

Sensorimotor Representations, Grounding & Frames

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Plan for the talk

- Say a few things about the nature of perception.
- Introduce the most relevant aspects of Frame & Grounded Cognition theories.
- **MAIN TARGET:** Examine the relation between perception, action & cognition.
- Argue that:
 - ✓ What resides at the lower level of any given frame are sensory and motor values.
 - ✓ Appealing to Frame Theory could allow us an insight of the intermediate stages on the basis of which cognition is grounded.
- Wrap it Up.

On Perceiving the World

- Selective Attention; Fixating; Features; Relations.
- Formation of Reprs; Storage.
- Initial rough sketch.
- Informational enrichment.
- **NOTE:** Storage of picked-up information in a manner that preserves the spatial relations between the object's parts, (stored in frames; associations), (Barsalou, 1999).

Framing the World

- Frames are recursive attribute-value-structures...
- ...**BUT not Infinitely.**
- At a conceptual level of analysis, a given concept is analyzed in terms of attributes (or 'features') of members of the category in question, which then take a given value for specific tokens. E.g. the concept CAR, has attributes such as COLOUR, which in turn take the value RED.

Grounding

- No amodal symbols but (multi-)modal reps.
- Bodily states cause and are caused by cognitive states.
- Cognition **simulates** perception.
 - “*Simulation is the reenactment of perceptual, motor, and introspective states acquired during experience with the world, body, and mind*”, (Barsalou, 2008).

→ Concepts are analysable/grounded in perceptual reps.

→ Grounding → Simulation → Associationism (as a tool₅ for examining the relation between P&A, and the

Getting Two Birds with One Stone?

- **WORKING HYPOTHESIS:** Given that frames are attribute-value structures, at the end point, i.e. ultimate level of analysis, of any frame there would be a **set of values**.
- **If cognition is grounded** on sensorimotor representations..., **then** it seems plausible to assume that the endpoint of any frame would be the point that **sensorimotor representations** reside.

Getting Two Birds with One Stone?

In this sense....,

- **Understand Frame Theory further** by examining the relation between perception and action.
- **Understand** (the stages of the) **Grounding** (process) by appealing to Frame Theory.

Sensorimotor Representations:

What are they?

- **Sensory Reps:** Info about sensory states, which are often taken to mean activation of our sensory apparatus (light reflections & about of bodily states (processing of proprioceptive and kinesthetic information).
- **Motor representations** carry information about the organism's outputs, actions or behavior, body schema.

Differences between S&M reps

- A distinct functional profile – contribute to distinct functions of the human body.
- Geographically spread/Underpinned by distinct brain areas.
- Using proprietary representational codes (*but see TEC*);
- Obey to different rules.

How are Perception and Action Related?

- A causal relation between the two (eye movements during visual perception).
- But how (exactly) do they interact?
- ‘Classical Sandwich’ views.
- Two main views:
 1. Constitution
 2. Functional Dichotomy

Is there a Constitution Relation?

- O'Regan and Noë's (2001) 'Enativist' views: **Register sensorimotor contingencies** related to a stimulus, (i.e. anticipate).
- Noë (2005): **without** dispositional motoric responses to visual inputs we would be **blind!**
- Kiverstein (2010): the content of perceptual experience is of a sensorimotor nature.

Is there a Constitution Relation?

- **Noë (2005): No perceptual content** without dispositional motoric responses to visual inputs, implies that motoric dispositions are constitutive for perception.
- **FOR: image stabilization:** a stimulus stabilized on the retina becomes invisible → **perception requires movements. BUT:** *we initially do see the stimulus in question, (specs of dust and blood vessels of the eye).*
- **FOR: Held and Hein's (1963) study on kittens** → **visual perception develops normally only in the presence of action;** → visual **perception necessarily involves understanding of motor responses. BUT:** the immobile kitten was still able to see and navigate around even though clumsily, (Prinz, 2006).

Are Action and Perception Functionally

Distinct?

- **Two distinct cortical pathways** of visual processing, the **dorsal**, ‘where pathway’/‘**vision for action**’, and the **ventral**, the ‘what pathway’/‘**vision for perception**’ .
- **Perception and action are:**
- **Cognitively distinct**, e.g. Jacob and Jeannerod (2003).
- **Functionally distinct**; (complex hierarchical system | two types of processing of stimuli, Jacob and de Vignemont (2010).
- **2 streams Partially dissociated | 3 streams** (*ventral; ventro-dorsal; dorso-dorsal* stream, Galesse (2007).
(the ventro-dorsal stream = interaction zone for ventral and dorsal streams. → a **functional coupling** between perception and action is implied).

Are Action and Perception Functionally

- Milner and Goodale (2010): **Double dissociation** between conditions associated with impairments in each processing stream:
- **Optic ataxia** – (**dorsal** stream – e.g. cigarette) – not explainable by motor, somatosensory, visual field deficits or acuity deficits.
- **Visual form agnosia** – **ventral** stream – compromised abilities to recognize familiar objects by sight.
- Predictions about performance of these patients in visuo-motor tasks were **empirically confirmed**; *BUT questioned* by Schenk (2006)
- Aglioti et. al.'s 1995 (**size-contrast studies | Optical illusions**).
- **PLUS: Motoric Impairments do not necessarily entail Compromised Perceptual Abilities:** Muscle atrophy; Degeneration of premotor neurons; Life-long congenital oculofibrosis; Myasthenia gravis.

So Far....:

- Perception and action **strongly interact**.
- **No conclusive evidence** either for a **functional dichotomy** or for a **constitution relationship**, in the sense of one being necessary and/or sufficient for the other.
- We'd be **better off by appealing to moderate views concerning the relation between perception and action**, such as TEC (Hommel et al., 2001), and Simulation Theory (Barsalou, 1999).

Theory of Event Coding

- TEC focuses on action planning.
- '**Perception**' = the **late cognitive products** of perceptual processing that represent specific features of actual events ***and not*** the **preceding** sensory processes that eventually lead to them.
- **Actions** = **early cognitive antecedents** of action that represent specific features of actions.
- The cognitive codes that represent perceptual objects are identical to those representing action plans.

Theory of Event Coding

- Both perception and action planning are **bound** on the basis of the **same mechanisms and structures**.
- Action planning and object perception follow the **same principles** followed during the process of integrating stimulus features in order to represent it.
- Thus, **coding of both** perceived and produced **events** occurs in virtue of the **same representational system**, most probably using the **same cognitive codes**.

Simulation Theory

- Thinking is **analogous to perceiving** (reenactment).
- Perception is underlain by activation in **both sensory and motor** parts of the brain.
- **Simulators** = concepts → stored reps producing **Simulations** = ways of concept individuation – (Proxytype Theory).
- Simulations occur in top-down & bottom-up manners.
- (Damasio's (1989) 'convergence zones' hypothesis/conscious access).
- **No *direct*** evidence that the same representations get reactivated. However...,
- During imagery quasi-perceptual representations are involved.
- **Closely related scanpaths** while viewing and imagery, i.e. the saccadic movements between perception and imagery are too similar to explain it any other way.
 - Brandt and Stark (1997); Chao, Haxby and Martin (1999); Norton and Stark's (1971) 'Scanpath Theory'.

Theories of Sensorimotor Reps & **Grounding**

Intersection of two points here:

- The **nature of the relation** between perception and action (Partly done).
- The issue of **the point at which** perception and action intersect (neuronal | cognitive).

Convergence under Constitution

Convergence at a Higher Level:

- **Theory of Event Coding:** The late output of a given perceptual experience will be *necessarily* fed in the process where the early antecedents of related action planning occurs – **commonly coded**.
- **(“Simulation Theory”) – Associationism:**
Necessarily (e.g. Hebbian learning; LTP) associate the late output of a given perceptual experience & the early antecedents of related action planning. NOT C-CODED. (*~simulate these intermediate level states*)
Vs.? Simulation Theory.

Grounding in the TEC way

- **Weaken** the notion of grounding **OR**
- Reps at the intermediate level of common **coding are in turn** analyzable/grounded in low level sensorimotor reps; the latter become idle once commonly coded...**BUT**
- Need to explain the relation between sensory and motor representations prior common coding.

Implications for Frame Theory

- Draw a **distinction between *formation*** of and ***activation/tokening/individuation*** of a given frame in cognitive tasks. (activation of a subset of reps, while the rest will become idle during cognitive processing).
- The **computational implications** of these suggestions in terms of frame theory are still to be evaluated.

Convergence under Constitution

Convergence at the Lower Level:

- **Need for an Interface between perception and action:**
 - **‘Mirror neurons’** (premotor cortex areas – commonly associated with action planning).
 - **Ventro-dorsal stream**, Galesse (2007) – (involves projections from the inferior parietal lobe to the pre-frontal and pre-motor areas) interaction zone for the ventral and dorsal streams.
- **BUT...**absurd to expect activation in the mirror system during execution of **all** general cognitive tasks.

Something has got to give!

Options for grounded cognition theorists:

- If read at face value: a **tension** between Grounded Cognition + the Constitution hypothesis (mirror neurons).
- → **Drop the strict (all-the-way) sense** of grounding or drop constitution.
- (Evidence suggests dropping constitution).

What if they are Functionally

- **Convergence at a Lower level:** Associationism: Concepts could be seen as grounded on sensorimotor representations, even without a constitutive relation between P&A.
- **Convergence at a Higher level:** TEC or Associations at a higher level.

Take Home Message

- **No conclusive evidence** (constitution or f-dichotomy) **BUT** constitution entails absurd implications...
- **TEC: good** reasons to assume that P&A converge at a higher level **BUT** a **compromise** for GCTs.
- **Regardless the outcome** of the P&A relation debate, concepts could be seen as grounded on SM reps brought together in terms of **associationism**.
- Plausibly talk about “**SM**” representations.
- Depending on whether TEC or Associationism is chosen as the most plausible scenario, **the endpoint of frames is either at a low or fairly higher level**.
- For Grounding → Follow down a Frame.

**Thank you for your
Attention!**

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Are Action and Perception Functionally

- **Predictions** of the dual visual system thesis: There will be a contrast in the performance of visual agnosic patients in visuo-motor tasks (e.g. passing their hand through a slot in a disc) and in perceptual judgment tasks (e.g. report the orientation of the slot) involving the same stimuli. Visual agnosics are expected to be significantly better in the visuo-motor tasks, while optic ataxics should be better in perceptual judgment tasks (and poorer in visuo-motor tasks).
- Predictions are **empirically confirmed**; *BUT questioned* by Schenk (2006): (impairments of the subject they cite is not due to a functional dichotomy between action and perception but merely to the subject's inability to encode spatial information in an allocentric frame irrespective of the nature of the task (motor or perceptual)).

Are Action and Perception Functionally

- Aglioti et. al.'s 1995 (size-contrast studies | Optical illusions), the automatic and calibrations required for skilled actions are mediated by visual processes that are separate from those mediating our conscious experiential perception. Each type of processing may depend on separate, visual pathways in the cerebral cortex.
- → Note though that it is not clear whether there is absolute and consistent immunity of visuo-motor processing to illusions, which nevertheless affect perceptual awareness.