Acta Neuropsychiatrica 2007: 19: 136–138

DOI: 10.1111/j.1601-5215.2007.00211.x

ACTA NEUROPSYCHIATRICA

Guest editorial

Neuropsychiatry and neurophilosophy

The objective of neuropsychiatry is to understand the diseased brain so that it can be healed. The seemingly loftier purpose of neurophilosophy is to understand the human mind and indeed consciousness on the basis of brain function. The two disciplines concur that we do not need to look beyond brain science to understand the mind. The ghost in Gilbert Ryle's machine has been securely laid to rest. Modern philosophers have, moreover, gone beyond the indulgence of armchair examinations of their own thinking to understand consciousness and have armed themselves with neuroscientific knowledge with increasing sophistication. In this climate of ever-dissolving interdisciplinary boundaries then, how might neuropsychiatry contribute to the understanding of mind and consciousness?

The time-honored approach of neuropsychiatry has been to attempt to delineate the consequences of part impairment of the brain. The neuropsychiatrist observes the consequent disturbance in behavior, emotion or cognition, and relates it to neurophysiological disturbance. Implicit in this is the realization that mind and consciousness are not unitary concepts, and disturbances in them are not categorical in nature. Indeed, the neuropsychiatrist does not venture to define the 'mind' or 'consciousness', recognizing that philosophers' attempts to do so have generally imposed a limitation on their conceptualization, and in fact colored the concepts with the tint of their own spectacles. Furthermore, the neuropsychiatrist is not mesmerized by how 'easy' or 'hard' a problem is. His/her concern is with the empiricism of the problem and whether the scientific method is applicable.

Many philosophers may not appreciate the salient contributions neuropsychiatry has made to the neurophilosophical debates. The work of Broca and Wernicke in the 19th century firmly put the study of higher brain functions on the agenda and began the challenge to the prevalent mind–brain dualism. The brain was now seen as an information processing machine capable of generating the mental functions that were hitherto mysterious and beyond scientific inquiry. The development of psychosurgery in the 1930s was a clear announcement of the neurophysiology of the mind, and while it suffered many attacks from psychodynamically oriented psychiatry, it had opened the mind to scientific dissection (1). The introduction of psychotropic drugs in the 1950s, and their rapid acceptance by the medical community, announced the physical basis of many mental phenomena and moved the debate to the ultrastructural level.

While these developments made mind and consciousness legitimate areas for scientific inquiry, the study of consciousness continued to be dominated by philosophical debates uninformed by science. This changed with the work on the split brain by Sperry and et al. (2), which showed that consciousness depended upon the anatomical connections in the brain, and each hemisphere could be described as having its own integrated awareness. It also became clear that the brain processed a great deal of information unconsciously – a kind of non-Freudian unconscious that of course begged the question about the elements that brought some of these brain processes to conscious awareness. The split brain studies, helped by the evidence for the lateralization of language, spawned an abundance of literature on the specialization of the cerebral hemispheres. It has even been conjectured that this lateralization of mental functions may be the essence of being human and has placed a massive distance between us and the ape (3). Miller (4) explores this through the paradigm of binocular rivalry, which elegantly shows the brain's ability to switch between hemispheres and to disambiguate overlapping objects.

Neuropsychiatry provided the model of examining the effects of brain lesions on mental functioning. There have been some outstanding stories that emerged from this approach. The famous case of H.M., an epileptic man who had bilateral temporal lobe surgery, informed us a great deal about the neuroanatomical basis of episodic memory (5). Phineas Gage, a 25-year-old construction worker in 19th century New England, who had an iron rod pass through his frontal lobes (6), vividly illustrated the importance of the frontal lobes in organization and planning, maintaining social convention, exercising responsibility, and controlling our irrational impulses, qualities we often regard as being uniquely human. The *Man Who Mistook His Wife for a Hat* (7) brought to popular consciousness the brain's incredible ability to recognize faces and objects with remarkable ease, a feat that computational scientists have been struggling to replicate in the most powerful computers. Some stories from neuropsychiatry are more complex, and some of these are dealt with by Hannan in this issue (8). Take the example of Alzheimer's disease. To observe a sufferer, from the early stages of mild memory lapses to a stage when he/she does not recognize his/her own self in the mirror, and relate it to the devastation brought upon by lesions in the brain, is in some ways a deconstruction of the development of full consciousness in us.

Modern neuropsychiatry has provided us with new probes into the brain that do not rely on the uncertainty of a naturally occurring brain lesion. The versatility of magnetic resonance imaging (MRI) and positron emission tomography has offered a unique window into the workings of the mind (9). Functional MRI (fMRI) can image the brain as it thinks, feels, acts or imagines, and determine wherein lies the greatest activity. Many interesting challenges have been posed to this technique. What part of the brain is critical for making a decision? What happens in the brain when a person is lying or faking a memory loss? How does the brain see a happy face as opposed to an angry one? Where is fear located inside the brain? Can an individual, who, for all intents and purposes, is deeply comatose still process information in his brain? There are of course limitations to this technique for probing the brain. Most brain activity involves a network of brain activation, and fMRI provides a correlation of brain blood flow change in different brain regions with mental states without establishing the salience of any particular change. Other techniques such as transcranial magnetic stimulation have come to the fore in helping to produce temporary and virtual lesions with consistency and repeatability not possible with natural experiments (10). For greater temporal resolution of brain activity association with mental function, neuroscientists have used electroencephalography, in particular evoked potentials, as well as magnetoencephalography. This is a large and growing bag of techniques that continues to provide richer and more elaborate information.

Interestingly, Miller and Ngo (11) review the data on the well-known and humble technique of caloric vestibular stimulation (CVS) as a cognitive probe. This technique was introduced nearly a century ago for the investigation of the vestibular system. The finding that CVS results in the excitation of the contralateral hemisphere, including the anterior cingulate cortex, temporoparietal cortex and the insula, has resulted in much refinement of the technique as a potential diagnostic as well as a therapeutic tool. It has already been applied for the study of vision, attention, anosognosia, somatoparaphrenia, mood, somatic representation and pain, and remains an exciting tool for future work.

While neuropsychiatry has understandably focused on networks and systems within the brain, no complex system can be understood without a deep understanding of its elements. In the case of the brain, Vickery's call to 'mind the neuron!' is not to be dismissed (12). While the brain has a large number of supporting cells – the glia – the neuron remains the focus of much of our interest. It is the networks formed by neurons that attract the most interest when explanations for mental phenomena are offered. Vickery cogently argues that in understanding consciousness, we must work at many levels, and some of the fundamental work must focus on the single cell. Mountcastle's reputation as one of the pioneers of neuroscience stemmed from his work on the single neuron and the columnar organization of the cortex. If information coding in the brain is to be understood, we must examine it at the larger network level down to the minicolumns in cortex (13).

Some other insights into consciousness will come from evolution. We have now come to accept that *Homo sapiens* are not the only species capable of consciousness, whatever our understanding of this term might be. However, the experience of human consciousness appears to be vastly different from that of any other species, including that of our closest cousins, the great apes. Can this difference be explained on the basis of brain changes across this ladder of recent evolution? The popular viewpoint is that humans have experienced an exponential growth of their neocortex, giving them a computational advantage that has elaborated into consciousness. Kirkcaldie and Kitchener (14) argue that while the size of the human brain is indeed large in relation to the size of the body, it has not developed any new processes in the cortex that do not exist in other mammals. In other words, we are smart because our cortices are bigger, and this expansion itself generates new cognitive abilities. If we can understand the molecular basis of this expansion of the neocortex, we may well have the elements at the lower level of the hierarchy of explanations for consciousness.

Neuropsychiatry may fall well short of the ultimate goal of neurophilosophy – to explain qualia or the 'redness of an apple', 'the funny feeling in the tummy' and 'the musical experience of a C-major'. Intuitively, this is indeed a hard problem for neuroscience. Some believe that this is a problem beyond science – a brain looking from within cannot explain its own subjective experience. However, some challenges have been presented to this belief. It is possible that the fallacy lies in using intuition to attempt to understand the workings of mental phenomena. We have learnt to distrust our intuitions when it comes to physical phenomena. We readily accept that the Earth revolves around the Sun, and around its own axis, or that matter can be converted into energy, or that light can behave both as a particle and a wave, or that black holes exist in the universe and space is warped. Why is it then that our recognition and emotional reaction to a symphony is so difficult to comprehend as the 'mere' consequence of a complex interaction of molecules and cells, however marvelous that interaction might be? We know from the neuropsychiatric investigations of synesthesia that the senses are not immutable and that the chord C may well arouse the sensation of green if the brain were differently wired (15). Qualia may be no more than convenient labels we attach to experiences that have particular neuroscientific signatures of experience. Their mystery may just be a matter of our ignorance thus far.

The papers in this special issue of the journal highlight the role neuroscience and neuropsychiatry can play in informing neurophilosophy. Neuropsychiatrists are best served if they understand the arguments and questions posed by neurophilosophers. The latter must pay close attention to the work of neuropsychiatrists and neuroscientists. One looks forward to the day when the articles in the journals representing the two disciplines would have little to distinguish them.

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Acknowledgement

The author is grateful to Angela Russell for manuscript preparation.

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