What **I**ntracerebral **S**ignals **D**o **O**ffer to clarify human decision-**M**aking (WISDOM project) ?

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Humans often have to integrate a number of factors to choose among available options. For example, a large number of factors/dimensions might influence the decision to buy one apartment rather than another (including aesthetic, economic, marketing, geographic, social constructs...). However, **the mechanisms through which the brain aggregates distinct value signals to make ecological choices are unknown**. A possibility is that the brain valuation system gradually integrates these dimensions across time. Alternatively, distinct sub-valuation processes might be distributed either between small neuronal populations within a given brain region or even between topographically distinct areas[1, 2].

To test these ideas, we will develop a decision-making paradigm[3] during which subjects will have to learn a cost and a benefit of a given option. Costs and benefits will be displayed at separate places on the screen so that we will also be able to track the role of visual attention during value-based choices by examining the pattern of visual fixation of subjects[4].

We will test the causal involvement of key identified brain areas by studying brain-damaged patients and by using a brain-computer interface to modulate invasively brain activity of epileptic patients. To demonstrate the causal involvement of identified brain nodes that are hypothetically necessary to compute a given decision signal, we will recruit a cohort of operated patients after the surgical removal of selective brain areas. We plan to constitute four groups with a lesion in either anterior insula (AI), dorsomedial prefrontal cortex (dmPFC) or ventromedial prefrontal cortex (vmPFC) - and a control group with a lesion in the medial temporal lobe (n=10 to 15 patients within each group). In addition, we will also modulate selectively the activity of these brain regions to test whether modulating the brain activity through volition have selective consequences on choice behavior of epileptic patients. We already developed the brain computer interface (Brain-TV), and we will slightly modify it to train subjects to up-regulate the 50-150 Hz activity within selective cortical areas during the task. **This is a radically novel approach that will have a significant impact by showing that human decisions can be improved (or worsened) at will by training a given brain region through the BCI** [5].

Importantly, the feasibility of our research plan is supported by our ability to monitor real-time iEEG activity while using a neurofeedback approach through "brain-TV"[6, 7].

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