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Brainwaves

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This issue of *Acta Neuropsychiatrica* publishes the abstracts of the Australasian Society for Psychiatric Research (ASPR) annual conference for 2006. The society is the peak body of psychiatric and mental health researchers in Australia and New Zealand and brings together researchers across a wide range of professions in the pursuit of a greater understanding of psychiatric disorders and improvement in the treatments offered for them. As such, it has been a place where the basic science researcher can meet his/her colleague in clinical and epidemiological research and exchange ideas.

Brainwaves, the theme of the conference, plays upon metaphors of inspiration and of communication that are essential for the scientific work that we do, the ripple effect of ideas thrown into the pond of scientific thought propagating across the whole community of researchers. Successful and fruitful research can be achieved within the restricted focus of a single field; however, insights into more complex problems such as disease require communication across the 'levels of explanation' (1) in which we accrue our knowledge. This is one of the prime purposes of conferences such as ASPR that do not have a specialty focus.

Waves of synchronized cortical electrical activity may underlie the brain activation required for these moments of inspiration. The identification of multiple areas of discrete cognitive activity with functions as defined as the recognition of a specific name (2) or the definition of contour as against form or movement for a simple visual percept has emphasized again the 'binding problem' of how these discrete and often distant areas of the brain can be rapidly coordinated to produce coherent cognition. The formation and modulation of connectivity between regions has been seen as the possible mechanism underlying cognition and consciousness (3,4). The level of connectivity between areas has been determined either as a function of the covariation or correlation of power, phase or activation between regions using techniques such as electroencephalography (5), evoked potentials (6), positron emission tomography (7) and functional magnetic resonance imaging (8), or as an effective connectivity, an estimate of the direct influence that one neural system exerts upon another (9). These measures provide a means of determining the network of brain regions that together are responsible for cognition but do not of themselves describe how this occurs.

Singer and Gray (10) have suggested that synchronous high-frequency (40 Hz) activity may be an index if not a mechanism for the binding of different cell assemblies together. High-frequency coincident bursts of presynaptic potentials, at the peaks of gamma rhythm, has been related to processing of different perceptual characteristics in the visual cortex (11,12). The activation of a network of cells, recognized by the 'coincidence detection' of their simultaneous firing, increases the reliability and the informational value of the cellular activity many fold (12). These bursts of activity appear to delineate the limits of perception with peaks of gamma activity accompanying the ability to perceive and discriminate auditory phenomena (13). However, it seems unlikely that information transfer or neuronal cell assembly coordination should be the province of such a restricted frequency band. Functional activity clearly extends over a broad range of gamma (30–100 Hz) for visual perception (14). Further, work over several decades has implicated alteration in other frequency bands in numerous cognitive and motoric actions. The interplay between alpha and beta synchronization/desynchronization has been used to track selective attention (15), and the preparation and execution of movement, both imagined (16) and actual (15). The manipulation of cognitive load or stage of processing in working memory tasks sees marked alteration in the interplay of theta and alpha power, desynchronization (17) and phase (18). The distance over which integration of cognition is to occur influences and may determine the frequency band used by the brain. At the local scale, visual phenomena elicit an increase in gamma power and synchrony over the occipital cortex but not over other brain regions. Supramodal integration of sensory inputs requiring interaction of areas across the brain elicited synchronization in the beta 1 frequency range, with possible contributions within the gamma band. Longer range interactions in a working memory task involving prefrontal and posterior cortical areas elicit theta activity (19).

What happens when the free flow of this information is disturbed as is seen in schizophrenia (20)? Schizophrenia research has identified very many areas of deficit, none of which alone has been able to account for the manifestations of the disease. A connectivity hypothesis allows one to account for this, as Friston comments '… the symptoms and signs of schizophrenia do not generally represent a single deficit but can be seen as resulting from the abnormal integration of two or more processes' (20). Genes identified as plausible susceptibility genes particularly affect glutamatergic transmission and synaptic plasticity (21), having obvious implications for cortical communication, but alone may be unable to explain the multitude of clinical and experimental deficits. A conception of schizophrenia as a disorder of connectivity allows for a broad conception of polygenetic, epigenetic and environmental insults coming together to compromise the connectivity and coordination of the brain network, emphasizing the interactivity of these factors and potentially spanning some of the levels of explanation for schizophrenia that have existed independent of each other.

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