Time accompanies our day to day cognitive and neural activity. Organisms are constantly engaged in encoding, perceiving and representing time and temporal features as part of their interaction with the world surrounding them. By and large we can find two orthogonal approaches for modeling the representation of time in the human brain: (1) Extrinsic representation, where time is represented in one or more centers in the brain; (2) Intrinsic representation, where time is represented by the inner activity of neural relations. Our goal in the following study was to collect evidence to support our hypothesis that these two approaches are not orthogonal; rather they are different stages in a multi-layer process of time perception.

In a series of experiments we tested for the existence of automatic pre-attentive encoding of time at the neural level as well as for the global representation of time in the human brain, based on a new fMRI methodology in the research of time. In an fMRI experiment we tested whether time is represented within category selective areas in the brain, which typically encode the shape of visual stimuli by imposing different degrees of duration’s variance on visual stimuli (e.g. faces and natural-scenes) practicing a block design experiment. Using the same fMRI experimental design and manipulation, we also tested for global effects in the brain. Results indicate the existence of both local (within the FFA and PPA) and global (e.g. Cerebellum, Basal-Ganglia and Thalamus) representations of time. However, activation in the Cerebellum and Thalamus peaks relatively late with respect to the Basal-Ganglia, FFA and PPA. Moreover, In an ERP experiment we tested for the early detection of temporal discrimination as well as for implicit temporal expectation in the visual modality, using the oddball paradigm. Results indicate an accurate covert estimation of durations based on implicit temporal expectation, as well as pre-attentive duration discrimination. Based on all our findings we concluded temporal estimation entails pre-attentive processes along with the well-established attentive processes. We also conclude that time has a local and global representation which may interact.

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