

Introduction: Recent Advances in Consciousness Research

Consciousness was long considered as the “holy grail” of cognitive psychology and neuroscience: a vague and uncertain goal, so remote as to seem almost entirely out of reach. Today, however, the perspective has changed. Characterizing the computational architecture and neurobiological mechanisms underlying consciousness remains a major unsolved problem in cognitive neuroscience, but it has become an area of intense research. Thanks to new advances in stimulation paradigms, brain imaging techniques, and neuronal theorizing, the issue now appears to be empirically addressable. Yet a major challenge still confronts these novel empirical and theoretical proposals: will they be able to help clinicians confronted with patients in coma or vegetative state? Can they help define novel diagnostic or even therapeutic tools?

In the present book, which is the outcome of a Fondation Ipsen meeting held in Paris on May 3rd 2010, 13 renowned neuroscientists and clinicians examine whether consciousness research is ripe for applications, from cognition to the clinic. The diversity of empirical research is impressive, and the theoretical convergence is quickly growing. At the cognitive level, paradigms such as backward masking, binocular rivalry or change blindness, together with quantitative probing of the subject’s introspective state of mind, are helping understand the extent of subliminal processing and the point where conscious processing starts. Brain imaging techniques, combined with novel analysis tools such as the new method known as multi-voxel pattern analysis, provides a window into the underlying brain state. A coordinated state of synchronized activity, emerging relatively late after the stimulus was presented and involving cardinal nodes in ‘associative’ cortical areas including prefrontal and parietal cortices, is frequently associated with conscious-level perception. Similar long-distance networks emerge spontaneously in the awake resting state, although whether they are necessarily associated with conscious experience remains debated. Many of these results appear compatible with the theory of a global neuronal workspace, which proposes that a distributed set of neurons with long-distance axons are involved in the global information broadcasting underlying reportability and what is experienced as a conscious state.

Most novel perhaps is the possibility to study consciousness in non-human primates. The ability of global networks to enhance their communication through phase synchronization is increasingly understood at the electrophysiological level.

Furthermore, new paradigms now ask whether animals possess meta-cognitive abilities, such as a self-monitoring of their competence in a task, and electrophysiologists now examine the underlying neuronal networks.

Turning to clinical applications, brain imaging in the resting state or in carefully crafted stimulation paradigms holds the potential to address three questions of central importance: Is a given patient conscious? Will he ever recover consciousness? And what will be his cognitive state if he does? Brain stimulation paradigms, whether cortical or in deep-brain nuclei, can alter the state of consciousness and may improve communication in some ‘minimally conscious’ patients.

In summary, consciousness research appears to be on the verge of concrete clinical applications. We hope that the present book will serve as an up-to-date survey of this exciting field.

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