Introduction to *Embodied Cognition*

Corrado Corradi-Dell'Acqua

corrado.corradi@unige.ch

Theory of Pain Laboratory

**What is Embodied Cognition?**

1) How the brain codes the body in which is kept in

**Coding one's own body**

Individuals have an implicit knowledge of the position of their body segments in space at each time
What is Embodied Cognition?

2) How the brain codes the world via the body


Coding others’ body

Is this hand right or left?


Phenomenology

Consciousness

Accessible
perspectively

Reality

Immanent sphere of conscious experience

Trascendent domain of external objects

**Phenomenology**

Consciousness

- Immanent sphere of conscious experience
- Accessible transparently (without perspectival mediation)

Reality

- Trascendent domain of external objects
- Accessible"Blue Vault"

E.g., Universe shows itself as a «Blue Vault»

What is the body?

Phenomenology

Consciousness

Reality

Immanent sphere of conscious experience
Trascendent domain of external objects

Is it internal to my consciousness?
Is it external to me, in the environment?

Consciousness

Reality

Is part of the subject, who perceives the world?
Is part of the world to be perceived?

Consciousness

Reality

?
Although both objects exist simultaneously in reality, they are available perceptually one at a time.

The subject’s body (the eyes) automatically orient itself towards the stain or the bird.
Case 1: the object moves and the subject is still

Case 2: the object is still and the subject moves the eye (the information on the retina is the same as in Case 1)

Case 3: the object is still and the subject believes he's moving (but eye-muscles are paralyzed)
"The movements of the body are naturally invested with a certain perceptual significance" (Merleau-Ponty)

Carman, T. (1999). *The Body in Husserl and Merleau-Ponty, Philosophical Topics*
The body is the place where consciousness and reality occupy the same conceptual space.

Perceptual experience incorporates the body movements, and spontaneously takes them into account in processing the external world.

Perception is always informed by a “Body Schema” (schéma corporel), which is…

…neither a conscious image of the body
…nor a mere physiological state
Phenomenology

_Schemas_ (kantian definition) can be understood as a set of rules and procedures aimed at anticipating and incorporating the world.

They are not the product, but the a prerequisite, of cognition.


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Image → conscious output of the schema

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“Body Schema” → bundle of procedures/skills (habits) that constitute the body’s precognitive and preconscious familiarity with itself and the world

“Body Image” → information about the human body transparently accessible to consciousness

_The two terms inappropriately used interchangeably in cognitive psychology/neuroscience_

We can also understand the body of others, not by a deliberate analogy, but through our spontaneous body skills/habits. When we copy the gesture of others, we don’t need to think explicitly about which movements we make. Our body follows naturally the seen displacements.

I am conscious of the world via my body. The body is a permanent horizon in the perception of the world.

Lean both hands on my desk. You feel the hands get stressed. By acting on the world you also become aware of your body.
I am conscious of my body through its interaction in the world.

Phenomenology

External perception is synonymous with a certain perception of my body.

The body is not accessible transparently. We can learn about it only by actively engaging it (as for other world objects).

"The theory of the body schema is implicitly a theory of perception" (Merleau-Ponty)

Phenomenology

Consciousness

Reality

Trascendent domain of external objects

Immanent sphere of conscious experience

The body occupies a middle-ground area in which the experience of the world can arise
Summary

- What is Embodied Cognition?
- Embodied Cognition and Modularity
- Embodied Cognition and Mental Representation
- Brain flexibility and cognitive strategies
- Outline of the course

Embodied Cognition

**Embodiment Thesis:** Cognition is deeply dependent upon features of the physical body of an agent.

The agent’s body (beyond the brain) plays a significant role in his/her cognition.

The body is not peripheral to understanding the nature of mind and cognition.

Embodied Cognition

Embodied accounts of cognition have been formulated in different ways in:

- Psychology
- Artificial life/Robotics
- Linguistics
- Philosophy of mind
- etc.

**Common Aspects**
Embodied Cognition

What is the role played by the body in cognition?

1) the body is a constraint.
Body features can make cognition easier or more difficult.

Parsons, LM (1987). Imagined spatial transformations of one’s hands and feet. Cognitive Psychology

Embodied Cognition

What is the role played by the body in cognition?

2) the body is a distributor.
Body shares part of the computational load with neural structures.

Cognition ≠ Brain


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Embodied Cognition

What is the role played by the body in cognition?

3) the body is a regulator.

The body regulates (e.g. through feed-back) cognitive activity through space/time.

Ensures cognition-action coordination.

Embodied Cognition

What are the theoretical implications of embodied accounts?

1) Primacy of goal-directed actions in real-time

2) Different forms of Embodiment shape differently Cognition

3) Cognition is constructive

Primacy of goal-oriented actions in real-time

Thought results from an organism’s ability to act in its environment

Organisms learn to move in an environment

They develop an understanding of their own perceptual and motor abilities...

…which are the first step for acquiring high-level cognitive processes
Primacy of goal-oriented actions in real-time

- Neurons in cortical areas VIP and PZ are multimodal, responding to tactile, visual, and sometimes auditory stimuli.
- The receptive fields are not always confined to the body surface, but extend like bubbles in the space around the body.


The same stimulus might be processed differently according to one’s arm-movements


Forms of Embodiment shape Cognition

The embodiment of an organism limits/prescribes the cognitive processes that are available to it

How organisms are embodied… move in the environment

…which is at the basis for acquiring high-level cognitive processes
Forms of Embodiment shape Cognition


Cognition is constructive

Concepts and categories are not passively apprehended from an observer-independent environment.

Concepts and categories are actively constructed based on our interaction in the environment.

Our body shapes how the world appears to us.

Cognition is constructive

The distance of stimuli within arm's reach is underestimated

Under tool-use, the distance of stimuli within tool's reach is underestimated

Witt et al. (2005). Tool Use Affects Perceived Distance, But Only When You Intend to Use It. JEP: HPP
Cognition is constructive

E.g., we process world’s objects according to spatial schemas from our own body


Summary

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Modularity

The concept of modularity has loomed large in philosophy and psychology since the early 1980s.

Modularity

Fodor draws the line of modularity at the low-level systems underlying perception, motion and language.

**Domain-specific:**

the narrower its range of inputs, the narrower the range of problems it can solve — and the more domain specific the module


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Modularity

Fodor draws the line of modularity at the low-level systems underlying perception, motion and language.

**Informational encapsulated & inaccessible**

It cannot access other information besides its' input (e.g., cannot access information stored in other modules)


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Modularity

Fodor draws the line of modularity at the low-level systems underlying perception, motion and language.

**Mandatory, fast & superficial**

Their operation cannot be modulated by conscious control. Once switched on, their operation are run automatically until completion

Modularity

Fodor draws the line of modularity at the low-level systems underlying perception, motion and language.

Dissociable & localized (neuropsychology)

Associated with specific anatomical correlates. Damage to one does not necessarily damage the other


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Modularity

High-level cognition is not modular. Central systems involved in belief fixation

Central Systems cannot be informational encapsulated as they require full access to information from central memory and to outputs of modular systems


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Modularity

High-level cognition is not modular. Central systems involved in belief fixation

Massive modularity

More recent accounts suggest that often high-level cognition meets the criteria of a modular system

Modularity

(Massive) Modularity accounts suggest little role played by other-than-brain structures (body) in cognition. Modular accounts see the body only as a source of input and the repository of output. Embodied theories instead suggest that the body is a distributor of cognitive processing.

Modularity

In contrast to Modular accounts, Embodied theories argue that the body is a constraint to cognition. E.g., Processing of visual stimuli is biased by one’s motricity. This is against “domain specificity” and “information inaccessibility.”

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Mental Representation

Standard theories of cognition assume that mental representations are symbolic structures with quasi-linguistic contexts.

Abstract

1) Representations are autonomous from perceptual systems, bodily-action and their operational details

(against embodied accounts)


Mental Representation

Standard theories of cognition assume that mental representations are symbolic structures with quasi-linguistic contexts.

Amodal

Vision

Olfaction


Mental Representation

Standard theories of cognition assume that mental representations are symbolic structures with quasi-linguistic contexts.

Standard theories of cognition assume that mental representations are symbolic structures with quasi-linguistic contexts.

2) Knowledge is organized **propositionally**, i.e., mental representations is organized symbolically. Symbols bear an arbitrary relation with its referent.

Embodied (grounded) accounts suggest instead that knowledge is not (only) amodal, and highlight instead a key role played by multimodal sensorimotor representations.

Representations of a concept are accessed through simulations of the sensorimotor events associated with it.

E.g., representation of the color “green” is a visual image of something of that color. It is mediated by activations of those neural structures which are normally used to see colors.
Not only cognitive and sensorimotor states share representational states, but cognitive processing re-activates sensorimotor areas to run perceptual simulations.

Mental Representation

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Cognitive Strategies

Embodied (or grounded) accounts do not exclude that part of the mental representations might also be symbolic and amodal.

Subject’s performance in many tasks can be accommodated by both modal and amodal explanations.
If cognition is grounded in sensorimotor representations, can we have different representations, each grounded in a different channel?

Corradi-Dell’Acqua et al. (2009). What is the position of my arm relative too my body? *Journal of Neuroscience.*
Cognitive control can be used to select whether a given stimulus (a hand) can be coded through a motor (bodily) or visual representation. Cognition can result from the dynamical interplay between several domains (domain-specificity is weakened!).

The brain is redundant → knowledge is represented in several visual/motor/amodal ways. The brain is flexible → able to cross traditional boundaries of cognition when needed.

### Embodied vs. Classicist/Cognitivist view

<table>
<thead>
<tr>
<th>Embodied view</th>
<th>Classicist/Cognitivist view</th>
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</thead>
<tbody>
<tr>
<td>Cognition = Interplay between brain, body and environment</td>
<td>Cognition = Brain</td>
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<tr>
<td>Primacy of goal-directed actions in real time</td>
<td>Primacy of computation (computer metaphor)</td>
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<td>Cognition is an active construction based on one’s goal-directed actions</td>
<td>Cognition is passive retrieval</td>
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<tr>
<td>Mental representations are (also) grounded in sensorimotor systems</td>
<td>Mental representations are symbolic and amodal</td>
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<td>Flexibility: boundaries can be broken if needed (e.g., by exerting cognitive control)</td>
<td>Modularity: informational encapsulated &amp; automatic</td>
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</tbody>
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Outline of the course

➢ How the brain codes the body:
  ▪ Neuropsychology: disturbances of the Body Schema
  ▪ Cognitive psychology & neuroscience

➢ Embodied cognition:
  ▪ Visual processing of other bodies/body parts
  ▪ Visual processing of biological movement

Outline of the course

▪ Visual processing of other bodies/body parts
▪ Visual processing of biological movement
▪ Memory & Conceptual Processing
▪ Language comprehension
▪ Social Cognition: the case of empathy
▪ Social Cognition: the case of moral reasoning