Exploring consciousness
University of Valparaiso
September 6, 2018

Cognitive affordance-sensings

Joëlle Proust
http://joelleproust.org
Our problem

• Why do we need to revise belief-desire psychology by the addition of a new attitude, "affordance sensing"?

• Comparative and evolutionary arguments will be used.
Outline

1. Nonhuman metacognition: evidence
2. Implications for how metacognition is represented.
3. The missing type of representation: affordance-sensings
4. Arguments from the evolutionary function of rationality
5. Conclusion
1. Non-human metacognition: evidence
Main types of tasks eliciting Judgments of uncertainty

• Seeking for information (SI) tasks:
  Will an animal ask for information only when needed? (Call & Carpenter, 2001)

• Buying hints when learning (Kornell, Son, & Terrace, 2007).

• Choose-or-decline-to-respond (« opt out ») paradigm (Smith et al., 2006, Beran et al. 2010)

• Wagering tasks (risk icons for betting on a given response).

• Action control based on internal vs external confidence feedback (Beran et al. 2015)
Smith and/or coll. on metacognition in monkeys

• Rhesus monkeys decline most the most difficult trials in visual discrimination tasks (Shield, Smith & Washburn, 1997) and in memory tasks (Hampton, 2001).
• They generalize their U- responses to new tasks. (Washburn, Smith & Shields, 2006)
• Macaques also use U-responses with blocked feedback (Beran, Smith, Redford & Washburn, 2006)
Metacognition in Phylogeny:

Yes

- Primates:
  - chimps and orangutans search for info (SI)
  - Chimps have MC control
  - Rhesus macaques (SI & U-R)

- Marine mammals:
  - Bottle-nosed dolphins U-R

- Pigeons, bantams (Fujita & al, 2011): retrospective U-R

- Rats: Kepees et al. 2008

No

- Pigeons: no prospective U-R (Sutton & Shettleworth, 2008)

- Capuchin monkeys: no SI, no U-R (Beran et al. 2006)
2. Non-human metacognition: Implications for representational contents
Difficulties for a metarepresentational understanding of metacognition
A well established, traditional claim

Metacognition coincides with the acquisition, or possession, of second-order propositional attitudes such as "I believe that I believe that $P$", "I believe that I intend to $F$ etc".

E.g.

Self-attributing or evaluating a belief requires recognizing a first-order occurrent belief as a belief.
On this view,

**Metarepresentations are formed by a mindreading device**

A specialized representational device takes an occurrent thought content $P$ as input, and produces the embedding representation "I believe" (or "perceive", or "imagine", etc.) that $P$ as output.
“Our access to our own propositional attitudes is always interpretative” (rather than introspectable), even though “the evidence base for self-interpretation is somewhat wider than we normally have available when interpreting other people”

(p. 124)
Peculiar access to one’s mental contents does not make it special or privileged access: inferences are always needed.

- One may access one's thought contents on the basis of one's motor and linguistic behavior, on the basis of inner speech and rule application, or on the joint basis of inner speech, patterns of attention and emotion, and self-interpretation (Carruthers, 2009).
Evaluation requires an ability to represent mental attitudes as such

• In order to have a critical attitude toward their own cognitive states as well as to others, children must be able to first represent the world-representation link and recognize that, in certain circumstances, it is false or illusory.

• Evaluating whether a remembered name is correct requires recognizing a first-order occurrent belief as a memory (Perner & Ruffman, 1995)
A common false premise

• Evaluation and attribution of thought actually do not belong to the same kind of representational structure.
Animal (and human) metacognition taps on an evaluative form of thinking
3. The missing type of representation: affordance-sensings
Acting requires **minimally** a sensitivity to one of two types of "affordances":

- Opportunities & risks in the environment: **world affordances**

- Opportunities & risks in information acquisition/retrieval: **cognitive affordances** (Proust, 2013, 2015, 2016)
A historical note

- Affordance across the literature has had several meanings

- Kurt Lewin 1931: *Aufforderungscharacter* translated by *valence* by Edward Tolman

- James J. Gibson 1977: potential of action on the environment, supposed to be directly triggered and non representational
As the word "affordance" suggests,

- Such an attitude has the double function of detecting opportunities and acting on them.

- An AS is a conscious, non-propositional attitude whose function is to detect and evaluate the opportunities and risks present in an agent's current environment.

Propositional structure

Based on the contrast between an **object** being subsumed under a **concept**: [a is F]

- **Constituents** in a proposition can be combined at will in agreement with syntax
- **Conceptual structure** enables deductive inferences
- This structure is adequate for both verbally expressing and reporting attitude contents
Evaluative attitudes

No contrast between an object and a concept
No combinatorial ability
No deductive, inferential power
No embedding

But still structure:

• Predictive ability connected with reactive action schemas
• Associative network
• Graded sensitivity to affordances
• Graded control precedence
The semantic structure of evaluative attitudes (affordance sensings)

- Affordance\textsubscript{a} [Place=here],[Time= Now/soon],
- [Valence\textsubscript{a}],
- [Intensity\textsubscript{a} (on a scale 0 to 1)],
- [motivation of degree\textsubscript{d} to act according to action program\textsubscript{a}].

$\rightarrow$ All the constituents are associatively related to perceptual cues in the affordance sensing

$\rightarrow$ A subset may activate the full representation
Role of feelings in the semantic structure of affordance sensings.

Affordance-valence - intensity in this predictive/evaluative structure, taken together, constitute a feeling, whether

• « affective » (social-affective)
• Agentive
• Proprioceptive

(for a defense: see Proust 2015)
Noetic feelings represent epistemic affordances

Examples:

• Affordance \(\text{familiar/rememberable, clear, } [\text{Time= present task}]\),

• \([\text{Valence}_a], \text{positive}\)

• \([\text{Intensity}_a (\text{on a scale 0 to 1})],\)

• \([\text{motivation to act of degree}_d \text{ according to action program}_a]. \text{Identify! Remember! Accept!}\)

• New cues can be added over time
Informational source of noetic feelings?

Not primary thought content, but the dynamic signature of thought vehicle:

• Processing onset,
• intensity (increased coherence of cognitive activity over time)
• Latency to reach threshold (fluency)

predict together likely cognitive success of a given decision.

In summary: noetic feelings

- Express a relation, not a state of affairs
  - Indicate a subjectively relevant condition and motivate an action (« pushmi-pullyu », Millikan 1995)
  - Are evaluative and graded
    - Nonpropositional
    - Do not conceptualize, but detect and categorize affordances
Objection

• One cannot simply "invent" a new category of representations just because one does not know how non-human metacognition might influence non-human decision making.

• **Response:** there are evolutionary constraints that explain why two types of representation are needed.
4. Arguments from the evolutionary function of rationality

Affordance sensings as building blocks of control
A new approach to representation

The analysis of representational functions or attitudes has traditionally been conducted from inside-out: from mental state to behavioral and distal outcome.

Our proposal is to explain representations from outside in (from distal outcome to mental state): in other terms, to explain representations in terms of action control.
In virtue of the cost-benefit trade-off:

- An organism should only be motivated to act when the resources used in order to attain its goal are not likely to exceed, all things considered, the gain likely to result from acting (probabilistic benefit-cost ratio).
  
  E.G.: is it worth trying to get food or water when there is a high probability of being killed in this process?
In virtue of the cost-benefit trade-off:

- The anticipated gain
- The resources made available to reach it

are both a matter of respecting a temporal window.

Anticipated gains and resources available are just what affordance sensings have the function to evaluate and represent.
Affordance sensings =

cognitive action:
Cognitive affordance-sensings

Instrumental affordance-sensings
3 constraints on action

• **Temporal:**
  – How urgent is action?

• **Economical:**
  – How effortful will this action be?

• **Unpredictability**
  – How uncertain/complex/important/is success of this action?
3 action systems are meant to respond to each constraint

• Impulsive or emotional actions: acting on urgent affordances.

• Habitual/routine actions: acting on recurrent affordances

• Strategic actions:
  – Acting in an affordance-detached way: Cooperative, public or covered goals in changing, complex environments
Impulsive action

- Examples: running away out of fright, shouting when watching a game, ducking to avoid a projectile etc.

- From the function viewpoint, "impulsive" means what Frijda (1986) calls "control precedence"
Examples of Impulsive mental actions

• Feeling that one can’t clearly see something and taking a closer look

• Recognizing a face as familiar, and trying to identify the person.
Control-precedence in Impulsive action

- An agent intentionally performs her impulsive action **here and now**, possibly interrupting another ongoing action

- Impulsive actions are "reflex-like" and **shortsighted** (no apparent concern for the consequences).

- They react to **some particular features** of a present situation, ignoring others.

  Frijda (1986), Hursthouse (1991)
  Searle (1983),
Experimental evidence

Temporal features of impulsive action: Affordance predictions can be made only milliseconds after visual sensations register on the retina, i.e. before the categorisation of perceived objects is completed.

Barrett & Bar (2009)
Empirical evidence for a specialized system for impulsive reactings

- Impulsive actions involve activation of a ventral system, including the amygdala, insula, ventral striatum, and ventral regions of the anterior cingulate gyrus and prefrontal cortex:
  - Bechara, Damasio & Damasio 2000
FIGURE 10.3. High road and low road to the amygdala. The amygdala receives inputs from sensory processing regions in the thalamus and cortex. The thalamic pathway, the low road, provides a rapid but crude representation, while the cortical pathway provides slower but more elaborate representation. The low-road inputs are thought to initiate amygdala processing, and the cortical inputs build upon this initial processing. Both pathways in all likelihood process emotional stimuli unconsciously, with conscious awareness of the stimulus requiring prefrontal areas (see Figure 10.4).
Impulsive action

- Philosophers have suggested that these actions are too quickly formed to respond to beliefs and associated desires.
- They are done "in the grip of an emotion".
- For this reason, some authors claimed them to be "arational" rather than irrational: although intentional, the agent did not do it for a reason.

Hursthouse (1991), Pacherie (2002), Scarantino (2014),
Resisting arationality

- The function of impulsive actions is to swiftly trigger an appropriate response to an unexpected, urgent threat or opportunity.

→ They are “reactings”.
Routine action

• Performed when an agent deals with habitual, recurrent situations, such as driving, preparing food, adjusting posture.
• Cognitive examples: checking up a bill, trying to remember a fact, a date, a forgotten shopping list etc.
• Control precedence: controlled "here and now" by recurrent schemas in the environment and their reward feedback.
• Automatic and shortsighted
Similarity with impulsive actions

- Performance "in the grip of a habit" vs. "in the grip of an emotion".
- Practical reasoning not involved.
  - Shortsightedness
  - Control precedence (interference with planned action)
- Little focal attention, or no conscious awareness (e.g. unconscious driving).
Similarity with impulsive actions

- Perceived objects are evaluated as allowing the agent to achieve a given end, in an embodied way
- practical reasoning **not** involved.
  - shortsightedness
  - control precedence (interference with planned action)
- The associated dispositions to act consist in **pragmatic schemas**:
  - the agent feels immediately and unreflectively "drawn to act in a certain way", (Dreyfus & Kelly 2007)
  - as a function of the **intensity and valence** of the sensed opportunity.
Differences with impulsive actions

– Different types of feelings involved: less affective, although having a gradient of valence and intensity
– Fluctuate with the time of the day, context, and cultural environment

Much more culture specific
Empirical evidence for an habitual "model-free" action system

- Habits are acquired through **extensive experience** by a process of **model-free** reinforcement learning.
- Habit = changes in the striatal responses, corresponding to stabilized action templates (Jog et al., 1999)
- Unlike goal-directed, model-based control, habitual control **cannot**
  - direct action selection according to new outcome utilities
  - Be sensitive **to outcome reevaluations**.

Daw et al. (2005), Niv, Joel and Dayan (2006)
Routine mental actions

• Are part of pragmatic schemas acquired through education and cultural practices.
• Are based on fluency, i.e. ease of processing, which heuristically predicts validity or truth (in appropriate contexts)
• satisfy our primary trade-off
  – being repeated over time, they are processed effortlessly and reliably.
  – They have inertia, however, and cannot easily be modified.
Examples of routine mental actions

- Question asking of a certain type (culturally driven)
- Trying to respond accurately/vaguely to questions.
- Looking up a number in a phone book/on internet,
- Reading newspapers at a given time of the day,
- Writing and consulting one's organizer
Strategic action

• Requires coordinating one's thoughts and actions in relation to a goal to be reached in the future, independently of present or later solicitations.

• Is the mode of action selected for high-stake goals in more complex, uncertain, but still relatively predictable environments.

• Is performed and guided as a consequence of a prior intention, often at a temporal distance from its initiating mental event.
Strategic actions: are not based on affordance-sensings

• Do not focus only on present opportunities or risks
• No control precedence (tend to be interfered with)
• Are not formed automatically (require conscious attention)
• Crucially involve beliefs and the mental action of planning to act (prospective memory).
• Are not controlled by habitual reward feedback
• Are resource demanding
Empirical evidence in favor of a system for strategic action

• The agent uses a forward model to work out the ultimate outcomes consequent on his planned actions by searching through the tree of state-actions consequences, along with the current utilities of outcomes.

  Doll, Simon, Daw (2012)

"In a model-based system, a cognitive map or model of the environment is acquired, which describes how different situations are connected to each other. Action values for different paths can then be computed by a sort of mental simulation (forward or tree-search strategy)"

  Gläscher, Daw, Dayan Doherty (2010)

Distinct neural signature for model-based strategic actions (LatPFC, FPC frontopolar prefrontal cortex)
Strategic cognitive actions: examples

Planning physical strategic actions is itself a strategic cognitive action:

• Relies on practical reasoning, beliefs, anticipations of consequences

Planning mental strategic actions: goal of acquiring epistemic competences by training

Planning for attaining collective epistemic goals (science, legal investigations, etc.)
5. Conclusion
Each type of action is triggered by a given type of sensed value:

- impulsive action system: fast detection of risk or error requiring speedy action → reaction to affordance sensing
- routine action system: detection of recurrent opportunities and risks in stable contexts → reaction to affordance sensing
- long-term future changes: → affordance sensing needed to signal error
Impulsive and routine actions are two forms of Reactings

- Reactings have a relational representational format: they are both indicating a condition and motivating an action.

- They have a specific, affordance-based format that is nonconceptual and nonpropositional.
The rationality of affordance-based reactings

• Although they are not based on propositional attitudes, and hence have no truth-conditions, affordance sensings have a gradient-based structured content, with conditions of felicity. (Proust, 2015, 2016)

• Although reactings are not voluntary in the sense of being triggered by a propositional intention, they involve an instrumental know-how and a flexible, motivated trigger that can be retrospectively endorsed or not.
Type of evaluative representation depends on the constraints applying to mental action.

- Reactive (Impulsive and routine) metacognition have an evaluative, feeling-based representational structure.
- Strategic metacognition takes advantage of transmitted concepts, such as knowledge, plausibility (and the associated deductions).

(Proust, 2014)
Thanks for your attention!

Articles online on:

http://joelleproust.org