Sources of rationality: the role of inhibition and its neural substrate in decision strategy use

Decision-making is a process in which thoughts turn into actions, and this process impacts our lives and shapes the world we live in. Some decisions are made in an impulsive manner, with only one reason in mind and other reasons ignored. This is in sharp contrast to the notion of perfect rationality – that one should carefully consider all available information before making a choice. For such a rational process to happen it is important that we withhold the decision, in order to process more information before committing to the final choice. How does the ability to put a brake on our actions impact the choices we make? Are some people better at it than others? How do their brains do it?

Philosophers and economists often postulate that when making complex decisions, humans should process all available information, carefully weighing the choice options, their attributes and combining this in a complex manner to arrive at options' overall evaluations which then can be compared. This is the "gold standard" of rationality with which human decision making is compared. However, people, rather than being perfectly rational, often use heuristics (mental shortcuts) to simplify decision problems and make choices faster. This happens, for example, under time pressure or stress. Also, some people use these shortcuts more often than others. Is it because their brains cannot withhold the decision a little longer?

How to find it out?

Research has showed that a 'braking network' exists in the human brain, in the surface cortex areas and also deeper, in the basal ganglia - a tightly packed structure important for thought, motivation and action. We propose that our ability to make rational decisions rests on the brain's ability to brake. We think that efficient functioning of the braking network is essential here, if it does not function well, there is a greater chance that we will use shortcuts to make choices.

We will study the functioning of this braking network with three different methods: functional magnetic resonance imaging (fMRI), transcranial magnetic stimulation (TMS) and deep brain stimulation (DBS). fMRI is a brain imaging technique that allows us to measure brain activity during thinking. We will use fMRI to map the surface and deep brain structures of the braking network and see how their work when we make choices. TMS is a noninvasive brain stimulation technique using magnetic pulses, tested in many previous studies. Stimulating the brain's cortex (from outside the head) results in short inhibition of neural processing in the stimulated area. We will study healthy adult volunteers to see if inhibiting their braking network results in using mental shortcuts to make choices. DBS is an electrical stimulation technique used to treat Parkinson's disease patients. The stimulation is delivered to a brain part important in the braking network. We will study Parkinson's disease patients treated with DBS, to see how they make decisions when the stimulation is working and when it is switched off.

Why is it important and what will we learn?

With this project, we will find out how our ability to withhold actions translates to making complex decisions with multiple criteria. We will be able to precisely see the brain activations that underlie the use of rational decision rules, both in the surface areas of the brain, and deep inside. We will be also able to see if stimulation of this braking mechanism results in making fast decisions with heuristics. The studies will bring important knowledge on the brain mechanisms of decision making. This knowledge can help us minimize the negative impact of impulsive decisions, which are often associated with problems like gambling or substance abuse. As part of the brain stimulation studies, the project involves Parkinson's disease patients. Studying brain processes in Parkinson's disease might help us find early signs of this devastating disease, and use them to predict its onset and course.