بسم الله الرحمن الرحیم

# علوم شناختی

## جلسه ۸ (الف)

# گسترش مدل‌سازی محاسباتی به مغز

# Extending Computational Modeling to the Brain

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# PART 1:
# HISTORICL LANDMARKS

# Chapter 3:
## The Turn to the Brain

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# Chapter 3.3: Extending computational modeling to the brain

# Connectionist information-processing

Basic principles

- Parallel rather than serial processing as activation spreads through a network
- Knowledge distributed across a network (rather than stored in discrete symbol structures)
- Processing does not reply on explicit rules (other than those governing how activation flows through the network)

# Features of connectionist networks

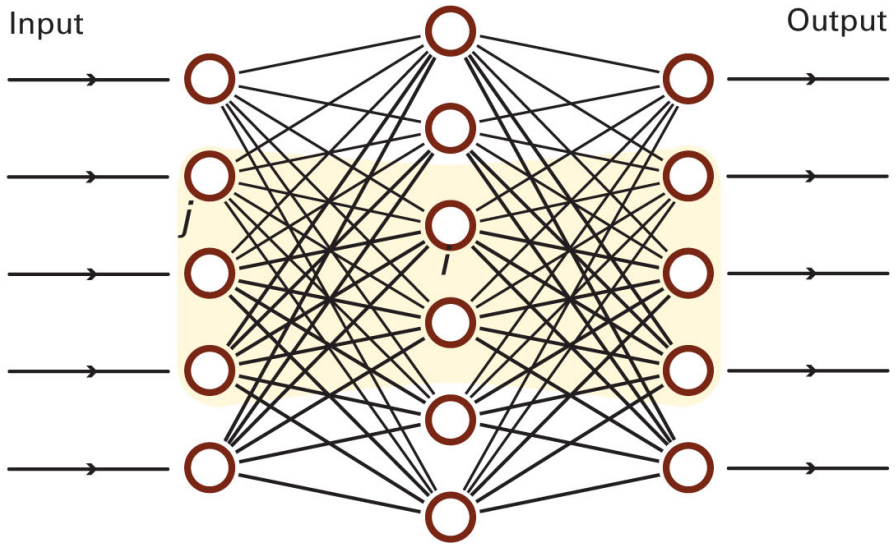
- Exploit parallel processing
- Exhibit graceful degradation
- Intended as models of information-processing at the algorithmic level
- Capable of learning

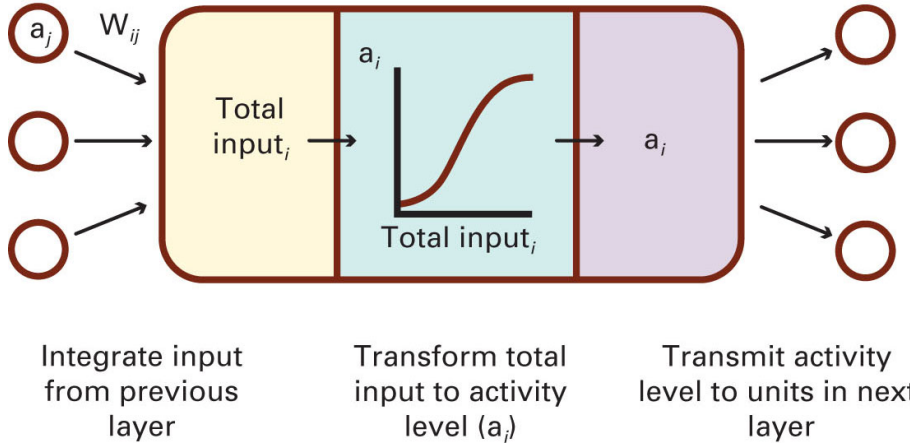
# Parallel processing

The basic principle of connectionist networks is that many different units are active at a given time

- If we think of each unit as performing an information-processing step, this vastly increases the number of steps that can be performed in a short time-span.
- The information processing steps in a network don't map straightforwardly onto the stages of a symbolic computation.

# Flow of activation



# Backpropagation

- Information is transmitted forwards through the network
- Error is propagated backwards through the network
- The backpropagated error signal is used to adjust the weights to/from the hidden units

# Backprop

- The algorithm needs to find a way of calculating error in hidden units that do not have target activation levels
- It does this by calculating for each hidden unit its degree of “responsibility” for error at the output units
- This error value is used to adjust the weights of the hidden units

# Serial processing

- Processing in physical symbol systems is step-by-step
  - Turing Machine can only read one cell at a time
  - each line of machine table only applies one instruction

- Can the brain actually work this slowly?
  - Distinction between computability in principle and practical computability
  - Practical computability imposes real-time constraints

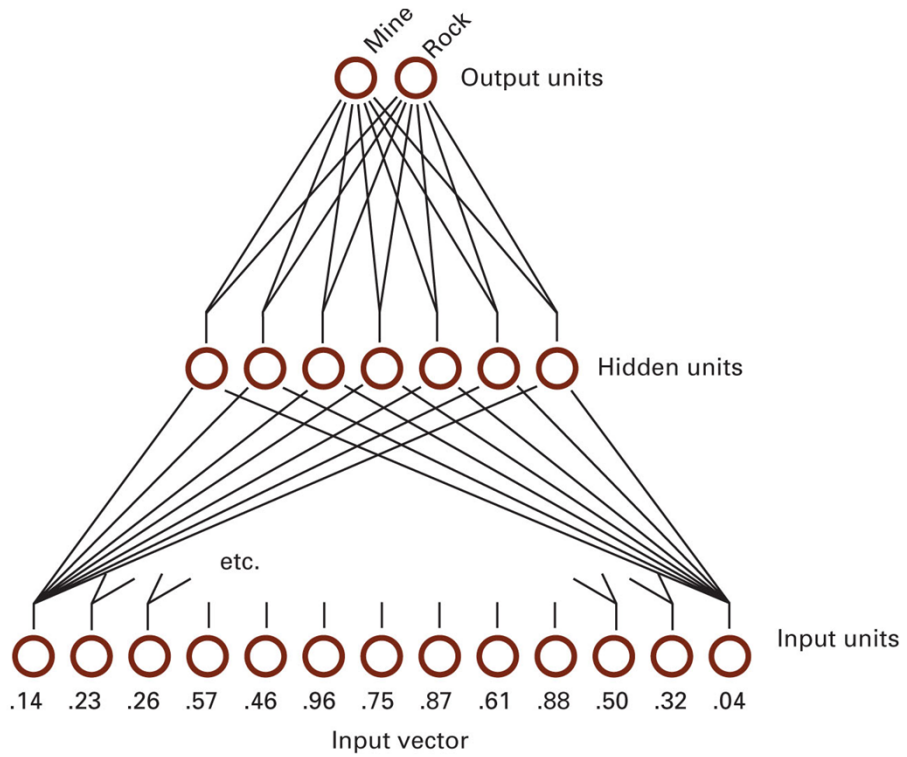
# Graceful degradation

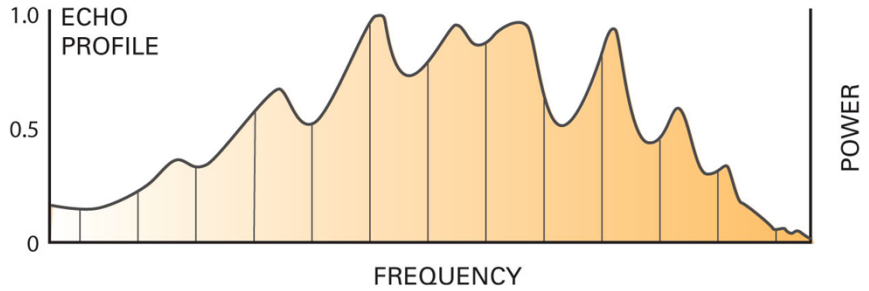
- Brains respond in distinctive and flexible ways to damage and impairment
  - characteristic partial breakdown patterns in response to local damage/lesions
  - graceful degradation when cognitive abilities slowly deteriorate
- Symbolic computer programs either work or they don't $\Rightarrow$ brittle

# Gorman & Sejnowski 1988

- Pattern recognition
  - Distinguish between the sonar echo produced by a rock and the sonar echo produced by a mine

- Pattern recognition



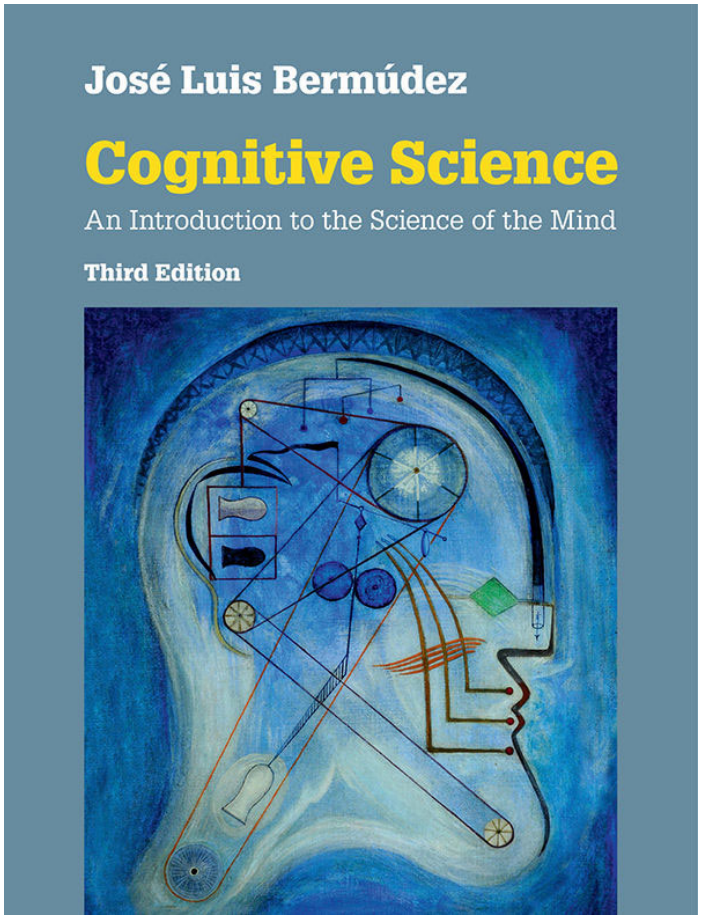



# Level of analysis

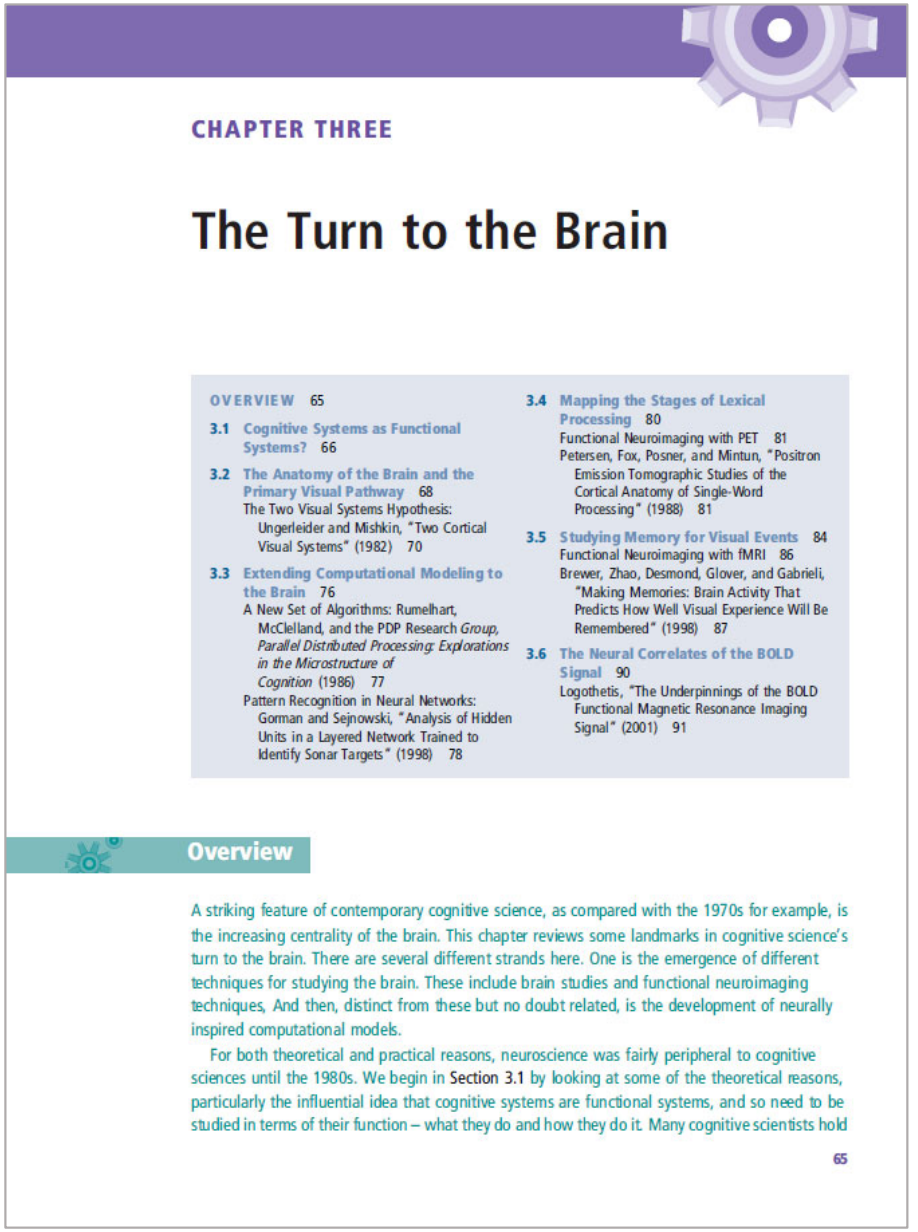
- Connectionist networks are models of information-processing at the algorithmic level

- Means that connectionists still have to answer questions of how networks are implemented in the brain

# منبع اصلی




José Luis Bermúdez,
**Cognitive Science:**
**An Introduction to the Science of the Mind,**
3rd ed., Cambridge University Press, 2020.
**Chapter 3 (Section 3.3)**



CHAPTER THREE

## The Turn to the Brain



### Overview

A striking feature of contemporary cognitive science, as compared with the 1970s for example, is the increasing centrality of the brain. This chapter reviews some landmarks in cognitive science's turn to the brain. There are several different strands here. One is the emergence of different techniques for studying the brain. These include brain studies and functional neuroimaging techniques, And then, distinct from these but no doubt related, is the development of neurally inspired computational models.

For both theoretical and practical reasons, neuroscience was fairly peripheral to cognitive sciences until the 1980s. We begin in Section 3.1 by looking at some of the theoretical reasons, particularly the influential idea that cognitive systems are functional systems, and so need to be studied in terms of their function – what they do and how they do it. Many cognitive scientists hold

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