Embodied Cognition and Language

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November 23rd, 2015
Psychology of Language
• Cognition
• Conceptual Understanding
  – The Internal Lexicon
• Language Acquisition
• Embodied Cognition
First thoughts

• Draw your representation of the relationship between the past, present and future
• What has been your experience of something:
  – Difficult
  – Unethical
  – Angry
  – Important
Inner Workings

Superordinate

“Oak”

Association

Verbal Reply

Watt, 1905
Inner Workings

Superordinate

“Rat”
Inner Workings

Superordinate

“Volkswagon”
Inner Workings

Part

“Ant”
Inner Workings

Superordinate

“Dancing”
Inner Workings

Part

“Oak”
What is happening here?

How are your thoughts, experiences and concepts of words represented in your 1) mind 2) brain

Superordinate

“Oak”

Association

Verbal Reply
Mimetics

• Find a partner
• As quickly as you can communicate the following words
$1^{st}$ words

- Car
- Throw me the ball
- Riding a horse
- Love
Mimetics

- How easy was it to communicate
- Where there similar actions across the groups?
Mimetics

• Now switch roles and try to communicate these words
2nd words

- Freedom
- Political Debate
- War
Mimetics

- How easy was it to communicate
- Were there similar actions across the groups?
How is the brain like a computer?

Philosophers
Psychoanalysts

Behaviorists

Cognitive Psychologists

Dissatisfaction with introspection
Science is objective
Science depends on observation
Abandoning the mental
Functional Relations – stimulus/Response
Cognition’s Articles of Faith

1. Cognitive processes and representations exist
2. Many, many phenomena involve them
3. Including a cognitive “point of view” is essential to getting a full understanding of these phenomena
4. They can be studied scientifically
5. Cognitive phenomena can be viewed as information processing tasks or problems
6. Cognitive constructs are useful (if properly operationalized) in theorizing and experimentation
Cognition as Information Processing: Early Guiding Ideas

• Computing information likely involves logical operations (rules/algorithms) on a formal language (internal symbols) – Frege
• Internal symbols isomorphic with the world - Wittgenstein
• Computers are machines that compute information – Turing
• Human nervous systems are machines that compute information – McCulloch & Pitts
• Computers can store programs and it is the operation of the programs that is of interest – von Neumann
• Human nervous systems can store programs and it is the operation of the programs that is of interest – Wiener, Shannon, Chomsky
The Classical View of Cognition

• structure separate from process
  – Structure
    • set of individual symbols, symbol expressions
  – Process
    • set of processes that operate or manipulate the symbols in some way (creating, modifying, reproducing)
  – Symbols and the processes that operate on them are the subject matter of cognitive psychology
The Classical View of Cognition

• Functionalism
  – Cognitive states defined in terms of functional, causal roles, not in terms of the material structure in which they are instantiated

Fodor  
Pylyshyn

Putnam
The Classical View of Cognition

• Functionalism
  – To study cognition, cognitive psychologists study the mind, not the brain
  – Effectively ignores the brain
  – Mental states (functional kind of thing) are multiply realizable
    • i.e., they are implementable in all manner of physically different devices
      – human brains, computers, Martian ‘brains’
The Classical View of Cognition

• Two major problems for the classical approach
  – Based on current digital computer technology, not on the brain (not biologically plausible)
    • computer metaphor for cognition
  – Disembodied – does not take the body into account
Amodal Architectures

- Mind as computer metaphor
  hardware vs. software (Block, 1995)
  body vs. mind (independent)

- High-level cognitive operations (inference, categorization, memory) is performed using abstract, amodal symbols that bear arbitrary relations to the perceptual states that produce them (Newell & Simon, 1972)

- The traditional theory implicitly claims that even action concepts, like grasp, do not make use of the sensory-motor system. As a concept, even grasp must be disembodied.

- Thus, it is claimed that the concept grasp is amodal. Since it is a concept, it must be modality-free, even if it designates an action in a specific modality.
1. Neurons produce sensory representation
2. Perceptual states are transduced into non-perceptual representational format

3. Feature List
   - Car
   - Machine
   - Engine
   - Wheels

3. Semantic network
   - Vehicle
     - Car
     - Boat
   - Tire
   - Wheel

Brain Regions
1. Sensory Area (V1, A1)
2. Sensory Integration Area (hippocampus, VMPC, parietal)
3. Conceptual Knowledge Area (temporal)
Mental Lexicon

- Mental store of information
  - Semantic
  - Syntactic
  - Word forms
  - Orthographic
  - Phonological

Levelt, 1994
Semantic Network

Modality Specific Conceptual Organization

Animacy Conceptual Organization

Caramazza & Shelton, 1998; Collins & Loftus, 1975; Farah & McClelland, 1991
Selective Deficits in Naming

Damasio, Tranel, Grabowski, Adolphs & Damsio, 2004
Neuropsychological Model

Broca, 1861; Wernicke, 1875; Geschwind, 1965
Language in the Brain

(a) Articulatory network: pIFG, PM, anterior insula (left dominant).
   Spectrotemporal analysis: Dorsal STG (bilateral).
   Combinatorial network: aMTG, aITS (left dominant?)

(b) Sensorimotor interface: Parietal–temporal Spt (left dominant).
   Phonological network: Mid-post STS (bilateral).
   Lexical interface: pMTG, pITS (weak left-hemisphere bias).

Input from other sensory modalities
Via higher-order frontal networks

Nature Reviews | Neuroscience
Hickock & Poeppel, 2007
What Concepts Are: Basic Constraints

Concepts are the elements of reason, and constitute the meanings of words and linguistic expressions.

- Universal
- Stable
- Internally structured
- Compositional
- Inferential
- Relational
- Meaningful
- Independent of the words used to express them
Basic Ideas

- **Multimodality** — Permits universality
- **Functional Clusters** — High-level, function as conceptual units
- **Simulation** — Necessary for meaningfulness and contextual inference
- **Parameters** — Govern simulation, strict inference, link to language
What Concepts Are: Basic Constraints

• Concepts are the elements of reason, and

• Constitute the meanings of words and linguistic expressions.
The Traditional Theory

• Reason and language are what distinguish human beings from other animals.

• Concepts therefore use only human-specific brain mechanisms.

• Reason is separate from perception and action, and does not make direct use of the sensory-motor system.

• Concepts must be “disembodied” in this sense.
Concepts may be either

‘concrete’ (sensory-motor)

or

‘abstract’ (not sensory-motor).
Embodied Cognition

• How the body interacts with the world influences the types of cognitive capacities we as humans have
  – evolutionary perspective: function of
    • perceptual and motor systems
    • how they aid with survival
      – cognitive capacities are heavily dependent on knowledge gained through how our bodies can function in the world
What Concepts Can you think of that have body based understanding/description?
ELIZABETH GILBERT
author of The Last American Man

eat
pray
love

Jake Kurczek
Psychology 705
Conceptual Understanding

“Embodied” View of Cognition

1. Neurons produce sensory representation

1. Neurons in same area represent conceptual knowledge

Brain Regions
1. Sensory/Conceptual Area
Metaphorically Feeling

Green = Textural Metaphors
Yellow = Visual
Red = Haptic

Lacey, Stilla & Sathian, 2012
Semantic Grounding

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Barros-Loscertales, Gonzalez, Pulvermuller, Ventura-Campos, Bustamante, Vostumero ... & Avila, 2012
Abstract Concepts

• Not all concepts are about physical things (e.g. car) or what we do with our bodies (e.g. grasp)

• Some are about emotions, like love.

• Others are even less concrete, like freedom or argument.

• How does the body contribute to understanding those?
Conceptual Metaphor Provides Embodied Reasoning For Abstract Concepts

• Virtually all abstract concepts (if not all) have conventional metaphorical conceptualizations — normal everyday ways of using concrete concepts to reason systematically about abstract concepts.

• Most abstract reasoning makes use of embodied reasoning via metaphorical mappings from concrete to abstract domains.