Verifying neural theories of consciousness with a data-driven approach

Consciousness and its theories
We all intuitively know what consciousness is. We woke up from a dreamless sleep and became conscious. Being conscious, we experience the world in an intrinsic, subjective way. However, any attempt to investigate consciousness scientifically seems incomplete. Some researchers focus only on the state of awareness. Others investigate qualities of sensory experience (such as subjective perception of colour, taste or pain). Some researchers describe how we integrate sensations in a coherent, multimodal experience (imagine the experience when you walk through the meadow on a sunny day). Others focus on the inferential processes, explaining why sometimes we experience things very differently from how they are objectively (consider visual illusion or hallucination). Finally, some focus more on how we know we are conscious and how judgements of consciousness are formed. Notably, the comprehensive theory of consciousness should cover all those issues, but current theories rarely do so. This project aims to change this state of affairs.

Aim of the project
Most research projects investigating consciousness follow one theory of this complex phenomenon. Only recently, it has been proposed that the theories should be compared directly within projects and that the one that fits the data more should be preferred. However, such model comparisons often give inconclusive results. This is because 1) the comparison is often based on a small set of experimental procedures favouring one of the theories by design; 2) the comparison typically focuses on one dimension, neglecting other significant differences between the models. Here, we propose to address this problem using a data-driven approach. We propose a multidimensional analysis to identify key aspects of conscious experience measured using various tasks applied in consciousness studies. This is possible because, contrary to most previous studies in the field, our database is not focused on a single paradigm. We measured consciousness with various yet converging and complementary tasks probing different aspects of conscious experience.

Description of research
The project aims at a multidimensional, in-depth theoretical, statistical and computational analysis of an already collected, comprehensive dataset. The dataset includes structural and functional brain organisation data collected with magnetic resonance (MRI), transcranial magnetic stimulation (TMS), and electrophysiological (EEG) data complemented with a large set of behavioural and declarative measures. Notably, the studies apply an individual difference approach, as we focus on the interindividual differences in conscious experience and the associated differentiation of the neuronal architecture of the brain. We plan to investigate brain architecture differences related to various aspects of consciousness. Thanks to the neuroimaging data, we can analyse how variability in different aspects of consciousness (measured with multiple tasks and methods) relates to brain organisation. All imaging modalities (MRI, TMS, EEG) tell us how the brain is organised and connected. This, in tandem with behavioural and self-reported measures, gives us a unique opportunity to understand the relationship between different aspects of consciousness on psychological, behavioural, and biological levels.

Expected results
We argue that human consciousness can only be understood as a complex phenomenon and should be approached from a multi-methodological, systematic and coherent perspective. To that end, we have developed a research program that involves a large set of converging behavioural, self-reported, and neuroimaging methods. We assume that data-driven analyses allow a more comprehensive view of the relations between the variables of interest and better understand the mechanisms behind consciousness. This project will contribute to our understanding of consciousness and allow us to evaluate the current consciousness theories.