

CHAPTER 1

Introducing Cognitive Neuroscience



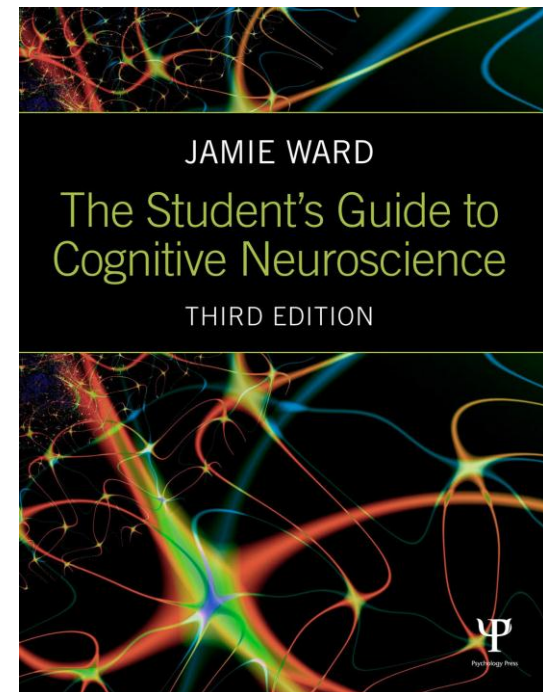
Mohammad Hossein Sorayani

PhD Student in Cognitive Neuroscience, ICSS

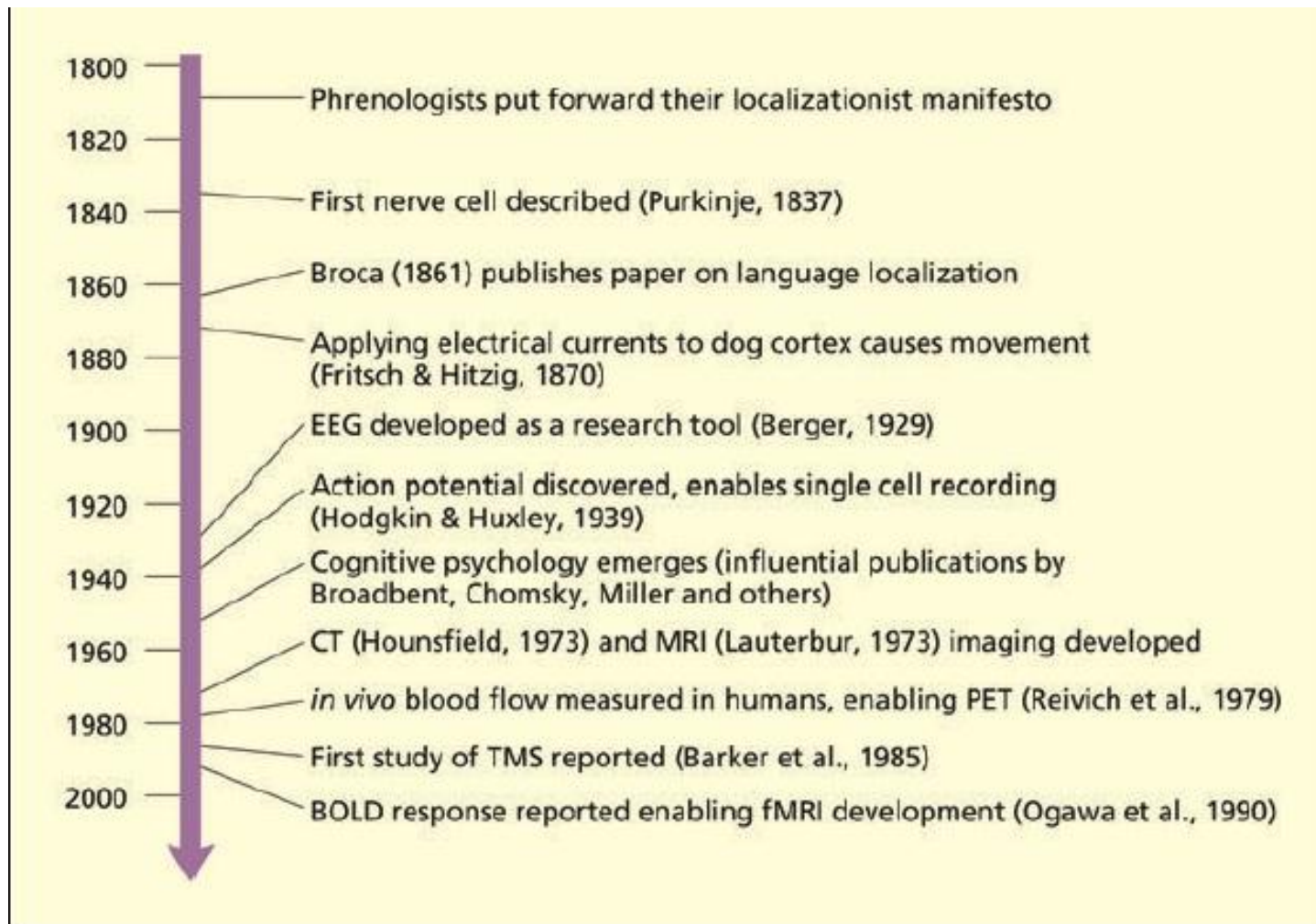
m.hoseinsorayani@gmail.com

CONTENTS

- ▶ Cognitive neuroscience in historical perspective
- ▶ Does cognitive psychology need the brain?
- ▶ Does neuroscience need cognitive psychology?




A timeline for the development of methods and findings relevant to cognitive neuroscience, from phrenology to present day.



COGNITIVE NEUROSCIENCE IN HISTORICAL PERSPECTIVE:

Philosophical approaches to mind and brain

- ▶ **mind–body problem** : The problem of how a physical substance (the brain) can give rise to our sensations, thoughts and emotions (our mind).
 - ▶ **Dualism** : The belief that mind and brain are made up of different kinds of substance.
 - ▶ **Dual–aspect theory** : The belief that mind and brain are two levels of description of the same thing.
 - ▶ **Reductionism** : The belief that mindbased concepts will eventually be replaced by neuroscientific concepts.
- 



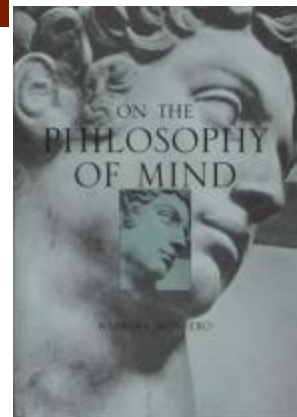
Dualism

Mind and body are distinct and non-identical entities.



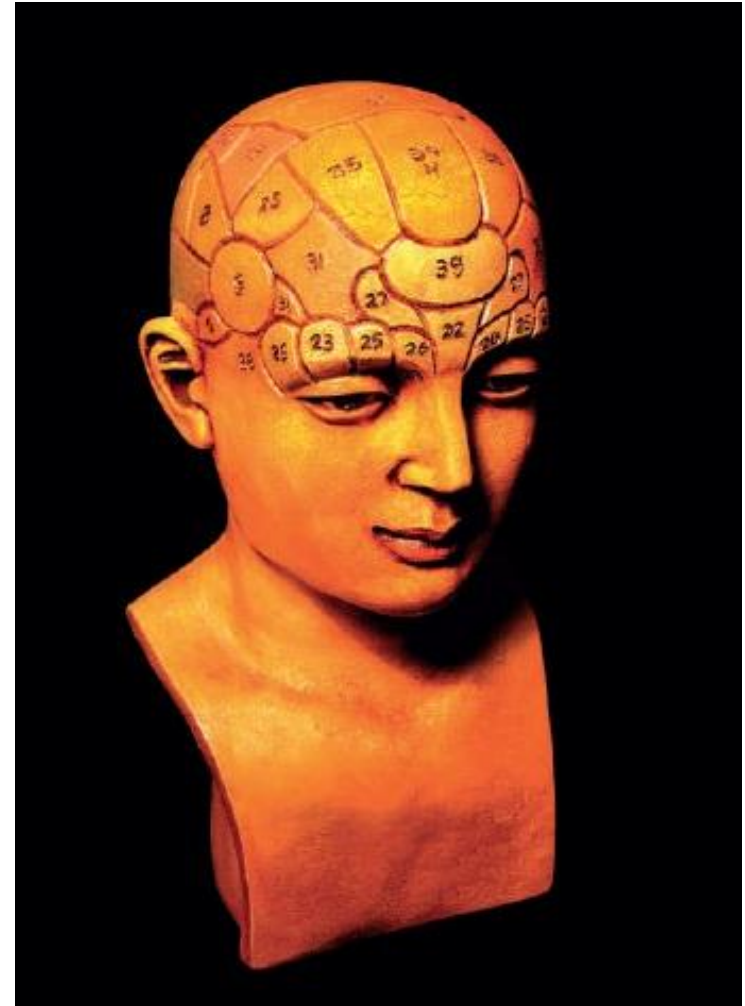
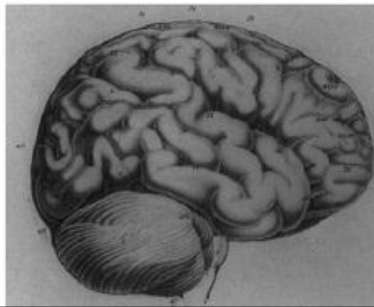
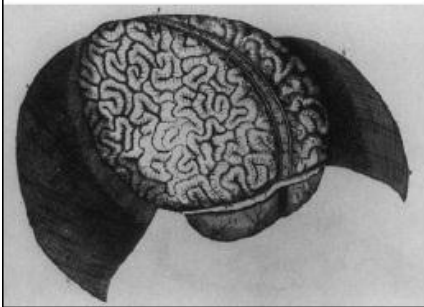
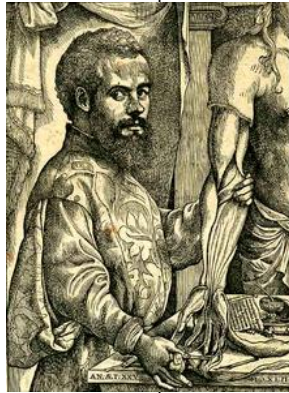
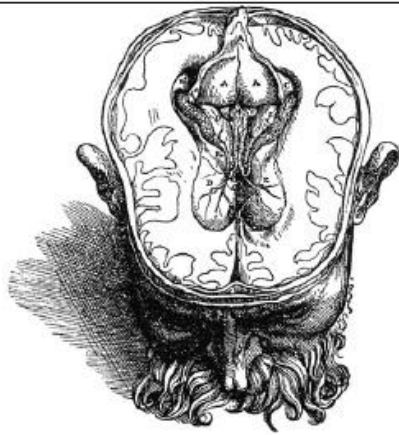
Monism

Mind and body are manifestations of a single substance.

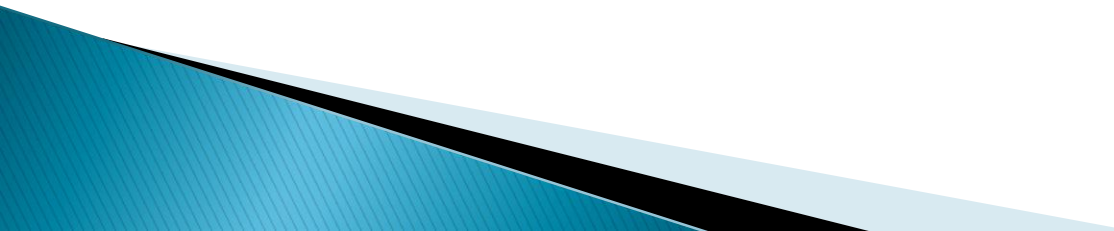


Scientific approaches to mind and brain

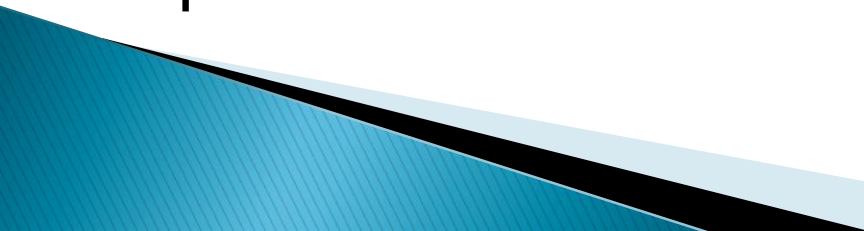
Phrenology : The failed idea that individual differences in cognition can be mapped on to differences in skull shape.

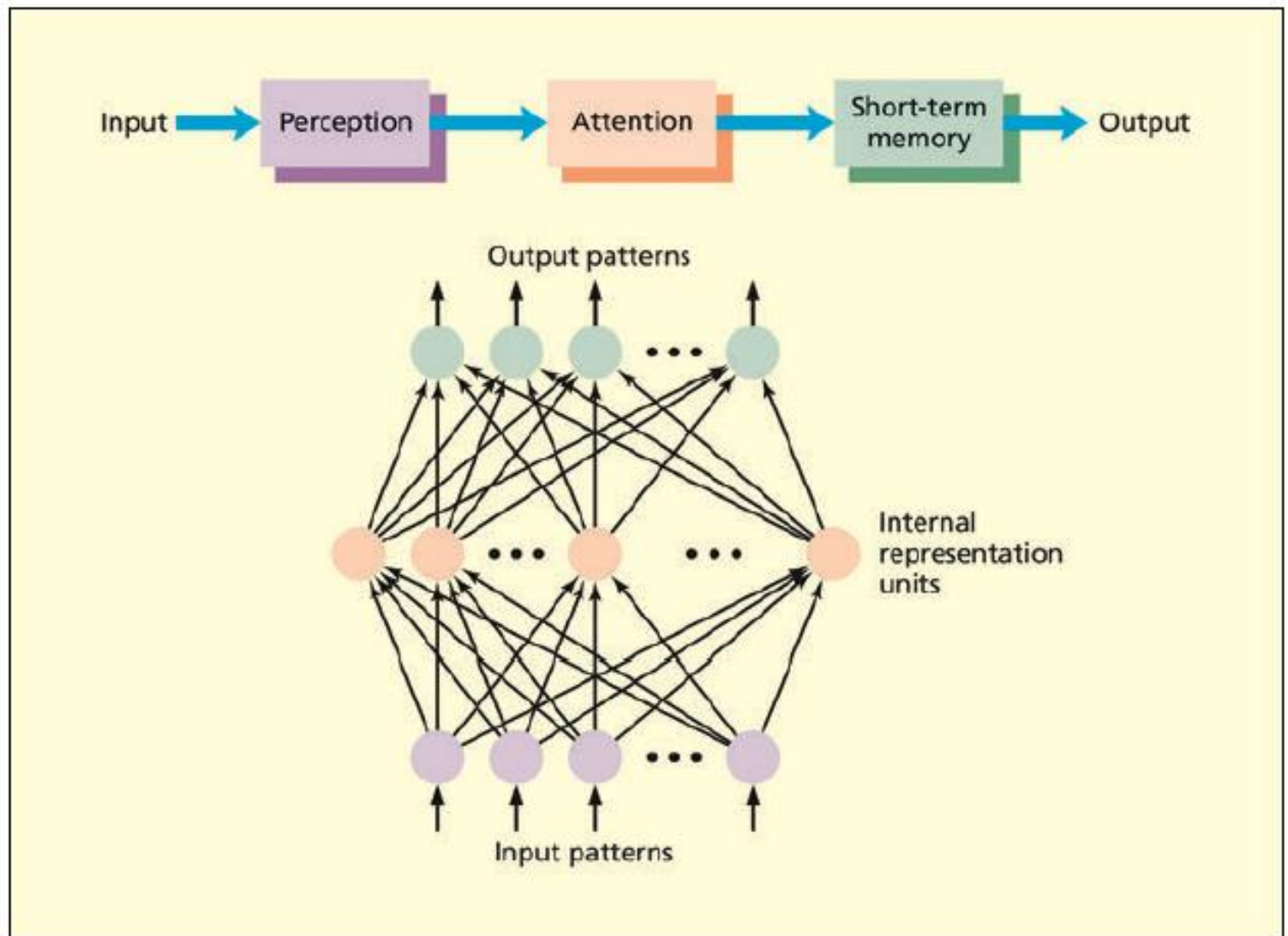


Scientific approaches to mind and brain

- ▶ **Functional specialization** : Different regions of the brain are specialized for different functions.
 - ▶ **Cognitive neuropsychology** : The study of brain-damaged patients to inform theories of normal cognition.
 - ▶ **Information processing**: An approach in which behavior is described in terms of a sequence of cognitive stages.
- 

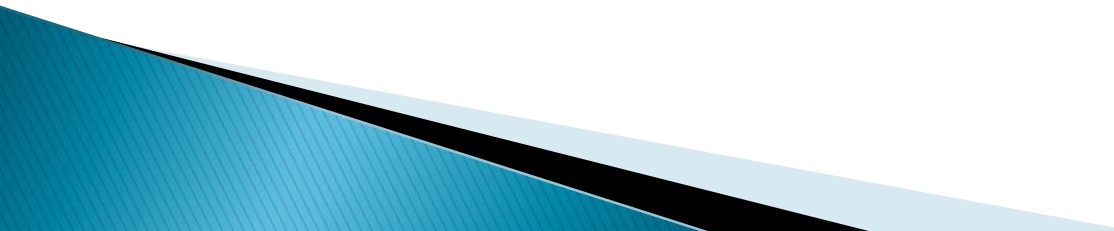
Scientific approaches to mind and brain

- ▶ **Interactivity**: Later stages of processing can begin before earlier stages are complete.
 - ▶ **Top-down processing**: The influence of later stages on the processing of earlier ones (e.g. memory influences on perception).
 - ▶ **Parallel processing**: Different information is processed at the same time (i.e. in parallel).
 - ▶ **Neural network models**: Computational models in which information processing occurs using many interconnected nodes.
 - ▶ **Nodes**: The basic units of neural network models that are activated in response to activity in other parts of the network.
- 



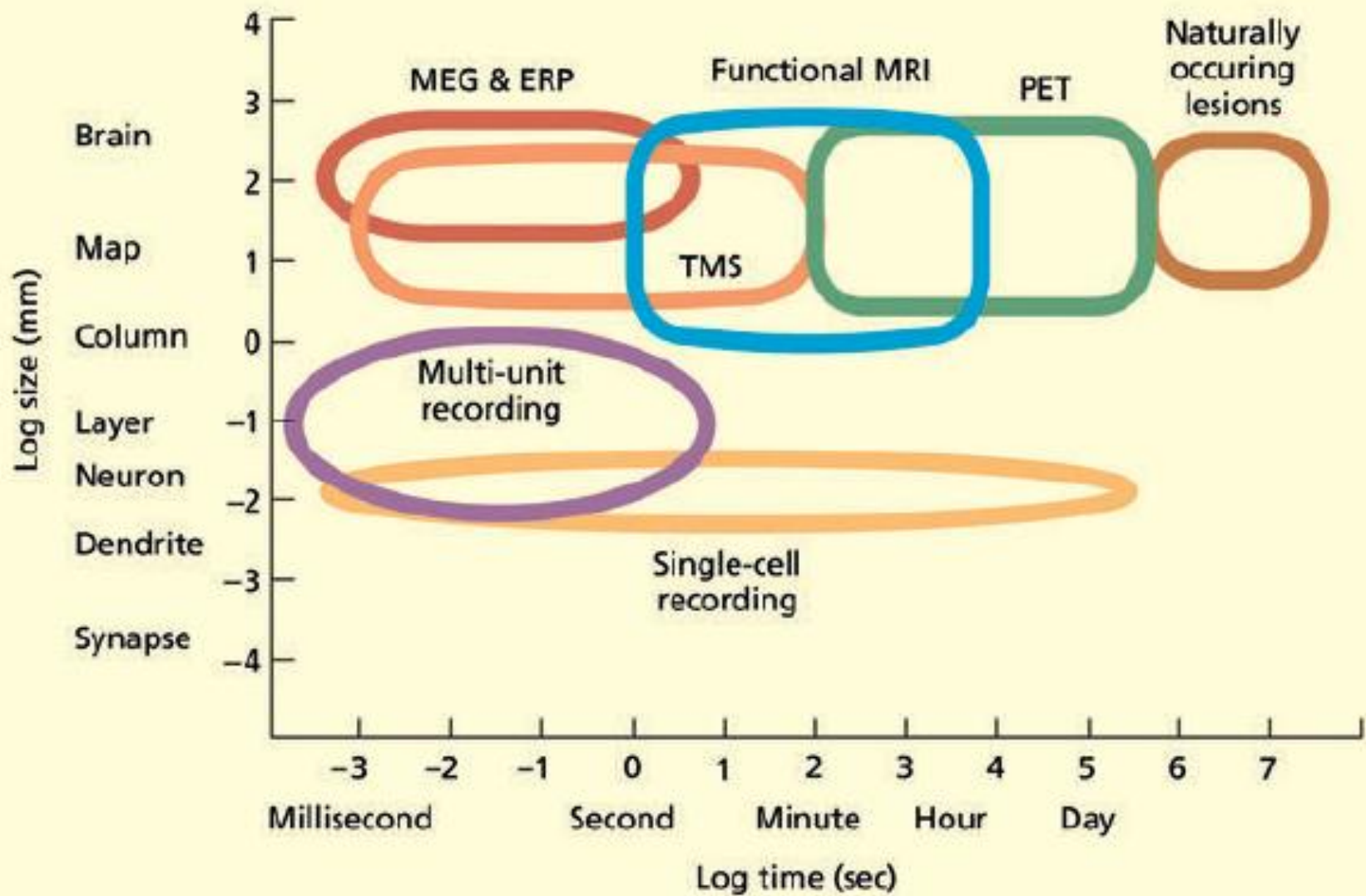
Examples of box-and-arrow and connectionist models of cognition. Both represent ways of describing cognitive processes that need not make direct reference to the brain.

The birth of cognitive neuroscience

- ▶ It was largely advances in imaging technology that provided the driving force for modern-day cognitive neuroscience.
 - ▶ **Temporal resolution**: The accuracy with which one can measure when an event (e.g. a physiological change) occurs.
 - ▶ **Spatial resolution** :The accuracy with which one can measure where an event (e.g. a physiological change) is occurring.
- 

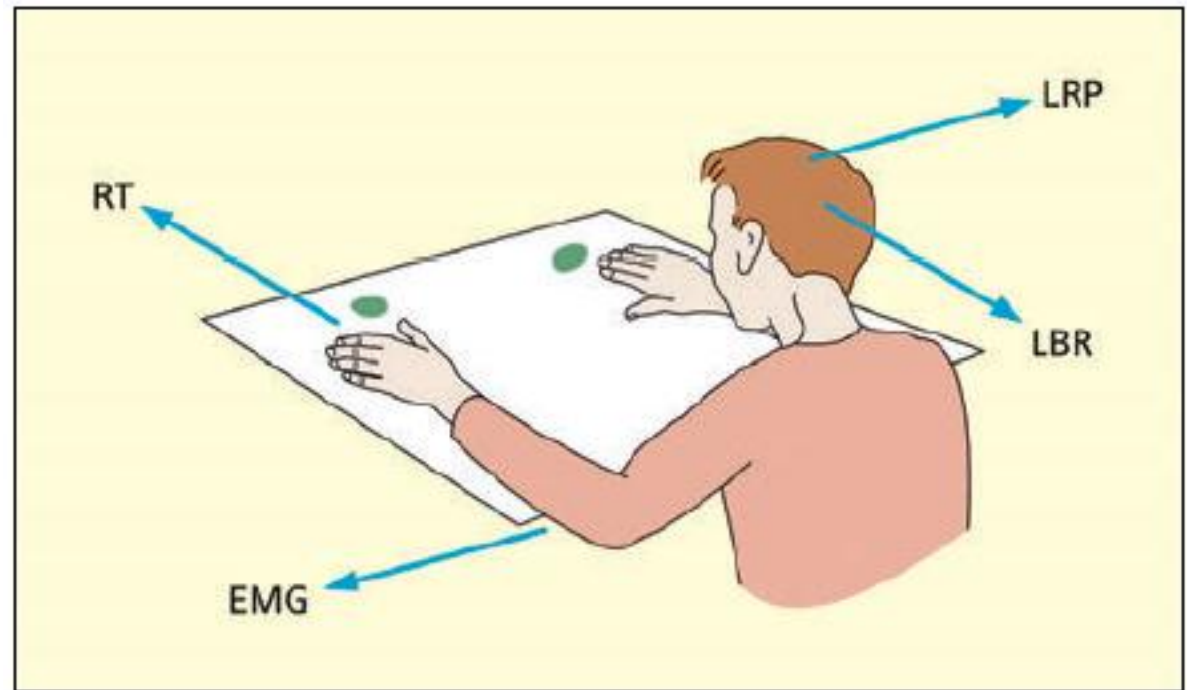
THE DIFFERENT METHODS USED IN COGNITIVE NEUROSCIENCE

Method	Method type	Invasiveness	Brain property used
EEG/ERP	Recording	Non-invasive	Electrical
Single-cell (and multi-unit) recordings	Recording	Invasive	Electrical
TMS	Stimulation	Non-invasive	Electromagnetic
tDCS	Stimulation	Non-invasive	Electrical
MEG	Recording	Non-invasive	Magnetic
PET	Recording	Invasive	Hemodynamic
fMRI	Recording	Non-invasive	Hemodynamic



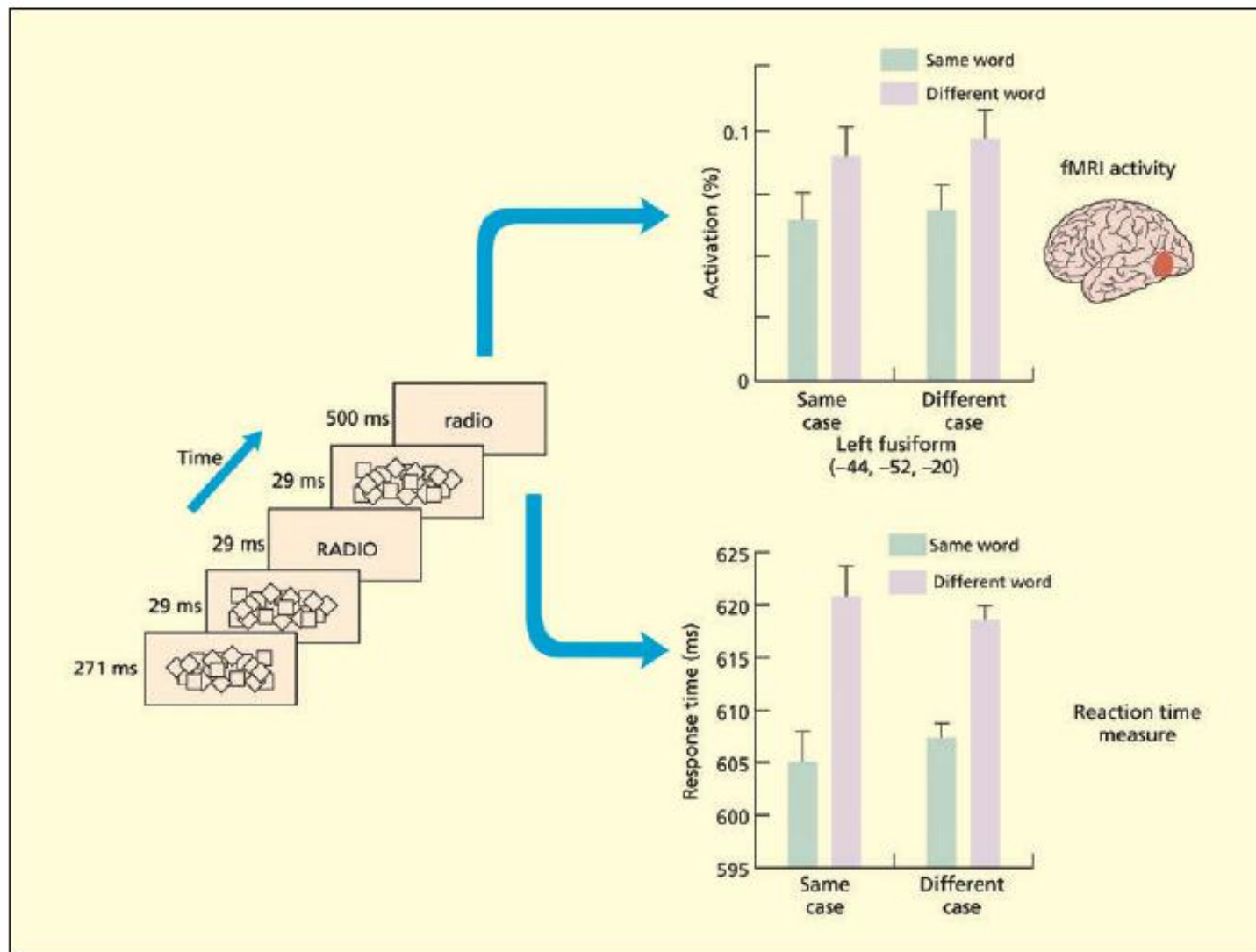
Does cognitive psychology need the brain?

▶ “E” or “e” ?



One could take many different measures in a forced-choice response task: behavioral (reaction time [RT], errors) or biological (electromyographic [EMG], lateralized readiness potential [LRP], lateralized BOLD response [LBR]). All measures could potentially be used to inform cognitive theory.

Adapted from Henson, 2005. By kind permission of the Experimental Psychology Society.



Both reaction times and fMRI activation in the left fusiform region demonstrate more efficient processing of words if they are preceded by subliminal presentation of the same word, irrespective of case.

Adapted from Dehaene *et al.*, 2001.

Does neuroscience need cognitive psychology?

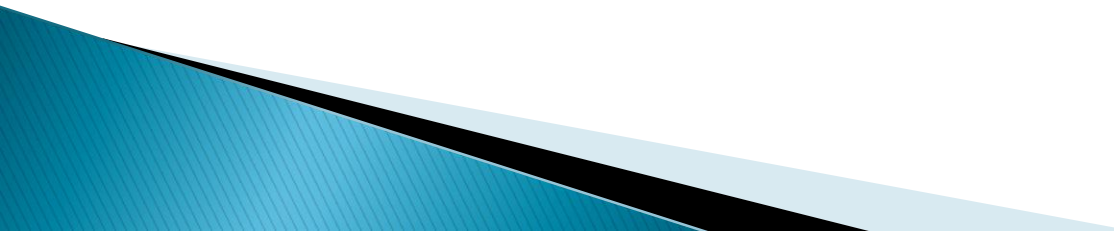
SOFTWARE VS. HARDWARE

The question of whether cognitive, mind-based concepts will eventually become redundant (under a reductionist account) or coexist with neural-based accounts (e.g. as in dual-aspect theory) is for the future to decide.

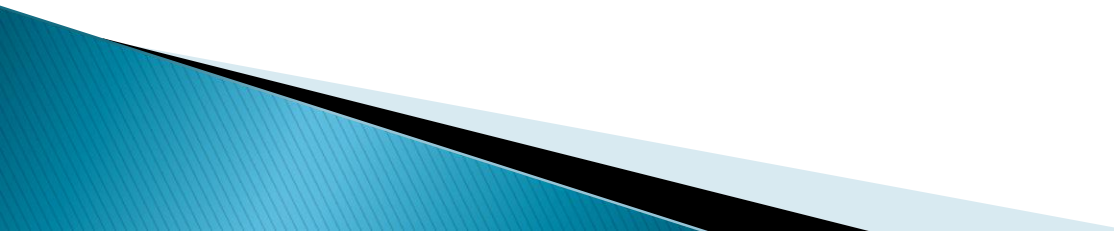
But for now, cognitive, mind-based concepts have an essential role to play in cognitive neuroscience.



IS THE BRAIN MODULAR?

- ▶ **Modularity** : The notion that certain cognitive processes (or regions of the brain) are restricted in the type of information they process.
 - ▶ **Domain specificity** : The idea that a cognitive process (or brain region) is dedicated solely to one particular type of information (e.g. colors , faces, words).
- 

SUMMARY AND KEY POINTS OF THE CHAPTER

- ▶ • The mind–body problem refers to the question of how physical matter (the brain) can produce mental experiences, and this remains an enduring issue in cognitive neuroscience.
 - ▶ • To some extent, the different regions of the brain are specialized for different functions.
 - ▶ • Functional neuroimaging has provided the driving force for much of the development of cognitive neuroscience, but there is a danger in merely using these methods to localize cognitive functions without understanding how they work.
 - ▶ • Cognitive psychology has developed as a discipline without making explicit references to the brain. However, biological measures can provide an alternative source of evidence to inform cognitive theory and the brain must provide constraining factors on the nature and development of the information–processing models of cognitive science.
- 

RECOMMENDED FURTHER READING

- ▶ • Henson, R. (2005). What can functional neuroimaging tell the experimental psychologist? *Quarterly Journal of Experimental Psychology*, 58A, 193–233. An excellent summary of the role of functional imaging in psychology and a rebuttal of common criticisms. This debate can also be followed in a series of articles in *Cortex* (2006, 42, 387–427).
- ▶ • Shallice, T. & Cooper, R. P. (2011). *The organisation of mind*. Oxford, UK: Oxford University Press. The chapters on “conceptual foundations” deal with many of the issues touched on in the present chapter in more detail.
- ▶ • Uttal, W. R. (2001). *The new phrenology: The limits of localizing cognitive processes in the brain*. Cambridge, MA: MIT Press. An interesting overview of the methods and limitations of cognitive neuroscience.
- ▶ • Wickens, A. P. (2015). *A history of the brain: How we have come to understand the most complex object in the universe*. New York: Psychology Press. A good place to start for the history of neuroscience.



کستیم منبر
کستیم منبر
حسین منبر
؟