

Disorientation Graduate Seminar

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# Metacognition & disorientation

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# Goal of the present talk

Discuss disorientation as a noetic feeling :

- Its specific function in cognitive agency
- Its representational format



# Outline

1. What is a cognitive action and how is it controlled and monitored? Internal predictive feedback as a basis of discrepancy signals
2. The predictive structure of evaluation
3. Noetic feelings as action guidance
4. Disorientation and its modes

# **1 - What is a cognitive action?**

# Examples of cognitive actions

## Epistemic function

**Perceptual attending**

**Dead reckoning  
orientation**

**Directed reasoning**

**Directed memory  
retrieval**

**Directed visualizing**

**Directed imagining**

## motivational function

**Planning**

**Controlling emotion**

**Preference management**

How do epistemic actions contribute to world-directed action?

- A cognitive action is usually embedded in an instrumental (world-directed) action. For example:
  - In order to shop for food, I need to remember the items on the list (which I forgot to bring with me).

# Example:

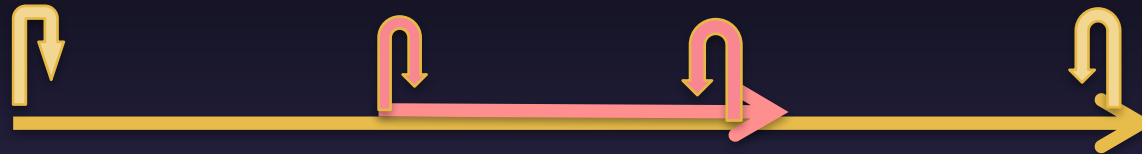
- The particular strategy of remembering (exhaustivity/accuracy) is selected for instrumental reasons.

# Cognitive actions are objectively regulated by two sets of norms

- **Instrumental norms** determine what cognitive action, if any, should be performed given the agent's ultimate goal.
- **Epistemic norms constitutively** determine the correctness conditions of a selected cognitive action.



Epistemic action:  
epistemic norm



Instrumental action: norm of utility

# Distinct epistemic norms constitute distinct cognitive actions

- Accuracy (memory, reasoning)
- Comprehensiveness or exhaustivity (memory, reasoning)
- Coherence (fiction, demonstrative reasoning)
- Consensus (negociation, deference to authority )
- Intelligibility or fluency (perceptual judgment, epistemic vigilance)

# Action monitoring has two temporal dimensions

- One is future-oriented: am I able to perform this action?
- The other is retrospective: is the action just performed correct?

# What is action monitoring

- Action monitoring, in the case of physical action, consists in checking whether a planned action, once selected,
  - can be performed,
  - Is being performed as predicted,
  - has been successful in attaining its goal

# Mental action monitoring

- Action monitoring, in the case of a cognitive action, also consists in checking whether a planned action, once selected,
  - can be performed,
  - Is being performed as predicted,
  - has been successful in attaining its goal

# Predictive: Self-probing

Before trying to act mentally, one needs to know whether, e.g.,

Some item is in memory (before trying to retrieve it)

One has epistemic competence in a domain  
(before one tries to predict an event)

One is sufficiently motivated to act in a certain way  
(when planning)

# Retrospective: Post-evaluation

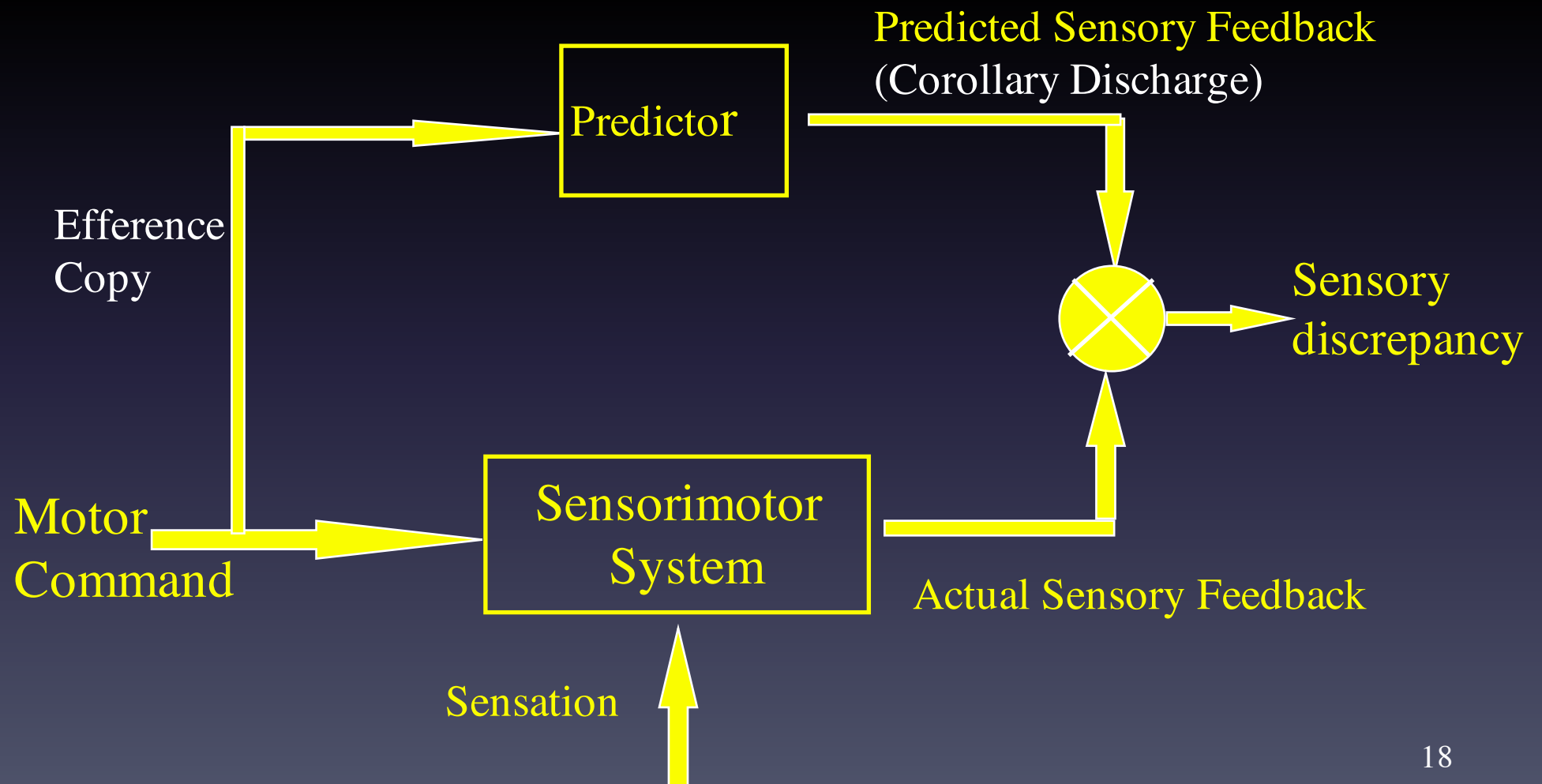
- Performing a mental action entails the ability to evaluate its success
- One needs to know, e.g., whether
  - ✓ The word retrieved is correct
  - ✓ One's reasoning is sound
  - ✓ One does not forget a constraint while planning

- **Pb: what kind of information can a subject use to compare what to expect and what is observed in monitoring her mental actions?**

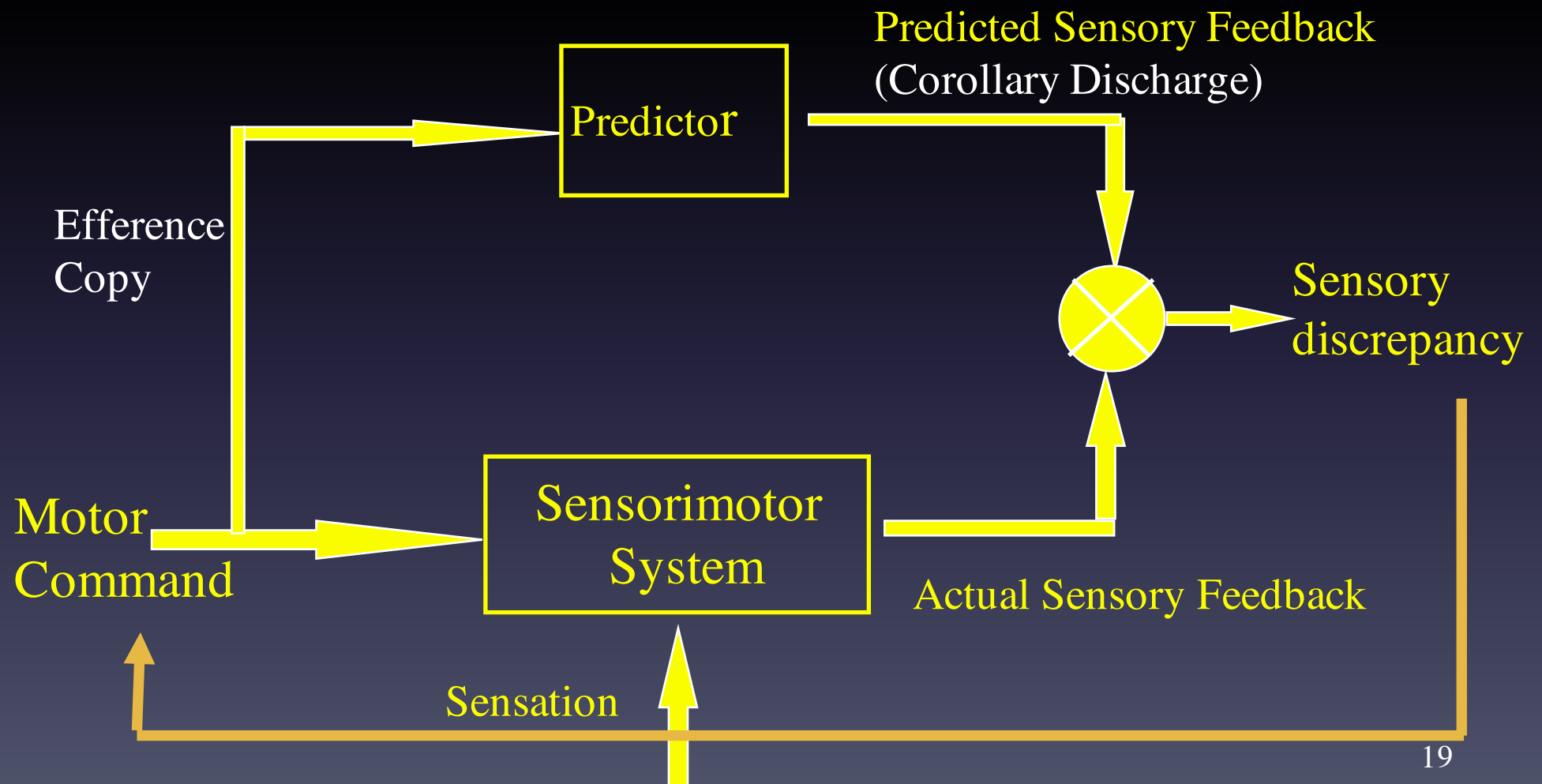


## 2. The predictive structure of evaluation

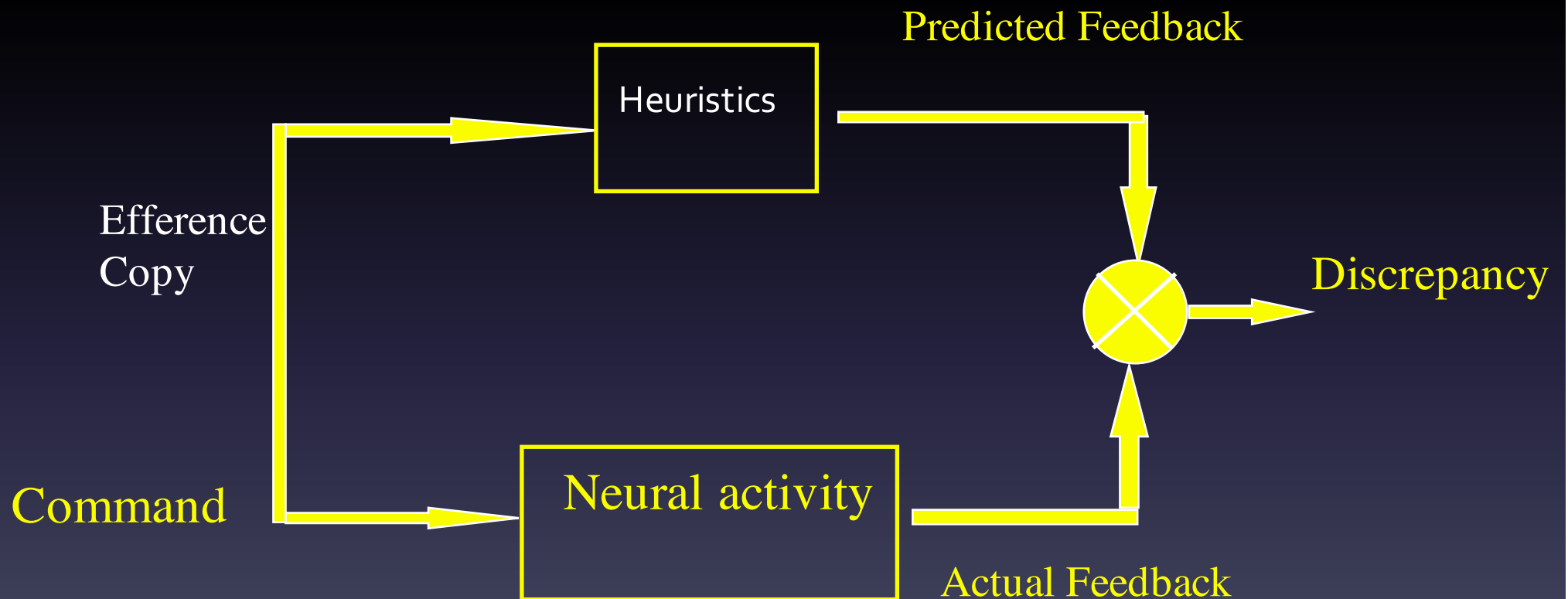
# Bodily action monitoring



# Bodily action monitoring



# Cognitive action monitoring



## ❖ Prediction as a basis of control and of monitoring

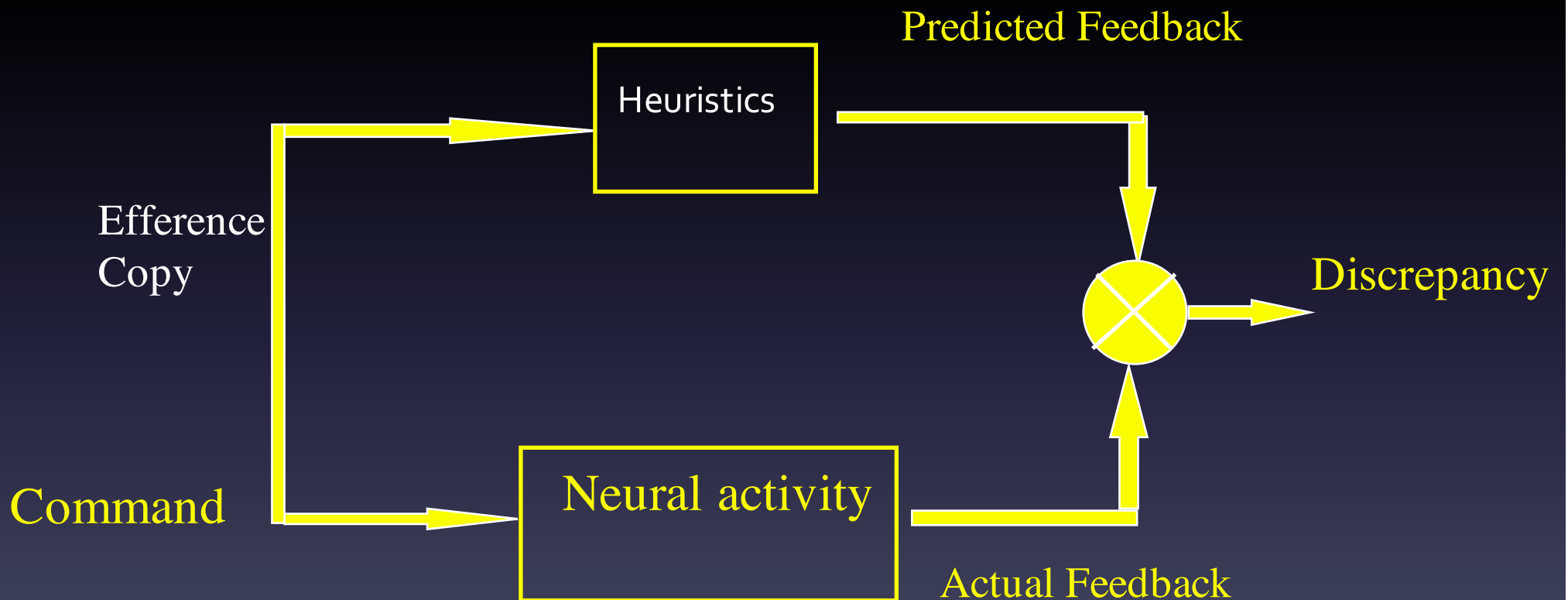
**Self-probing** : predicting, from a set of cues  $S_1$ , whether a given action can be successfully performed.

**Post-evaluating**: predicting, from a set of cues  $S_2$ , whether the outcome reached is likely to be correct.

# Set of cues depend on predictive value for a selected action

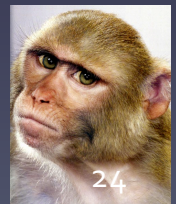
- what information to use is closely related to the correctness conditions for a specific cognitive or physical action.
- Set of cues = unconsciously extracted and used predictive heuristics

# Cognitive action monitoring



# Kiani & Shadlen, 2009

- They found that the firing rate of neurons in the lateral intraparietal cortex (LIP) correlates with the accumulation of evidence, and the degree of certainty underlying the decision to opt out.
- This result fits nicely with an accumulator model of judgments of self-confidence.





# Metacognitive heuristics

- **Cue familiarity**: elicited by the terms of the question (Reder, 1987)
- **Overall accessibility** of pertinent information regarding the target: elicited by the activity triggered by the question (Koriat, 1993)
- **Fluency heuristic**: responses that come to mind quickly are deemed correct (Kelley & Lindsay, 1993)

# Other activity-dependent heuristics

- Neural-signatures of first-order processes: Kepecs & Mainen (2012).
- Predictive interoceptive cues from the respiratory, circulatory, digestive, and endocrine systems: Barrett & Symons (2015), Park & Tallon-Baudry (2014), Chua & Bliss-Moreau (2016).
- Proprioceptive (postural, facial) cue-based heuristics (Stepper & Strack (1993))

# The accumulator model

. Evidence for the two alternatives is accumulated in parallel, until one of the evidence totals reaches a criterion value, and the associated response is emitted.

Vickers & Lee, 1998

# The accumulator model

An adaptive accumulator is a dynamic comparator, where the values compared are rates of accumulation of evidence relative to a pre-established threshold for each possible answer.

# How is calibration performed?

- A secondary type of accumulator, called "control accumulator", accumulates positive and negative discrepancies between the expected and the observed levels of confidence in two independent stores.
- If, for example, a critical amount of overconfidence has been reached, then the threshold of response in the primary accumulator is proportionally reduced

Vickers & Lee, 1998).

### **3. Noetic feelings and action guidance**

# Noetic Feelings

- Are **experienced** before and after an epistemic action,
  - Are motivational ingredients in metacognition
- They have the function of selecting and monitoring epistemic actions

# Cross-over model: a summary (Koriat, 2000)

Metacognitive experiences are

- implicit in their antecedents (unconscious processing)
- (once formed): explicit in their consequences (controlled decision-making)
- Their guidance role is related to their having **valence & intensity in a gradient structure**



# Noetic Feelings

## Predictive

- cognitive effortfulness
- Familiarity
- knowing
- Tip of the tongue

## Retrodictive

- Uncertainty about correct performance
- Uncertainty about existing competence
- Feeling of being right
- Feeling of understanding

# What are feelings, in general?

- "Feeling" denotes a reactive, subjective, embodied experience with a distinctive embodied phenomenal quality and a "formal object", which may or may not coincide with the embodied experience.
- "Reactive" means that feelings are closely associated with an appraisal of a present property or event.
- The reactive experience has a given intensity and valence

## Representational structure (Proust 2015)

- Feelings are nonconceptual representations which analogically predict affordances.
- Affordances are opportunities of action
  - Feelings constitute a modular type of nonpropositional representational format

# Representational structure of feelings

- A feeling is indexing an *occurrent* (relational) affordance, rather than an individual event or object.
- Affordance<sub>a</sub> [Place=here], [Time= Now/soon], [Valence<sub>a=+</sub>], [Intensity<sub>a=.8</sub> (on a scale 0 to 1)], [motivation to act of degree<sub>d</sub> according to action program<sub>a</sub>].

**Proposal: noetic feelings have a gradient representational structure similar to that of other feelings** (Proust, 2015, 2016)

Noetic feelings express *an epistemic affordance* as being incident (at a time): *e.g.*,

Now, poor (excellent etc.) A-ing affordance where A-ing is the future or past success of a current cognitive performance

- Content triggers the associated *cognitive program* (trying to remember, accepting as valid and deciding what to do, etc.)

What are the functions of noetic feelings?

# First function: evaluation

## Predictive

- cognitive effortfulness
- Familiarity
- knowing
- Tip of the tongue
- Coherence,  
incoherence

## Retrodictive

- Uncertainty about  
correct performance
- Uncertainty about  
existing competence
- Feeling of being right

## Second function: motivation to act

Once a performance is appraised, noetic feelings are supposed to **motivate a decision in agreement with the appraisal** (e.g., launch the cognitive action/accept its cognitive output)

This second step involves “control sensitivity”:  
agents can have reliable feelings of confidence in a performance, and fail to apply them adequately.



## Third function: epistemological

- Noetic feelings allow agents to **reliably** evaluate their epistemic states
- They are the potential basis of agents' being **entitled** to taking their perception, memory, etc. to be valid.

Burge (2003), Proust (2008)

# The third function: epistemological

To be reliable, however, noetic feelings must be:

- **Well-calibrated**: the standard (expected value) for a cognitive task must be based on previous sufficient, unbiased recurring feedback. (*Loussouarn et al. 2011*)
- **Relevant** to a given epistemic acceptance
- **Sufficiently informative** for an appropriate decision to be taken.

# 4. Disorientation and its modes

# Defining disorientation

- Casati & Fernandez-Velasco
  - a subjective feeling of being lost
  - An objective failure in spatial alignment between expected and perceived spatial affordances

# Defining disorientation

Casati & Fernandez-Velasco:

- emphasize that objective and subjective disorientations are dissociable, because of the proneness of metacognitive feelings to various illusions.

# These illusions are interesting to discuss

- They remind us that the spatial dimension is overruled, in brain functions, by various temporal features of cognition and of metacognition.

- One feels well-oriented when path integration by self-motion cues can be conducted thanks to a consistent comparison between internal & external feedback

Eichenbaum and Cohen (2014)

- What, then, are the sources of divergence between internal and external feedback?

# Fluency heuristic (no trade-off)

- Familiarity is elicited by mere exposure:
- A sense of subjective fluency (ease of processing) results from context-predictable **quick processing – a temporal feature** (in contrast to variable features of context).
- Familiar stimuli are used to guide specific routine behaviors (Proust, 2015)
  - S expects familiarity feelings, and uses them to perform low-cost cognitive actions, such as spatial and sensorimotor routines.



# Trade-off fluency-informativeness

- Meeting a familiar face **in an unpredictable location** raises an informational issue (conflict internal/external feedback): → potential cognitive failure to recognize this person
  - Hence cognitive affordance and social or instrumental affordances are at stake
- **It is no longer a pleasant feeling.**

# Trade-off fluency-informativeness

- This trade-off applies to places: scenarios where you
- should recognize a place, remember a trajectory, and do not, or
- should not recognize a place, and do.

# To what extent is a feeling of disorientation merely spatial?

- It is arguable that a feeling of disorientation is spatial because it engages our navigation in space.
- One might want to contrast:
  1. spatial relations (eg to the left of a landmark)
  2. Sensori-motor commands triggered by spatial features
  3. Spatial maps

## 3 types of spatial computations involved in disorientation

- the human hippocampus and entorhinal cortex support **map-like spatial codes**,
- posterior brain regions anchor maps to fixed **environmental landmarks**,
- hippocampal and entorhinal spatial codes are used in conjunction with frontal lobe mechanisms to **plan routes** during navigation.

- "These basic elements of cognitive map based navigation-spatial coding, however, may be applied to *nonspatial domains* to provide the building blocks **for many core elements of human thought.**" (Epstein, Patai, Julian & Spiers, 2017)

# Spatial cognition permeated by episodic memory

- The existence of time cells offers a parallel temporal organizing mechanism to the spatial organizing mechanism offered by place cells, supporting our notion that the hippocampus represents episodes by mapping events within a framework of time as well as space.

(Eichenbaum & Cohen, 2014)

# An additional temporal component in perceptual metacognition

- The neural signatures involved in fluency heuristics and corresponding confidence gradients, rely both on
  - a *temporal* information from distinctive *functional areas*
  - *on the distribution and intensity of activity across sub-systems*

# Potential sources of disalignment

- Explored through scenarios in Casati & Fernandez-Velasco
- An additional scenario is worth emphasizing, in which an initial mistake in spatial coordinates (unrevisable) makes a local map conflict with an inclusive spatial map.



# Partitioned disorientation

- On this scenario:
- A subject first experiences a given landmark – say the house she wants to buy – as being exposed to the east on the street side, and on the west on the garden side.

# Partitioned disorientation

- She later realizes that she was wrong. the street is actually on the west of the house, and the garden on the east.
- She however discovers herself unable to revise her spontaneous sense of orientation with respect to the whole area, although she can revise her conception of the general map.

# Partitioned disorientation

- This illustrates the dominance of episodic memory on spatial cognition, as far as spatial projection and control is concerned.

# Take home messages

- Disorientation reflects brain predictions through specialized heuristics
- These heuristics are driven by the cognitive action as selected.
- Disorientation has to do with context (valence, and context-based arousal)

Thanks for your attention.



Articles and presentations downloadable at:

<http://joelleproust.org>