fMRI: Not the Only Way to Look at the Human Brain in Action

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To the Editor:

The *Observer* (September 2006) is to be commended for presenting a balanced view of fMRI research, resisting the megahype that characterizes so much of this literature. It is a pity, however, that you did not extend your coverage across the entire domain of cognitive neuroscience. As someone who began studying brain activity using a "…non-invasive, high-resolution, totally safe way to look at a human brain…" in 1961, I take exception to the assertion attributed to Joy Hirsh regarding fMRI that "This is the first time in history we have a non-invasive, high-resolution, totally safe way to look at a human brain,…to look at how the brain drives and controls behavior…"

As cognitive neuroscientists who use fMRI should know (but all too often ignore) event related brain potentials (ERPs) *are* a non-invasive, high resolution, way to "look at the human brain in action." In fact, the ERP is a record of the "brain in action" manifested as fluctuating voltage fields generated by neuronal ensembles as they "act." The fMRI, on the other hand, measures blood flow, inferring past brain action from current oxygenation demands. This is not to deny the invaluable contributions by many fMRI studies when conducted with proper sensitivity to the complexity of defining and measuring psychological constructs. The unbridled enthusiasm of our fMRI-wielding colleagues, however, is purchased at the cost of blindness to a massive body of data. Furthermore, many of the pitfalls in the interpretation of fMRI data enumerated by Nicholson may have been avoided if fMRI researchers attended to the conceptual and methodological lessons of ERP research.

Over the past few decades there has developed a huge literature that, using the ERP as its tool, has greatly advanced our knowledge of the way the mind is implemented by the brain. As early as 1965, with Sutton et al's discovery of the P300, Kornhuber and Deecke's discovery of the readiness potential, and Grey Walter's discovery of the CNV, we were provided powerful tools for investigating, inter alia, the brain's executive control system, the motor preparatory processes, and the brain's response to certain deviant and novel events. The discovery of the N400 by Kutas and Hillyard opened an entire area of neuro/psycho linguistic studies of considerable consequence. More recently, studies of error related negativities added much to our understanding of the anterior cingulate and other pre-frontal structures. Studies of P300 and its relation to subjective probability and decision making in my own lab were early examples of the now faddish "neuroeconomics." Of course, one must also consider the recently developed, fast optical neuroimaging, a technique that matches ERP's temporal resolution and fMRI's spatial resolution, at least for the cortical surface. This brief enumeration barely skims the surface of ERP studies of the "brain in action."

It is true that the spatial resolution of ERPs is inferior to that of fMRI, and that until recently it was very difficult to identify the precise intra-cranial locus of the generators of the ERPs. On the other hand, the ERPs temporal resolution is in the millisecond range, allowing a much more precise and detailed identification of the functional significance of the brain activity manifested by the ERP. Furthermore,

source-localization techniques developed some ten years ago and are now readily available and the advent of dense array recordings have provided ERP studies with much improved spatial resolution.

This is not a plea for favoring one approach over others. The elephant is too large and too complex, and we are all blindly groping to understand it.

But, we can not afford to ignore any approach that yields useful insights into the mind/brain puzzle.