

## The Challenges of Cognitive Neuroscience in the 21st Century

**B**asic neuroscience has been the backbone of neuroscience studies and as a result a tremendous amount of knowledge has been learned from research on how human brain works. But there are still challenges to be answered on the neural mechanisms responsible for the higher levels of human neural activities.

The last decade of the 20th century was designated the "Decade of the Brain" by the US congress. But some scientists argued that this was overly optimistic and suggested that we should instead designate the 21st century as the "Century of the Brain" (Bear et al., 2001).

The reason for being overly optimistic about the destiny of the "Decade of the Brain" is that a vast amount of research in basic neuroscience has demonstrated that a lot is already known about the function of the human brain. But what we know today is insignificant compared with what is left to be learned especially if we consider understanding the neural correlates and mechanisms responsible for the higher levels of human mental activity (Bear et al., 2001, p.20).

It is claimed that today we are far from understanding how objects and perceptions are encoded in the brain by the activities of neurons. As a result, the hypothesis that there may be a neuron in our brain that only recognizes our "grandmother" deserves some serious reconsideration (O'Keefe, 2005).

It has also been suggested that perhaps the greatest challenge of neuroscience in the 21st century is to understand the neural mechanisms responsible for the higher levels of human mental activity. Three major areas of higher levels of human mental activity have been proposed (Bear et al., 2001):

- Self-awareness
- Mental imagery
- Language

The major research aim at each level is to see how the activity of the brain creates the mind or higher mental activities.

With respect to neural foundations of language as a higher mental activity, the classical brain-language models derived from studies by great neuroanatomists and neuro-psychologists (Broca, Wernicke, Geschwind and others) have been claimed to be empirically wrong and anatomically underspecified (Poeppel & Hickok, 2004). Consequently, new models have been proposed based on neurobiological basis of words and sentences in terms of forming specific neural networks in the brain (Pulvermüller, 2004).

Also some new serious questions have been raised in cognitive neuroscience about the origin and nature of human language:

- Do animals naturally use language?
- Can animals be taught human language?

Some neuro-scientists have argued that it is clear that most animals certainly use language but if we generalize the definition of language, we miss a very major point. Human language is a remarkably complex, flexible, and powerful system of communication that involves the creative use of words according to the rules of a systematic grammar. Non-human primates at their best have a very limited system of communication used in the stereotypical situations. While human language is a much more complex and creative system limited only by the rules of grammar which are effectively finite (Ellerman, 2005).

Focusing on cerebral cortex, neurobiology and brain imaging studies indicate that the cortex probably does not possess innate representations, i.e. regions of neo-cortex do not appear to be intrinsically predestined to support particular classes of representations such as faces and language (Ibid, p.20). Rather, the fairly consistent structure-function relations observed in the cortex of a normal human adult appear to be the consequence of multiple constraints both intrinsic and extrinsic to the organism.

In fact, new methods in neuroscience have provided an exciting opportunity to elucidate major commonalities about the nature of species differences that make us uniquely human, for example:

# Challenges For Neuroscience In The 21st Century

**Brendan G. Carr**



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