Embodiment (1)

SS16 - (Embodied) Language Comprehension

Ross Macdonald
13.05.16

Overview

- **This week**

- Traditional cognition

- Cognition for action
    - Theoretical basis
    - Supporting evidence
    - Problems with this concept

- Body-based cognition
    - Symbol grounding problem
    - Perceptual symbol systems

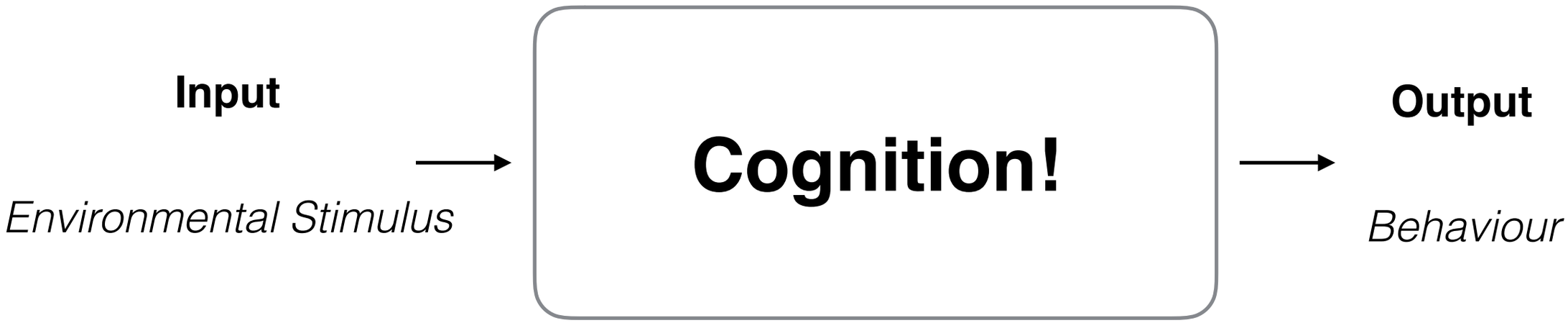
How does one process language?

Behaviouralists said…

How does one process language?

Cognitive accounts

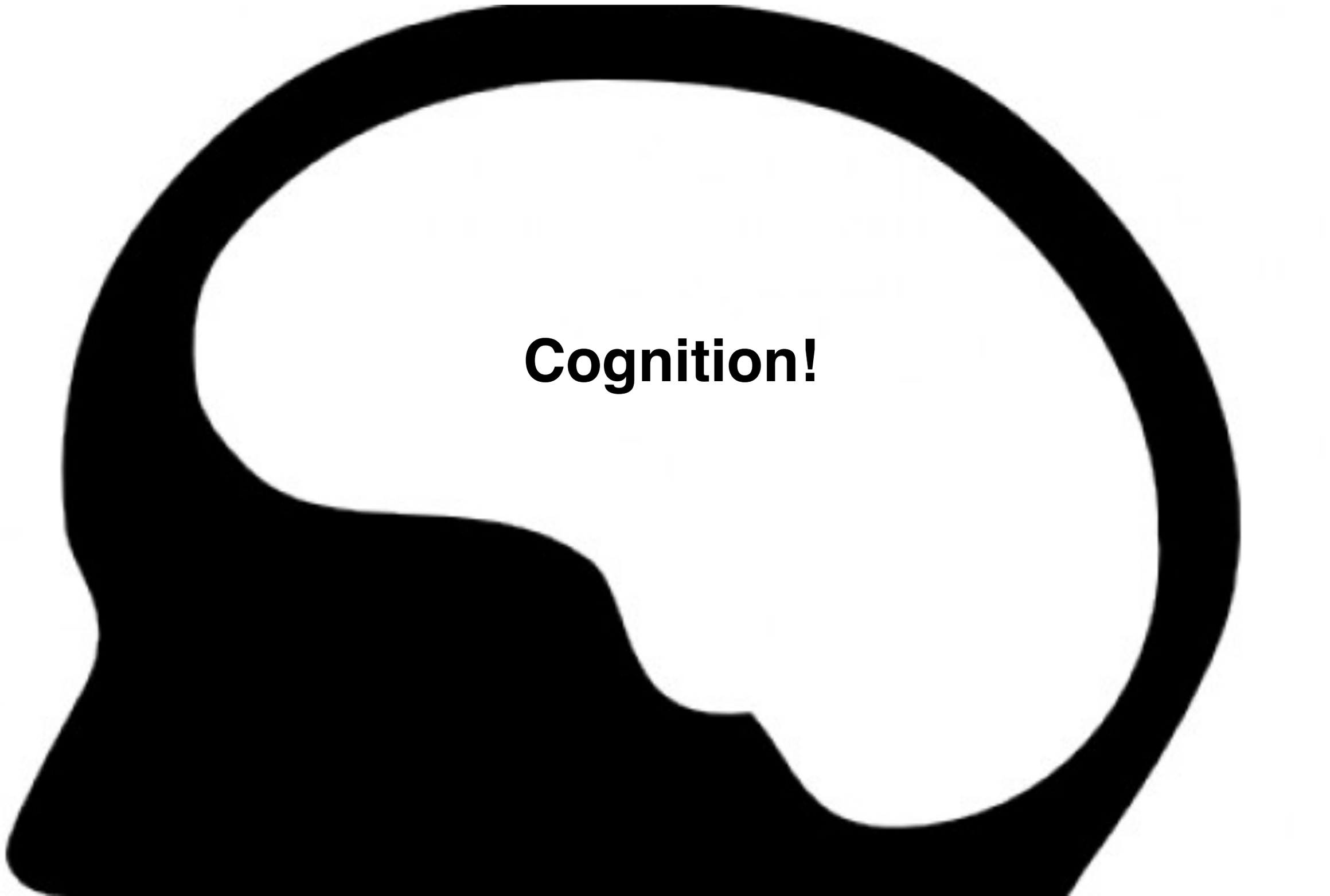
In Cognitive Science/Psychology



These involve internal processes/computations

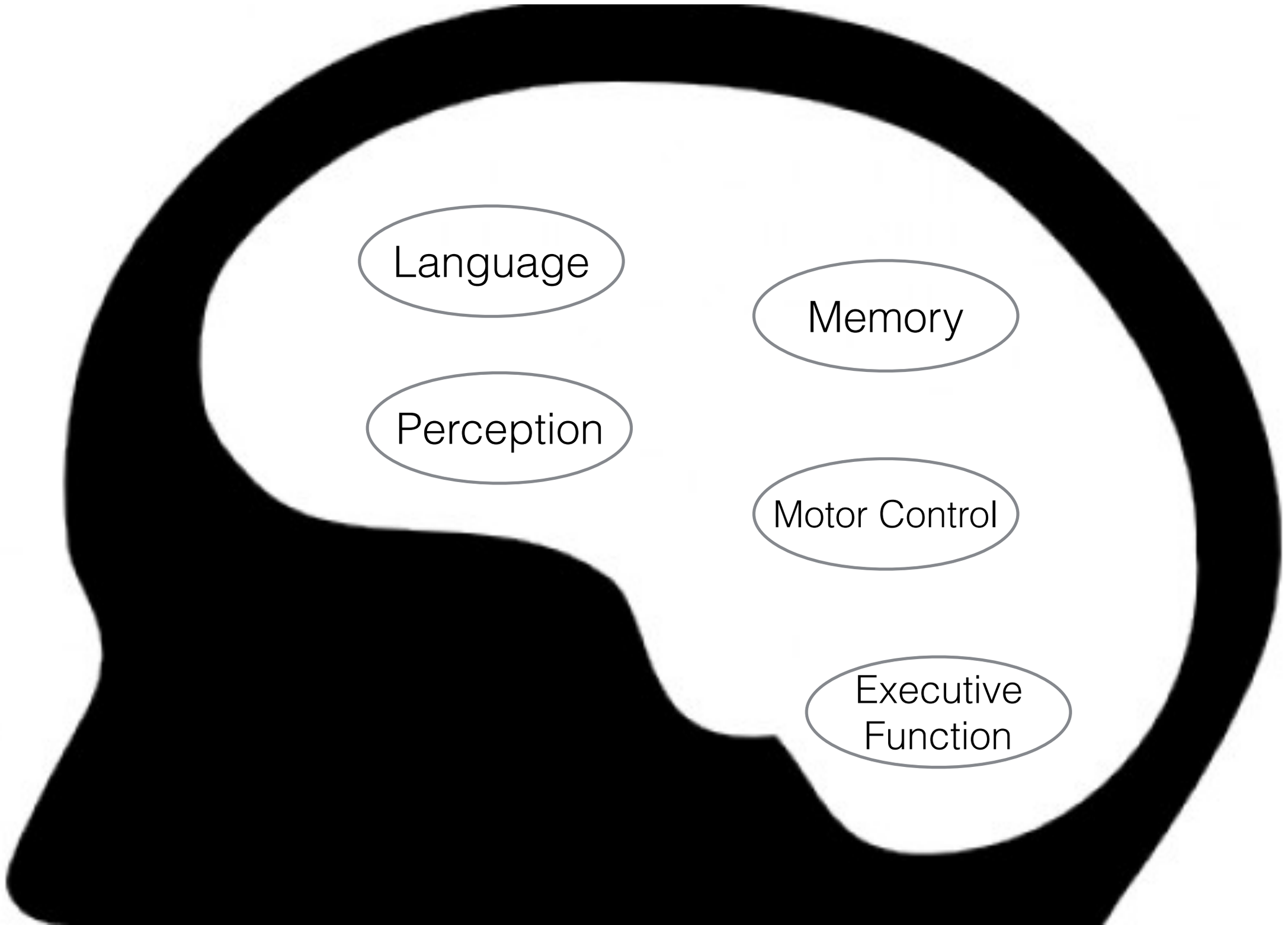
How does one process language?

Amodal, traditional Cognitive accounts



How does one process language?

Amodal, traditional Cognitive accounts (Fodor, 1983)



How does one process language?

Amodal, traditional Cognitive accounts (Fodor, 1983)

Language

- **Innate**
- Automatic
- Localised
- Encapsulated

How does one process language?

Universal Grammar (Chomsky, 1965)

Commonalities across language

Universal development across cultures

How does one process language?

Amodal, traditional Cognitive accounts (Fodor, 1983)

- Innate
- **Automatic**
- Localised
- Encapsulated

How does one process language?

Look at this, without reading it:

Romantic Badger

How does one process language?

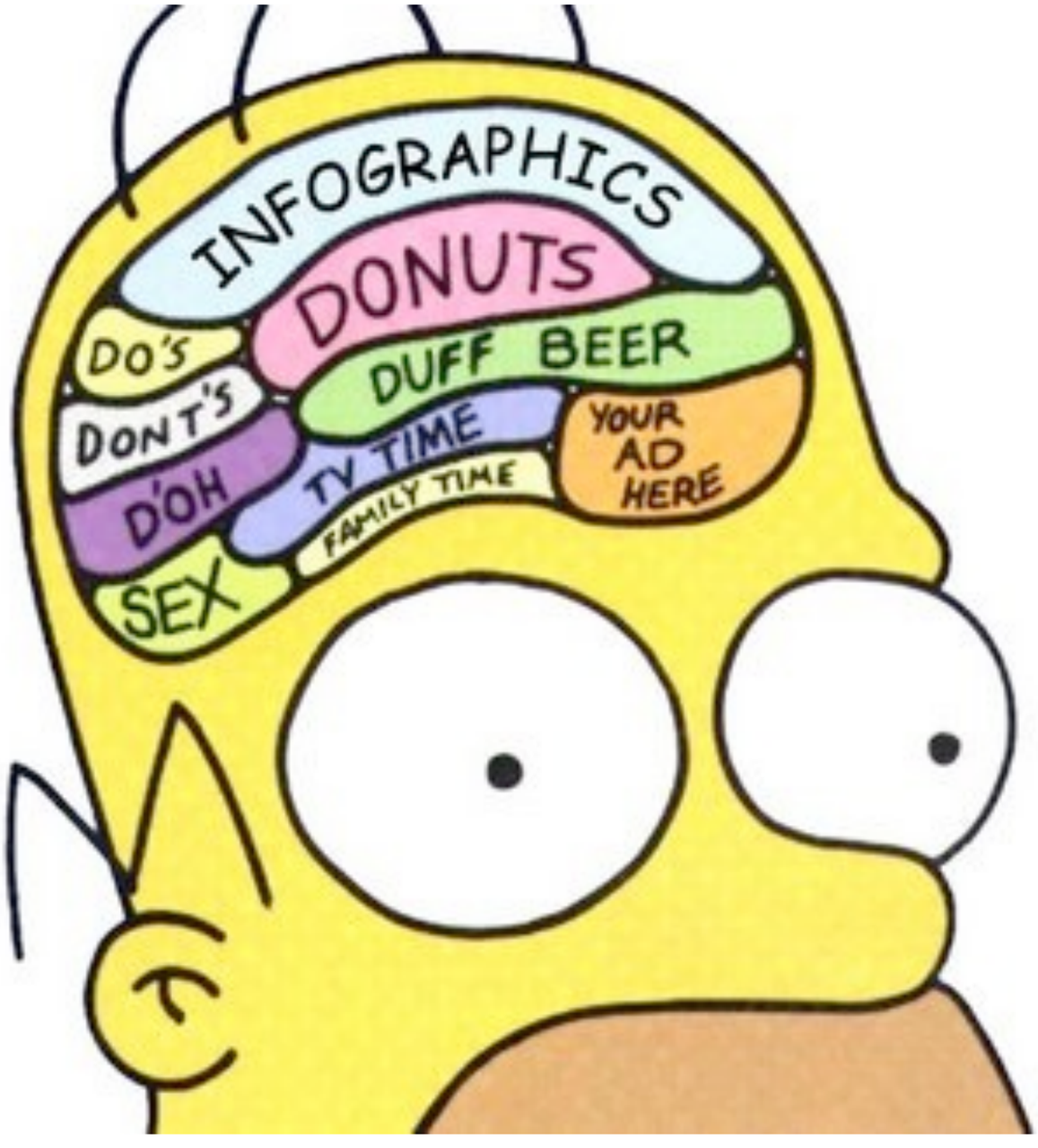
How does one process language?

Amodal, traditional Cognitive accounts (Fodor, 1983)

Language

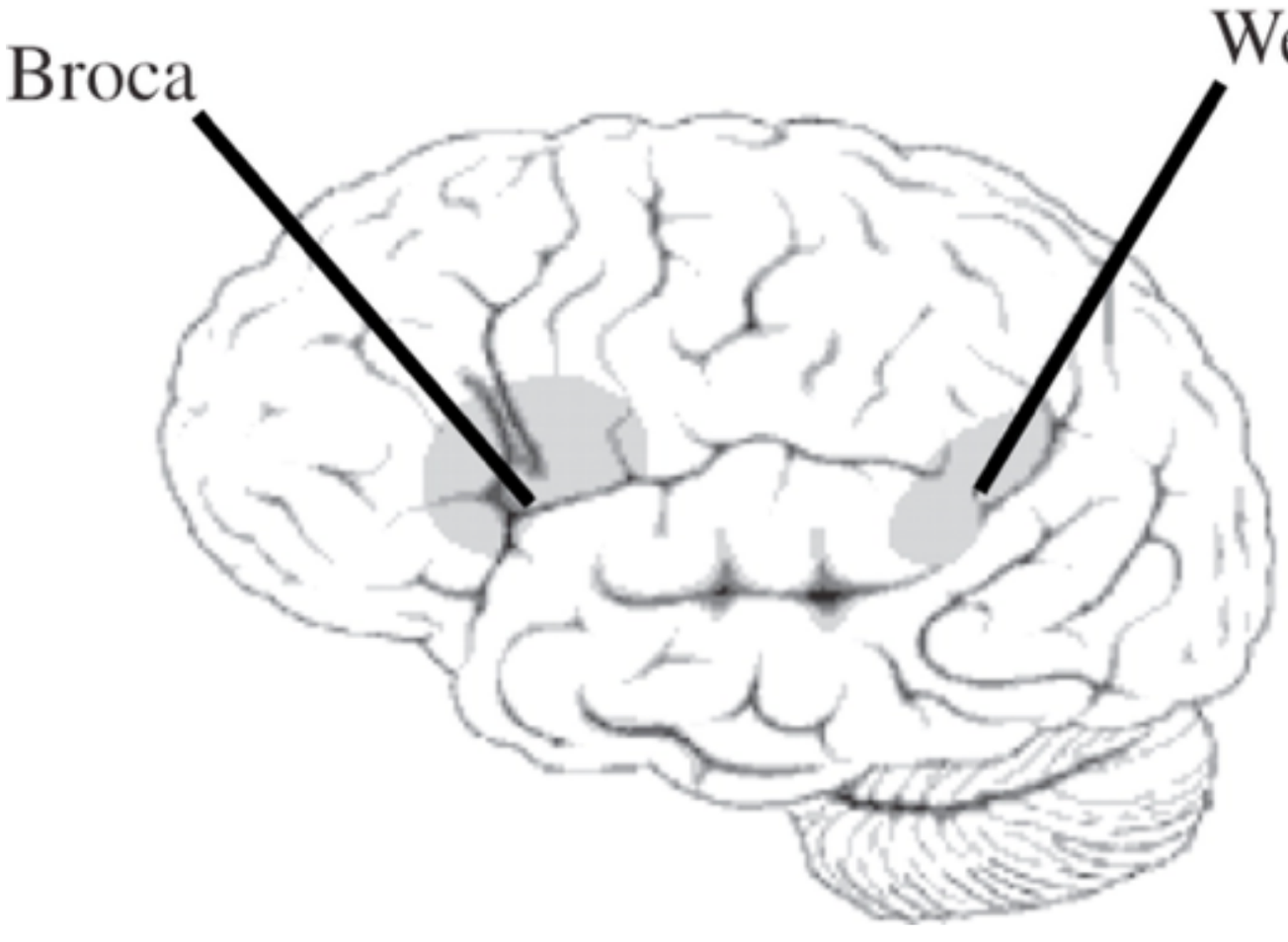
- Innate
- Automatic
- **Localised**
- Encapsulated

How does one process language?



How does one process language?

Lots of evidence for language areas in brain:



Broca's area traditionally thought to be for production

Wernicke's area traditionally thought to be for comprehension

How does one process language?

Amodal, traditional Cognitive accounts (Fodor, 1983)

- Innate
- Automatic
- Localised
- **Encapsulated**

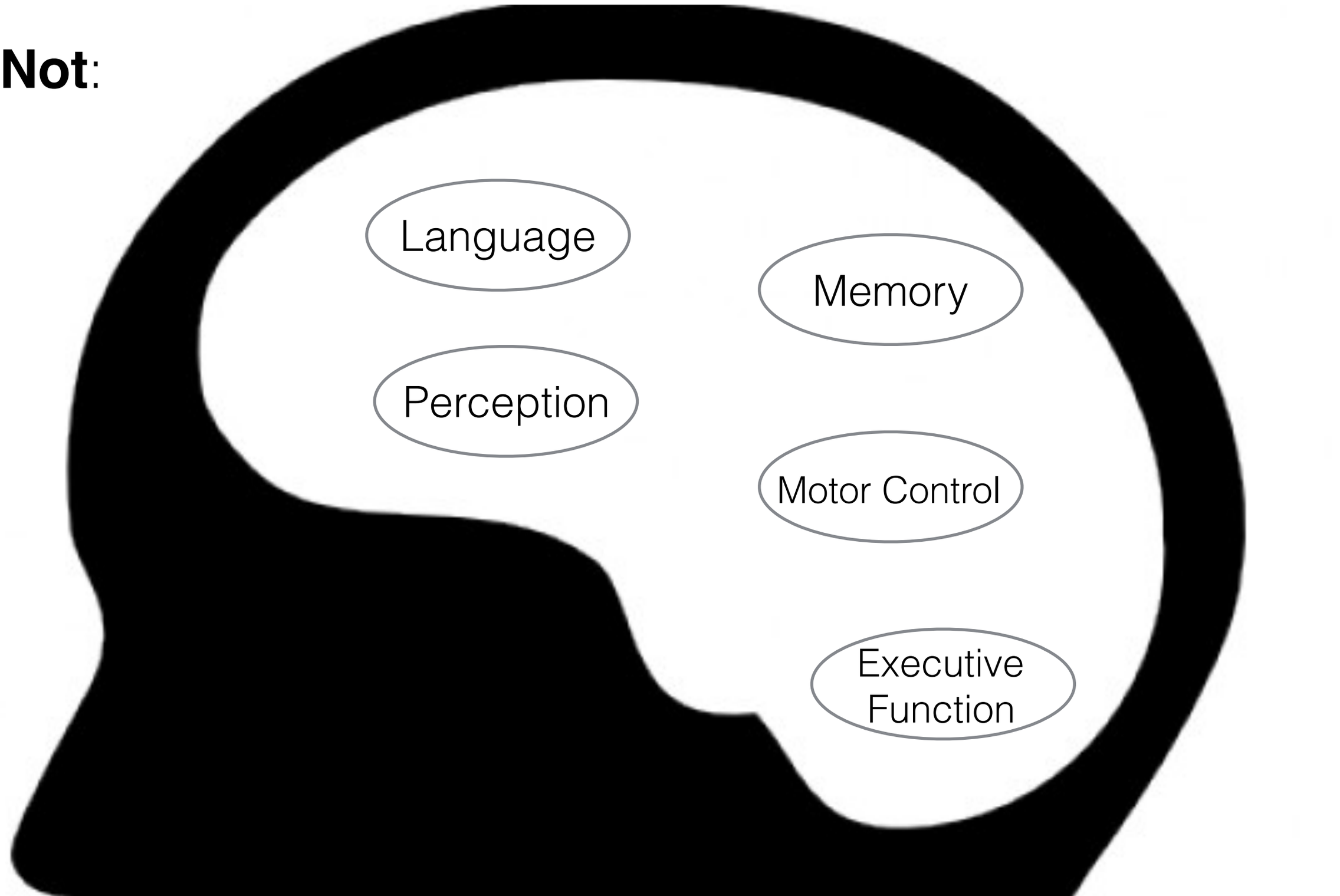
How does one process language?

- **Encapsulated**

- This is not the same as localised
- This refers to informational encapsulation
- Processes rather than location
- Is language processing, modular and encapsulated?

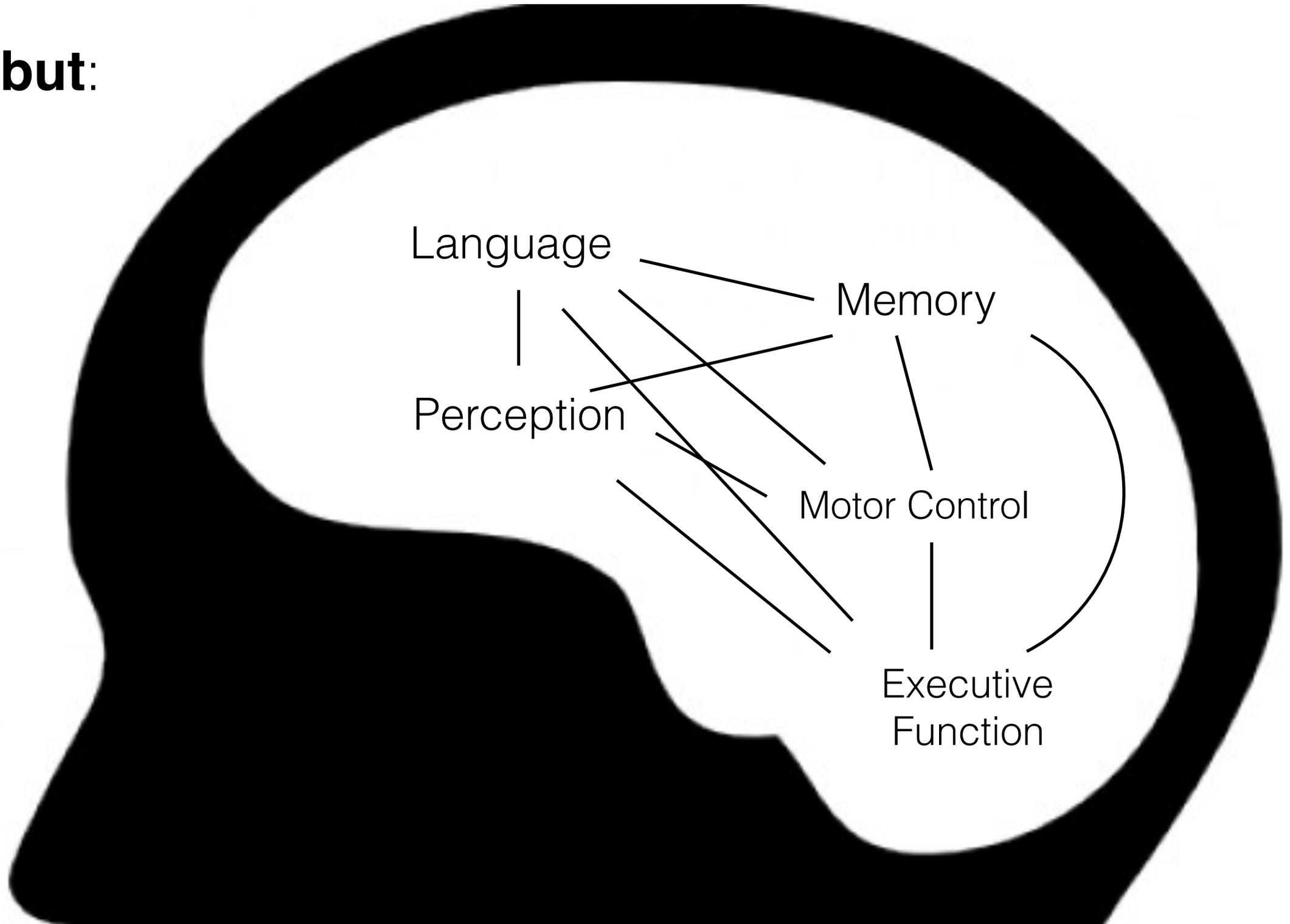
Embodied cognition

Not:



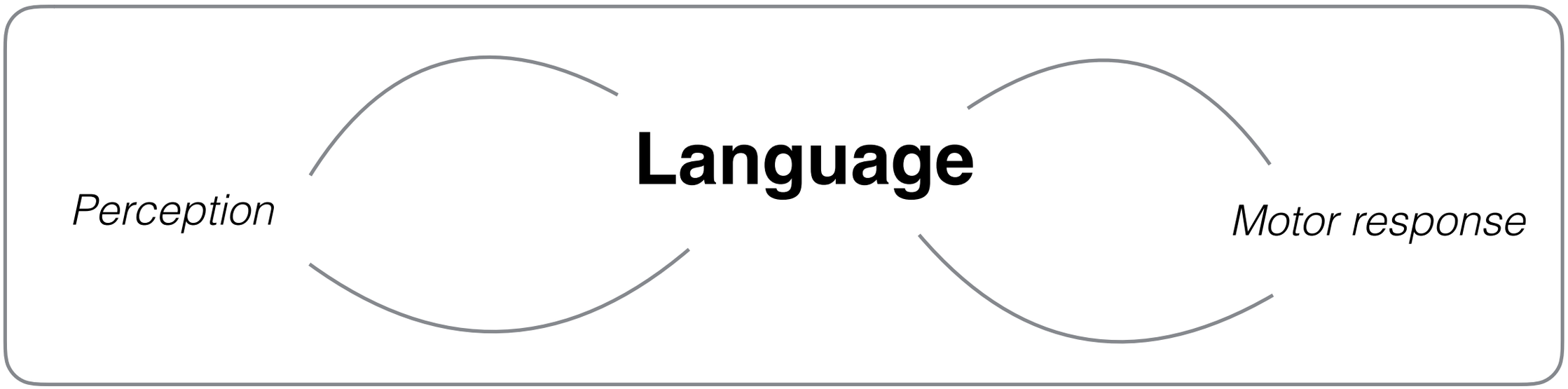
Embodied cognition

but:

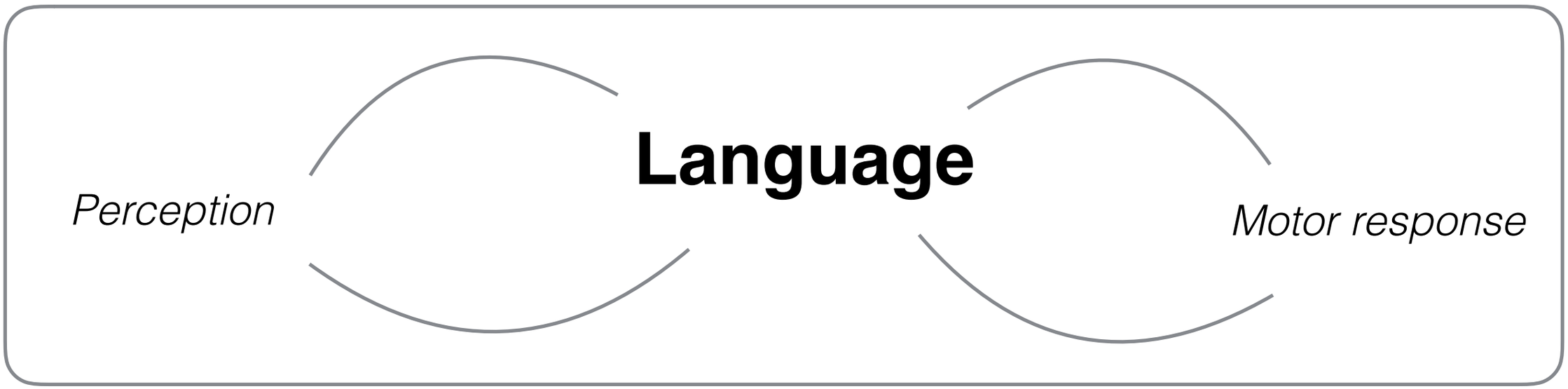


Embodied cognition

Embodied cognition



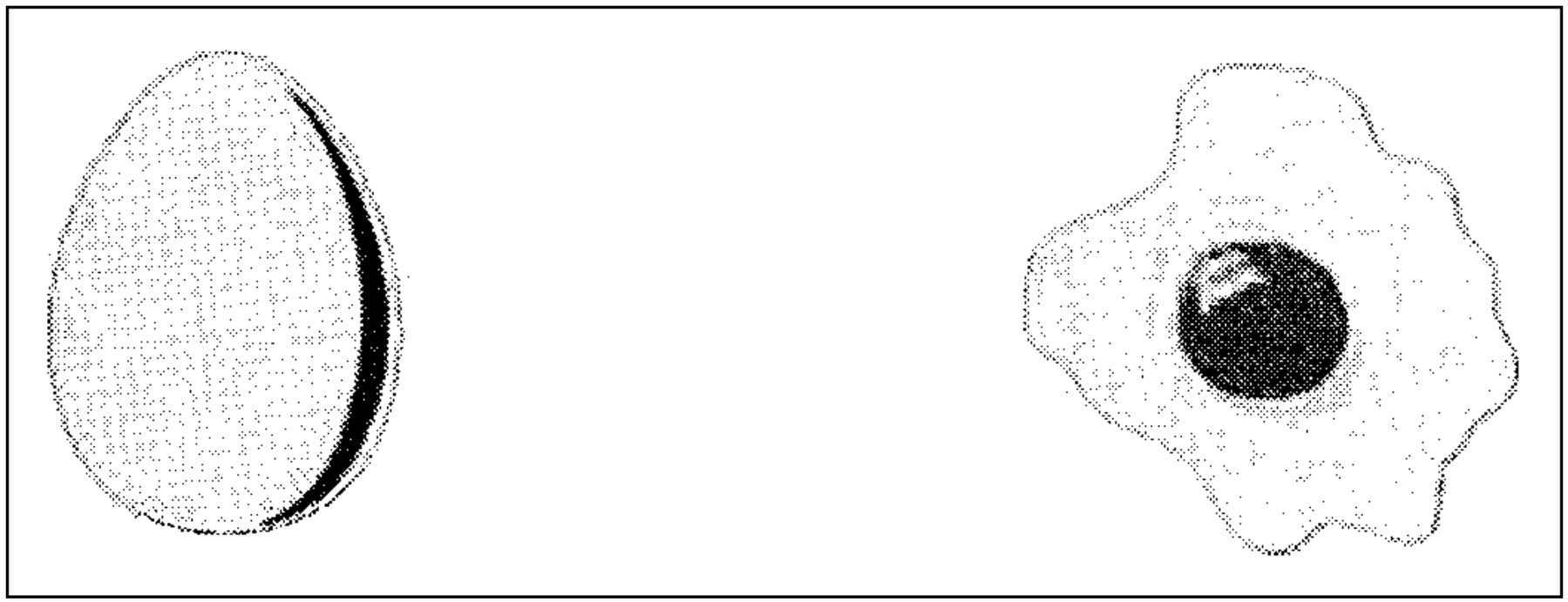
Embodied cognition



Sensorimotor system

Embodied cognition

Sensorimotor and cognition link - example



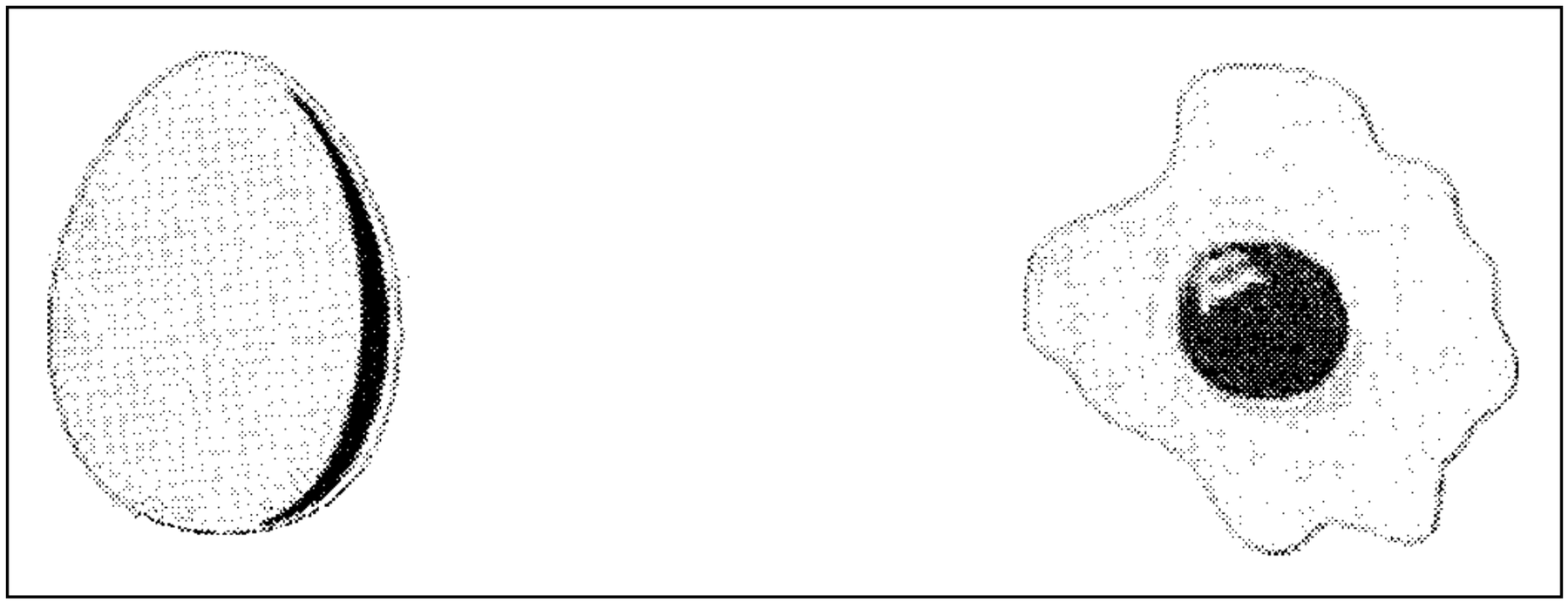
“The woman saw the egg in the *carton*”

“The woman saw the egg in the *pan*”

Zwann, Stansfield & Yaxley, 2002

Embodied cognition

Sensorimotor and cognition link - example



Was the object mentioned in the sentence?

Participants were faster to respond to the image congruent with the sentence they heard

Zwann, Stansfield & Yaxley, 2002

Embodied cognition

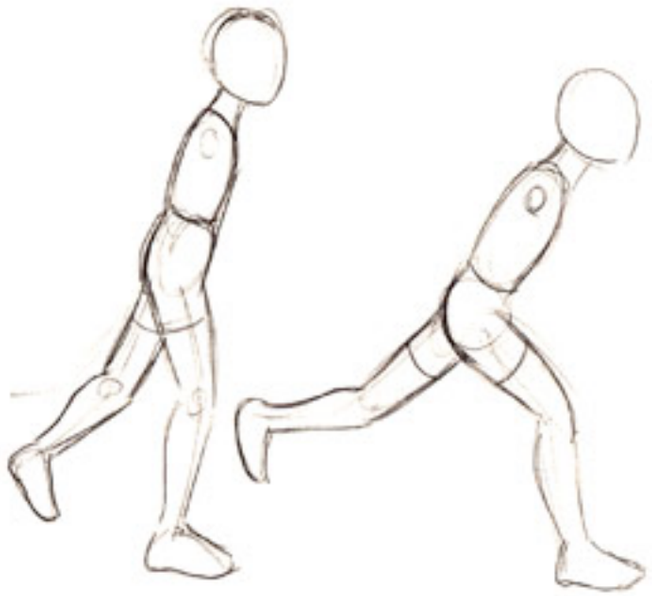
Embodied cognition covers a range of theories and types of theory:

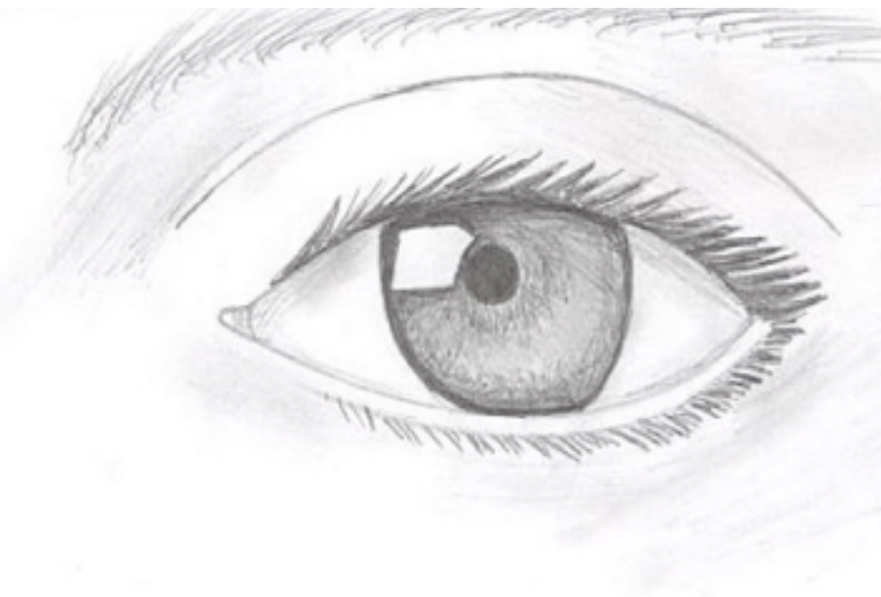
- Cognition (language processing too) is ***for action***
- Cognition is necessarily ***body-based*** and requires sensorimotor input

Wilson, 2002

Cognition for Action

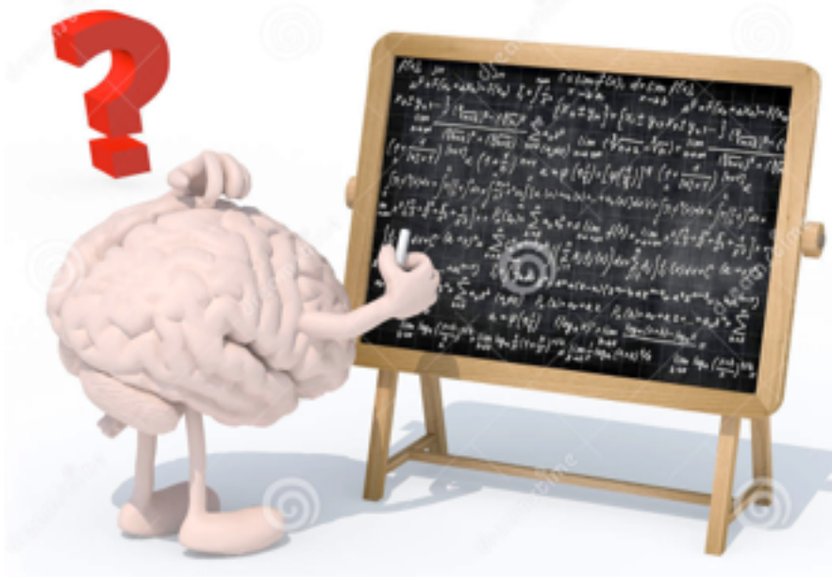
- Our bodies have adapted to environment
- Hands, arms legs, eyes are there for us to manipulate environment, allowing us to survive





Glenberg, (1997)

Cognition for Action

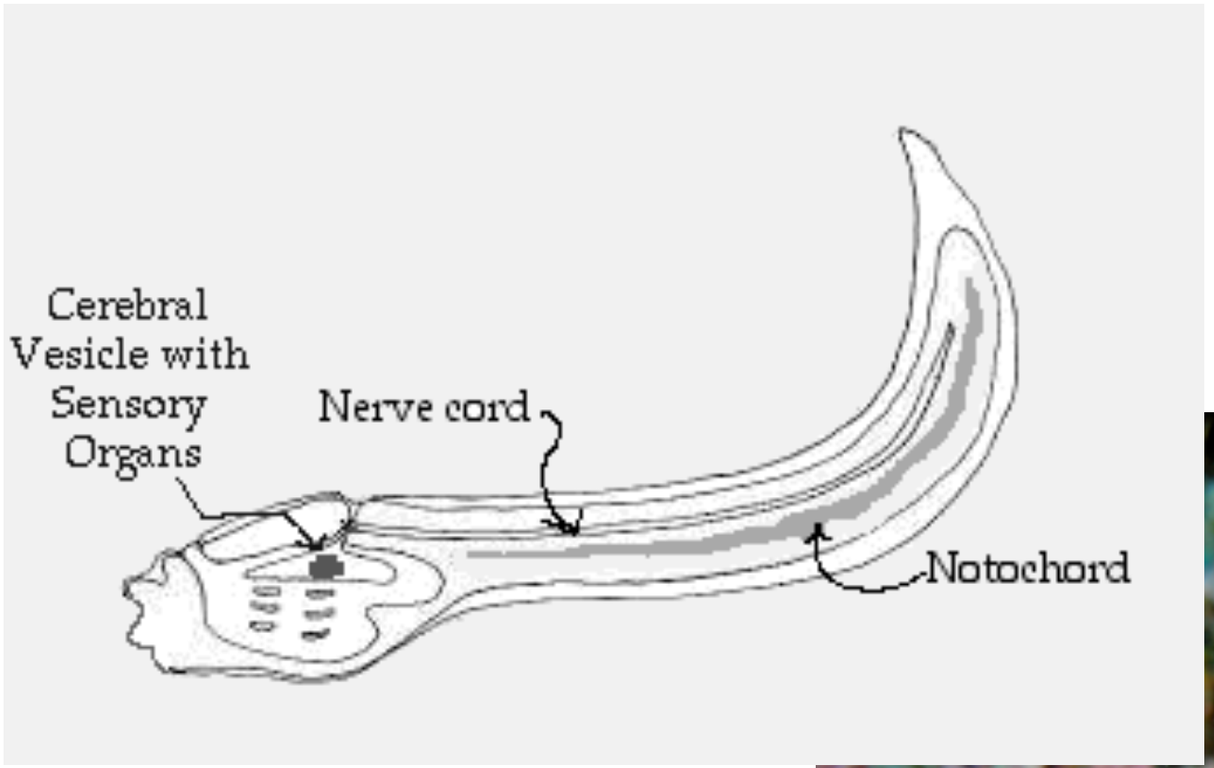


- Brain is no different, and brain houses cognition (and language processing)

- Thus cognition has evolved to allow us to manipulate environment

Glenberg, (1997)

Cognition for Action



Cognition for Action

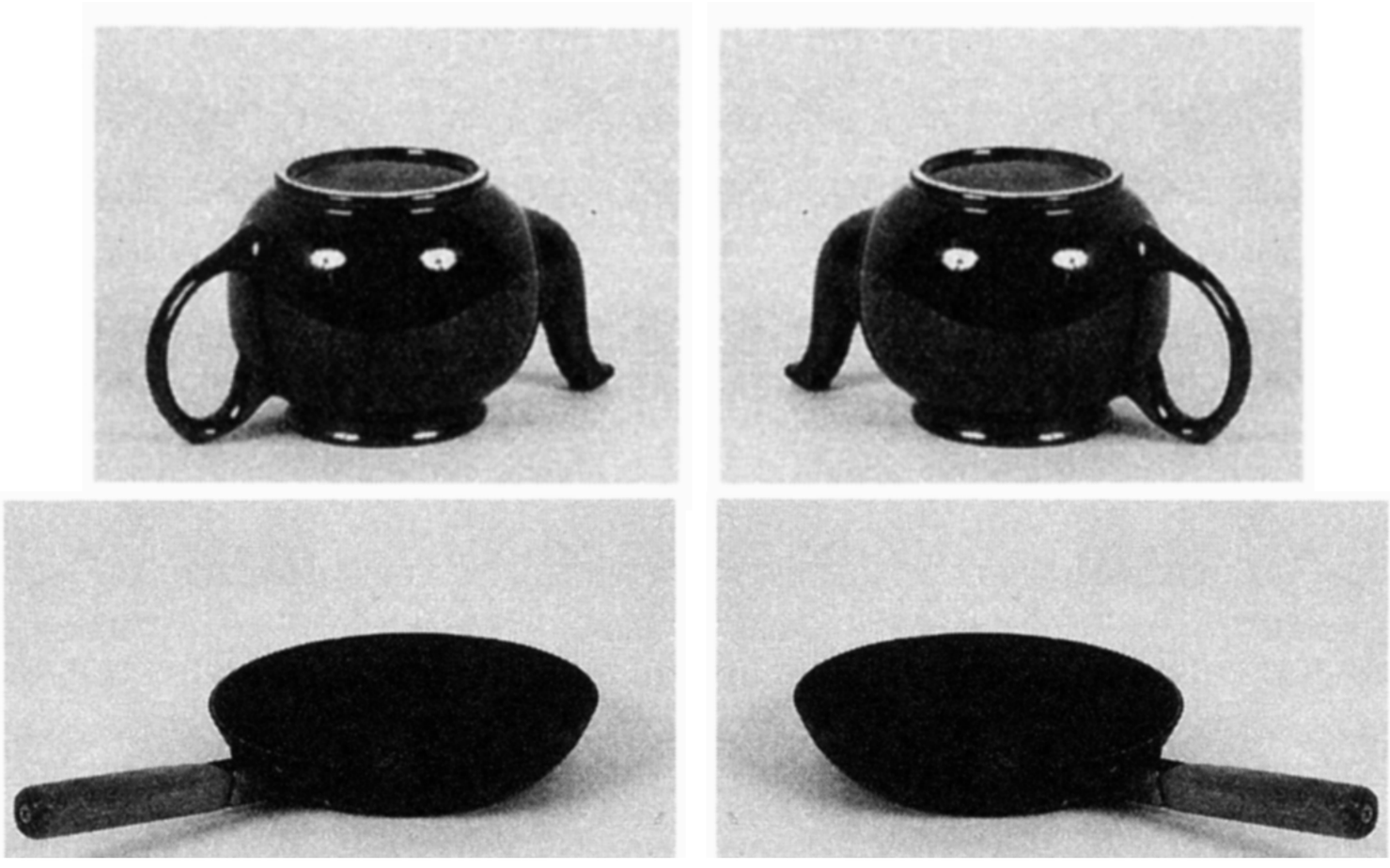
Affordances

The motor opportunities an object affords.

If cognition is for action, affordances should affect cognition

Cognition for Action

Behavioural evidence



- Is this image inverted?
- Answered with left or right hand
- images either had handle to left or right

Tucker & Ellis, (1997)

Cognition for Action

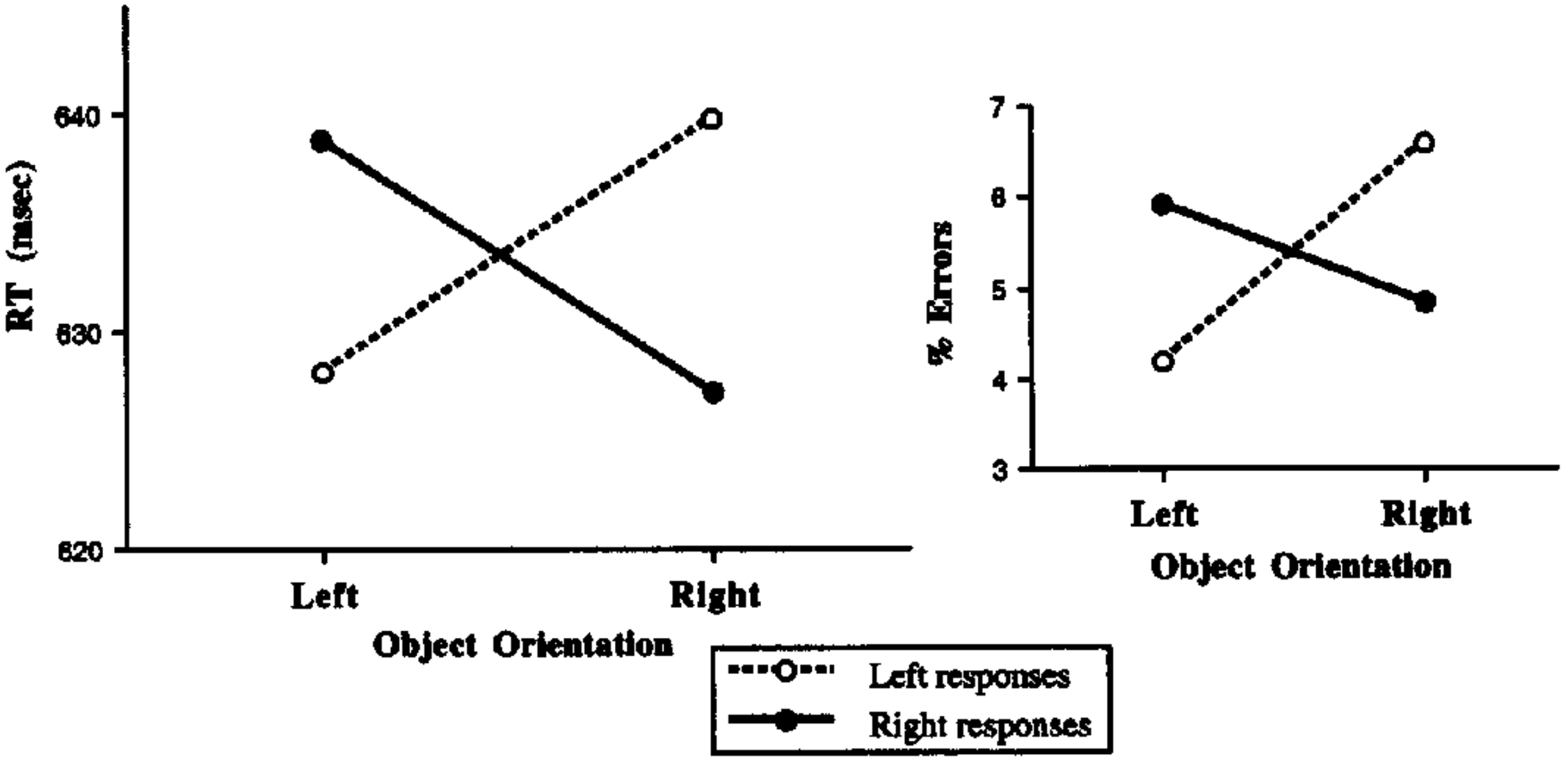
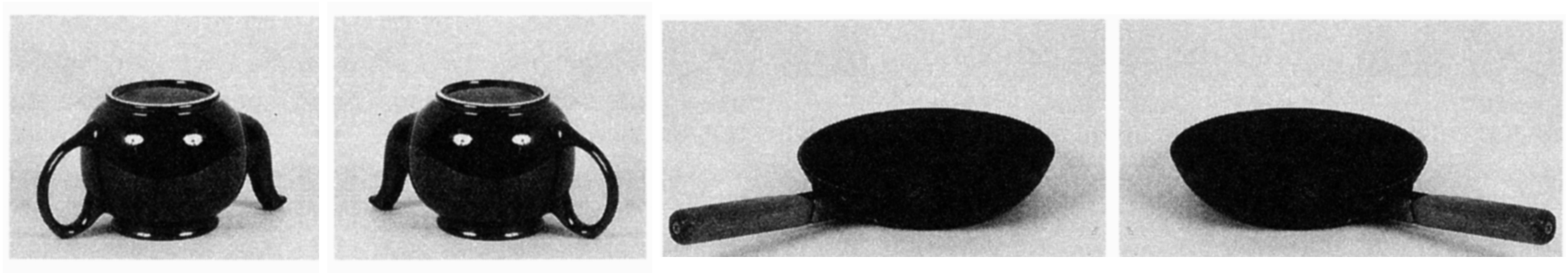


Figure 2. Mean reaction times (RTs) and error rates for Experiment 1 as a function of left–right object orientation and response (left or right hand).

Tucker & Ellis, (1997)

Cognition for Action



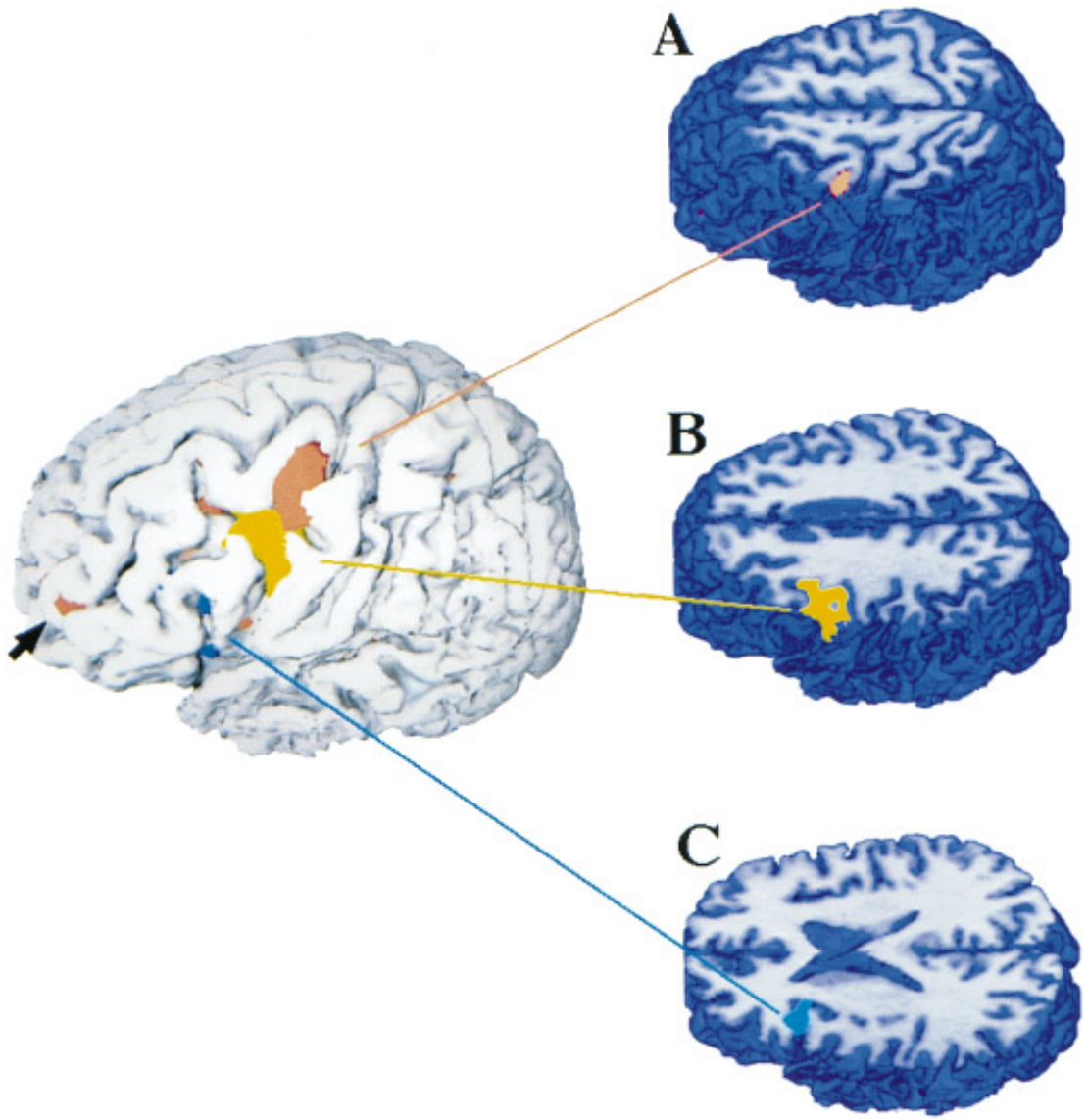
Although no manipulation of object in the task, it seems motor system is nevertheless activated

Sensory information seems to activate motor, which influences cognition

<u>Cognition for Action</u>

Cognition for Action

Brain imaging evidence



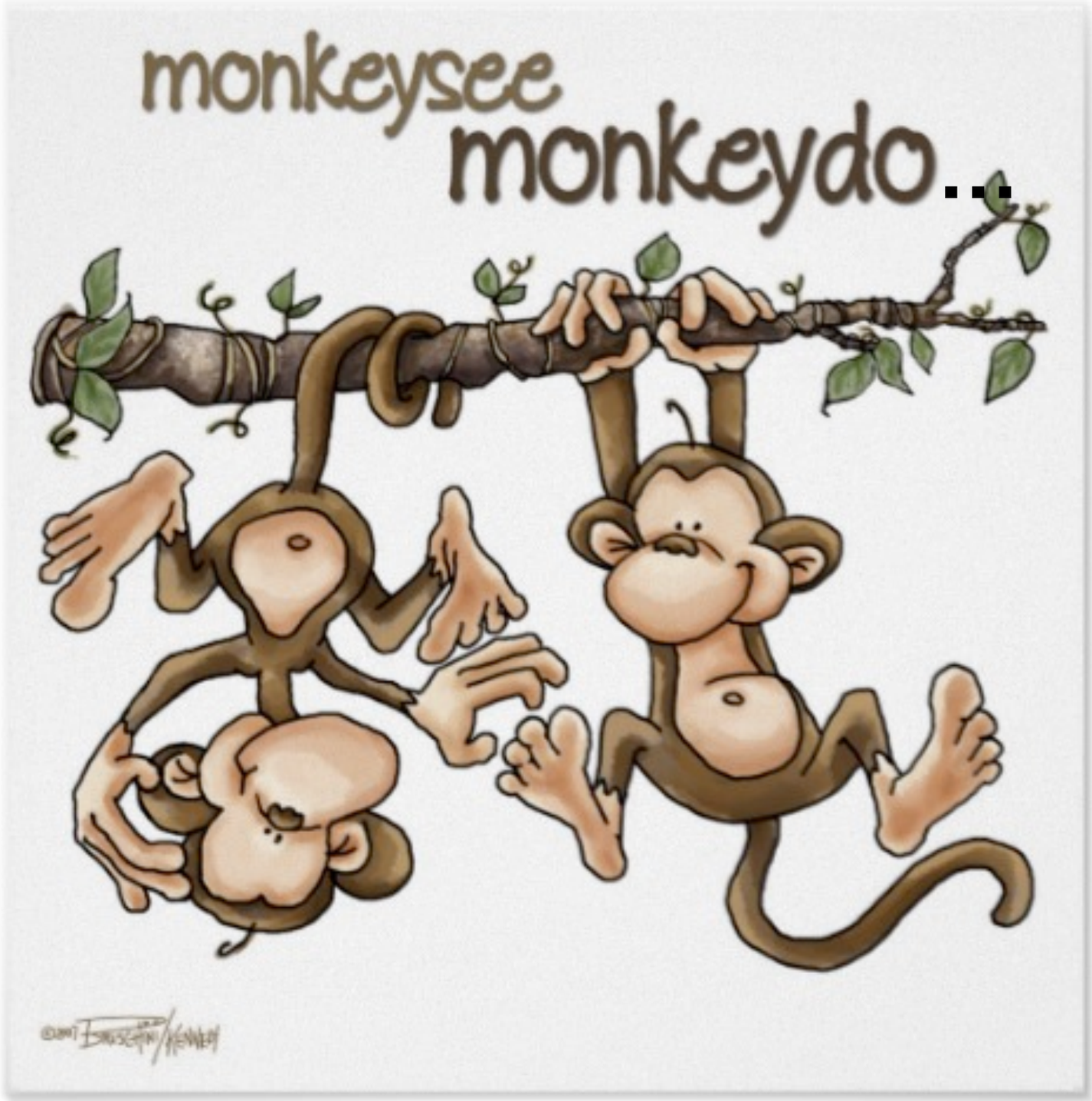
- Positron emission tomography (PET)
- Observing tools activated dorsal pre-frontal cortex
- Silent naming led to Broca's area activation
- But silent tool use naming also led to increase in pre-frontal cortex

Grafton et al, (1997)

Cognition for Action

Mirror Neurons

Mirror Neurons

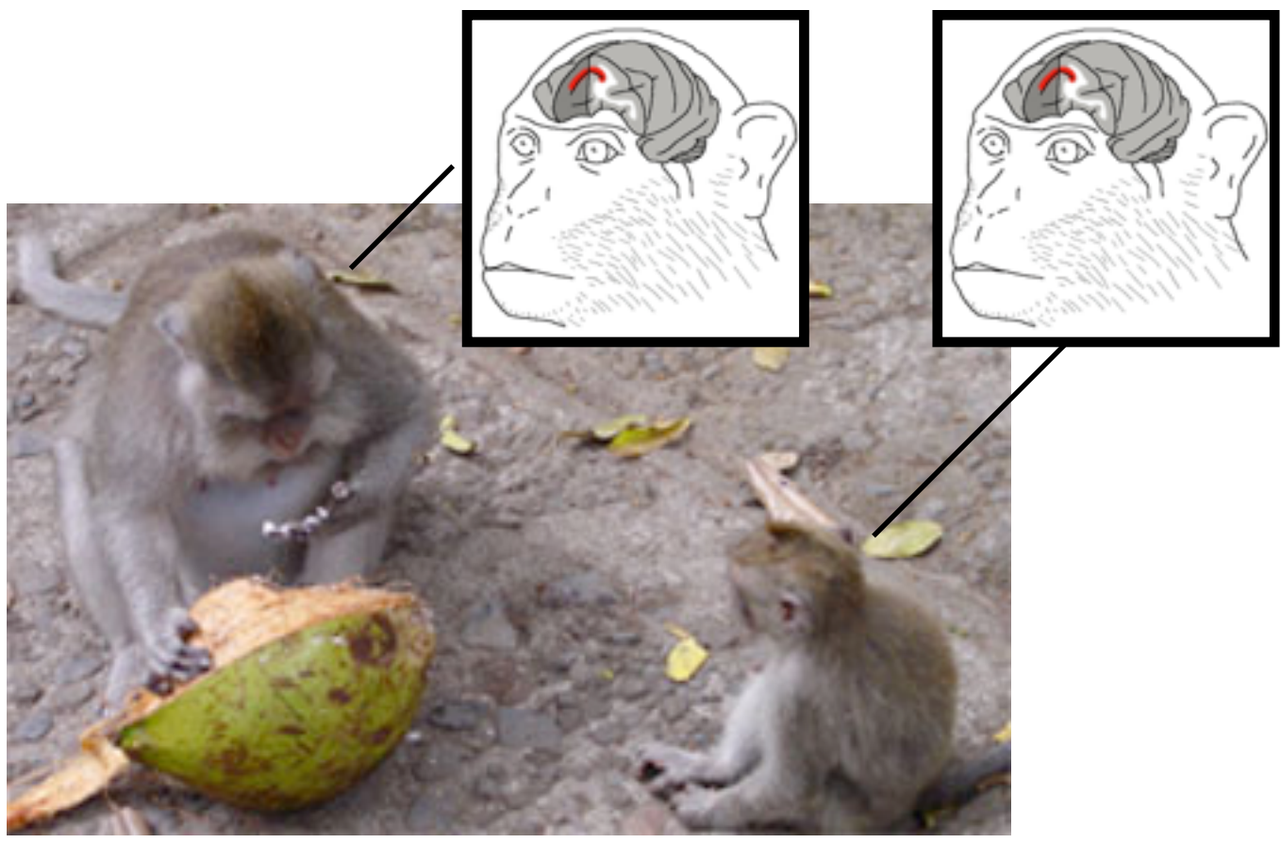


…In his brain

Mirror Neurons

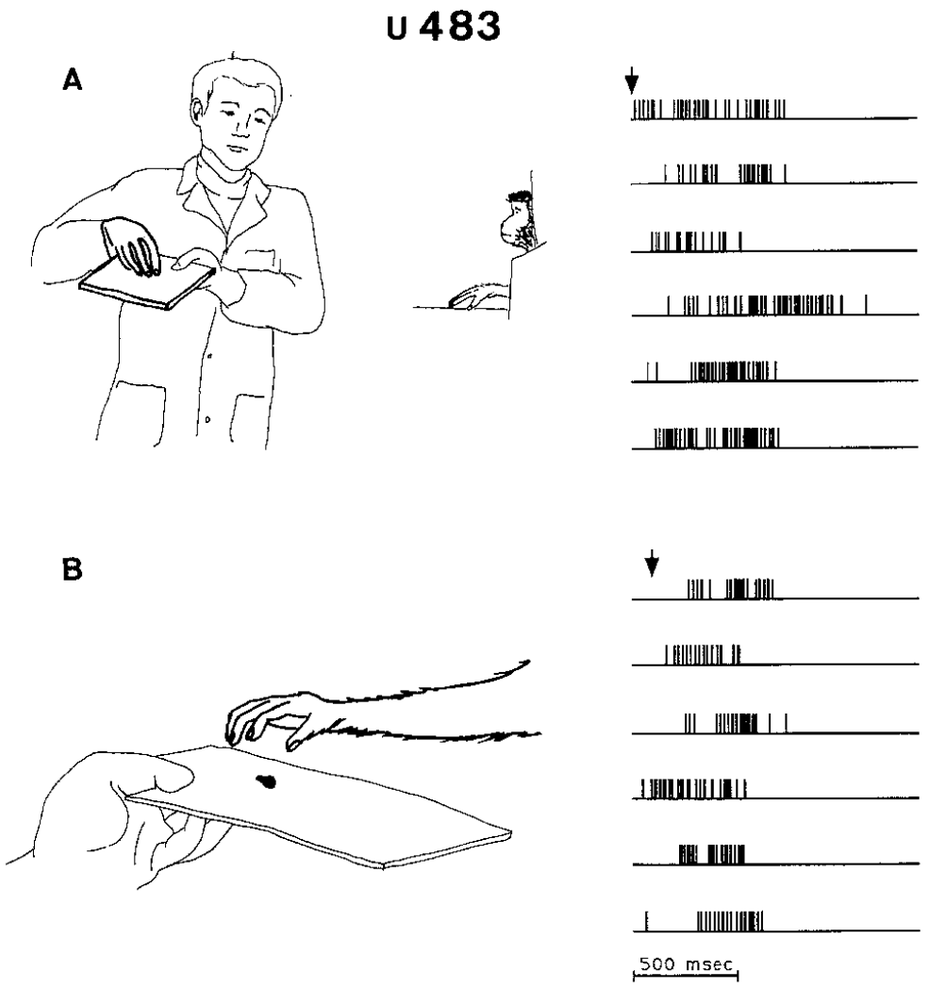
In primates, evidence that the same neurones in the brain that are activated when ***doing*** an action are activated when ***seeing*** an action

Overlap between modalities here - doesn't look amodal



Mirror Neurons

What about humans?



Methods

Surgical preparation and recording procedure

The experiments were carried out on three macaque monkeys (Macaca nemestrina) selected for their docility. A few days before the first recording session a craniotomy over the posterior part of the frontal lobe was performed under general anesthesia (ketamine hydrocloride, 15 mg/kg i. m. repeated every 30 min) and the coordinates of the arcuate sulcus and central sulcus were assessed. A chamber was positioned over the hole and cemented to the skull. A support for the microelectrode advancer and a device which allowed a rigid fixation of the head during the experiments were also implanted. The surgery was made in aseptical conditions.

Pellegrino et al. (1992)

[Gentilucci et al. (1988)]

Mirror Neurons

What about humans?

Scientists have been nicer to humans, so evidence is indirect.

But fMRI data have suggested mirror neurons pattern

Embodied cognition

Put a pencil in your mouth!

1/2 Lips

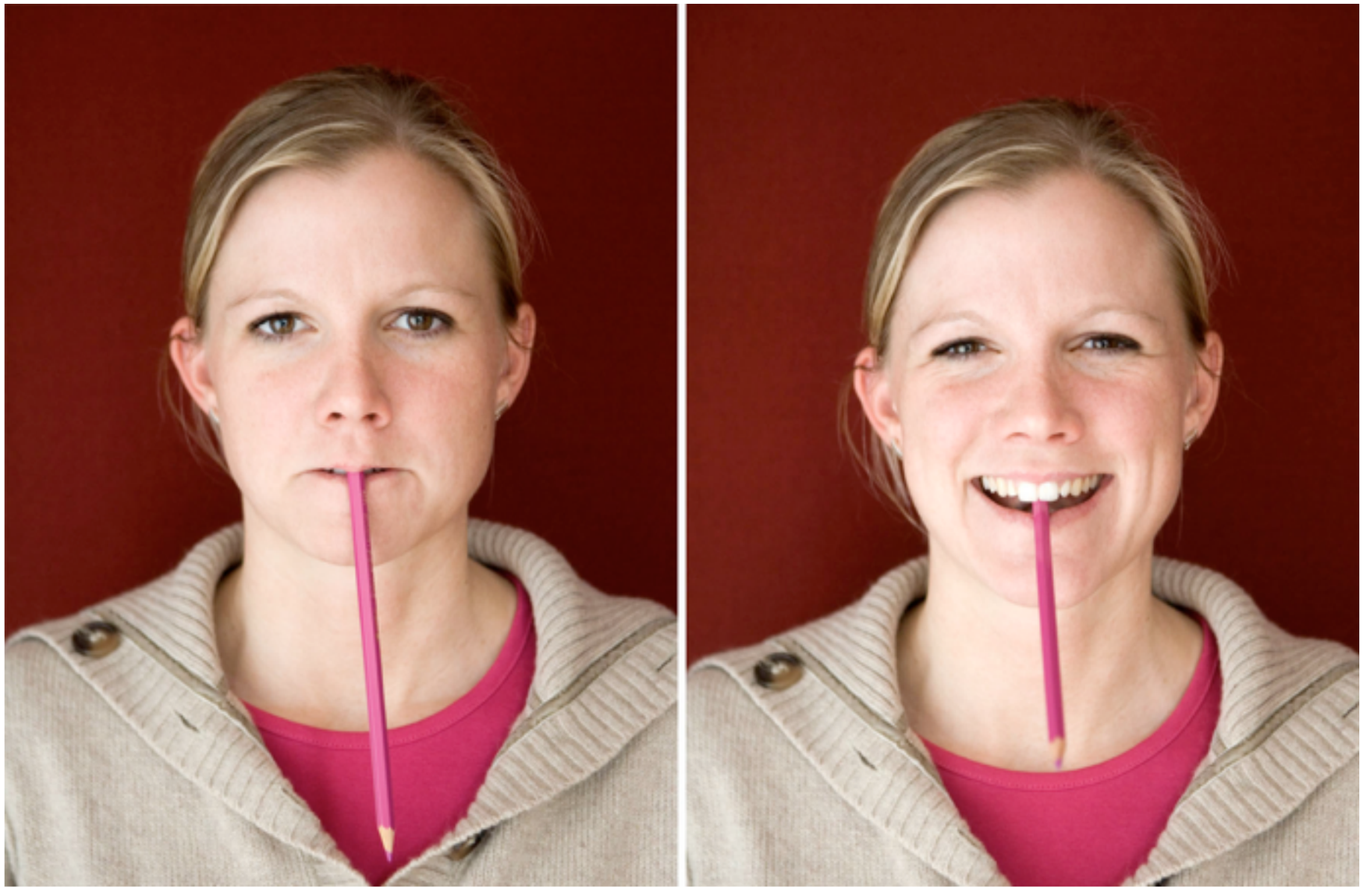
1/2 Teeth

Embodied cognition

Is this funny?

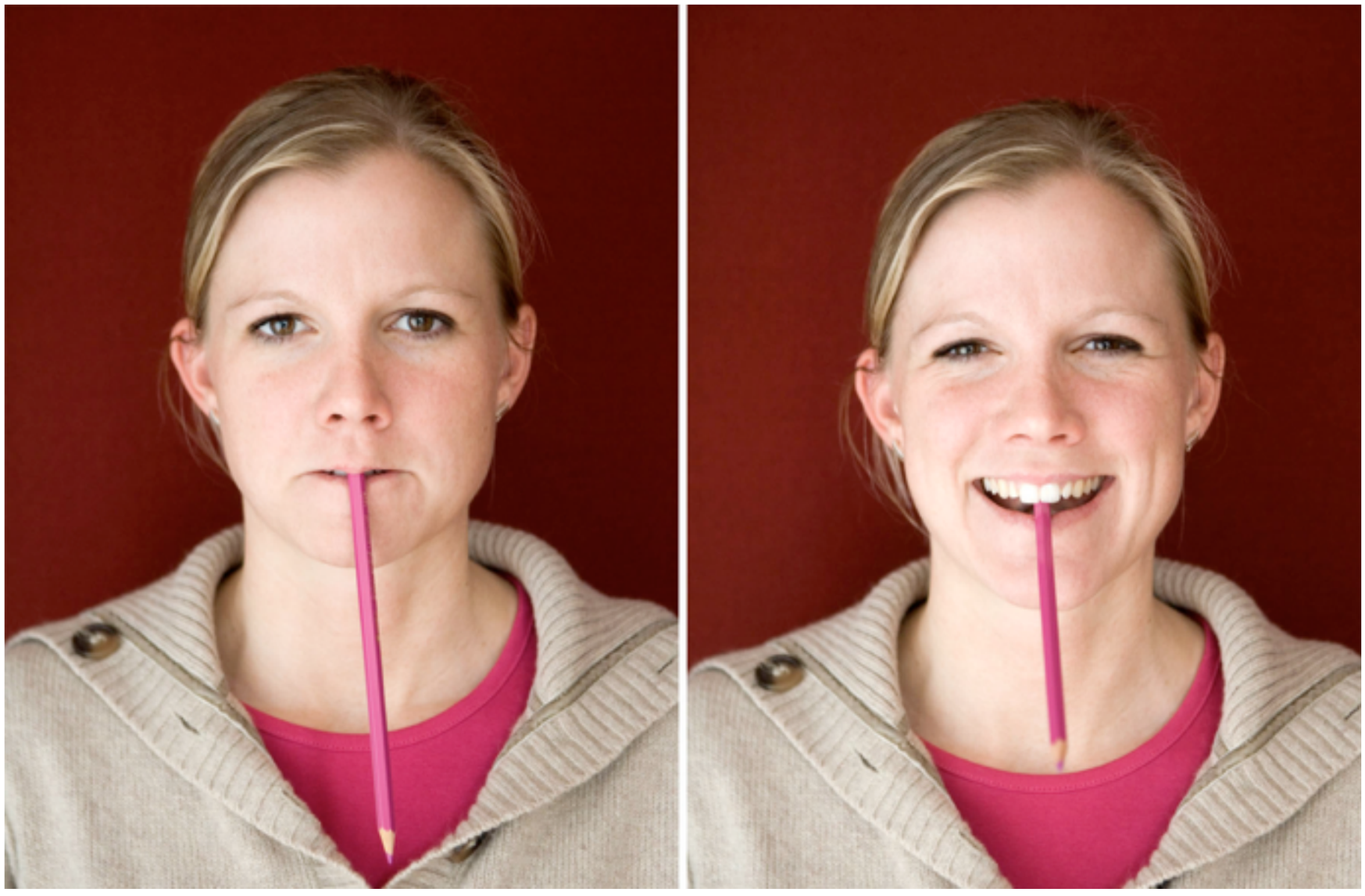
Embodied cognition

Sensorimotor and cognition link



Embodied cognition

Sensorimotor and cognition link



Frown muscles

Smile muscles

Embodied cognition

Table 1
Ratings of Funniness and Difficulty: Study 1

	Position of pen		
Cartoon	Lip	Hand	Teeth
First	3.90	5.13	5.09
Second	4.00	4.10	4.19
Third	4.47	4.67	5.78
Fourth	4.90	5.17	5.50
Mean funniness	4.32	4.77	5.14
Mean difficulty	4.47	2.72	4.91

Note. All ratings were made on a scale from 0 to 9, where a lower value stands for lower funniness and difficulty, a higher value for higher funniness and difficulty.

Embodied cognition

Sensorimotor and cognition link

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Changing muscle position altered emotion judgments

Sensorimotor experience therefore affecting cognition

Stepper & Strack (1988)

Cognition for Action?

- What do “push” and “hammer” make you think of?

- What about “contemplate” and “sophisticated”?

Cognition for Action?

- Thought without any action?
- Or simply perception for perceptions sake
- Are there separate pathways for perception?

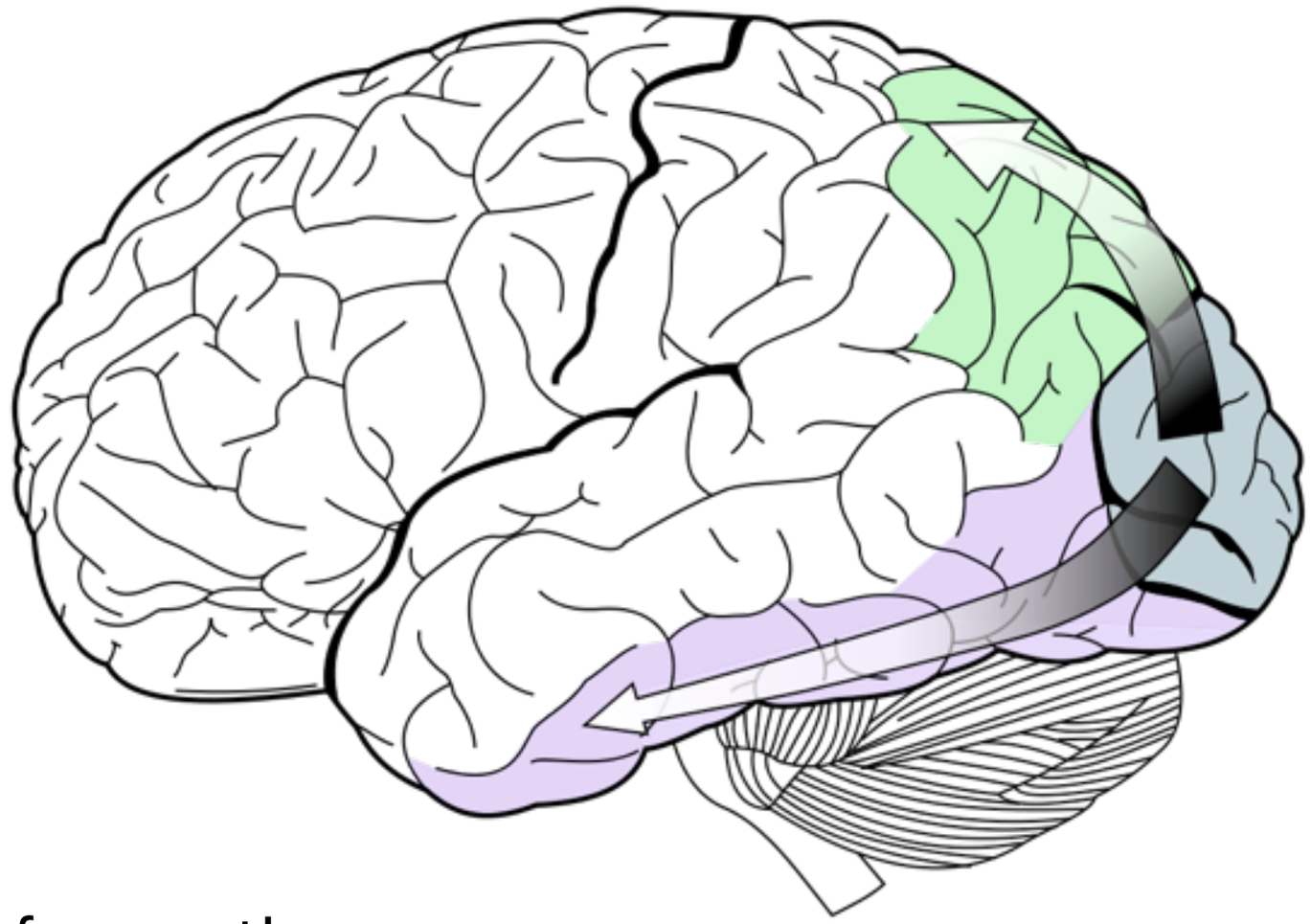
Cognition for Action

Clinical population evidence

- Patient D.F had severe agnosia
- Couldn’t recognise objects
- However could navigate around the world perfectly

Goodale et al. (1991)

Cognition for Action



- Two streams of visual information

- A “conscious” (purple) stream for *what* and a “subconscious” (green) for *how*

Goodale et al (1991)

Cognition for Action

- Does this make sense for language?

Embodied cognition

Embodied cognition covers a range of theories and types of theory:

- Cognition (language processing too) is ***for action***
- Cognition is necessarily ***body-based*** and requires sensorimotor input

Wilson, 2002

Body-based cognition

Body-based cognition

- A more extreme anti-amodal position
- All cognition (including language processing) requires sensorimotor input/integration
- Why would this be the case?

Body-based cognition

Symbol grounding problem

Big philosophical questions:

Are cognition and consciousness compatible?

Subjective experience and computational accounts?

Body-based cognition

Symbol grounding problem

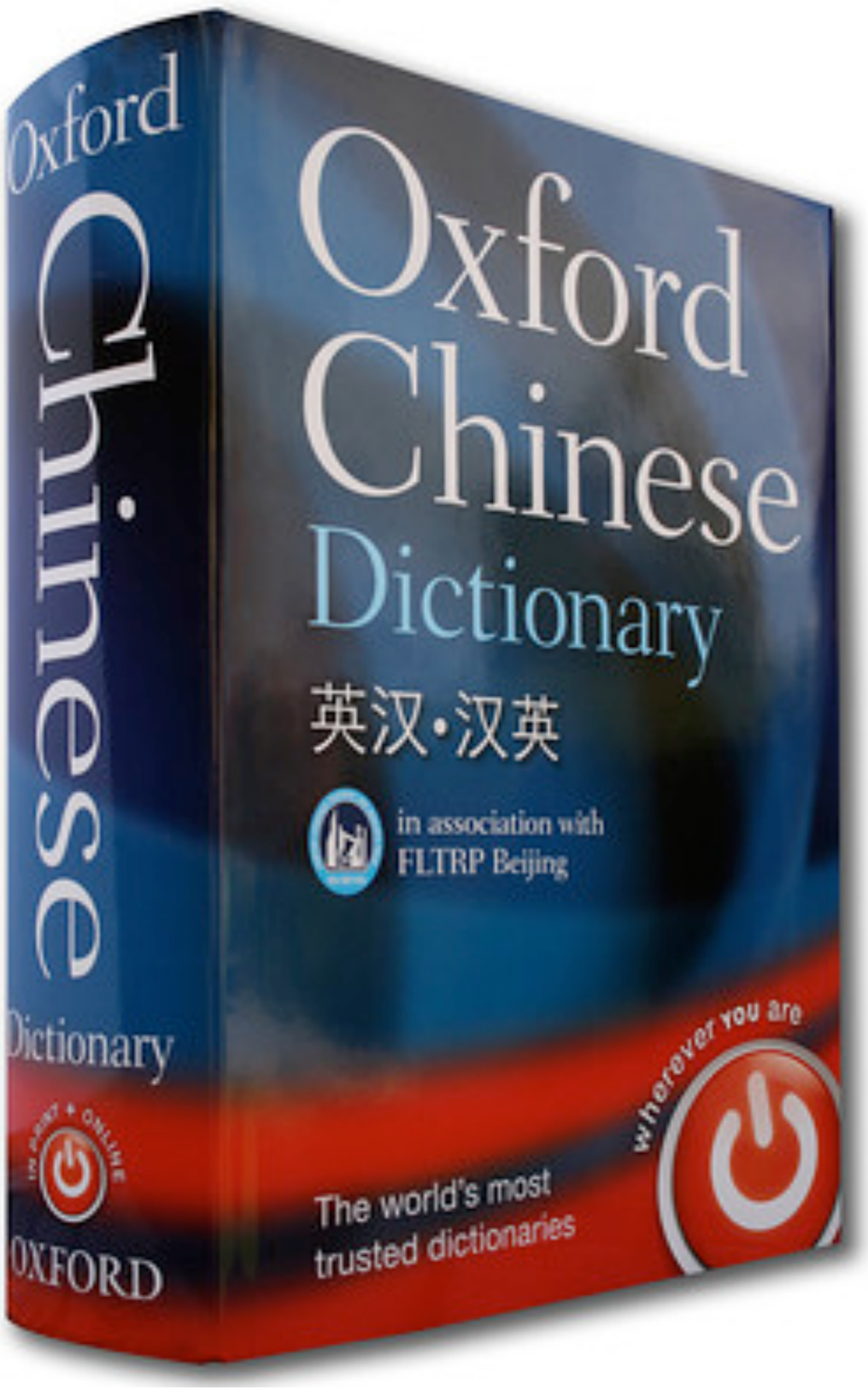
For us:

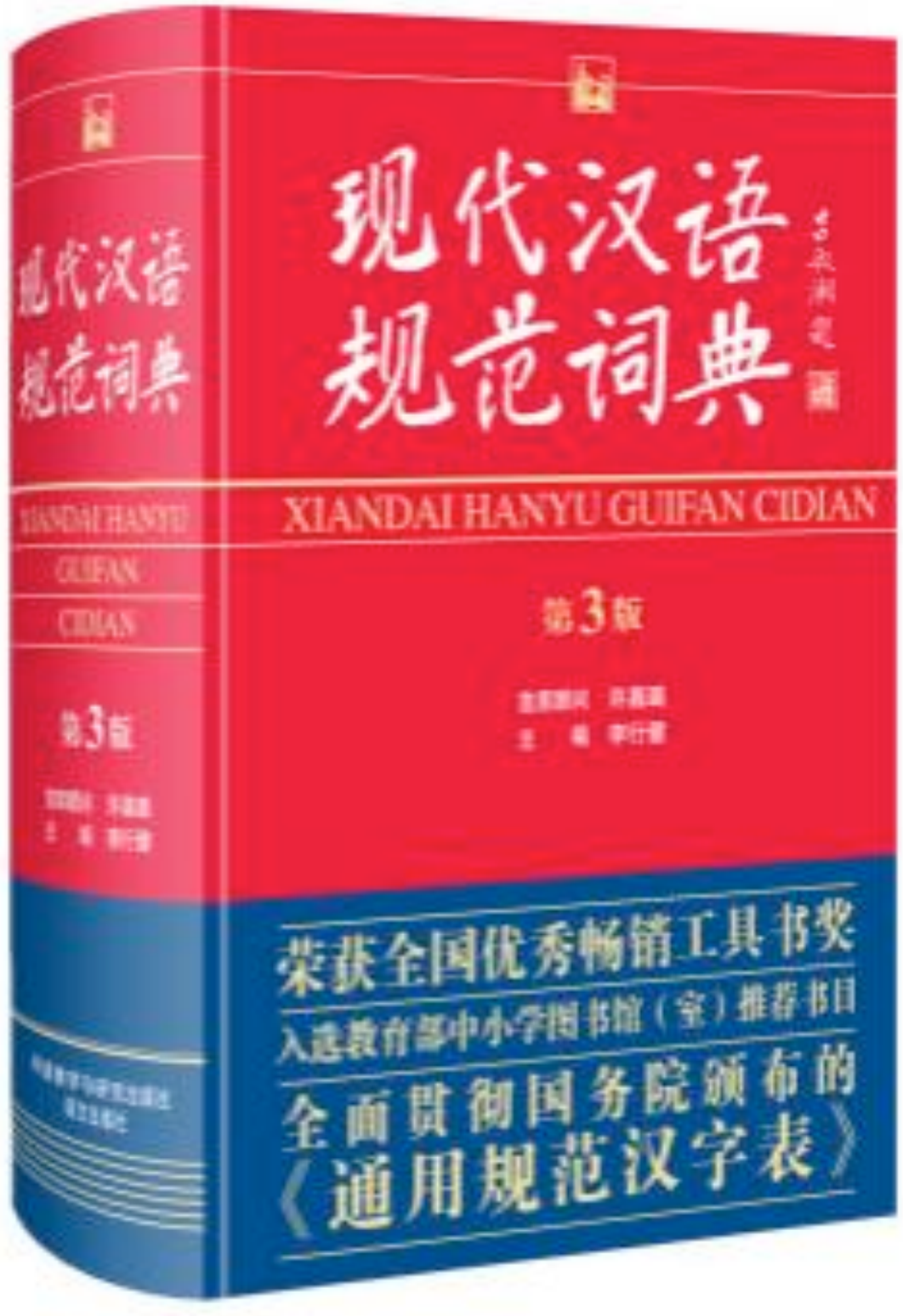
Imagine we have an encapsulated language system

A symbol maps on to a symbol maps on to a symbol

Where does **meaning** come into this?

Body-based cognition



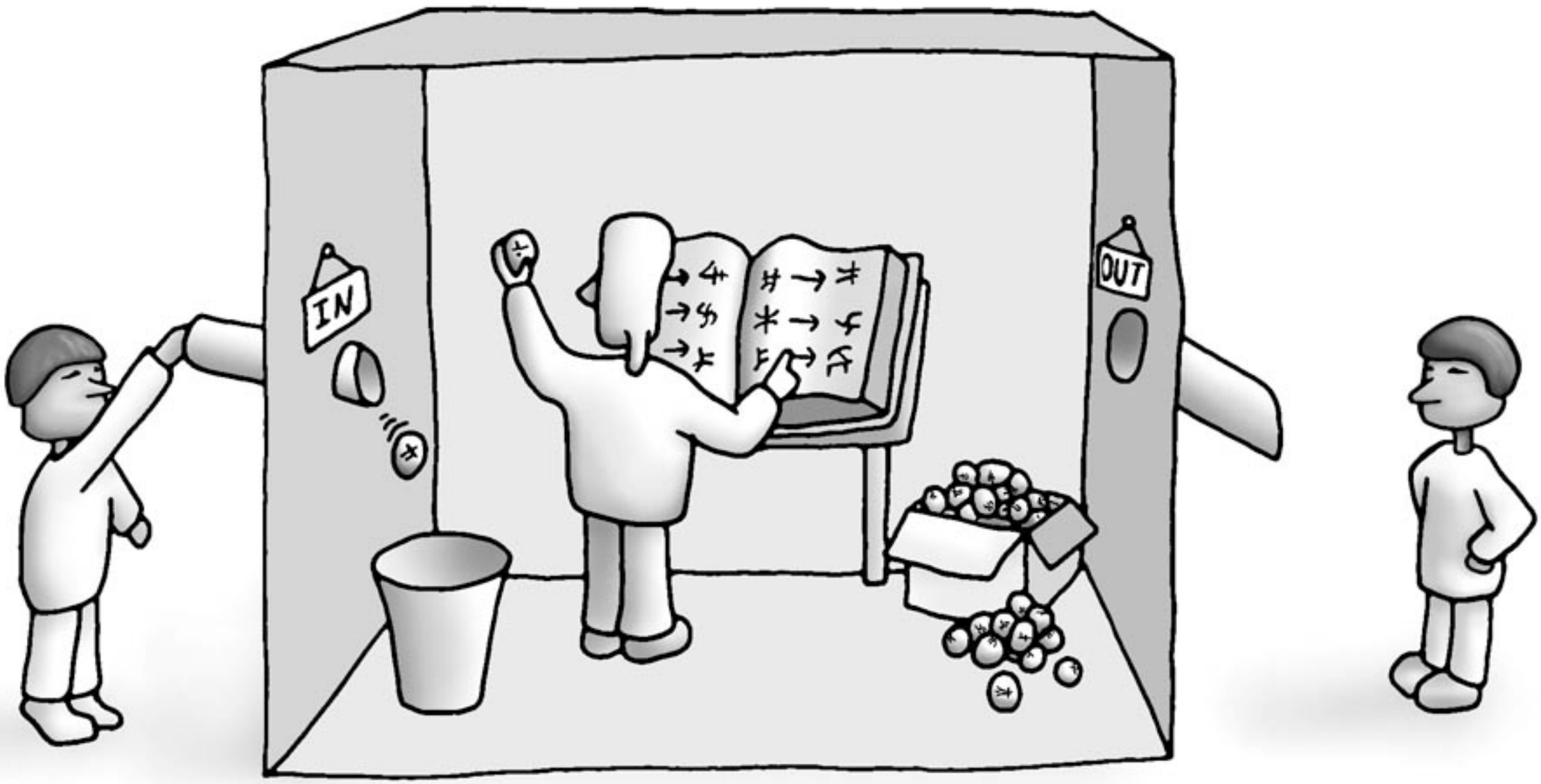


Body-based cognition

Searle's (1980) Chinese Room

Body-based cognition

Searle's Chinese Room (1980)



jolyon.co.uk

Body-based cognition

You need experiences to make sense of symbols

Meaning therefore **MUST** be grounded in terms of experiences - sensorimotor.

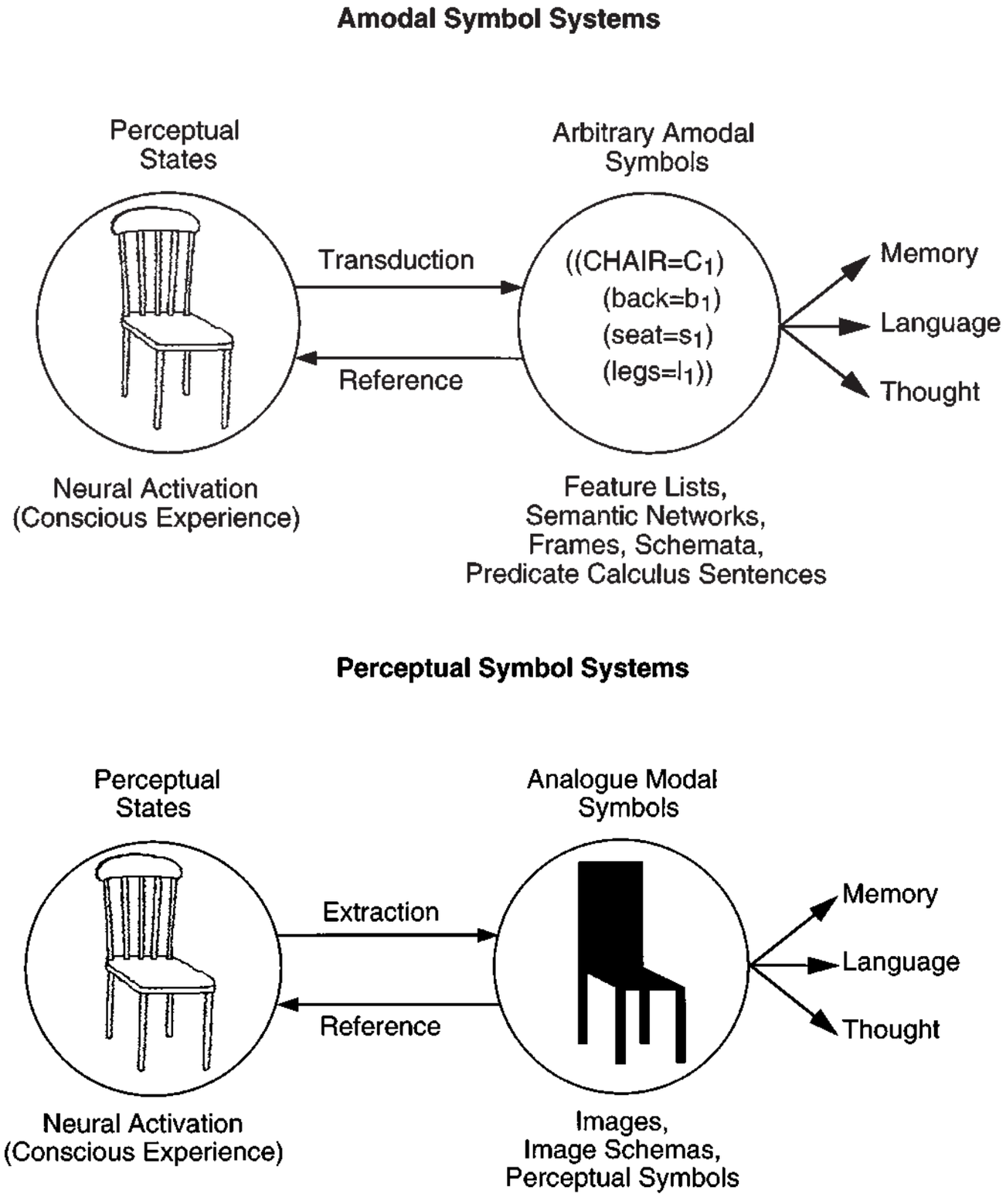
Body-based cognition

Perceptual Symbol Systems

- The perceptual and conceptual overlap
- accessing concepts requires activation of sensorimotor experiences

Barsalou, 1999

Body-based cognition



How does transduction work?

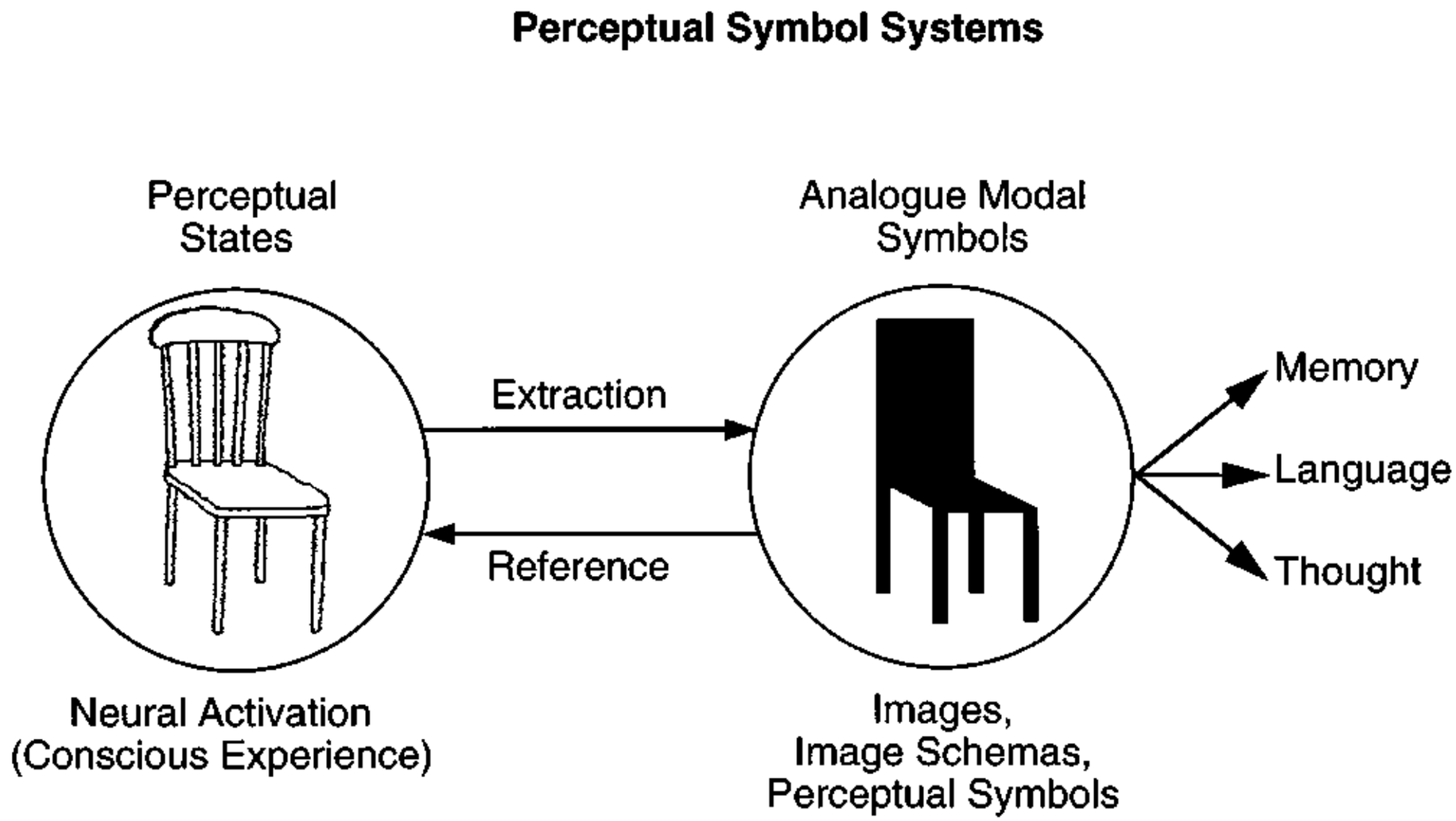
Symbol grounding problem

No need here for transduction

Symbol grounded in perception

Barsalou, 1999

Body-based cognition



Multimodal system

Barsalou, 1999

Dog

Is Simulation required?

Must we simulate things to understand them?

Is there evidence to support this view?

Overview

- **This week**
- Traditional cognition
- Cognition for action
  - Theoretical basis
  - Supporting evidence
  - Problems with this concept
- Body-based cognition
  - Symbol grounding problem
  - Perceptual symbol systems

- **Next week:**
- Body-based cognition
  - Behavioural evidence
  - Brain imaging evidence
  - Evidence from clinical populations
- Problems with embodiment
- Middle ground approaches

References

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