NEST
Pathfinder

CONSCIOUSNESS UNRAVELLED AT LAST

MINDBRIDGE

How can the human brain transcend its physical structure to create conscious experiences and a sense of self-awareness? The MindBridge partners believe they are ready to answer the question that has so far defeated all comers. They believe that by pursuing the challenge on all fronts – including subjective accounts and behavioural studies of learning and memory, as well as brain scanning – they will be able to crack one of science's last great problems: what are the causes and mechanisms of consciousness?

Understanding consciousness is a key objective of scientists who study the human mind and brain. Something in the structure of the brain creates consciousness, but despite a large amount of research we still do not know how it happens. The MindBridge project aims to close the gap between the subjective experience we call consciousness – perceptions, judgments, feelings and desires – and the objective, third-person accounts produced by the cognitive neuro-sciences.

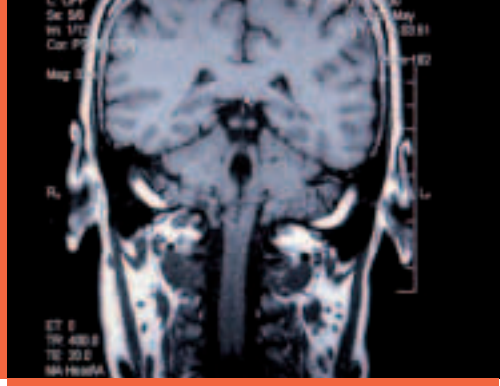
Six institutes are working together to develop a toolbox for studying different levels of consciousness, as well as the relationships between conscious and unconscious processing in the brain. The novelty of MindBridge is that it is multidisciplinary and more integrated than previous research, bringing together subjective reports, behavioural studies and functional neuroimaging.

Their ultimate goal is to produce an empirical theory of consciousness. Practical results could include an understanding of the mental state of people who are unable to communicate, and new insight into conditions such as schizophrenia. The results are also expected to generate new rehabilitation methods for patients with moderate and severe brain injury.

Mapping objective to subjective

In recent years, several tools have become available for studying the physical state of the brain and, in particular, the way it changes during different thought processes. These tools include electroencephalography (EEG), magnetoencephalography (MEG), positron emission tomography (PET) and functional magnetic resonance imaging (fMRI). The results of these investigations are known as the neural correlates of consciousness (NCC), and they have a high priority as tools in research into consciousness.

"Consciousness is one of the most important unsolved problems in science."



Despite much research effort, though, we so far have no adequate models of how consciousness arises or relates to brain state. In the words of one researcher, "No-one has produced any plausible explanation as to how the experience of the redness of red could arise from the action of the brain." But to a capable, multidisciplinary team with the right resources, the MindBridge researchers believe reaching this understanding is only a matter of time.

The project will analyse both qualitative and quantitative characteristics of conscious and unconscious processing. The researchers will examine different cognitive functions, such as perception, attention, memory, learning and language. They will work with a wide range of subjects, including people who are awake, asleep, or in altered states of consciousness (such as those with pathological conditions such as minimally conscious, comatose or vegetative states).

The consortium's first task is to develop measures of consciousness based on subjective reports and behavioural measures. Next, they will compare this measured consciousness with the corresponding brain states as defined through structural and functional neuroimaging. A key factor here will be the use of computerised pattern-recognition techniques to decode the data produced by fMRI and MEG, a task previously thought to be impossible but which now seems within reach. Measurements over short timescales, as with MEG, and multivariate analysis are already producing impressive results.

The ability to see how the activity of neurons in the brain varies with different states of consciousness will help to solve the 'binding problem', one of the biggest unresolved issues in the search for neural mechanisms of consciousness. The binding problem addresses how networks of neurons in different parts of the brain can act together to produce specific mental states. The answer may lie in the timing of the neurons' firing, specifically that sets of neurons become locked into an oscillatory pattern with a frequency of 30 Hz or greater.

Self-consciousness and schizophrenia

Self-consciousness is one of the mental functions to which MindBridge will pay particular attention. Self-consciousness is important not least because social functioning depends on being able to distinguish one's own mental state from those of others, and many experts believe that it is likely to be 'hard-wired' into the brain. The researchers plan to develop an experimental platform for characterising self-consciousness, and ultimately to explore the 'neural signatur' that may give rise to this state.

Existing studies of consciousness draw few conclusions that are useful in the diagnosis or treatment of mental problems, the MindBridge researchers say. They, in contrast, plan to develop practical new tools for assessing patients with conditions such as brain injury, schizophrenia and autism.

The ultimate goal is to produce an empirical theory of consciousness to supplement existing theories, which are based largely on philosophical reasoning about how consciousness ought to work. Consciousness is one of the most important unsolved problems in science, so this is certainly an ambitious project whose implications reach well beyond what will be possible in the three-year timescale.

AT A GLANCE

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Measuring Consciousness: Bridging the Mind-Brain Gap

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