

# The disunity of cognitive science?

16 July 2007

PNP-CPCS workshop

Tsinghua University

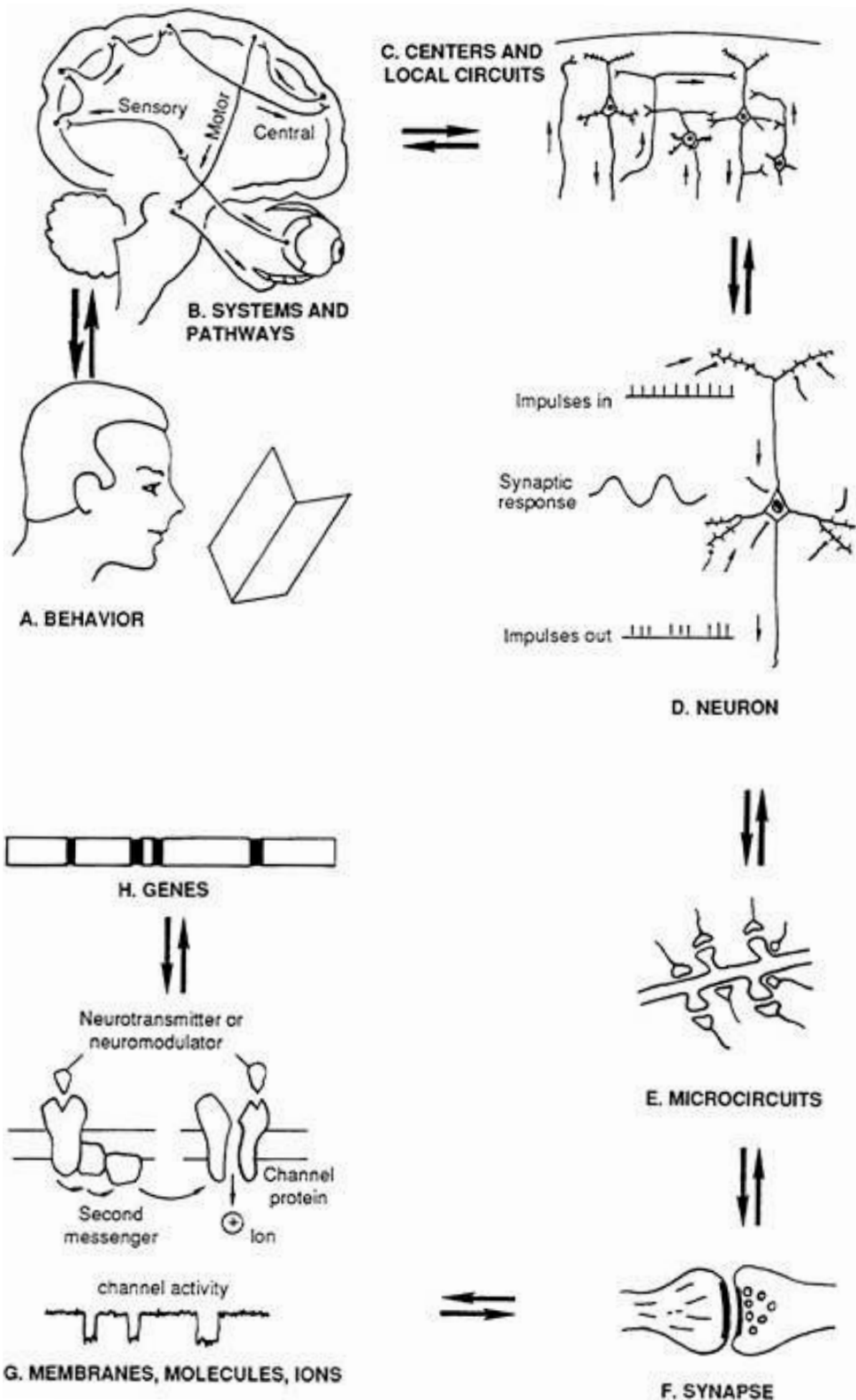
Beijing

# Overview

- Cognitive science is a multi-level discipline
  - Levels of cognitive/biological complexity
  - Levels of explanation
- It is standardly assumed that these levels form an integrated hierarchy
- Consider two standard models of integration
- Point out why neither is satisfactory
- Discuss implications for cognitive science

# Hierarchies in cognitive science

- Hierarchy of levels of complexity in cognitive organization  
E.g. the neural hierarchy
- Hierarchy of levels of explanation
- Hierarchy of technologies and methodologies



## Levels of explanation

- A Cognitive psychology
- B Cognitive neuroscience  
Behavioral neuroscience
- C Systems neuroscience
- D Cellular neuroscience
- E-H Molecular neuroscience

# Studying neural pathways

## Functional neuro-imaging

- paired subtraction paradigm
- lexical access studies
- Petersen et al. 1988

## Lesion studies

- crossed lesion disconnection studies
- two visual systems hypothesis
- Mishkin and Ungerleider 1982

## Neurological studies

- double dissociation

# Two types of explanation

## Horizontal explanation

= explanation of a particular event or state in terms of distinct (and usually temporally antecedent) event or state

## Vertical explanation

= explanation of the mechanisms that make horizontal explanations possible

# Relation between horizontal and vertical explanation

- Horizontal explanations frequently involve lawlike generalizations
  - E.g. generalizations about action potentials occurring because incoming signals to a neuron depolarize the axon hillock beyond a threshold value
- Vertical explanations explain why those lawlike generalizations hold
  - E.g. explanations of the channels that allow ions to be transported across the cell membrane

# The unity of cognitive science?

Requirements on unity:

- A A privileged level of explanation
- B Vertical explanatory relations between different levels
- C An understanding of how cognitive explanations “bottom out” in non-cognitive explanations

# Two “standard” models of unity

## The cognitive scientist’s answer

Appeal to Marr’s three levels of explanation

## The philosopher’s answer

Take “folk psychology” as the privileged level of explanation and propose an account of the interface between folk psychology and the sciences of the mind

E.g. Fodor’s version of the representational theory of mind

# Marr on levels of explanation

## *Computational level*

Translating a general description of a cognitive phenomenon into a specific information-processing problem

## *Algorithmic level*

Specifying a detailed set of information-processing instructions [algorithm] able to solve the specific problem

## *Implementational level*

Finding physical structures that can properly be described as computing the algorithm

# A Marrian model of unity

- The computational level is the privileged level of explanation
- The tri-level hypothesis gives two top-down relations between levels
  - Algorithm at level  $n+1$  computing information-processing problem at level  $n$
  - Implementation at level  $m+1$  of algorithm running at level  $m$

# Problems for the Marr approach 1

It cannot work as a general model of cognition. Marr's model is only applicable to *modular* systems

- It requires an information-processing task sufficiently circumscribed to be solvable algorithmically
  - ⇒ domain-specificity
- Algorithms must be computationally tractable – there can only be a limited number of representational primitives and parameters (on pain of *frame problem*)
  - ⇒ informational encapsulation

# Problems for the Marr approach 2

The idea of a single implementational level is hopelessly crude

There are many different implementational levels  $\Rightarrow$  we have no account of how these levels fit together

The Marr approach cannot be iterated without losing the idea of a privileged level of explanation

# A different model: Fodor

One can say in a phrase what it is that computational psychology has been proving so successful at: viz. the vindication of generalisations about propositional attitudes, specifically, of the more or less commonsense sorts of generalizations about propositional attitudes. Thus, for example, we have got fragments of a theory of perception, and it makes clear how a computational system could regularly come to believe that P in causal consequence of its being visibly the case that P. . . what a computational theory does is to make clear the mechanism of intentional causation; to show how it is (nomologically) possible that purely computational – indeed, purely physical – systems should act out of their beliefs and desires. (Fodor 1986, p.422)

# Folk psychology: A privileged level of explanation?

Folk psychology = the implicit theory that we (allegedly) use to navigate the social world

- allows us to predict how people will behave in given situations, given what we know of their preferences and the information they have at their disposal
- allows us to work backwards from people's behavior to their psychological profile

# Folk psychology: A privileged level of explanation?

Distinctive vocabulary:

- appeals to class of cognitive state that do not appear at lower levels in the hierarchy
  - intentional states with content

Distinctive generalizations:

- picks out behavioral regularities that cannot be picked out using non-psychological vocabulary
  - Pylyshyn's example of calling for help

# The interface problem

Perhaps the most fundamental problem for philosophy of mind and philosophy of psychology:

How do folk psychological explanations of human behavior interface with the explanations of cognition and mental operations at other levels in the hierarchy of explanation?

# How important is the interface problem?

The importance of the interface problem depends upon the significance of folk psychology in how we navigate the external world

There are reasons to think that the ubiquity of folk psychology may be something of a philosopher's myth (Bermúdez 2002, 2005)

# Social coordination/understanding without folk psychology 1

Much social understanding and social coordination does not involve any form of explanation or prediction at all

E.g. collective behaviors with shared goals, where coordination is often achieved through sensitivity to the moods and emotional states of others

In non-collective interactions there is evidence from developmental psychology that goal-directed actions can be directly perceived on the basis of behavioral cues

# Social coordination/understanding without folk psychology 2

Many social situations are navigated on the basis of heuristic strategies that look backwards to the results of previous interactions - rather than to their psychological origins

E.g. applying the TIT-FOR-TAT rule in repeated interactions in prisoner's dilemma-type situations

- TIT-FOR-TAT says: Start by cooperating, and then on each round do what the other player did on the last round
- simply requires knowing what the options are, and remembering what happened on the last play

# Social coordination/understanding without folk psychology 3

Even when social interactions do involve explanation and/or prediction, this need not exploit the concepts or generalizations of commonsense psychology

Many social interactions follow scripts (“frames” in AI) that allow predictions to be made on the basis of individual roles and behavioral cues

E.g. the restaurant script

# Thinking without Words



- Thematic continuities with one way of thinking about the cognitive abilities of infants and non-linguistic animals
- Argument that thinking about thoughts (and hence folk psychology) requires language
- Suggestions for forms of social cognition common to linguistic and non-linguistic creatures that do not involve thinking about thoughts.

# A happy ending?

Not that I am aware of. . .

- Many cognitive scientists and neuroscientists talk about multilevel explanation and the need for cross-level integration
- But there is a shortage of worked out models in this area
- Perhaps we need to take seriously the radical possibility of *the disunity of cognitive science*. . .

# What might disunity look like?

No privileged level of explanation

No systematic, explanatory relations between levels of explanation

(as opposed to piecemeal convergences between different “grains of analysis” and different methodological tools)