiency of TIP. The relations between these differences and existing individual differences in the efficiency of cognitive functions, as well as the neural basis of these complex relations have not been identified. Moreover, different time ranges seem to control various cognitive processes. Thus, complex interactions between TIP ranges seem important for controlling the human behaviour. It is another neglected area in timing research, as previous studies concentrated only on separate time ranges (either milli- or supra-seconds), whereas, between-ranges relations were studied very rarely.

Taking into account these limitations, the current project consists of 2 parts. Part 1 is addressed verification of individual differences in TIP on these two time ranges, moreover, correlations between effectiveness of TIP and effectiveness of other (non-temporal) cognitive functions. It will be studied, using neuropsychological (behavioural) procedures in a relatively big sample comprising ca. 150 heathy subjects (half male) aged between 20 and 25 years. On the other hand, Part 2 is aimed to explain the neural underpinnings of individual differences in TIP. From the sample of 150 subjects (tested in Part 1) we select individuals characterized by high, moderate or low TIP efficiency on a basis of statistical analyses, as well as previous studies. Each of these 3 subgroups comprises ca.25 individuals. In each subgroup subjects will be tested individually, using complementary electrophysiological (EEG, characterized by good temporal resolution) and functional Magnetic Resonance Imaging (fMRI, good spatial resolution) procedures. These two procedures assess the effectiveness of milli- and supra-second TIP, similarly to neuropsychological procedures (used in Part 1) with markers that are more sensitive and not mirrored in neuropsychological indicators. At each TIP range we employ easy, medium and difficult task, creating 3 conditions. The outcome measures from particular procedures will be analysed, first, separately within a given procedure and, next, jointly using cross-ranges and cross-procedures approach. In each subgroup correlations will be analysed within, as well as between EEG, fMRI and neuropsychological data. Finally, in the whole sample (N=75) we test correlations (and regression) between measures from particular cognitive tests and fMRI (or EEG) markers. We expect to validate the individual differences in TIP which will be distinguished using neuropsychological procedures and confirmed, next, in EEG and fMRI markers. We assume also that timing efficiency at each range is correlated positively with subject's cognitive efficiency. Broad timing neural network may be verified using EEG and fMRI procedures and influenced by the timing range (different brain regions will be engaged in milli- and supra-second TIP), as well as a task difficulty. At this point more focussed activations of the brain areas in the subgroup of highly efficient TIP will be evidenced, usually reported for more skilled performance. The most important trump of this project is to analyse these activities jointly with the conjunction analysis to identify the common, range- , subgroup- and condition-independent region, critical for TIP. It supports a hypothetical core timing mechanisms, referred as a hypothetical '*internal clock*' which appears to be in operation.

The verification of our hypotheses during project realisation provides the new knowledge on subjective experience of time and will contribute importantly to existing models of psychological time. Complex interdisciplinary markers of TIP tested in this project indicate neural mechanisms sensitive to TIP in the healthy brain and '*timing-cognition*' relations. Such a new knowledge may provide more insights into dynamic flow of information in our brains. Our inspiration for these multidisciplinary studies is a better understanding of human brain functions, specifically, the neural basis of TIP which constitutes an essential component of human cognition. The studies of time perception are believed to give some insight into the "machinery" of the brain.