In recent years extensive research was dealing with the processing of visual information. One important feature of the visual cognition is that how our brain can group together objects or events. It seems that at least three distinct procedures are playing role in categorization. In the first case, category membership is decided on the basis of rules describing the category. Another possibility is the similarity-based categorization, when the subjects have to determine the overall similarity of the test object to a remembered exemplar of the category. The third possibility is the prototype similarity, when the subject has to determine the level of similarity compared to a stored virtual prototype, an average central tendency of the category.

Several neuroimaging and electrophysiological studies provided evidence for a discrete categorical organization of the brain. Discrete brain areas were related to different categories such as faces, buildings, animals, fruits etc. On the other hand other studies failed to find robust evidence of functional segregation by domain or categories.

In 1996 Thorpe and his co-workers showed that the earliest phases of categorization can take place in such early part of the visual processing which was thought to be clearly perceptual. They recorded event-related potentials (ERP) in a paradigm, in which subjects had to categorize pictures on the basis whether they contained animals or not. ERPs evoked by animal and non-animal pictures diverged very sharply at ~150 ms after the stimulus onset. How the visual system is able to perform such a phenomenal amount of computation in such a short interval is clearly a challenge for current theories of object vision. Taking into account the large number of stages across the visual processing, it seems that much of this processing must be based on essentially feed-forward mechanisms. Regarding to the reaction times and the differential activity in the ERP, the detection of object belonging to the target category can be done almost as fast as in a simple perceptual signal detection task. A very tempting interpretation of these results is that categorization does not occur after object perception but parallel with that.

In our studies we have examined the categorization processes and their relation to the striato-cortical circuitry. In the first set of experiments we have recorded ERP in a categorization task in three neurodegenerative patient groups and in healthy control subjects. Subject had to decide whether a picture, presented for 30 ms, contained animal or not, by pressing one of the two response buttons. In normal control subjects there was a sharp difference between the responses evoked by animal and non-animal pictures, peaking around 200 ms (N1). Parkinson’s disease (PD) patients showed no differential responses, non-animal responses were not more negative than animals. In the Huntington’s disease (HD) group the responses differed for target and distractor stimuli as in the healthy subject at all electrode sites but the lateral temporal electrode sites. Between group comparison demonstrated that the N1 amplitudes were significantly smaller for both kind of stimuli in the HD group. In the Alzheimer’s disease (AD) group the non-animal pictures evoked more negative responses as well as in the control group. These results are interesting from the point of view that the general mental status of the AD patients was far worse. The difference between the pictures was present in demented AD patients with severe clinical symptoms and cognitive decline, while it was absent in non-demented PD patients with much better general cognitive
functioning. On the bases of these results we suggest that the striato-cortical pathways, which are between the primary affected structures in PD play a crucial role in the early categorization processes. Contrary the long cortico-cortical pathways of which disruption is the main feature of AD are not critical for this kind of ultra rapid visual categorization. Pathways damaged in HD seem to play minor role in the ultra-rapid categorization because the differential response is spared. Since several neuroanatomical studies directed attention toward the closed-loop interconnection of the temporal lobe and the striatum, the deficiency in the temporal electrode sites of the early electrical signs of the categorization process probably attributed to the basal ganglia pathology. On the other hand, the general amplitude diminution of the potentials evoked by both kinds of stimuli may be related to the widespread cortical degeneration that was described in HD.

In the second experiment we have examined the role of the fronto-striatal system in the implicit leaning. Recently, the probabilistic classification learning (PCL) task has been introduced as a promising tool to investigate implicit learning functions. In this task subjects learned which of two outcomes would occur on each trial after presentation of a particular combination of cues. The relationship is not absolute: cues and outcomes are statistically related. During the task individuals learns gradually the statistical probability of the given combination, without having conscious knowledge about the rule.

In order to modulate the activity of the fronto-striatal system we have applied transcranial direct current stimulation (tDCS) over the prefrontal cortex for 10 minutes. tDCS known to be a useful non-invasive method to up- or down-regulate the underlying cortical excitability, depending on the current direction. The effectiveness of the tDCS has been proved over the motor as well as the visual cortex. Transcranial direct current stimulation (TMS) induced motor evoked potentials were decreased by cathodal stimulation and was increased by anodal stimulation. In the visual system Antal et al. has showed that cathodal stimulation of the occipital cortex can decrease the contrast sensitivity, and the amplitude of the primary visual evoked potential, and increase the threshold of the TMS evoked phosphenes. The plastic changes caused by tDCS have been related to N-methyl-D-aspartate (NMDA) receptors, while NMDA-receptor antagonist dextromethorphan suppressed the post-stimulation effects of both anodal and cathodal DC stimulation, in humans.

10 min anodal stimulation resulted in an improvement of the implicit learning of the task, while cathodal stimulation failed to reach any significant effect. We suggest that this improvement was due to the plastic changes in the fronto-striatal circuit evoked by the increased neuronal excitability.

The role of the basal ganglia formation in visual perception and cognition was investigated intensively over the last decades. Indeed, there are some evidences to suggest that the basal ganglia play role in both the complex visual object cognition and visuospatial cognition. Receiving inputs from the ventral and dorsal stream, sending and receiving information to and from the frontal areas, makes the basal ganglia complex an ideal structure to organize the incoming sensory information on the basis of behavioral requirements which probably stored in the frontal cortex working memory system. In this way the striato-cortical network is an indispensable connecting point of the categorization processes irrespectively of the explicit or implicit nature of the process.