

ERMITES 2014 – September 23-25, 2014

# Theory of neuronal Cognition and Reading

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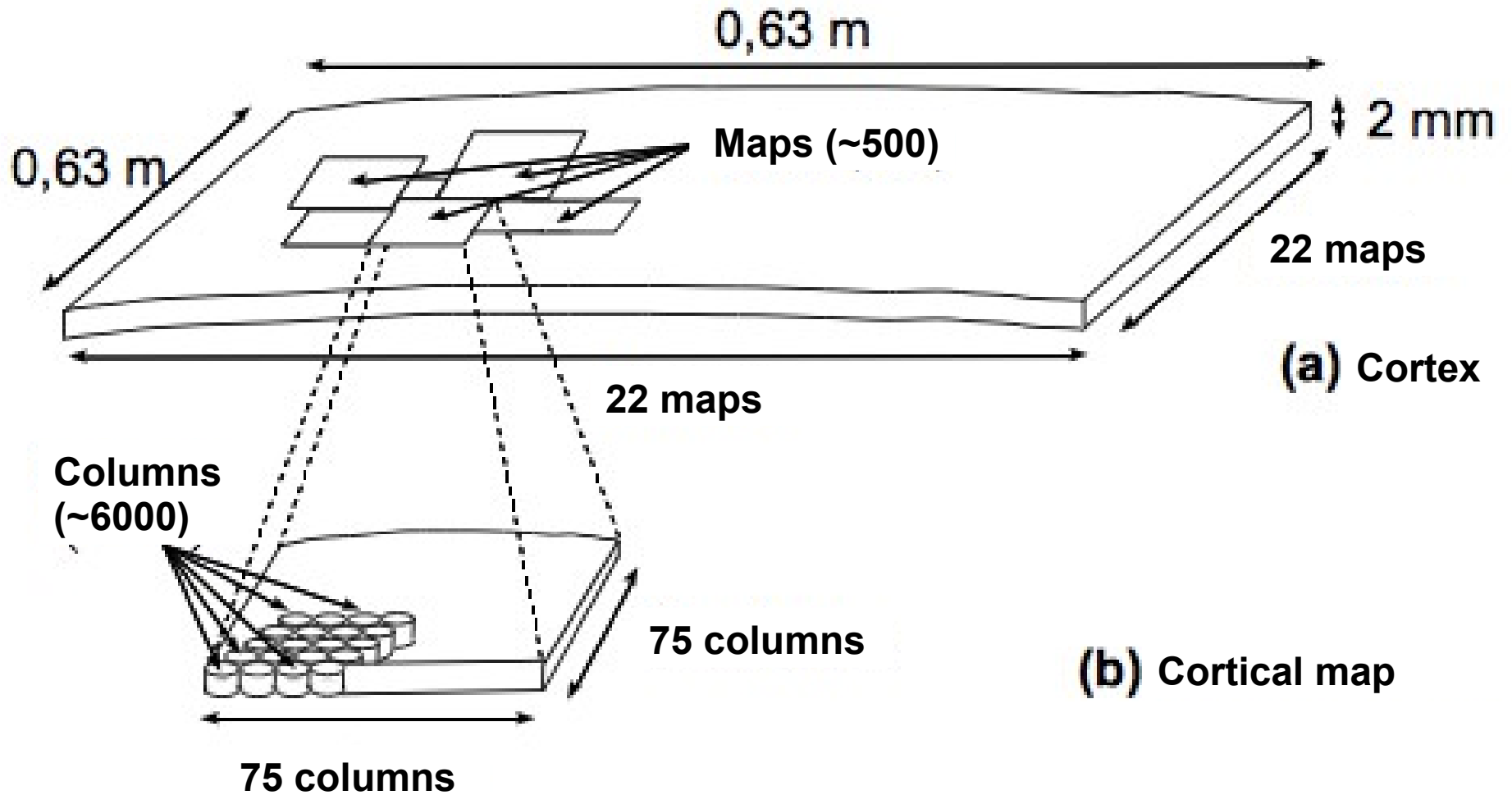
# Abstract

Formalized in 2010, the Theory of neuronal Cognition (TnC) departs from all existing materialist theories of mind by claiming that our brain does not process information, but only represents information. The logical implication is that we are only a crystallization of our interactions with the environment. Since « extraordinary claims require extraordinary proofs », the goal of my talk will be to provide the audience with the neuronal blueprints of a number of cognitive functions and concepts. Reading will illustrate my description of the cortex as a hierarchy of self-organizing associative memories. After what, I will show how the synergy between sensory and sensory-motor maps generates behaviors, and offer explanations about intelligence (a side effect of the observer knowledge), consciousness (an automatic verbalization), endogenous and exogenous attentions, episodic and semantic memories, motivation or joy (a side effect of associative memories functioning). Last, I will present new insights about how unsupervised systems achieve homeostasis.

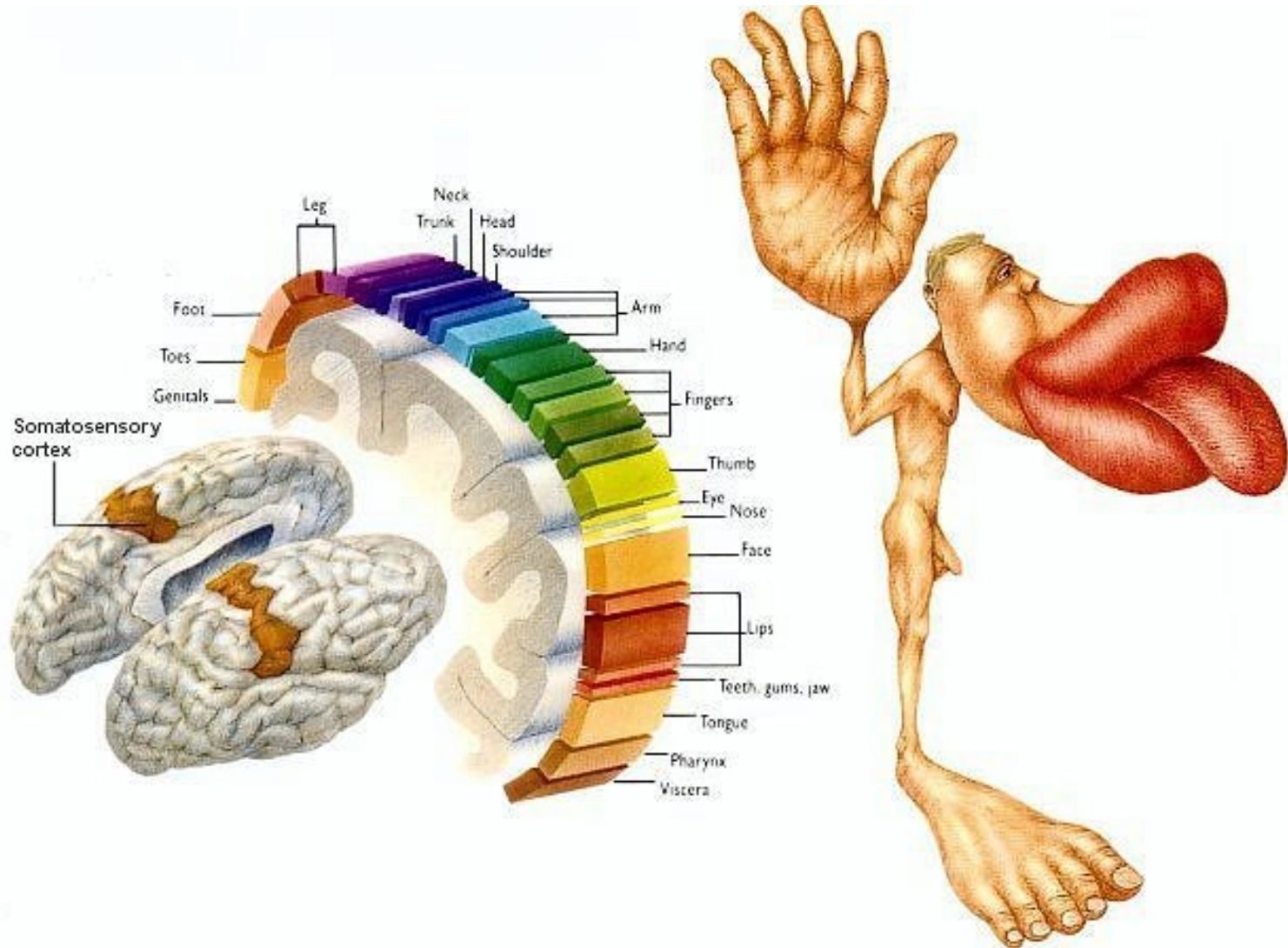
# Summary

1. Cognition & Cortex
2. Self-Organizing Maps
3. Hierarchy of SOMs
4. Serial order
5. Supervised learning
6. Memories
7. Attentions
2. Actions
3. Hierarchy of goals
4. Motivation
5. Homeostasis
6. Global coherence
7. Intelligence
8. Consciousness

# 1. Cognition & Cortex

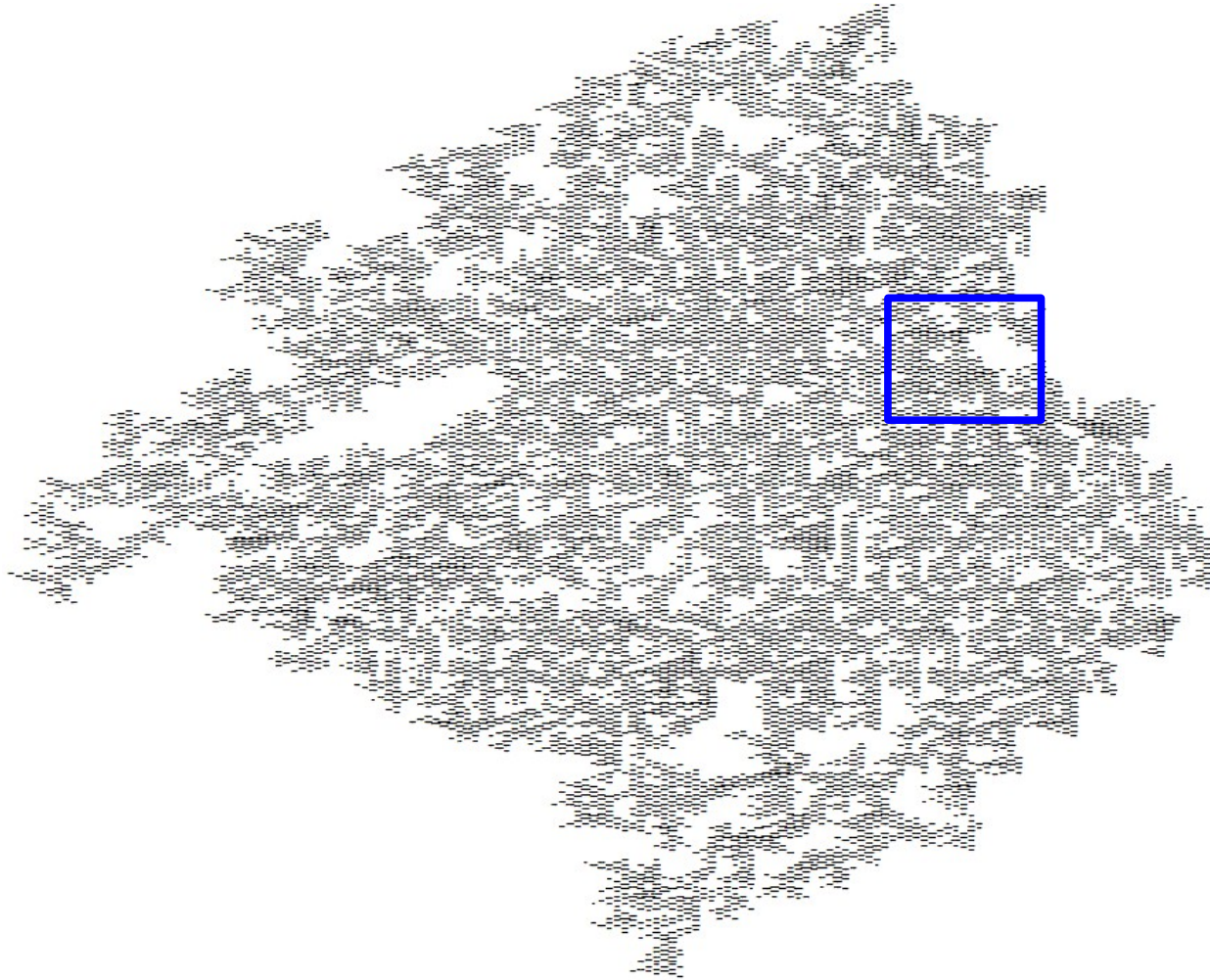


## 2. Self-organizing maps



W. Penfield, T. Rasmussen, *The cerebral cortex of man*, Macmillan, 1950.

## 2.1 Orthographic word form map



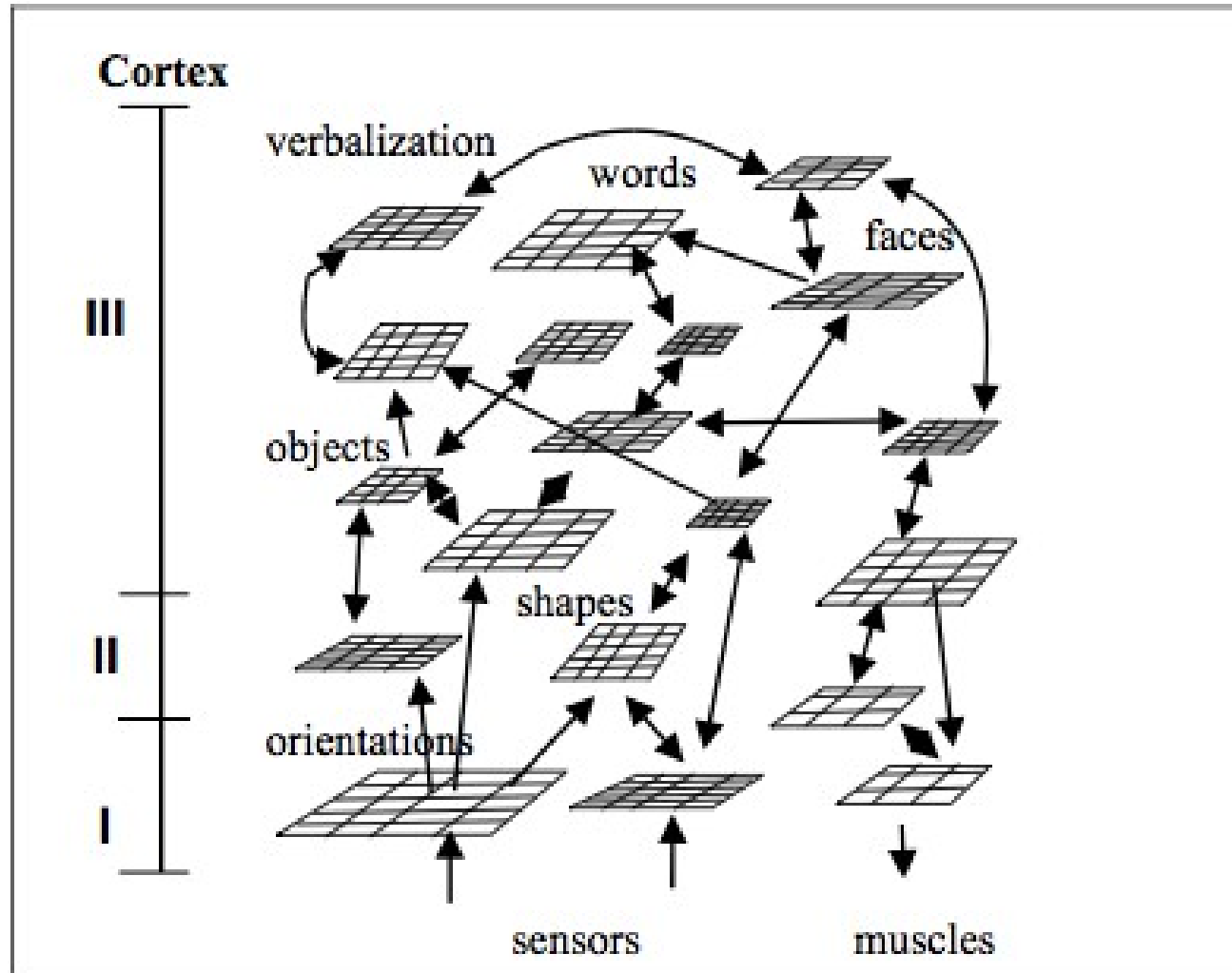
C. Touzet, K. Kermorvant and H. Glotin, "A Biologically Plausible SOM Representation of the Orthographic Form of 50,000 French Words", *WSOM 2014* (10th Workshop on Self-Organizing Maps), July 2014, Mittweida, G.



# 2.2 Orthographic word form map

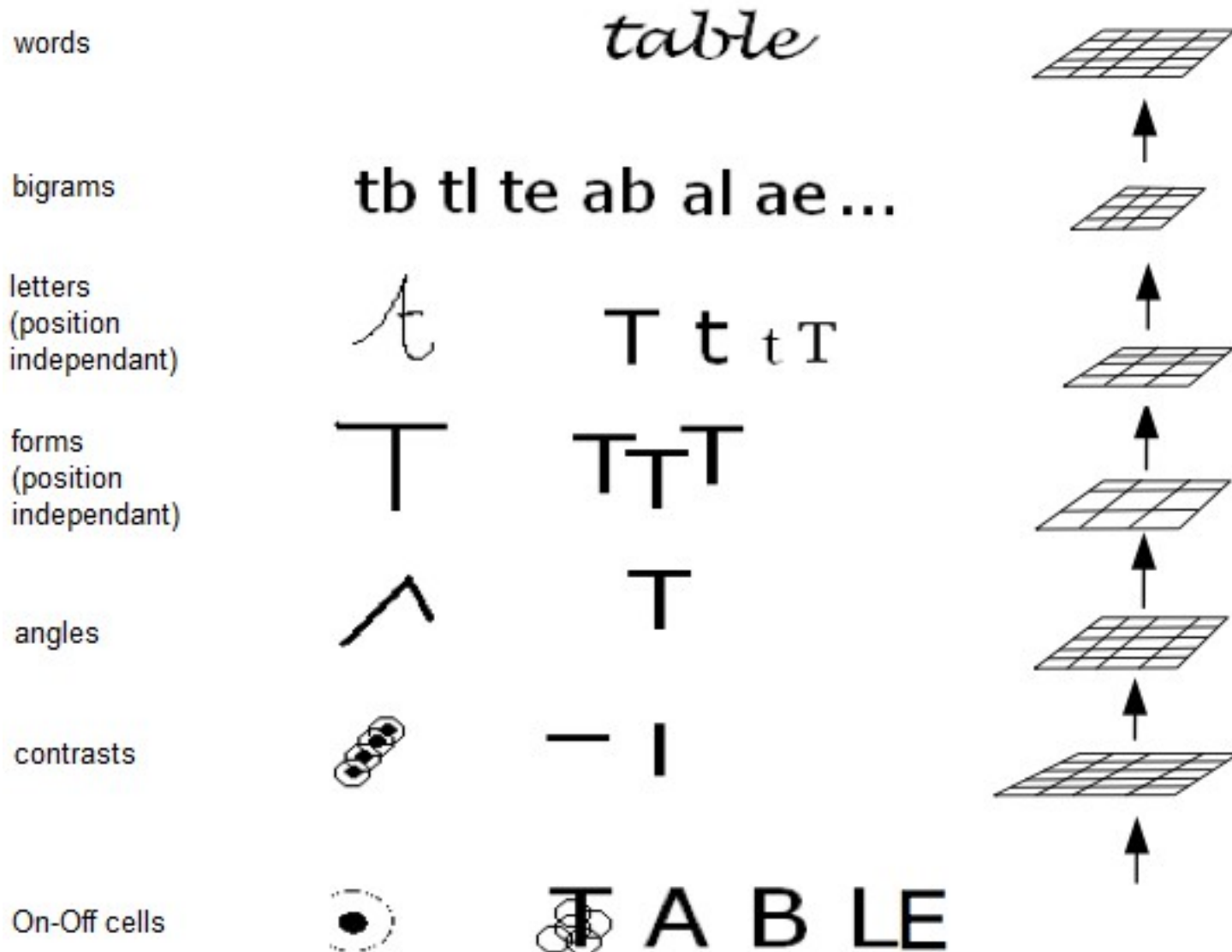


### 3. Hierarchy of SOMs



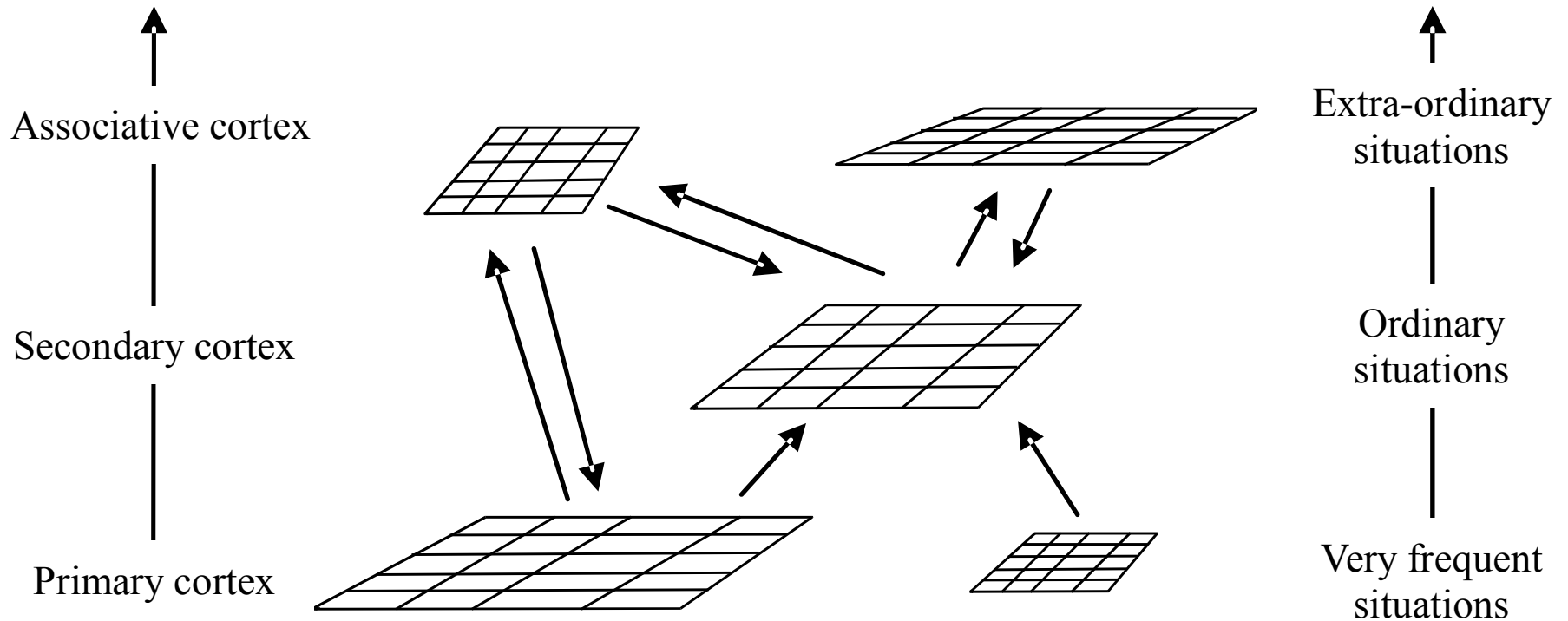


# 3.1 Reading orthographic hierarchy



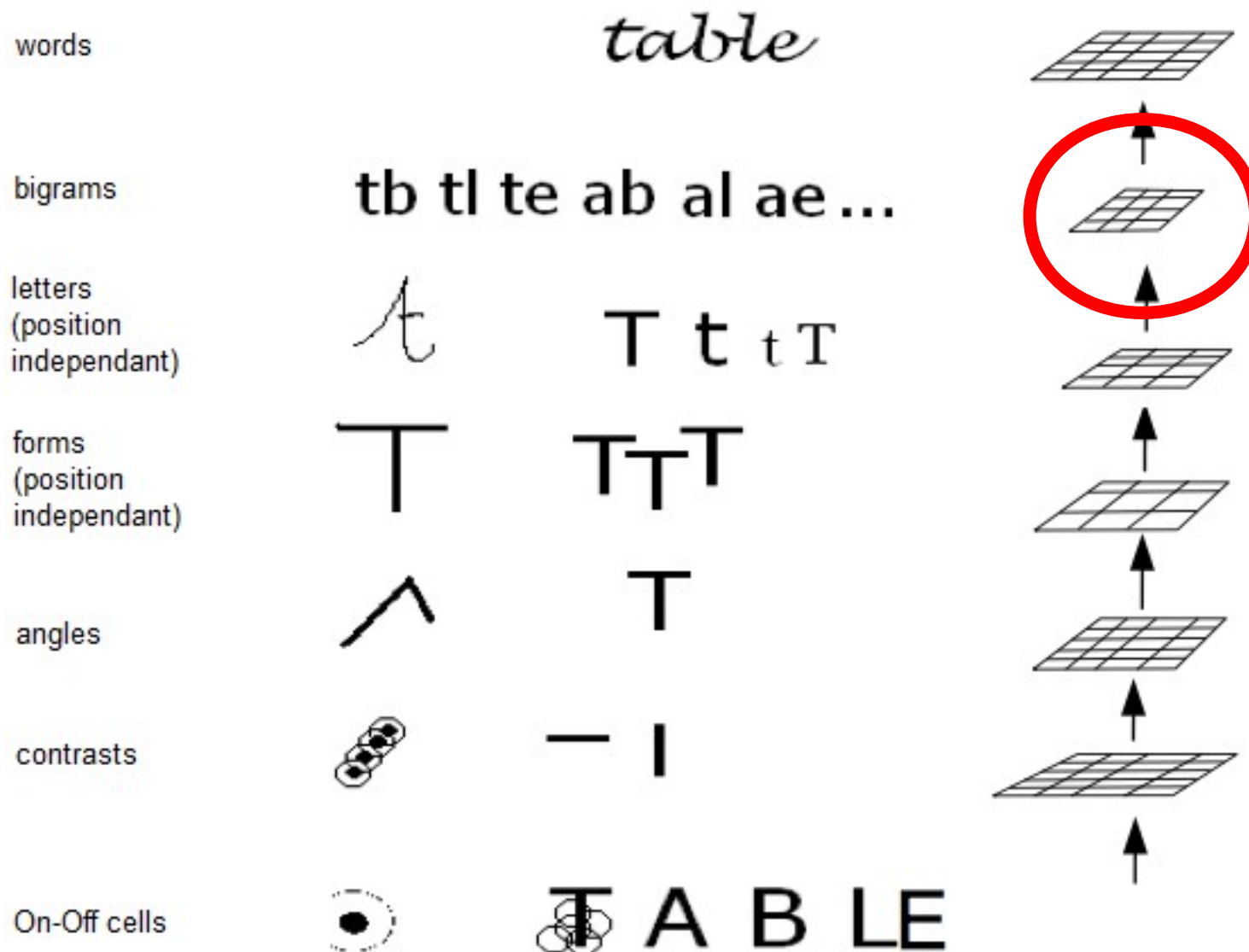
Dehaene, S., Cohen, L., Sigman, M., & Vinckier, F. (2005). The neural code for written words: a proposal. *Trends Cogn Sci*, 9(7), 335-341.

# 4. Development: serial order



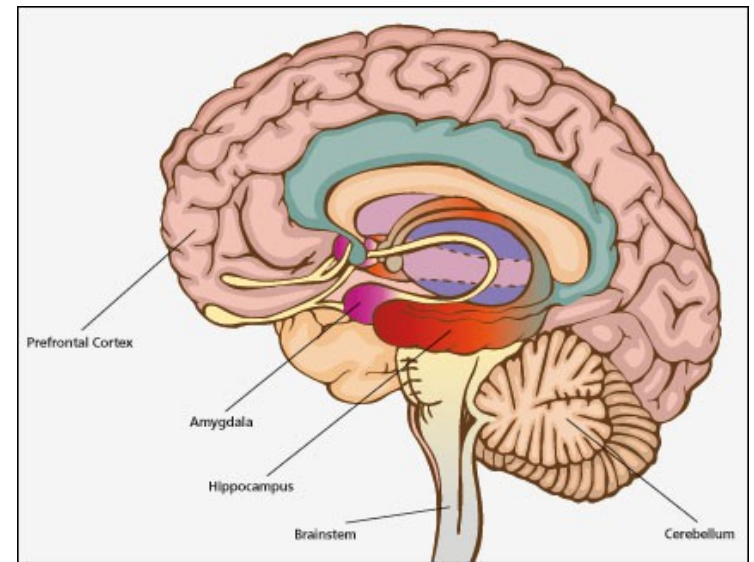
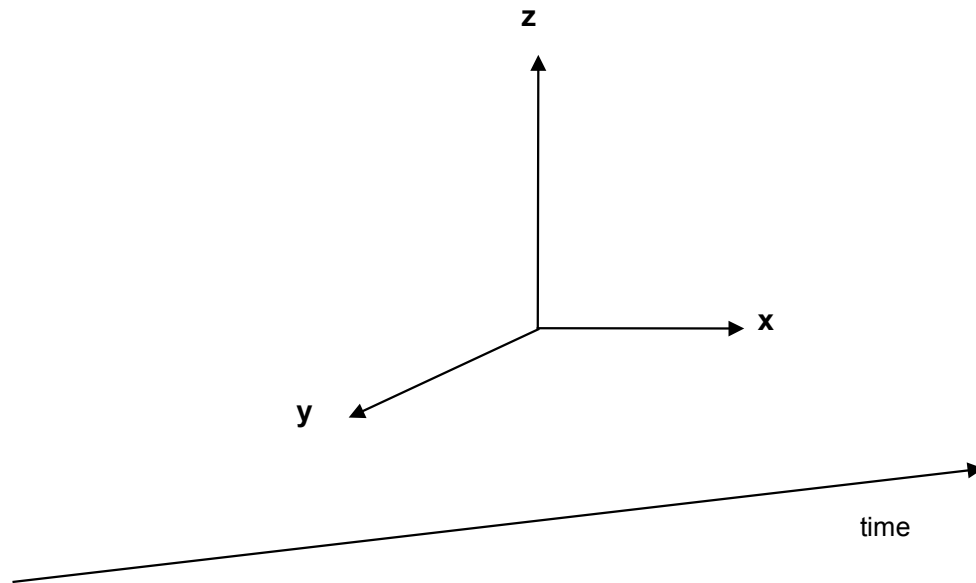
<i>l</i>	1	2	3	4	10	12
%	100	20	4	0.8	$5 \cdot 10^{-5}$	$4 \cdot 10^{-7}$

# 5. Supervised learning (syllabic method)



## 6. Episodic, cultural and implicit memories

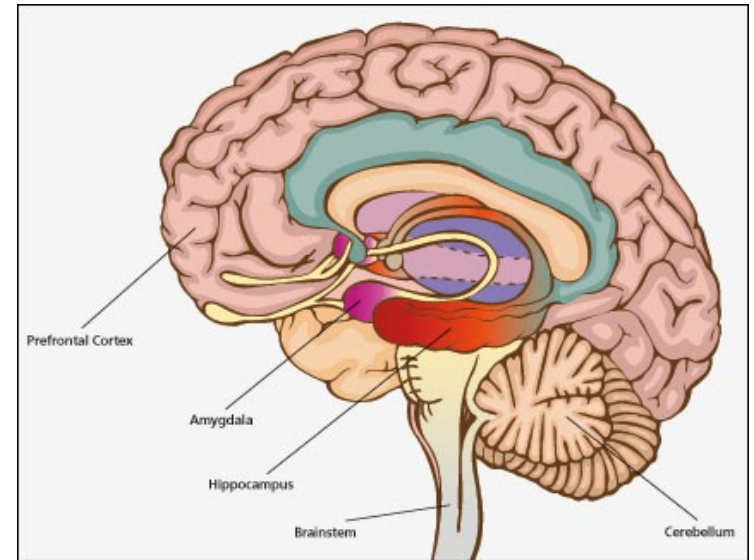
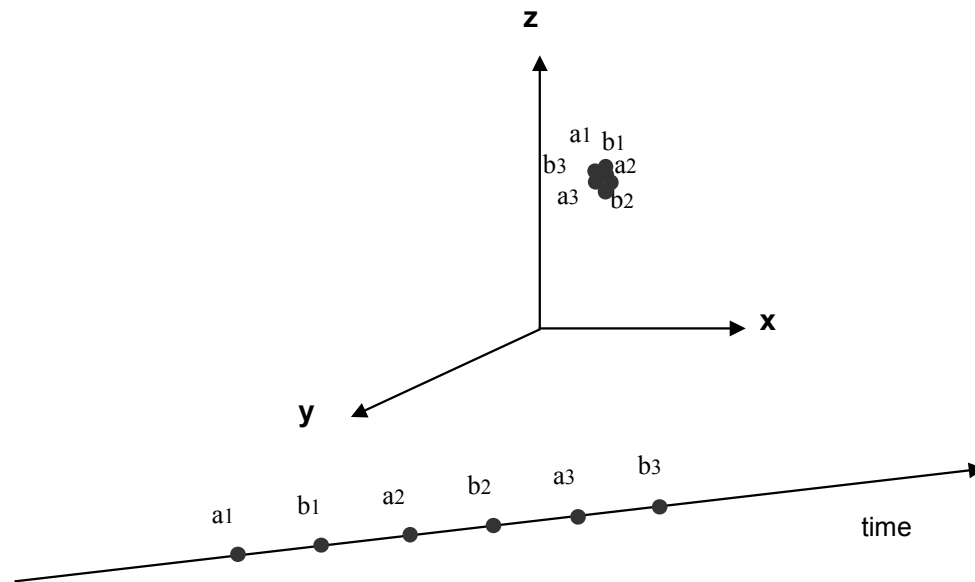
- time and space coordinates



Charles R. Gallistel, *The Organization of Learning*, MIT Press, 1993.

# 6. Episodic, cultural and implicit memories

- time and space coordinates

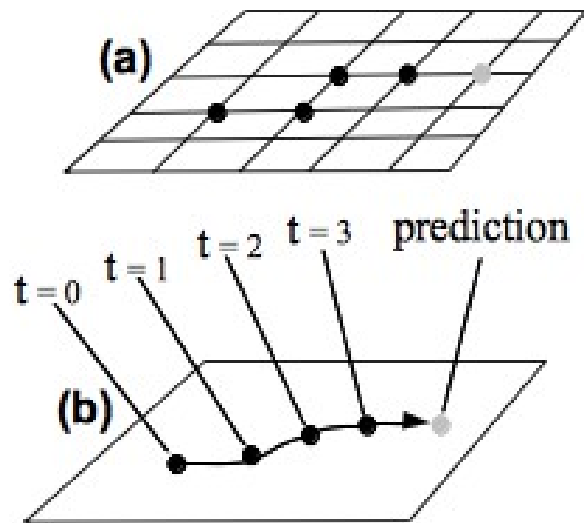


Charles R. Gallistel, *The Organization of Learning*, MIT Press, 1993.

# 7.1 Exogenous attention - bottom-up

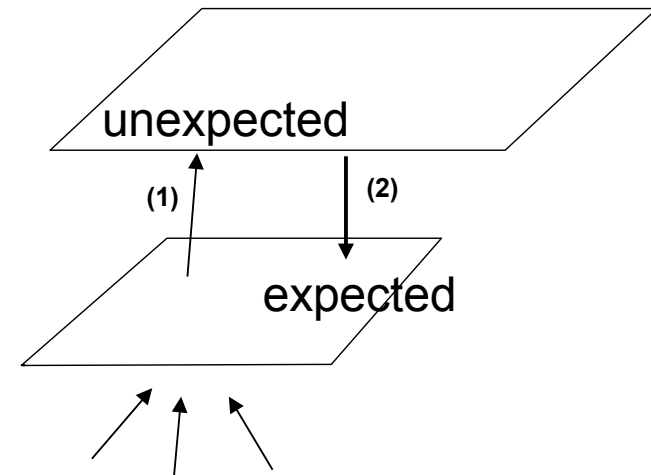
« Selecting one aspect of the environment while ignoring other things »

- Prediction
- A-causal backward connections – loops (novelty filter)



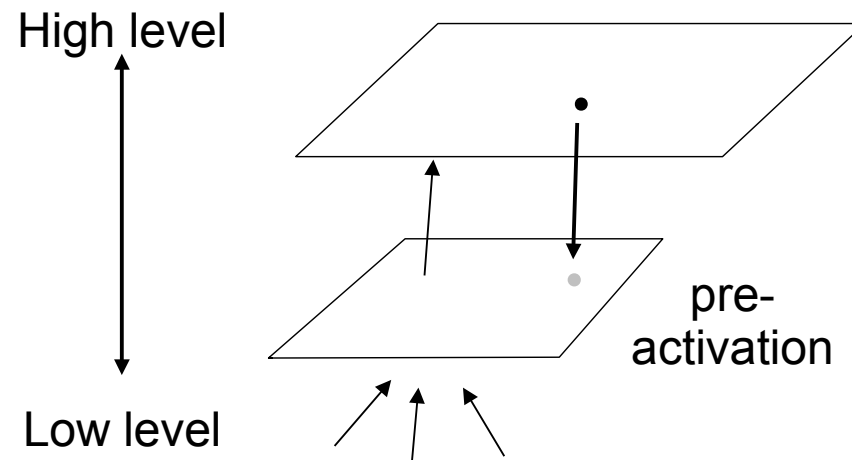
High level

Low level



## 7.2 Endogenous attention - top-down

- Priming





## 8. Acting in the environment

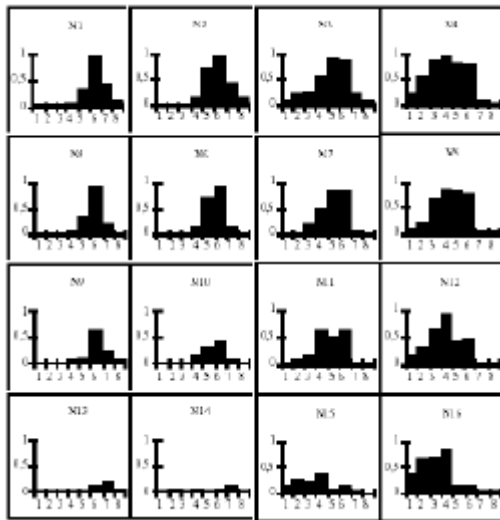


Khepera (8 IR)

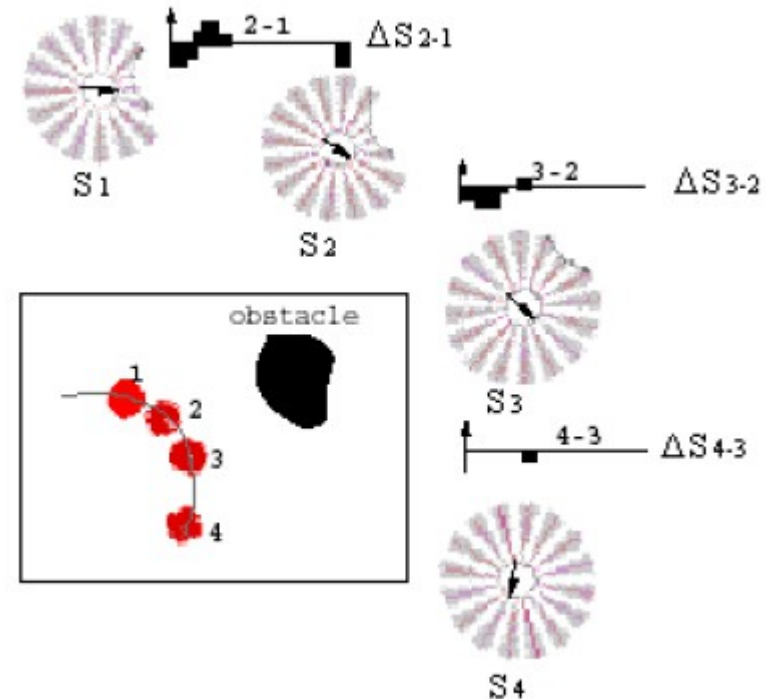


Nomad (16 sonar)

# 8.1 Sensory and sensory-motor maps

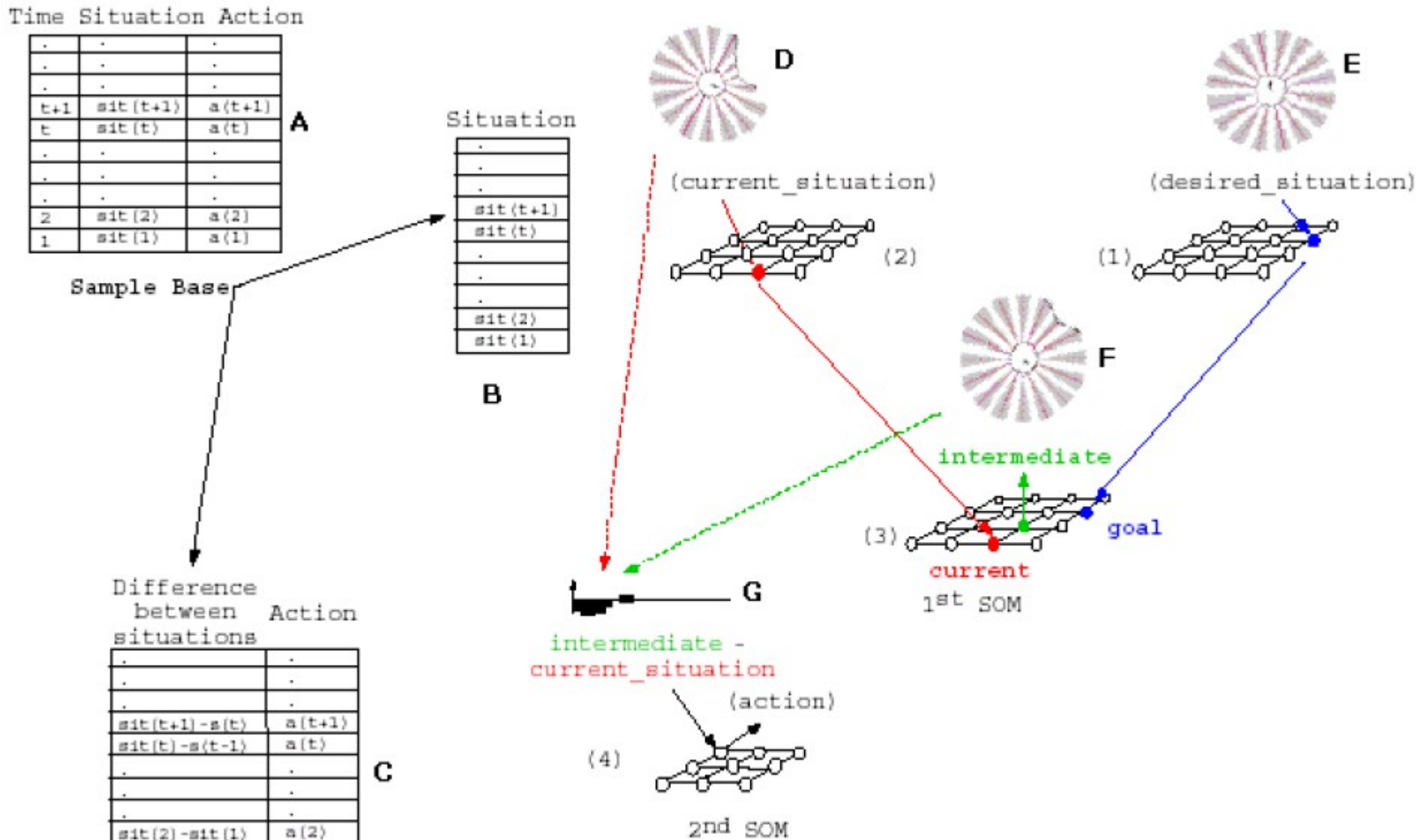


100 learning iterations  
(16 neurons SOM)

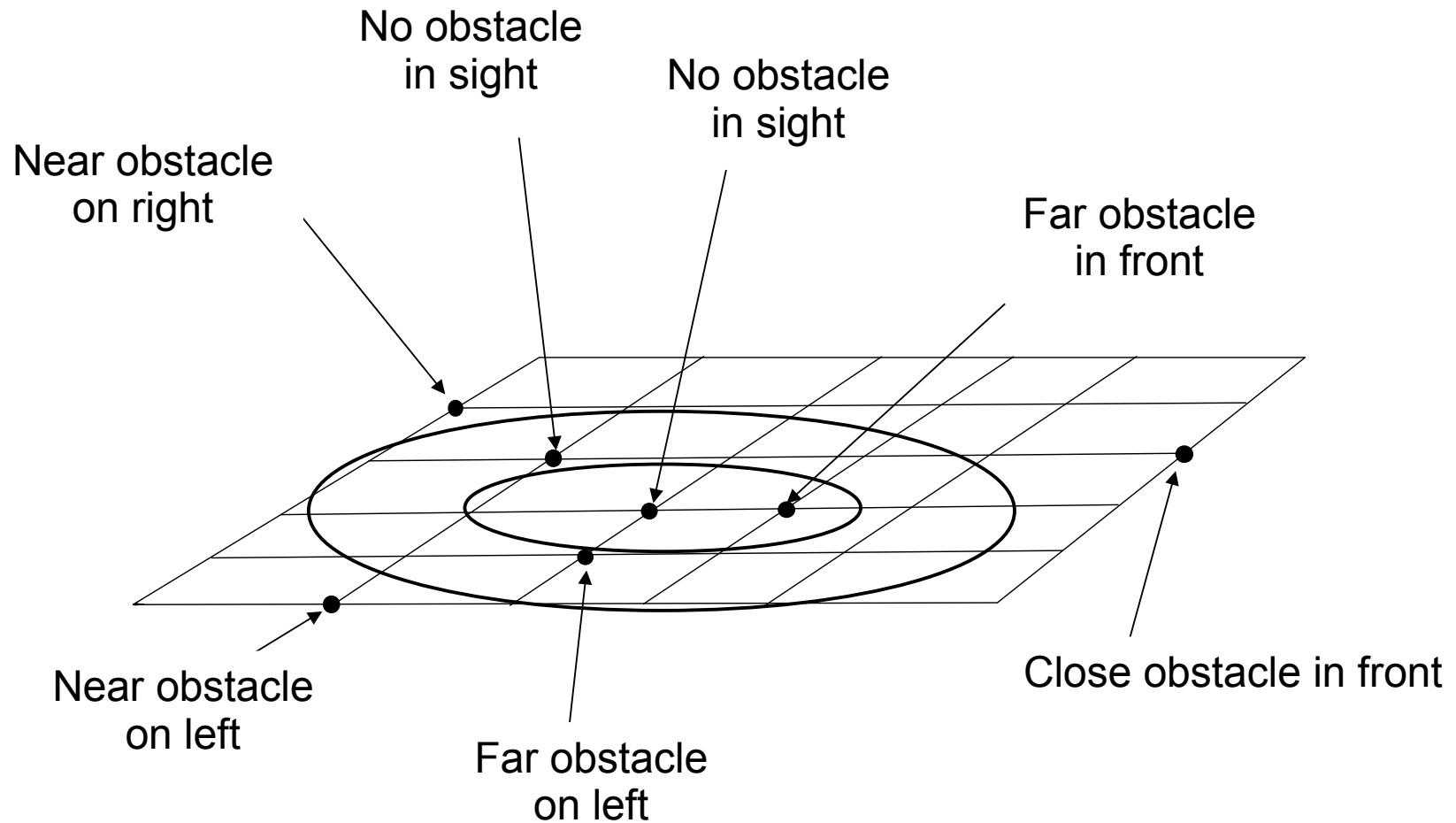


Variations of situations

## 8.2 Synthesizing a sequence of actions respectively to a goal

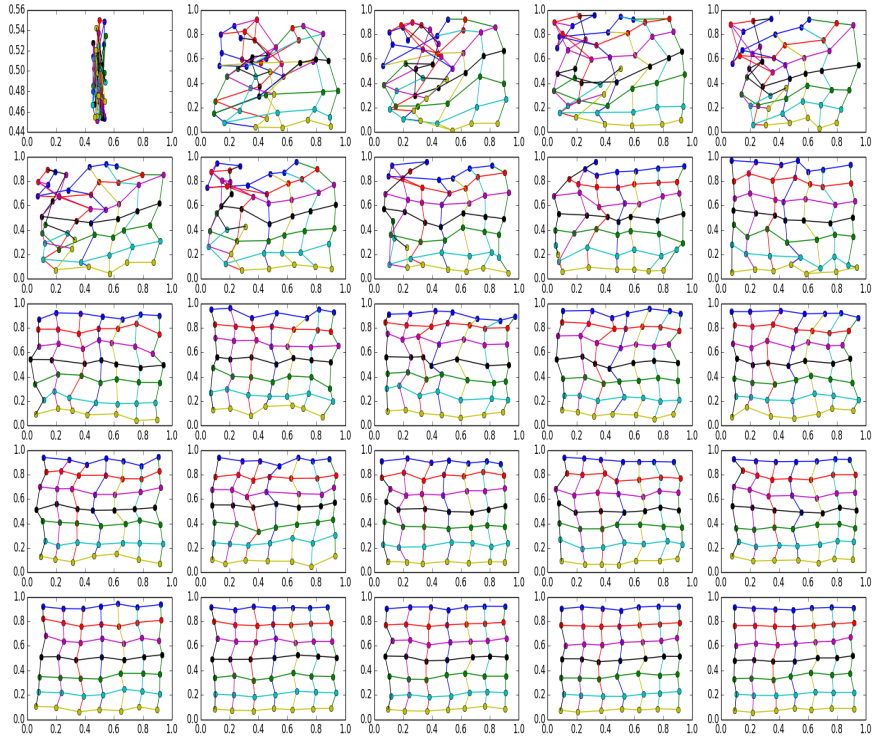


## 8.3 Immediate synthesis of multiple behaviors



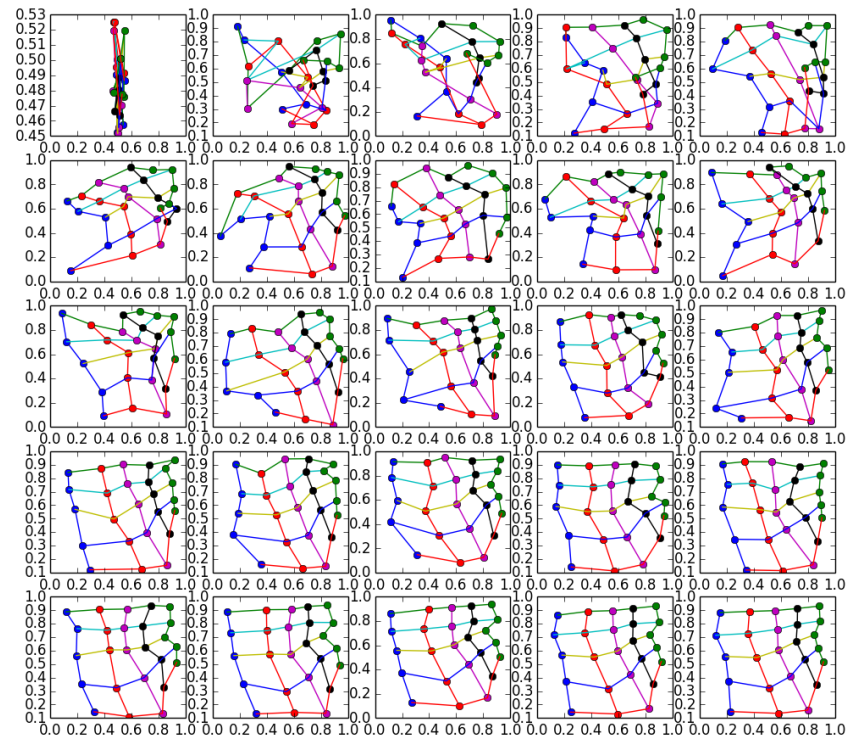
- Hunting, avoiding, following, ...

# 8.4 Improving by doing

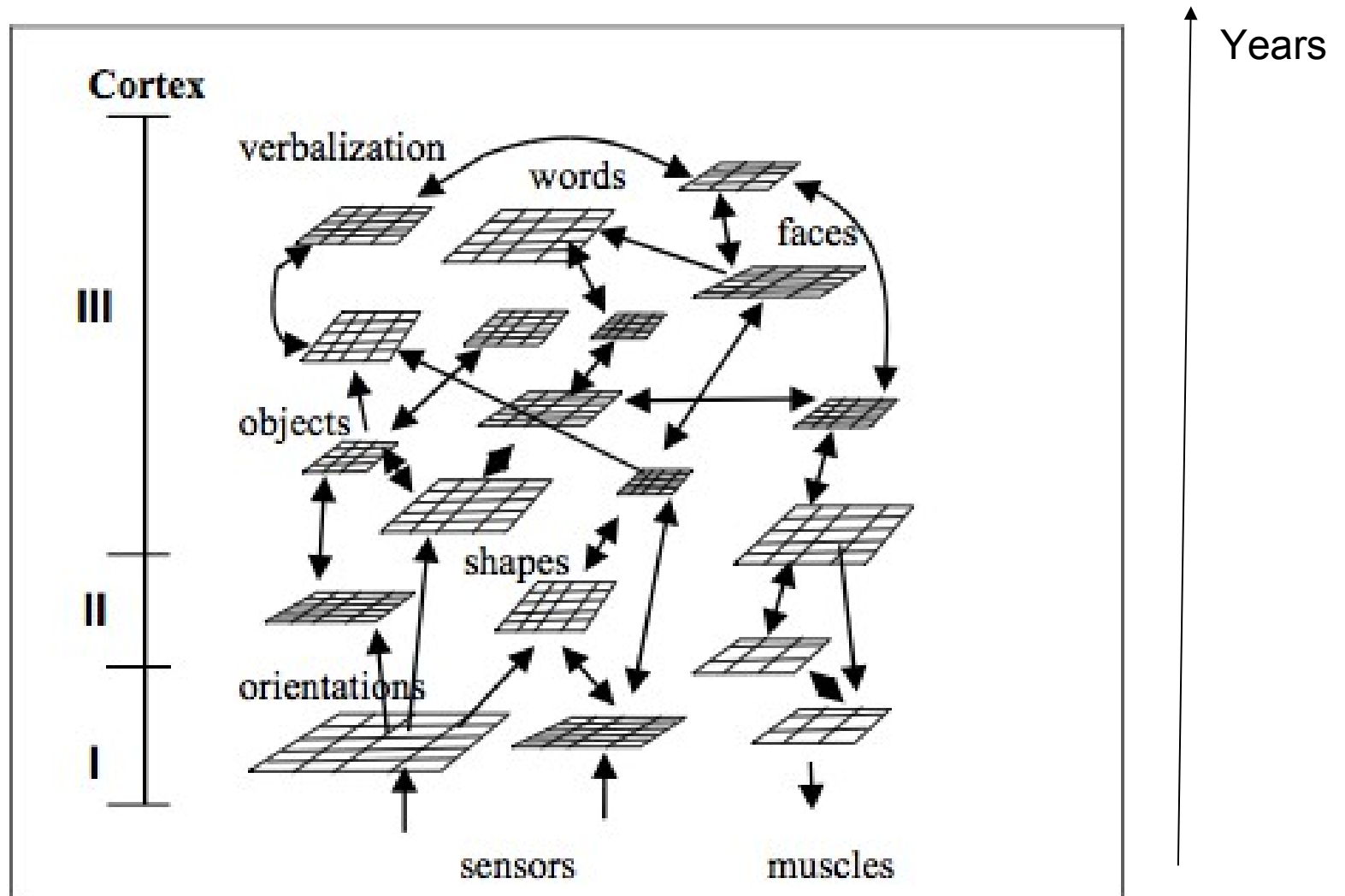


Uniform distribution

Non uniform distribution



## 8.5 To write or to speak : set a goal



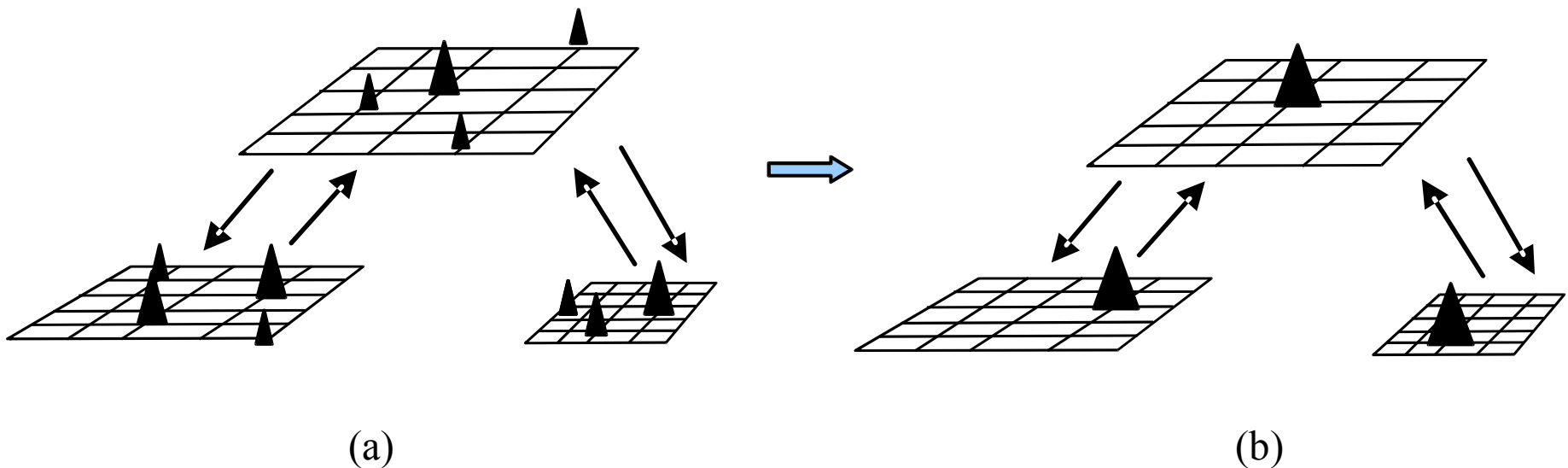
## 9. Hierarchy of goals : complex behaviors

The ultimate goal of a speaker is to have the listener understand, *i.e.*, acquire a new knowledge. The whole speech is devoted to move from the supposed knowledge of the listener to the knowledge state wished by the speaker. Having defined an initial state and a final goal, a series of intermediate goals emerged. Each « elementary » behavior that resolves an intermediate goal is a sentence, or a set of sentences. The whole set of sentences is a speech.



# 10. Implicit goal (motivation)

- The smallest common activation pattern between multiple memorized events is an attractor state.



# 11. No goal (homeostasis)

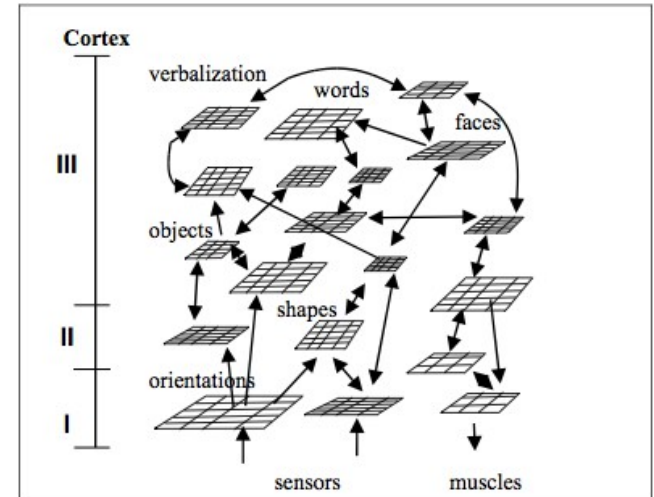
The equilibrium is defined by the fact that the frequency of changes is particularly low. The last “action” of the neurons will be well recorded, and therefore will be easily replayed next time the situation is similar. This learning – by only allowing complete synaptic modification for the associations that are not immediately followed by other actions – favors the emergence of equilibriums. Applied to biology (verticality, blood pressure, etc.), these equilibriums may be referred to as “homeostasis”.

Palimpsest learning explains how well-timed additional information (supervision) help organize the various cortical maps.

## 12. Global coherence and matching

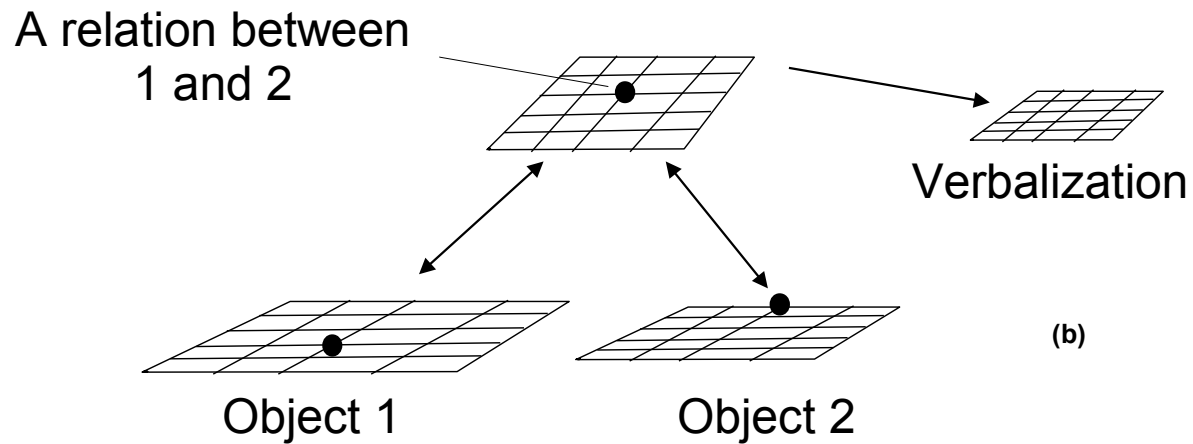
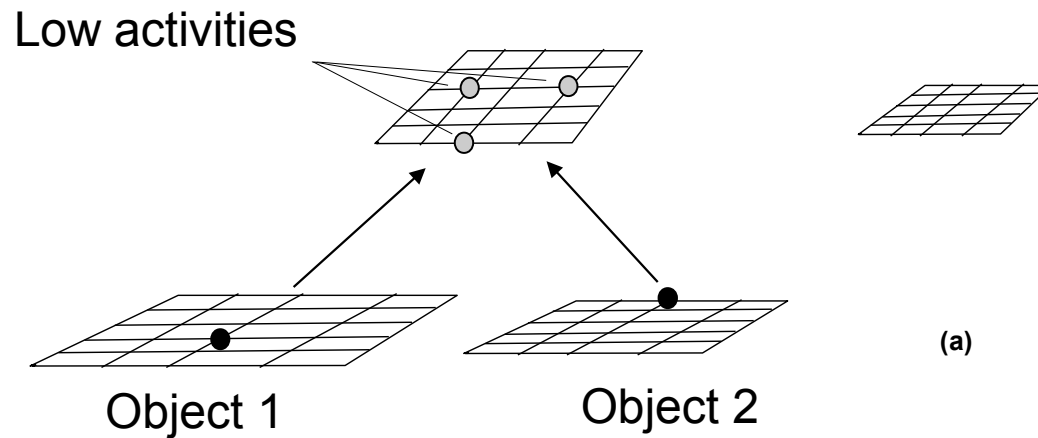
No arbitrary (either randomness or free-will), the language has gestural origins.

- Toussaint, M. 1983. *Contre l'arbitraire du signe*. : Didier Erudition.
- Corballis, M. 2003. *From Hand to Mouth : les origines de la langue*. University Press Group.



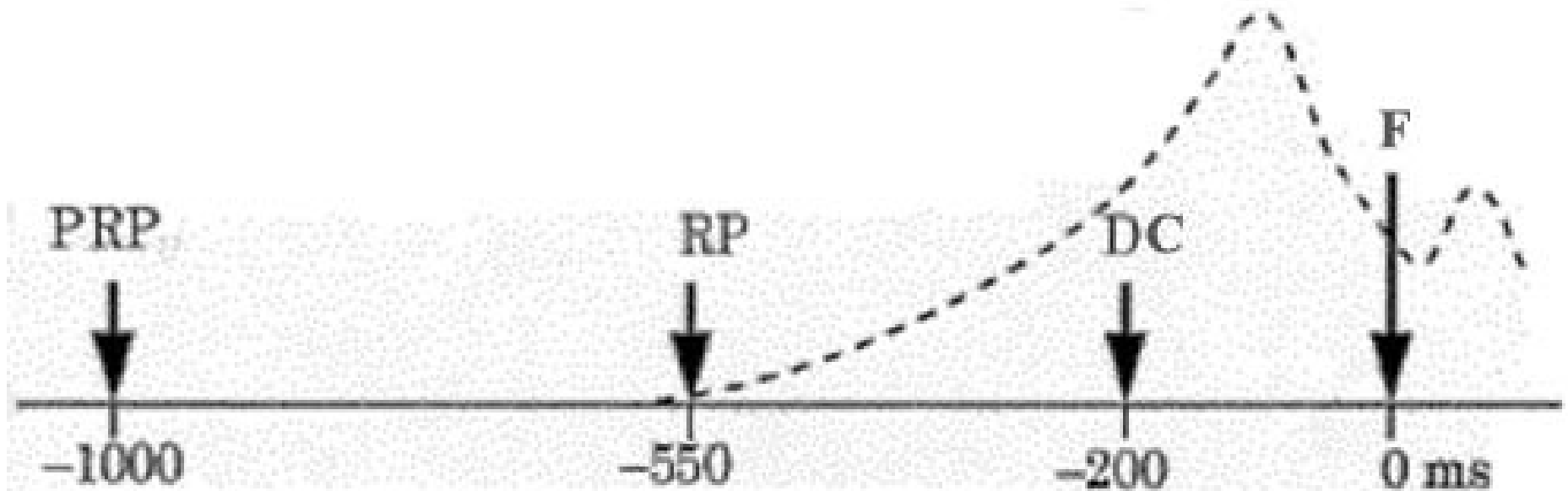
- Bottineau, D. 2010. « La théorie des cognèmes et les langues romanes : l'alternance i / a. La submorphologie grammaticale en espagnol et italien ». In : *La recherche en langues romanes : théories et applications*, Gilles Luquet-Wiaczeslaw Nowikow (éds.), Actes du Colloque : Paris 29-30 juin 2007. Université de Łódź (Pologne), p. 11-47.
- Saffi, S., Pagès, S., 2013, « La question de la motivation du signe. Le morphème [a] en italien et en espagnol », *Cuadernos de Filología francesa*, (Hommage à Maurice Toussaint), Cáceres, Universidad de Extremadura, p. 187-210.

# 13. Intelligence : A (hierarchical) matching



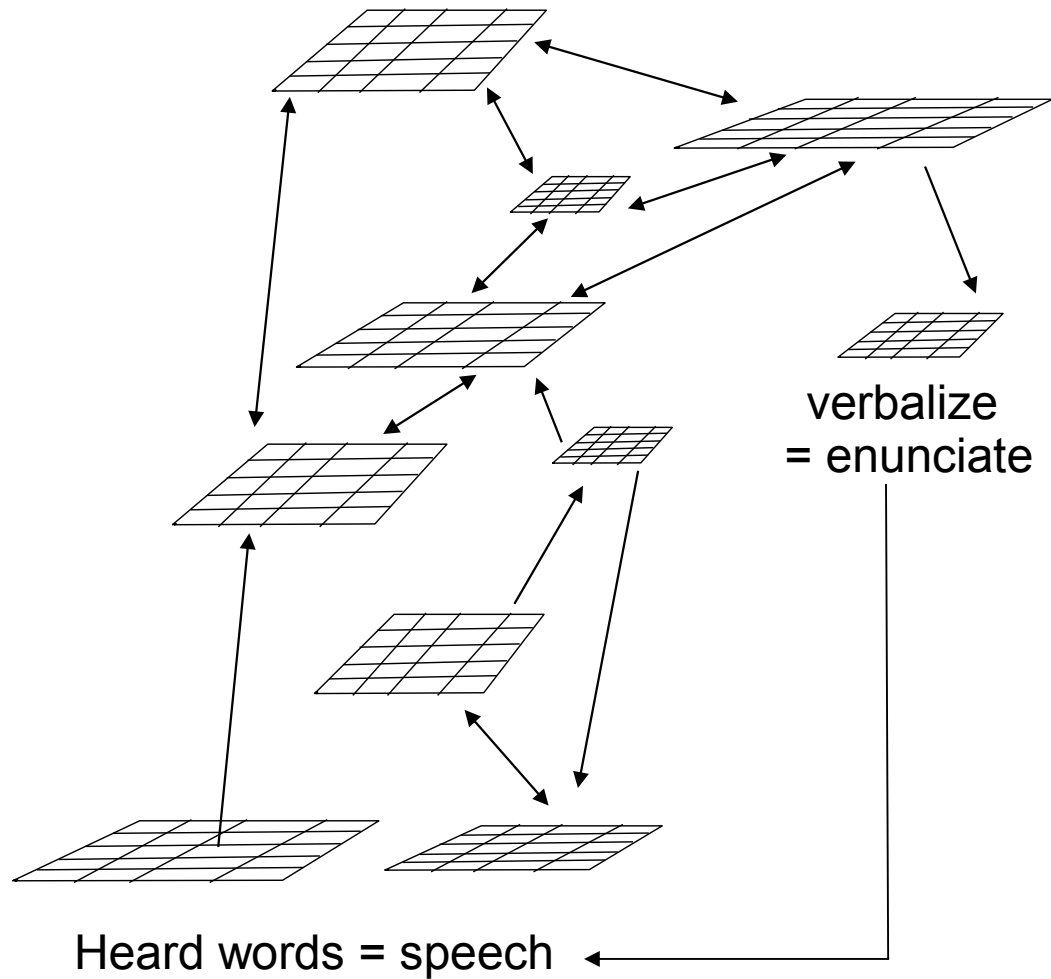
Something is (or isn't) « intelligent » depending on the knowledge of the observer.

## 14.1 Acting before (automatic) verbalizing



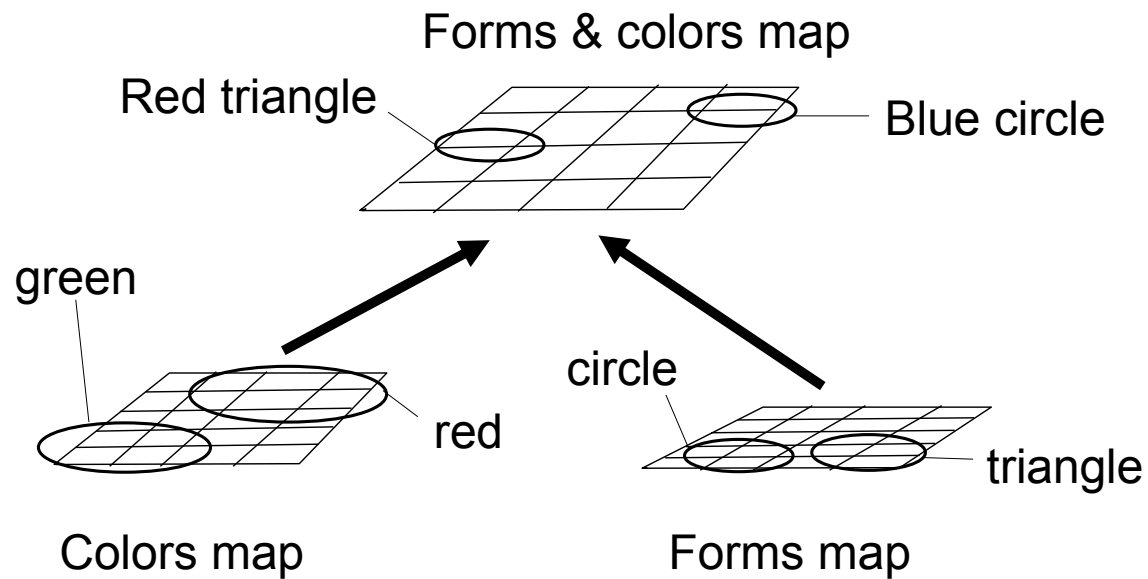
Libet, Benjamin (1985). "Unconscious Cerebral Initiative and the Role of Conscious Will in Voluntary Action". *The Behavioral and Brain Sciences* 8: 529–566.

# 14.2 Consciousness: automatic verbalisation



Baby-sitting = Supervised language learning

# 14.3 No semantics, only examples





# References

- C. Touzet, "The Theory of neural Cognition applied to Robotics", *International Journal of Advanced Robotic Systems*, 2014, to appear.
- C. Touzet, *Hypnose, sommeil, placebo ? Les réponses de la Théorie neuronale de la Cognition - Tome 2*, 166 pages, éd. la Machotte, 2014.
- C. Touzet, *Conscience, intelligence, libre-arbitre ? Les réponses de la Théorie neuronale de la Cognition - Tome 1*, 156 pages, éd. la Machotte, 2010.