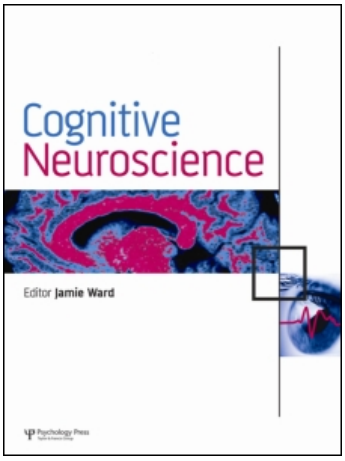

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The cognitive neuroscience of consciousness

Geraint Rees[a]; Anil K. Seth[b]
[a] University College London, London, UK [b] University of Sussex, Brighton, UK

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Introduction

The cognitive neuroscience of consciousness

Geraint Rees[1] and Anil K. Seth[2]

[1]University College London, London, UK
[2]University of Sussex, Brighton, UK

The past decade has seen an explosion of interest in the neural mechanisms underlying consciousness. Experimental approaches from cognitive neuroscience that emphasize converging evidence from multiple methodologies have changed our understanding of how conscious mental states are associated with patterns of brain activity. In this special issue of *Cognitive Neuroscience*, we bring together five new empirical contributions to this literature plus a new theoretical discussion paper and associated peer commentaries.

To understand the relationship between conscious mental states and brain activity, we must make progress in three distinct areas. To be conscious is to be awake (rather than in a dreamless sleep, or unconscious) and so we must understand the neural mechanisms associated with changes in level of consciousness. But when we are awake, our conscious states are individuated by their content, which has a particular subjective feel. We therefore need to understand the neural underpinnings of conscious content, and how such representations in the brain are distinguished from merely unconscious processing. And finally humans (and possibly some other animals) are self-aware and able to make introspective judgments about their perception and action. Understanding the neural correlates of such metacognitive ability is also required.

In this special issue, exciting new empirical data are presented in each of these areas. Bruno et al. (this issue) focus on the challenging problem of assessing patients in a minimally conscious or persistent vegetative state. These disorders are difficult to characterize clinically and there has been much recent interest in using functional neuroimaging to investigate possible residual cognition and consciousness. Bruno and colleagues review the relevant work, and present new data collected in the resting state that may prove helpful in diagnostic and prognostic classification.

The level of consciousness does not only change following brain injury, but follows a natural pattern in healthy animals of sleep/wake cycles. Massimini and colleagues (this issue) focus on the consequences of such cycles for cortical processing, using transcranial magnetic stimulation in combination with high-density EEG to show striking changes in cortical reactivity and effective connectivity during rapid eye movement (REM) sleep compared to non-REM sleep; notably, the changes observed in REM sleep are similar to those observed in wakefulness. These findings suggest that measuring cortical reactivity and effective connectivity may help evaluate whether an individual is capable of having conscious experiences, and so have wider application in brain injured patients.

Brain injury can also cause selective impairment to the contents of consciousness. Spatial neglect commonly follows right parietal injury and results in difficulty noticing or responding to objects in the contralateral visual field. In this issue, Eramudugolla,

Correspondence should be addressed to: Geraint Rees, UCL Institute of Cognitive Neuroscience, University College London, 17 Queen Square, London WC1N 3AR, UK. E-mail: g.rees@ucl.ac.uk

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Mattingley, and Driver report a single case where awareness of contralateral stimuli critically depends on biases in figure–ground segregation induced by changing the relative salience of figure and ground.

Two studies explicitly examine self-awareness, but from different perspectives. Menzer and colleagues (this issue) focus on the sense of agency that we experience in linking the sound of our footsteps to our own actions. By manipulating the delay between walking and hearing the sound of footsteps, they examine the temporal dependency of this sense of self-agency. In contrast, Rounis, Maniscalco, Rothwell, Passingham, and Lau (this issue) examine how humans make introspective (metacognitive) judgments about their accuracy in a simple visual discrimination task. Transcranial magnetic stimulation over dorsolateral prefrontal cortex impairs such metacognition while leaving actual discrimination unaffected, indicating a role for this structure in making metacognitive judgements.

All empirical work ultimately requires a theoretical framework, and in this special issue Victor Lamme provides a thoughtful and provocative discussion paper attracting vigorous peer commentary. Lamme presents an extended argument that the phenomenality of conscious experience is explained by recurrent neural activity, contrasting this position with the notion that consciousness is associated with activity in an extended fronto-parietal network. Critically, Lamme argues that consideration of recurrent processing as a fundamental explanation for phenomenality allows us to take seriously the notion advanced by philosophers such as Ned Block (e.g., Block, 2005) that we can have phenomenal states that are unreportable. On Lamme's account, phenomenality arises through recurrent processing, while it is reportability that requires involvement of a frontoparietal network.

Taken together, the work reported in this themed issue of *Cognitive Neuroscience* demonstrates the empirical vigour and ingenuity that characterize this field, together with the increasing theoretical sophistication and debate surrounding elaborated theories of visual awareness. Such interaction between theoretical debate and empirical work is testimony to the rapidly growing maturity of this work on the cognitive neuroscience of consciousness.

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