

What cognitive abilities are indispensable to experience welfare?

Berry M. Spruijt

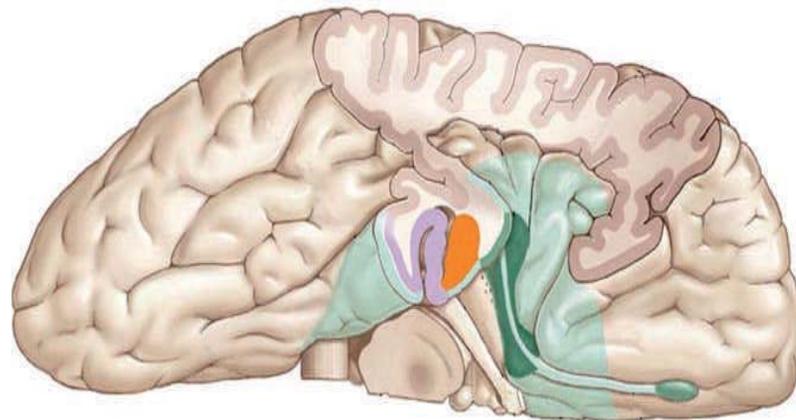


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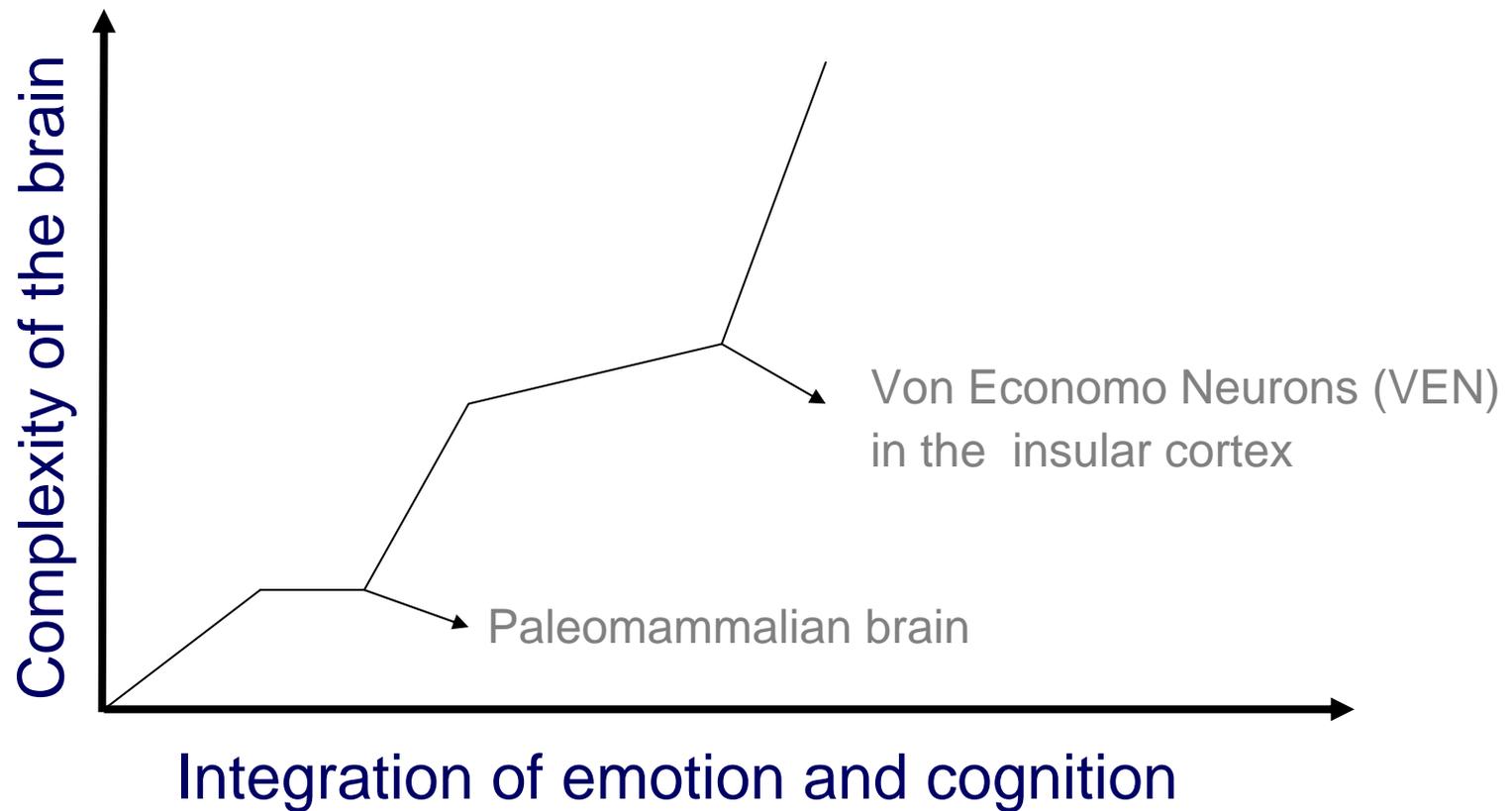
The ability to experience welfare depends on:

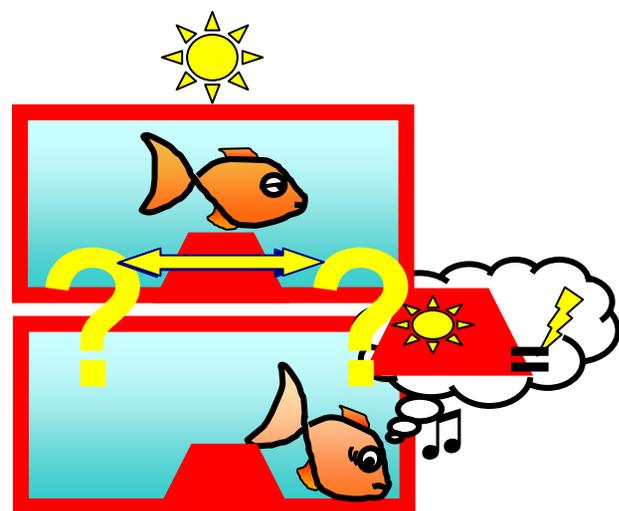
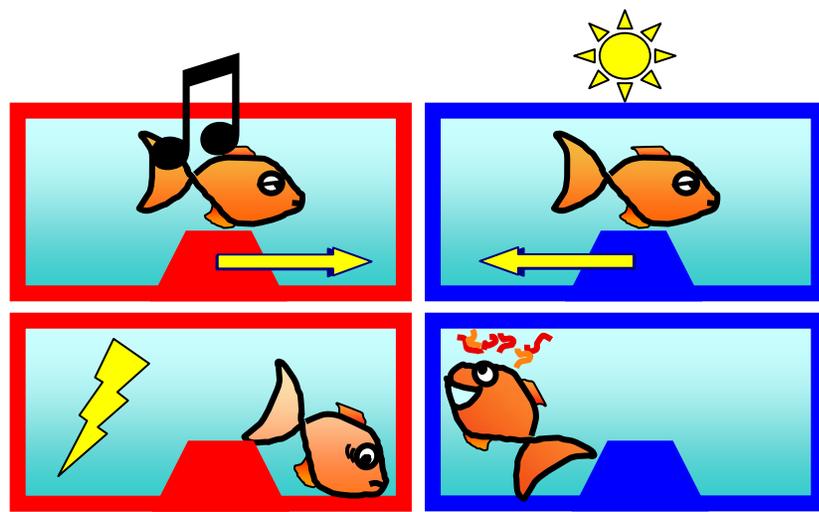
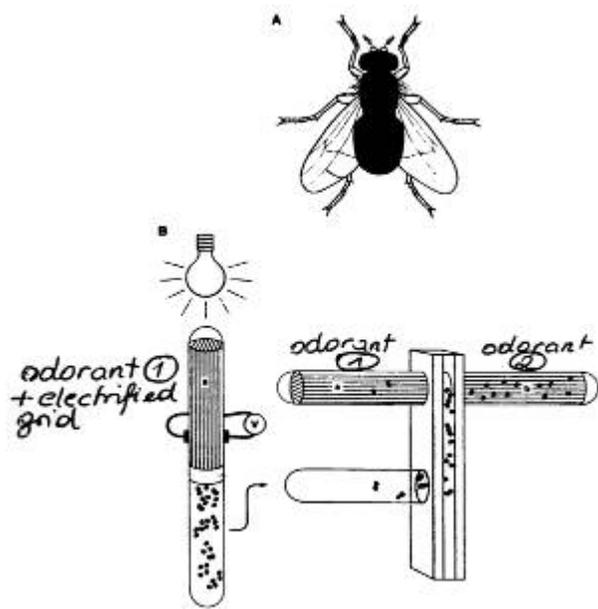
1. The complexity of the brain: size and structure
2. Cognitive abilities: memories and expectancies
3. Integration of emotion and cognition



Nature Neuroscience Reviews: How do you feel — now? The anterior insula and human awareness. *A.D. Craig (2009)*

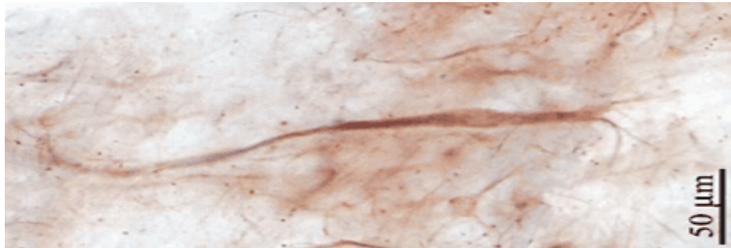
Ability to experience the own state



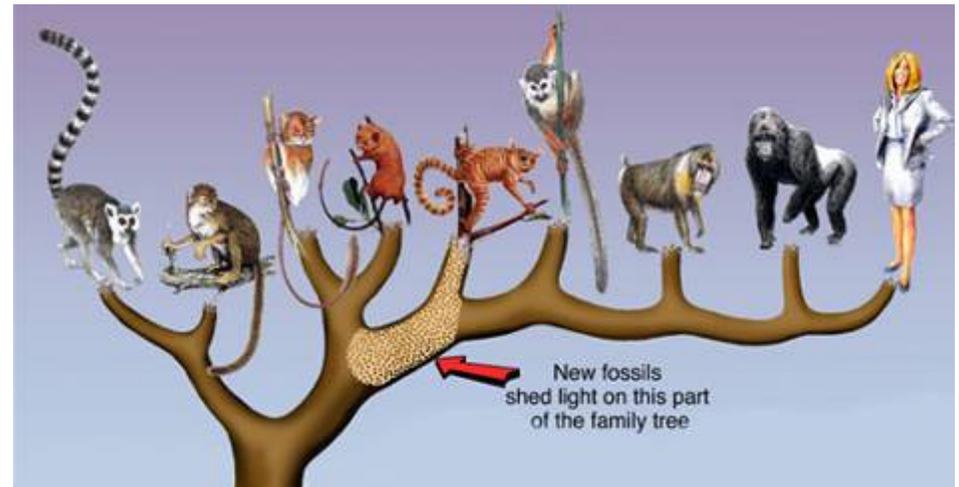


Size:
not all that matters

Van Economo Neurons –VEN



in humans - - - ,
whales, dolphins,
primates, elephants



Capacity to understand and
give social signals

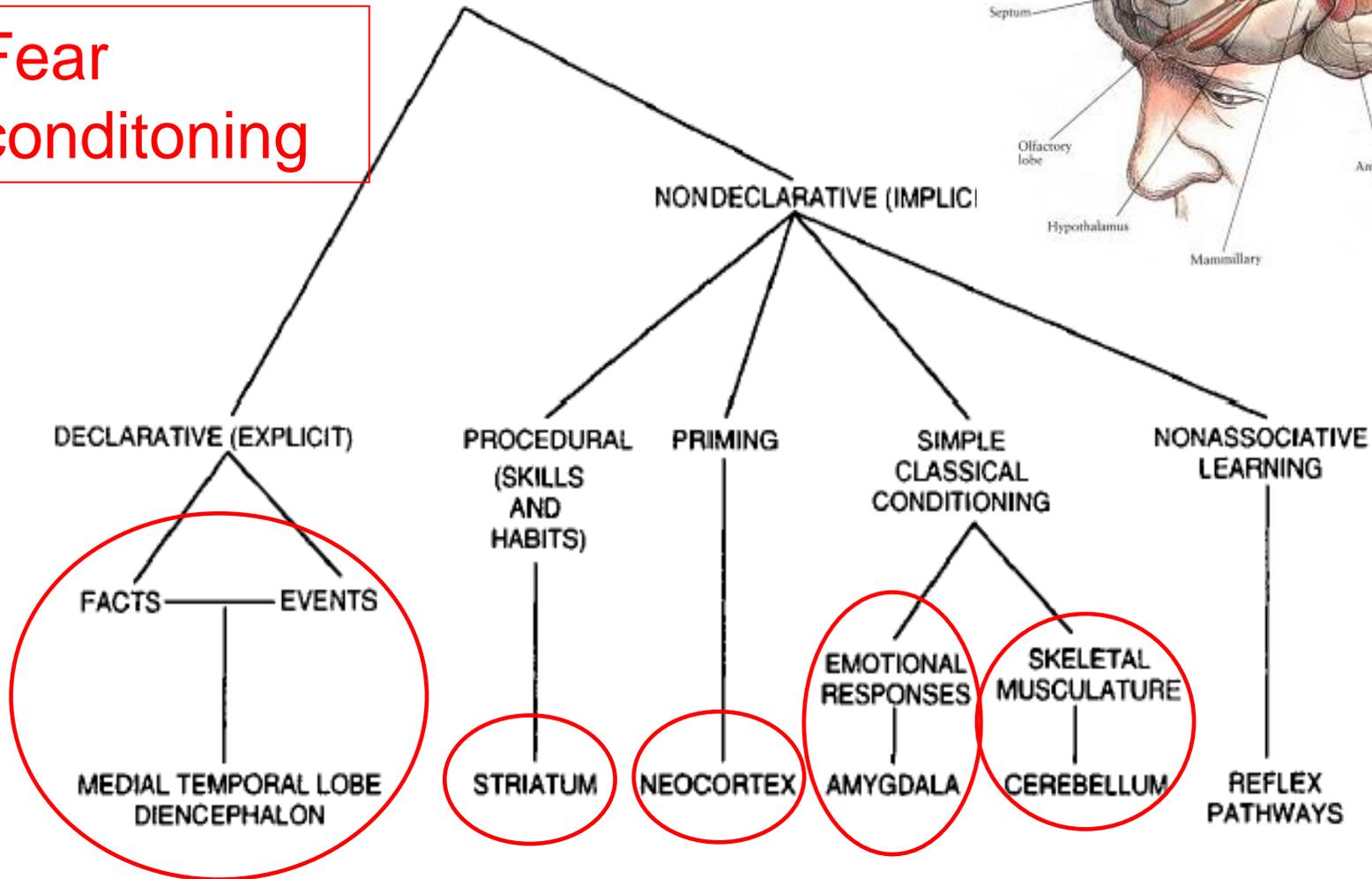
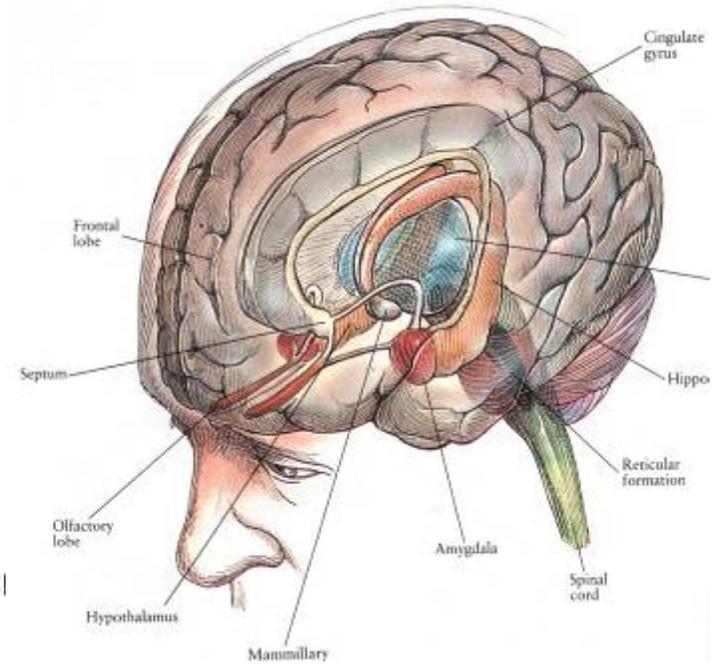


Levels of “cold” cognition

1. Sensitisation / habituation: *every organism*
2. Association, classical conditioning: *snails*
3. Operant conditioning: *vertebrates*
4. Multiple concurrent discriminative learning: *birds*
5. Spatial representation; spatial orientation
6. Absolute and relative concept: select oddity based on different dimensions (apple, pear, ball)

Memory systems

Fear
conditioning



Emotions:

a complex preprogrammed set of responses applicable for a class of stimuli.

Emotions have centers of

- Command at the hypothalamic level
- Evaluation at the meso-limbic level
- Inhibition and excitation at a limbic level

Emotions are phylogenetically old answers for a standard problem.

Cognition affected by Emotion

- Memory is affected by emotion and stress (*Oitzl*)
- State dependency
- Interpretation of known signals are biased by emotional state: *cognitive bias* (*Mendl*)
- Animals know their emotional state: *discrimination learning* (*Colpaert*)

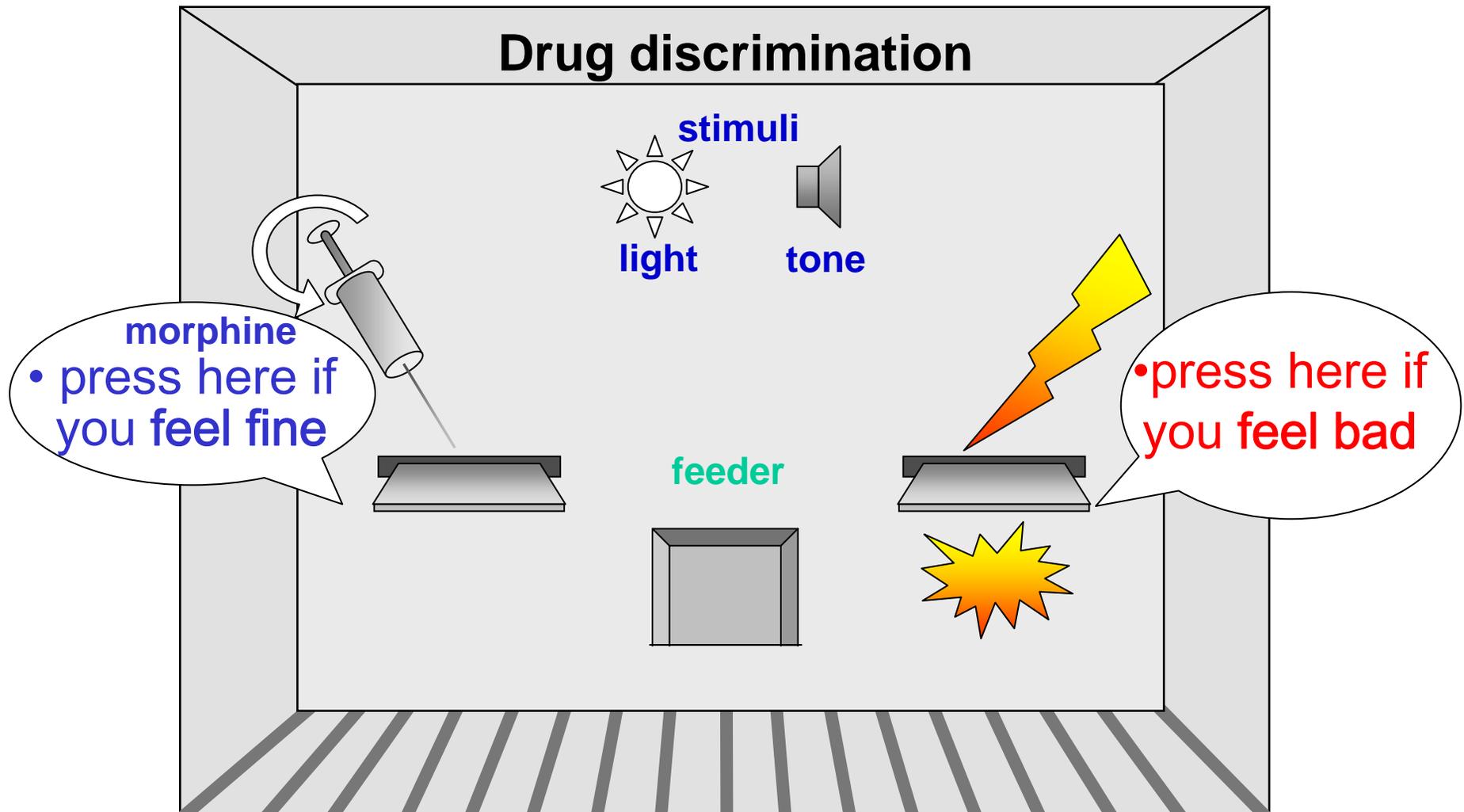
Cognitive bias



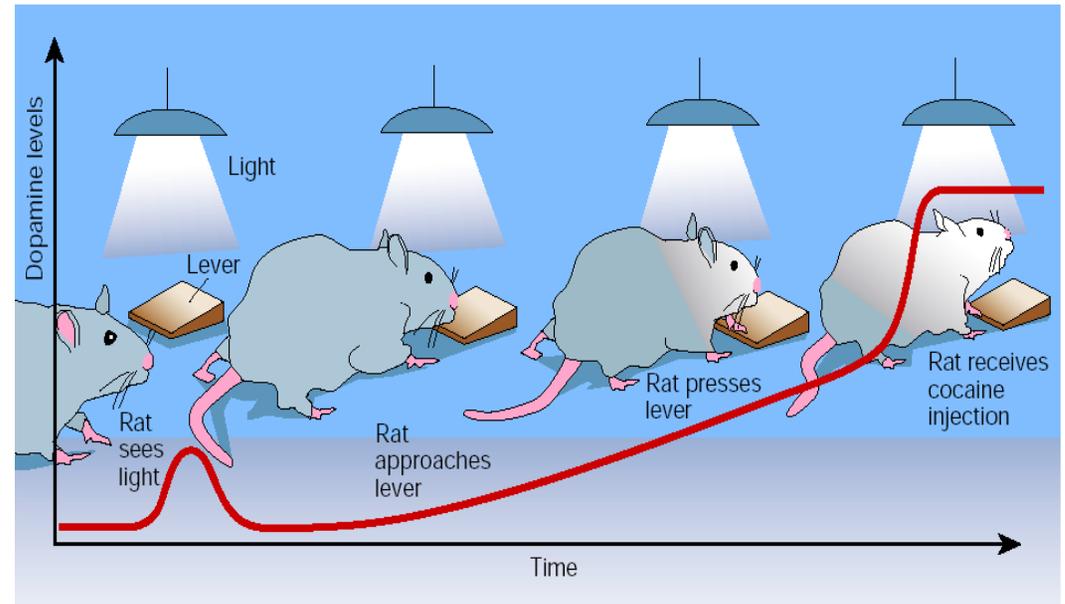
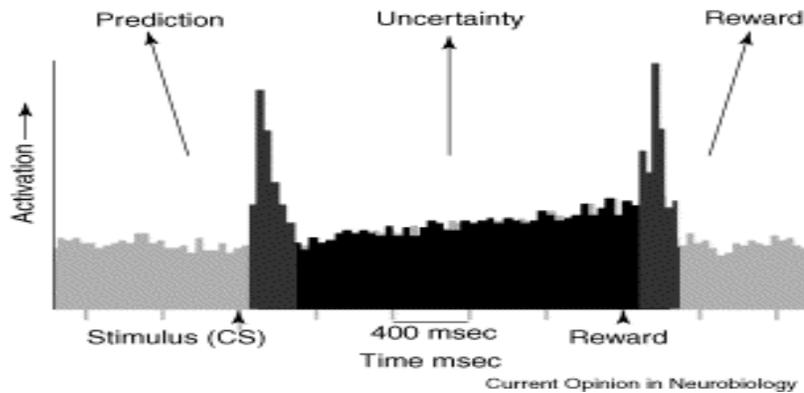
- Optimistic or pessimistic disposition
- Interpretation of ambiguous stimuli
- Stressed animals are more pessimistic



Animals “know” what they feel



Dopamine motivates reward-seeking behavior and signals the receipt of a reward.



Philips et al NATURE, 10 APRIL 2003

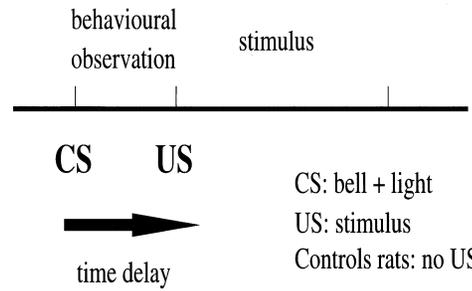
Subsecond changes in dopamine levels in the nucleus accumbens in rats.

The animals had been trained to press a lever to receive an injection of cocaine. Rats had learnt to associate a flash of light and a tone with the drug >> a brief pulse of dopamine in response to the audio-visual cue.



SOCIAL REWARD IN RATS

Procedure anticipation-experiments



Parameters: hyperactivity, number of behavioural changes



Conditioned expectancy is affected by prior emotional state.

Wanting → expecting → planning → sentience
Increased size of frontal brain areas

Animals know

- **what they want:**

Requires the maintenance of focused attention, comparison of different scenarios, decision making, planning and impulse inhibition

- **what they want, where and when:**

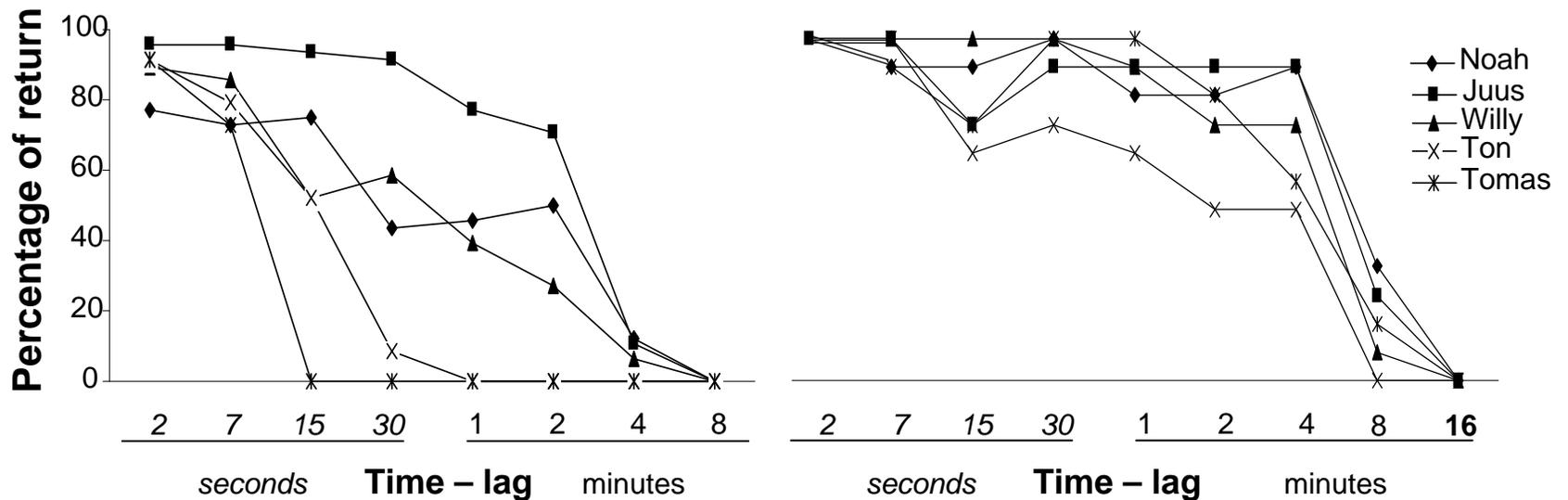
episodic-like memory

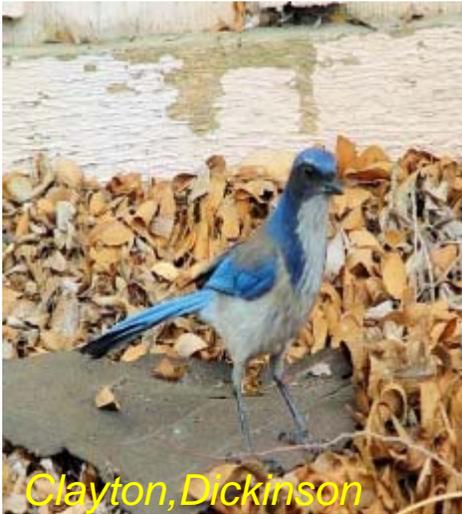
- **what others want**



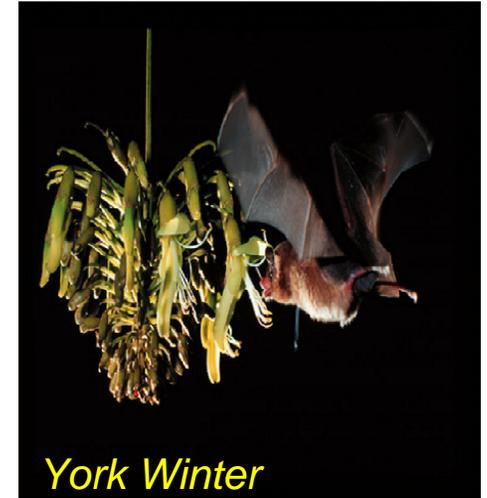
Anticipation and impulse inhibition

How long can they wait, when they know **how much** will be provided?

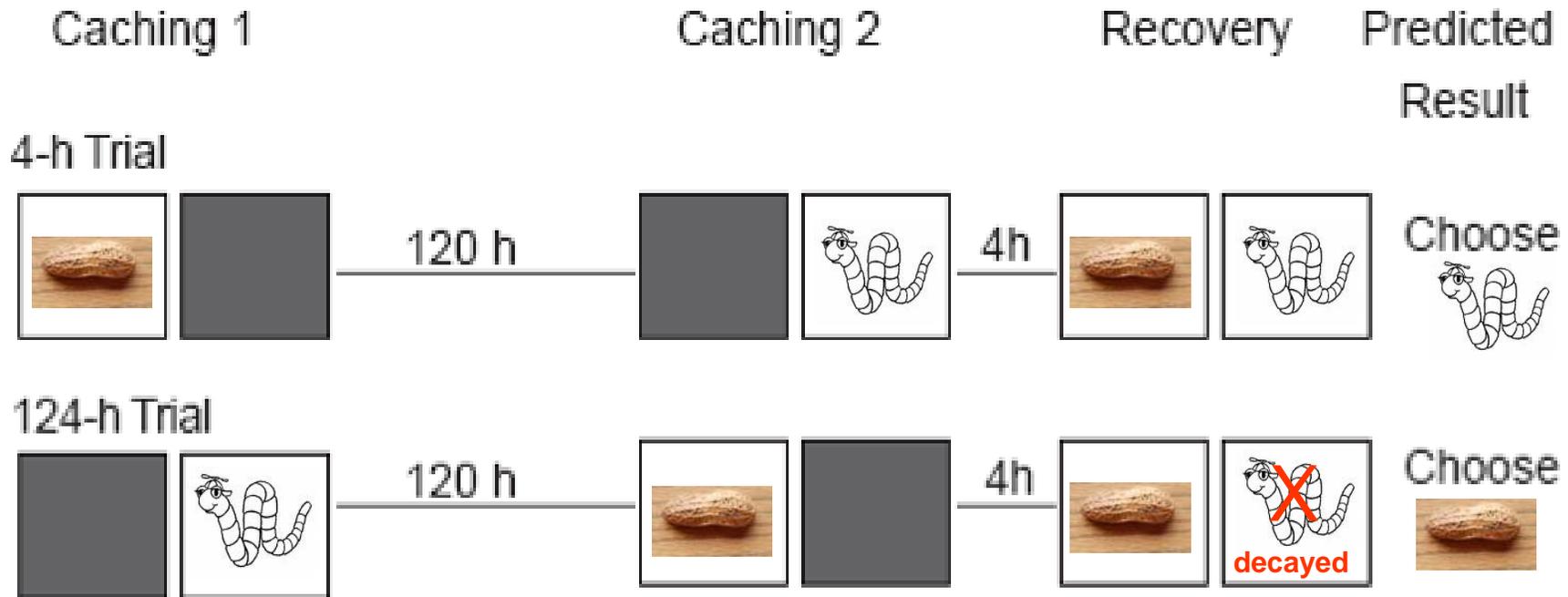




Episodic-like memory in Jays and Bats



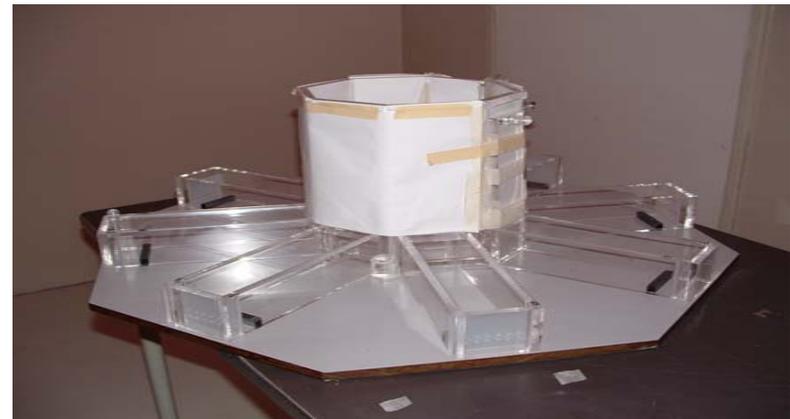
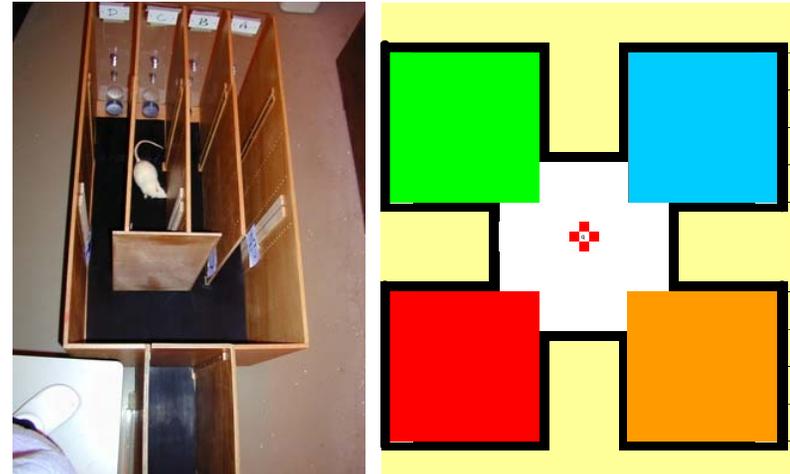
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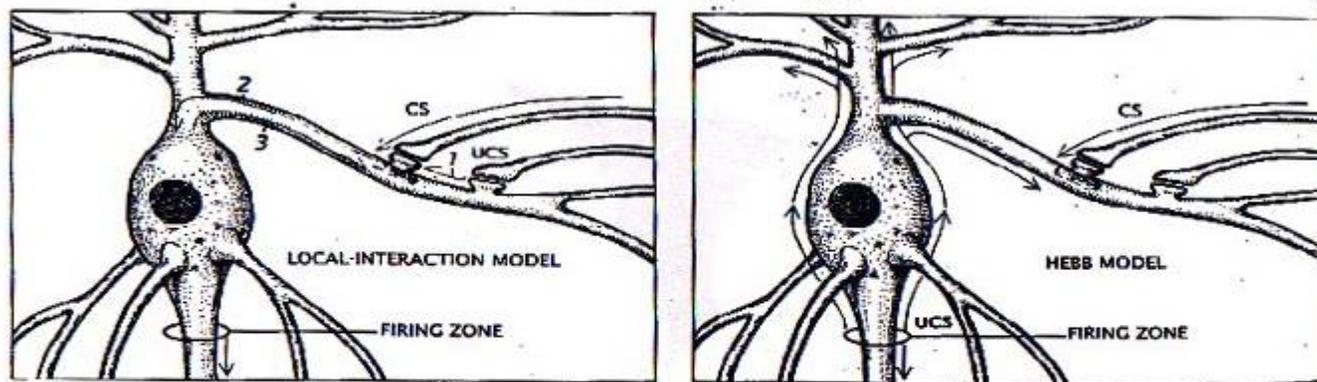
To be efficient,
animals need to
know the value of

- what
- where
- when
- who

**The level of integration
determines the efficacy
of behavior.**



From software to hardware



MODELS OF LEARNING-INDUCED CHANGES vary with respect to the interactions necessary to bring about the changes. The local-interaction model, which the author's research supports, postulates that the changes (*color*) originate at a neuron's receiving site when an input there from a conditioned stimulus (CS) is temporally associated with the input from an un-

conditioned stimulus (UCS) on an adjacent receiving site (1). The interaction is communicated to the cell body (2), generating factors that return to the site of the interaction and "hard-wire" it (3). In contrast, the Hebb model assumes that the changes occur when input from a CS arrives at a receiving site at the same time the neuron is firing in response to a UCS.

32 SCIENTIFIC AMERICAN July 1989

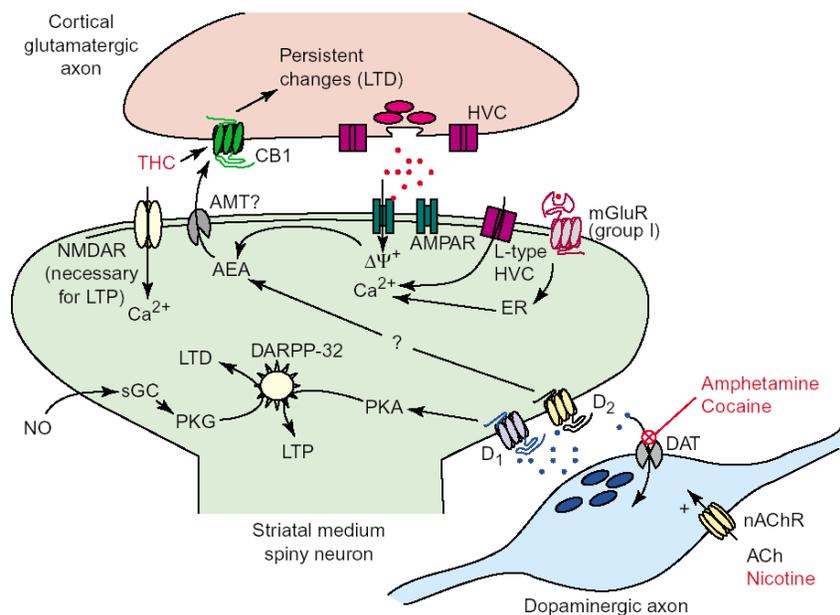
D. Hebb: coincidence detection

Synapse is memory and processor

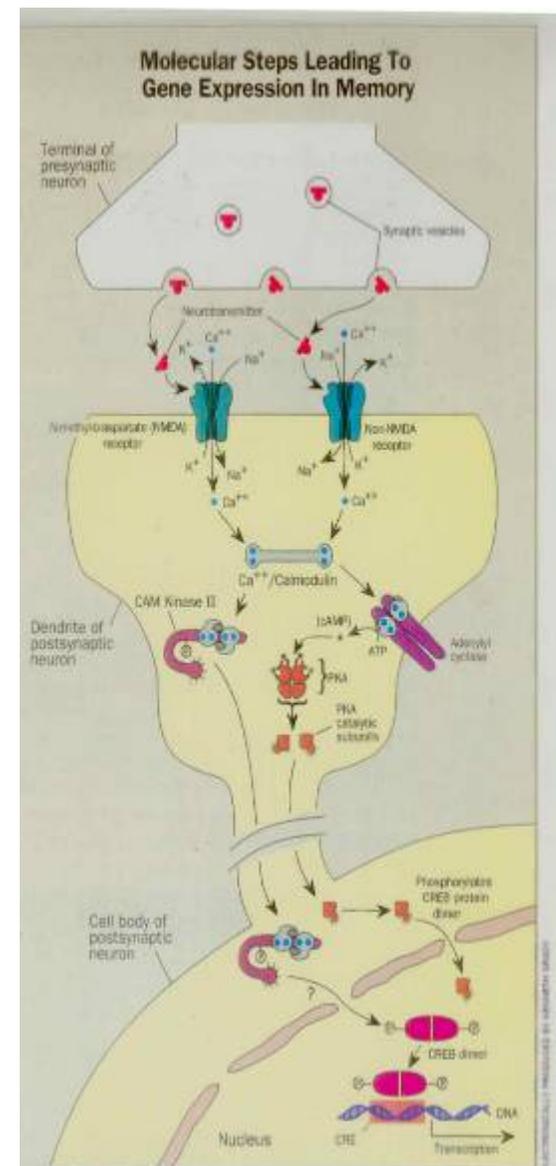
Complexity is the result of the same mechanisms in different structures

amygdala (fear), VTA (reward), hippocampus, frontal cortex

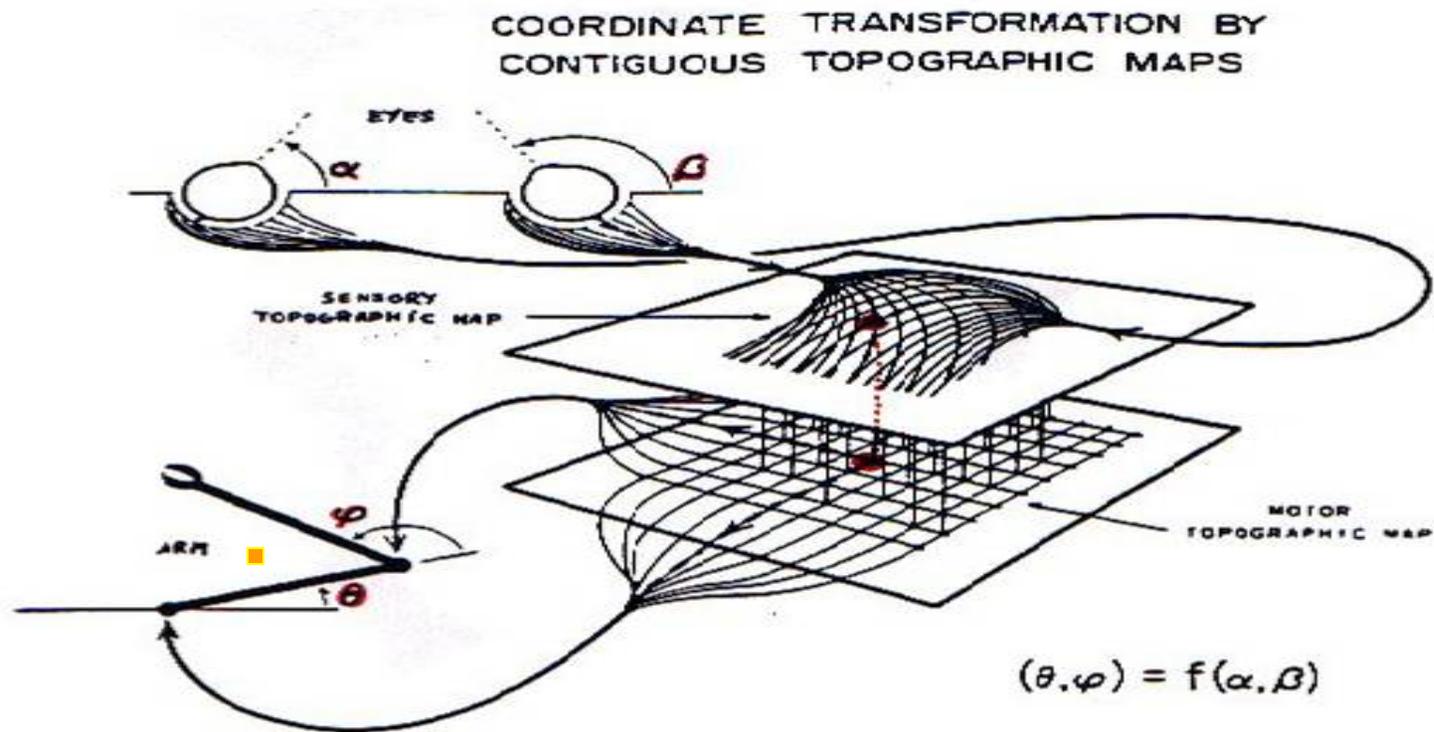
Insects: Mushroom bodies

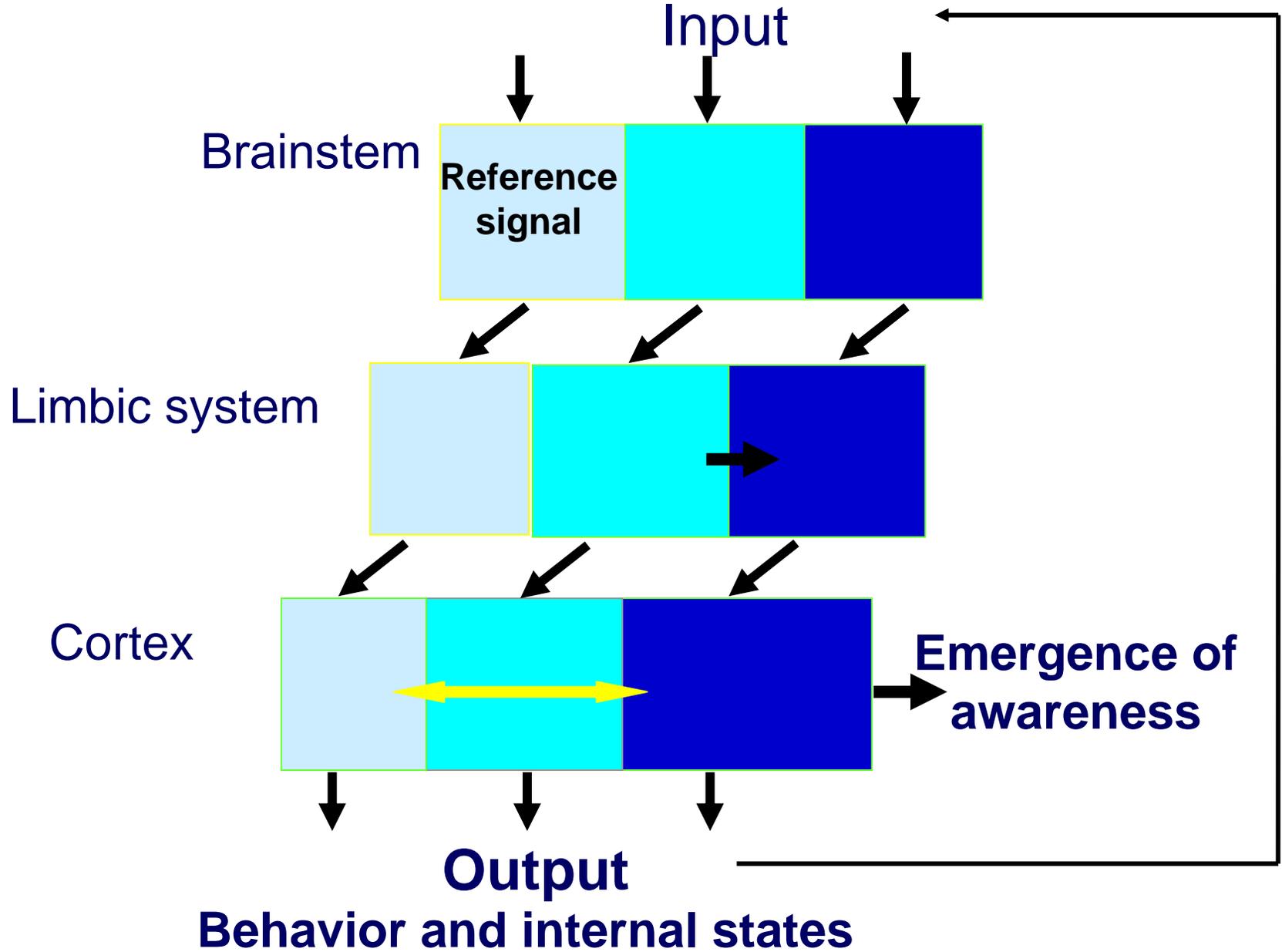


TRENDS in Neurosciences

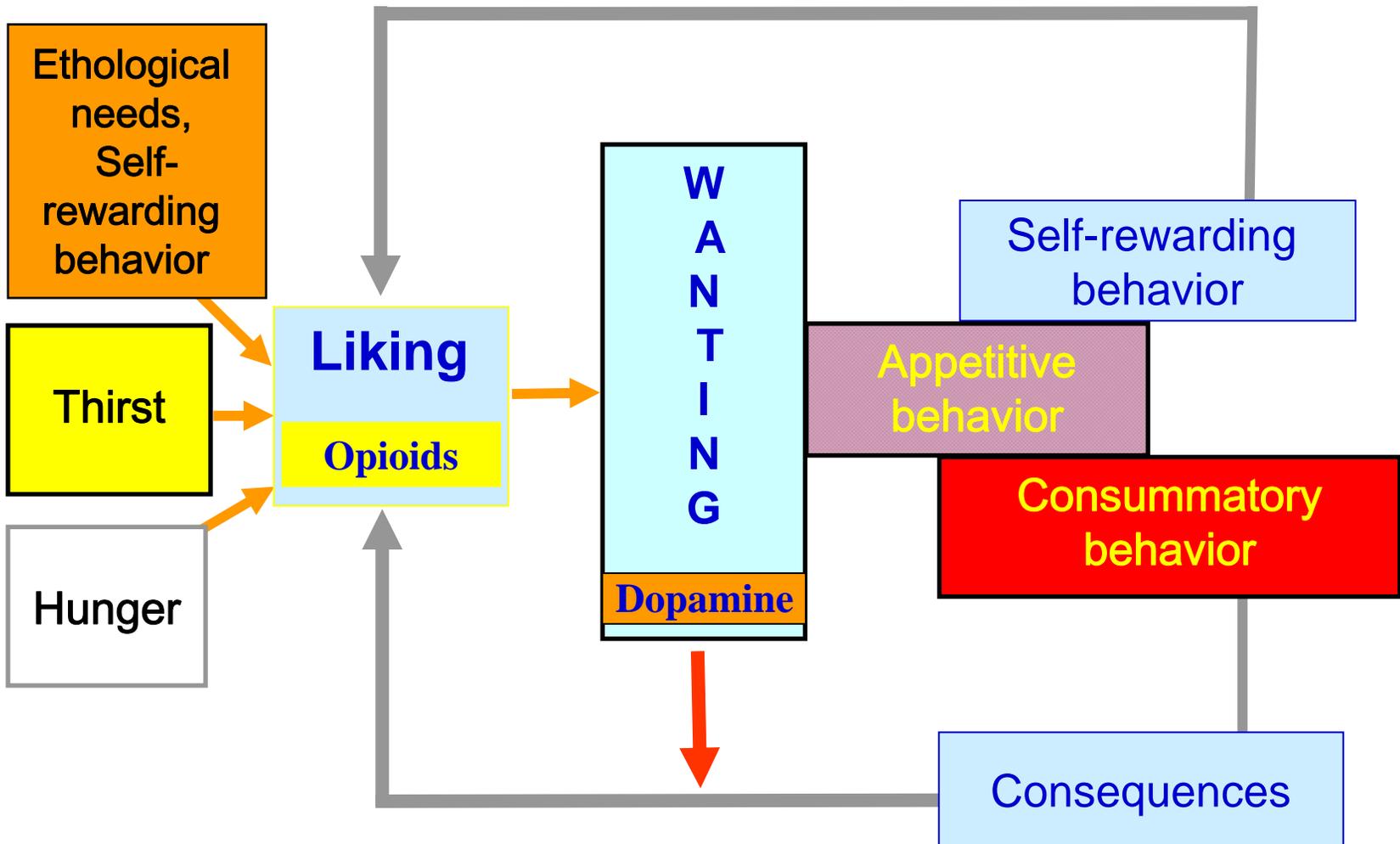


Somatotropic representation of information in neuronal networks in sensory perception, cognition and movement systems.





Floating value: **Liking**. Value “an sich”: **Wanting**



Pleasure is the currency of the brain

The value of the currency depends on the economic climate

- Consumer demand: related to stress and reward systems
- Elasticity in price: variable sensitivity to reward / stress
- Profit: rewarding value of a commodity
- Investment: requires preparatory behavior

Efficient **Wanting** needs more brain:
Planning → frontal cortex

Extended neuronal networks require systems to classify the multimodal input

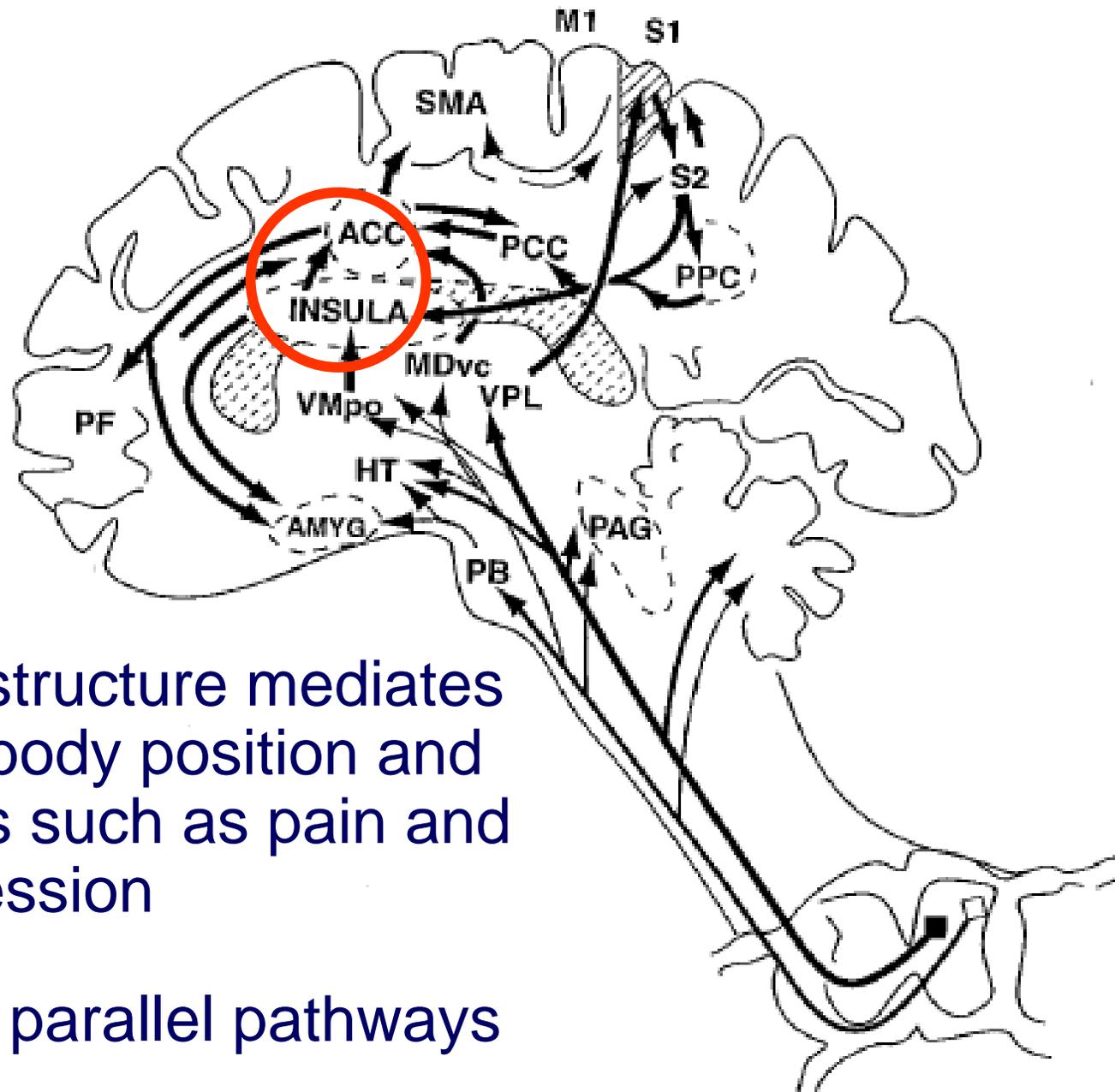
- Sensory modality: visual, auditory
- Somatotopographic representation
- Spatial representation
- Emotional classification

Planning and decision making comparing “here and now” versus future

Simultaneous representation of

- the own state: body to feelings
- objects
- context

Comparator: insular cortex

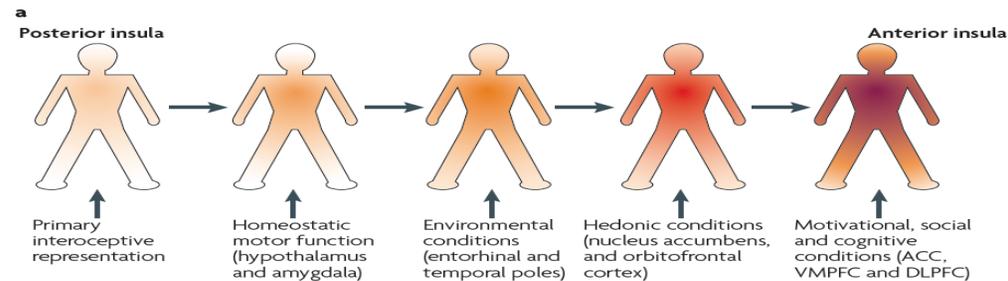


One structure mediates both body position and states such as pain and depression

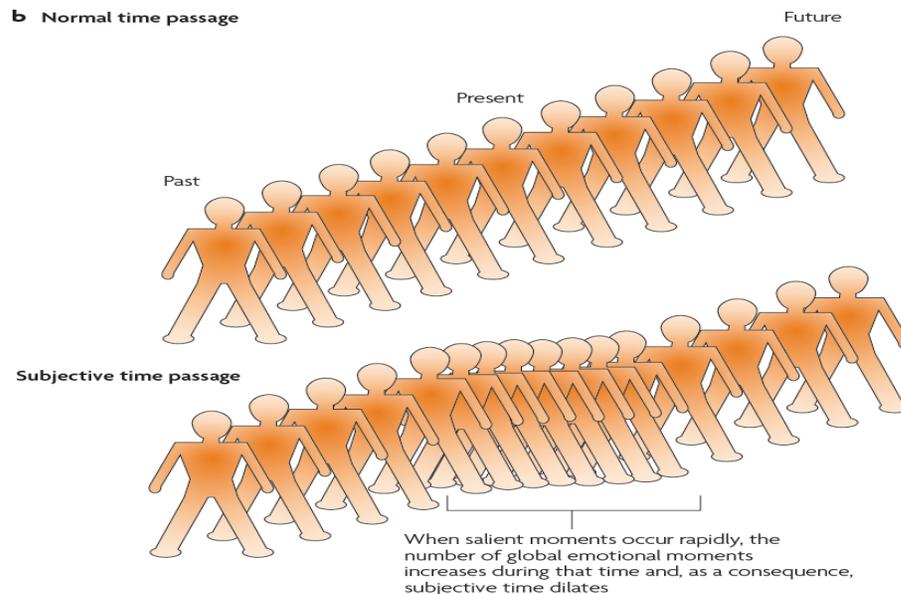
Pain: parallel pathways

The insular cortex:

A network representing the organism from posterior (body) to anterior (emotion)

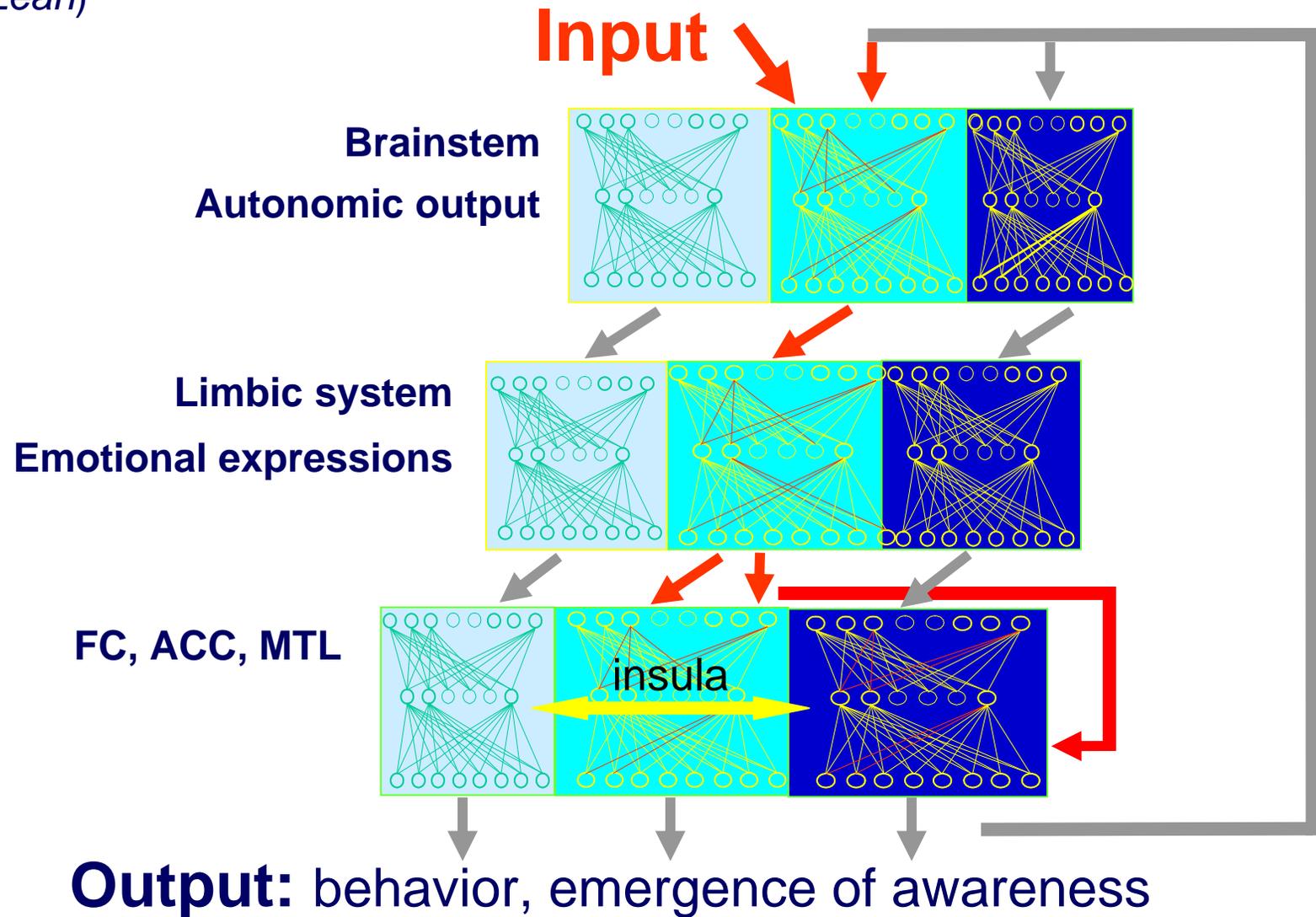


b Normal time passage

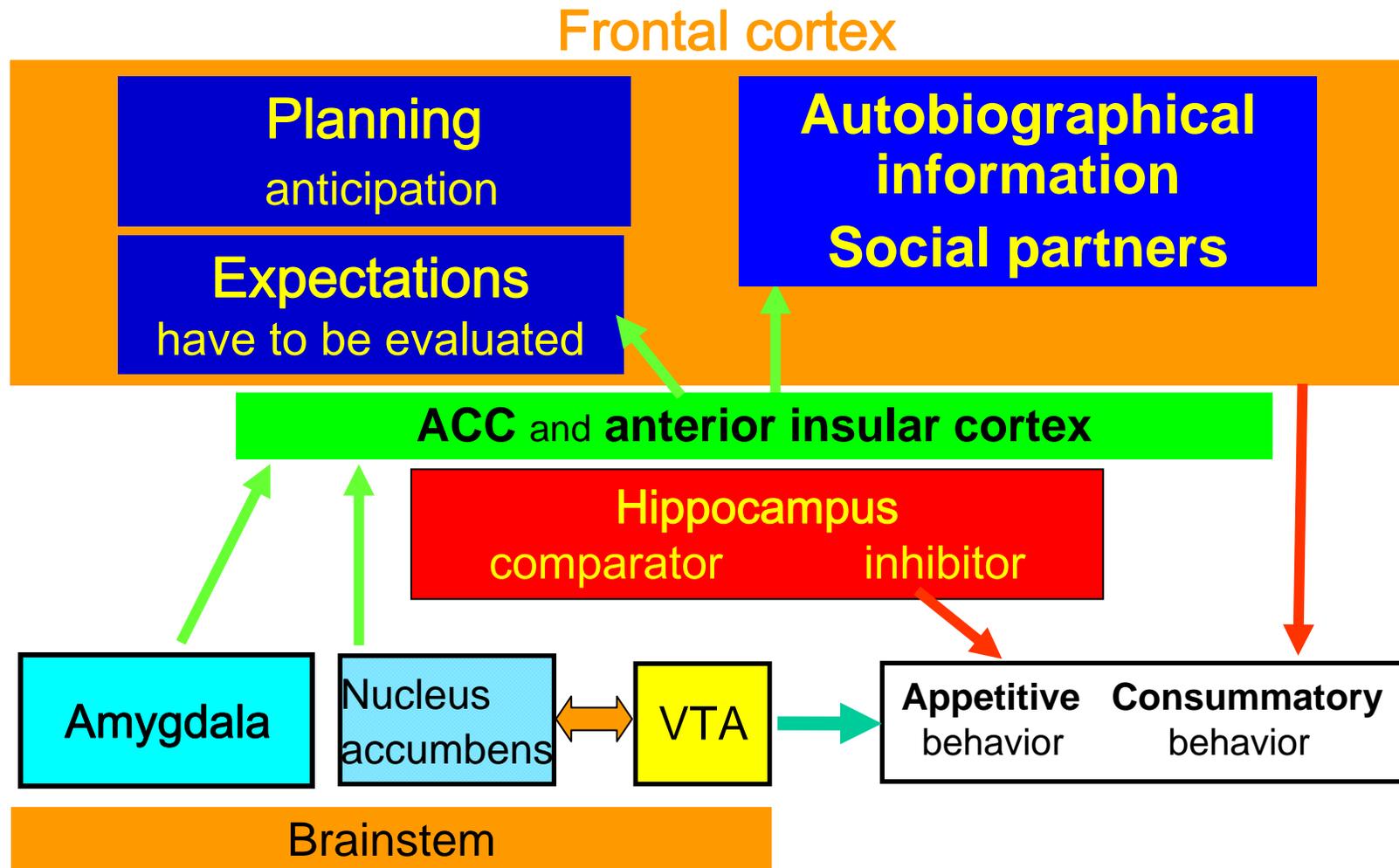


Integrated *triune* concept of the brain

(MacLean)



A network encoding self-related information → sentience



Neurons for integration of emotion and cognition

TICS-559; No of Pages 5



Opinion

TRENDS in Cognitive Sciences Vol.xxx No.x

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ScienceDirect

The self and social cognition: the role of cortical midline structures and mirror neurons

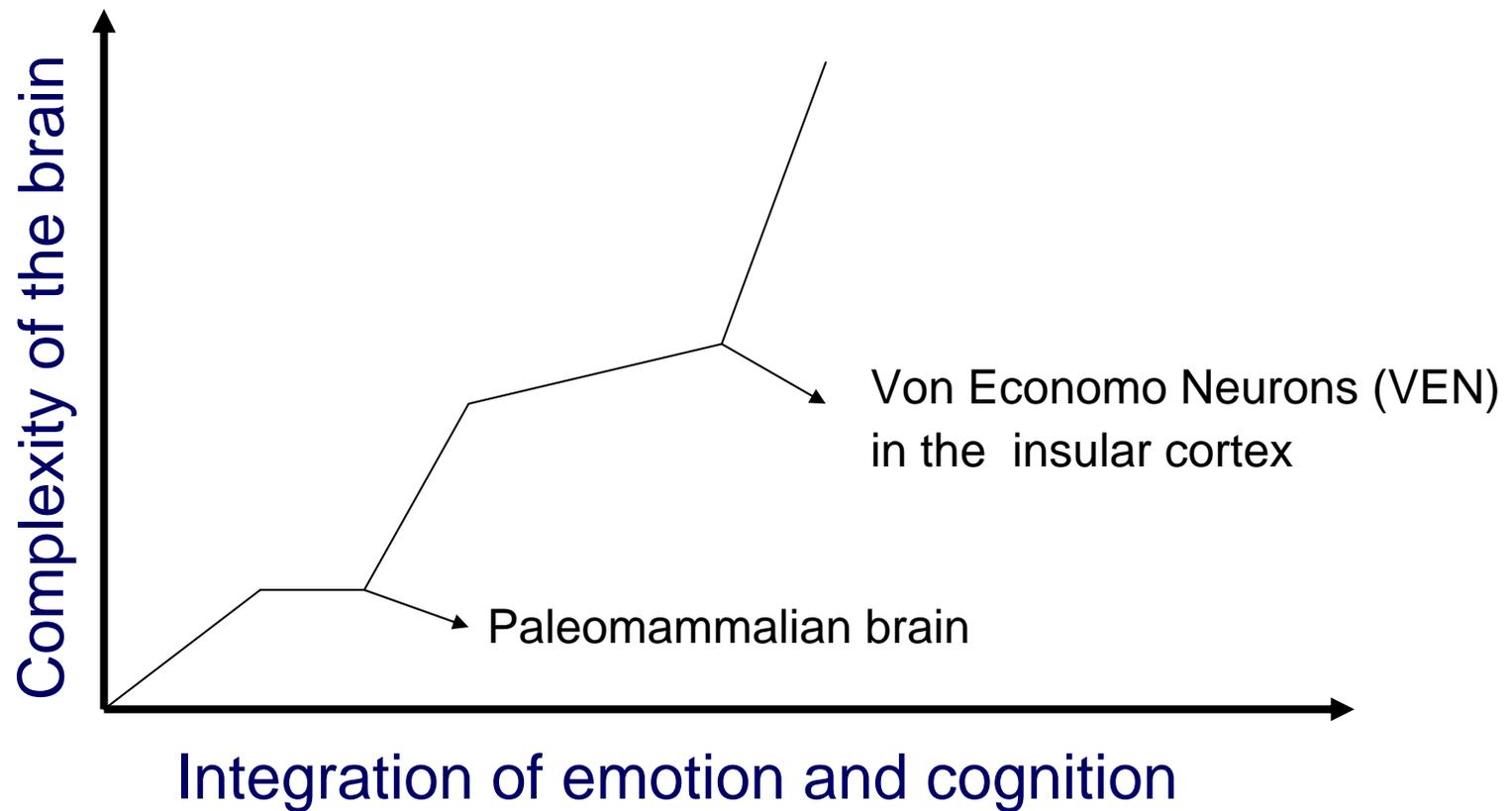
Lucina Q. Uddin^{1,2}, Marco Iacoboni³, Claudia Lange⁴ and Julian Paul Keenan⁴

Early Frontotemporal Dementia Targets Neurons Unique to Apes and Humans

William W. Seeley, MD,¹ Danielle A. Carlin, BA,¹ John M. Allman, PhD,² Marcelo N. Macedo, BS,¹ Clarissa Bush, BA,³ Bruce L. Miller, MD¹ and Stephen J. DeArmond, MD, PhD,³

Ann. Neurol. 2006

Ability to experience the own state



The Mentality of Crows: Convergent Evolution of Intelligence in Corvids and Apes

Nathan J. Emery^{1*} and Nicola S. Clayton²

SCIENCE VOL 306 10 DECEMBER 2004

..... we argue that complex cognitive abilities evolved multiple times in distantly related species with different brain structures

A burden or a blessing?

- Patients without past and future do have awareness.
- They are not necessarily sad.

Cognitive abilities are relevant for welfare:

- To label memories and expectations with an internal subjective value.

Cognition and its affective value provide hope and hopelessness.

Welfare of invertebrates?

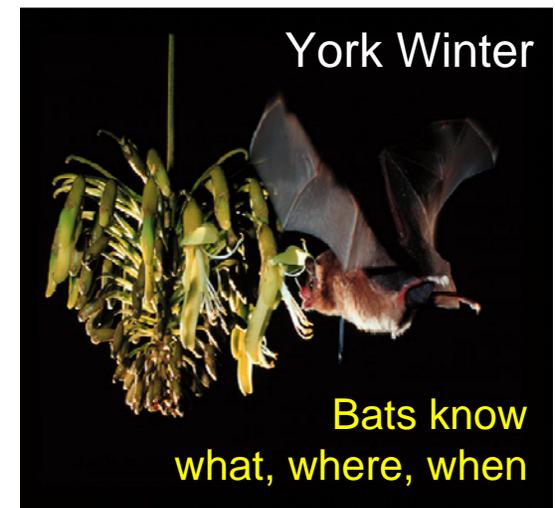
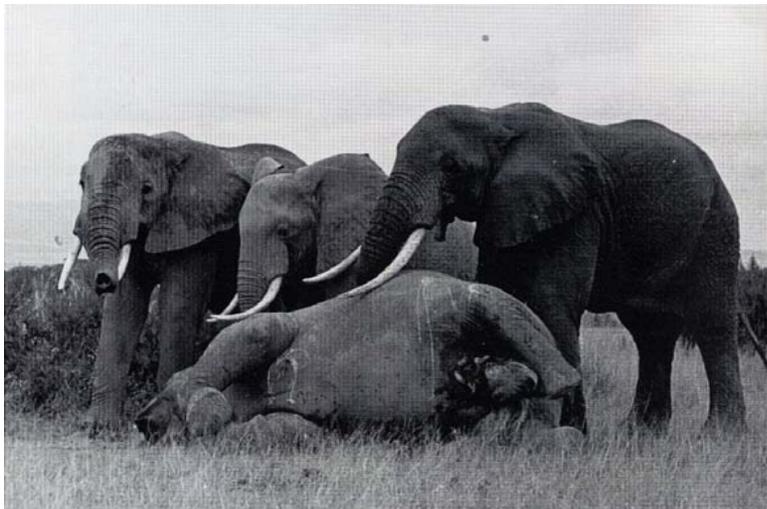
The brain of many invertebrates is not hierarchically organised.

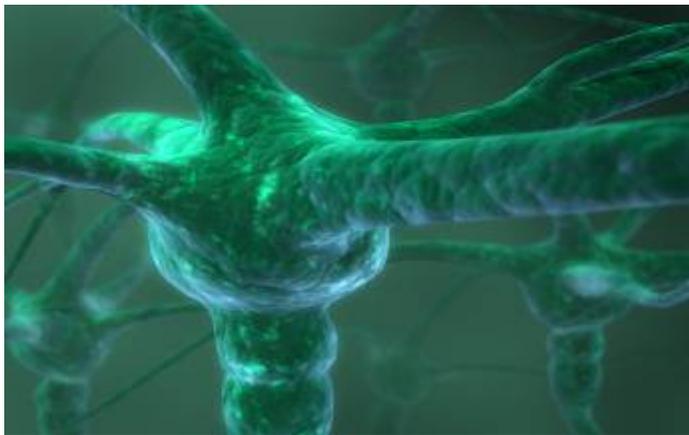
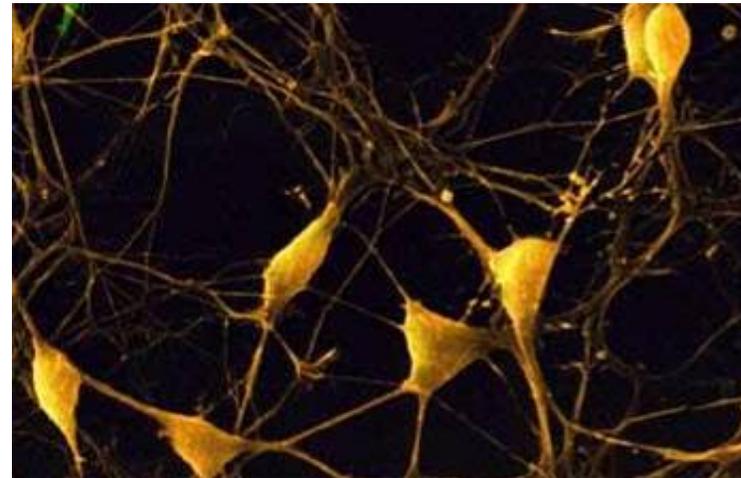
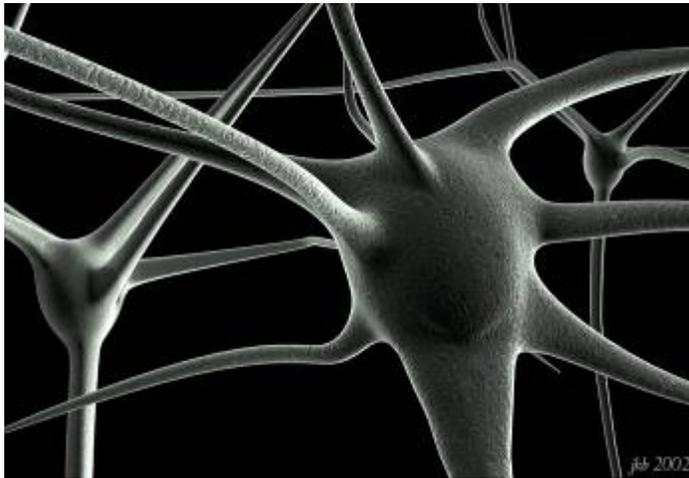
The continuous perception of their own internal state by other decision making networks seems unlikely.

The more brains, the more relevant welfare is?

So called “higher” cognitive abilities are not all indispensable for experiencing the own subjective state.

Also without the ability for a ToM, deceit, mirror recognition, an animal can be unhappy.





It is not so much the nature of the conductor
but the structure of information processing which counts.
If every element is replaced by a silicon chip, awareness would
be the same. Thus, AI systems might develop as well.

Liesbeth Sterck
Jorg Massen
Marusha Dekleva
Ellen Evers
Anne Overduin-de Vries
Adriano Lameira
Department of Biology

Johanneke vd Harst
Raymond de Heer
Marco Melace
Niek Stipdonk
Delta Phenomics

Inspired by
Cabanac, Panksepp,
Berridge, Clayton,
Craig, Northoff.



TURN UP THE POWER...!
WAIT! THAT'S IT!
I THINK I CAN SEE A
THEORY OF MIND!!!



Appeared in: Povinelli & Vonk 2004: Mind and language, 19,1-28.