

Theory of neuronal Cognition and Reading

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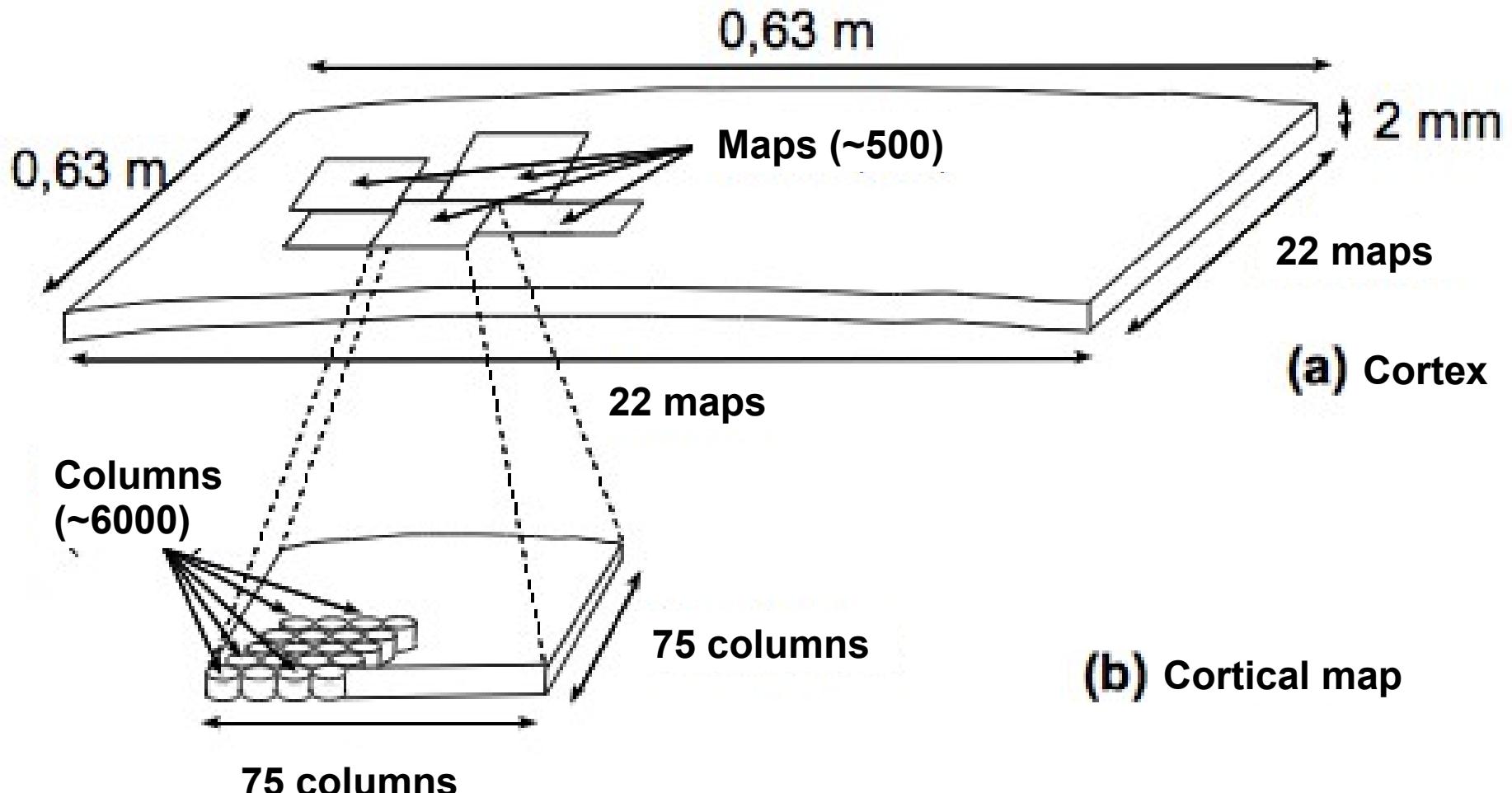
Abstract

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.

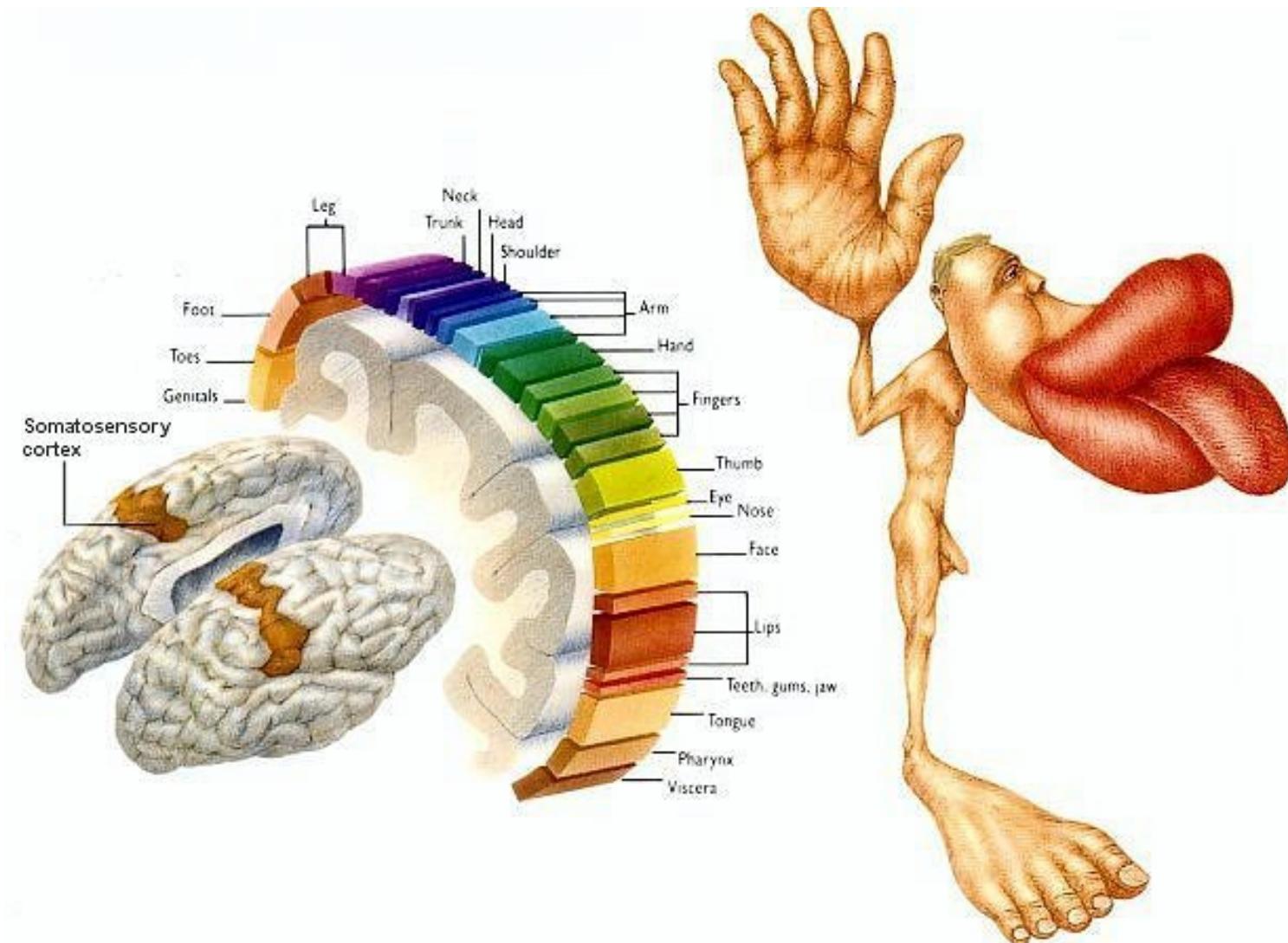
Summary

- 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

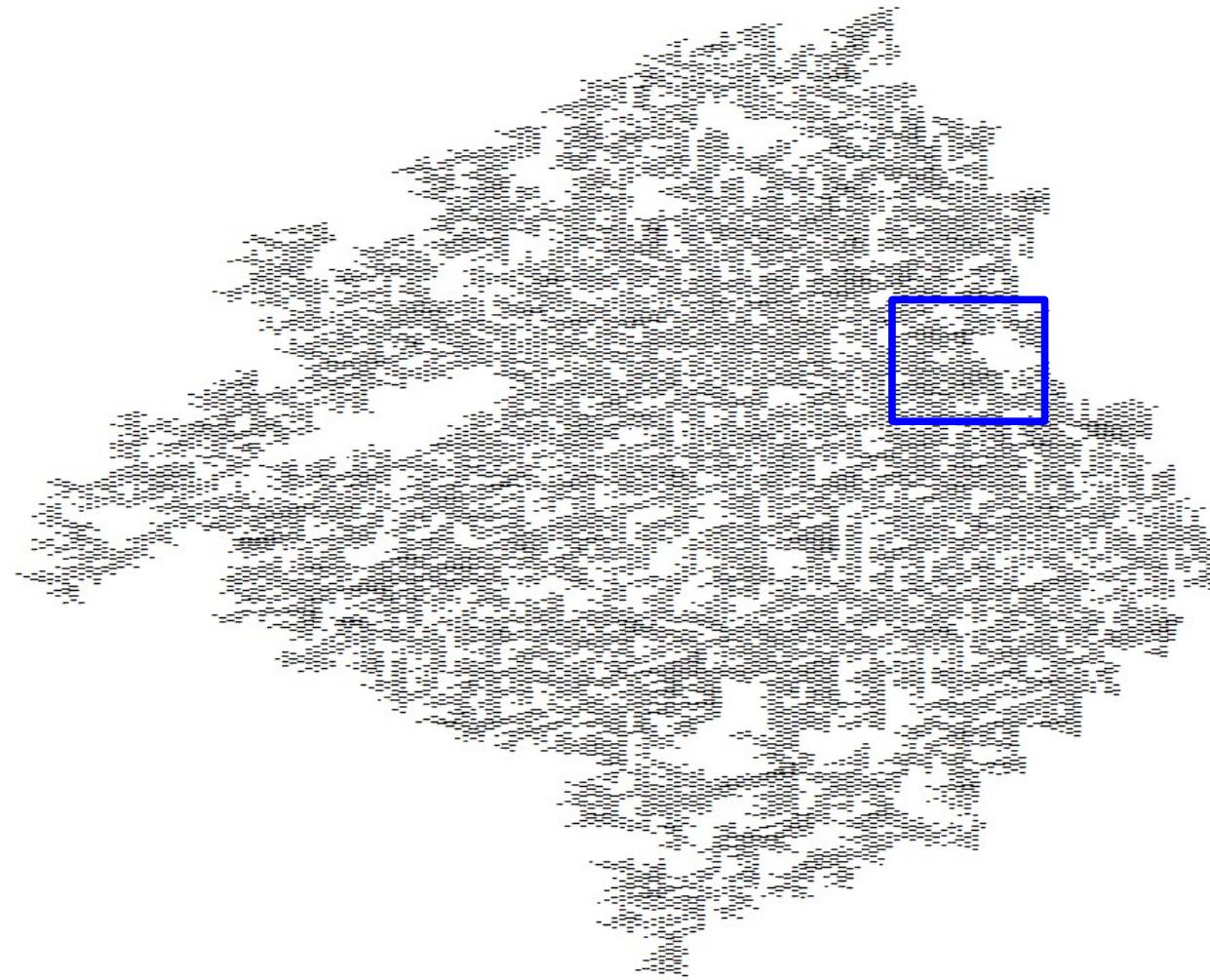


2. Self-organizing maps



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

2.1 Orthographic word form map

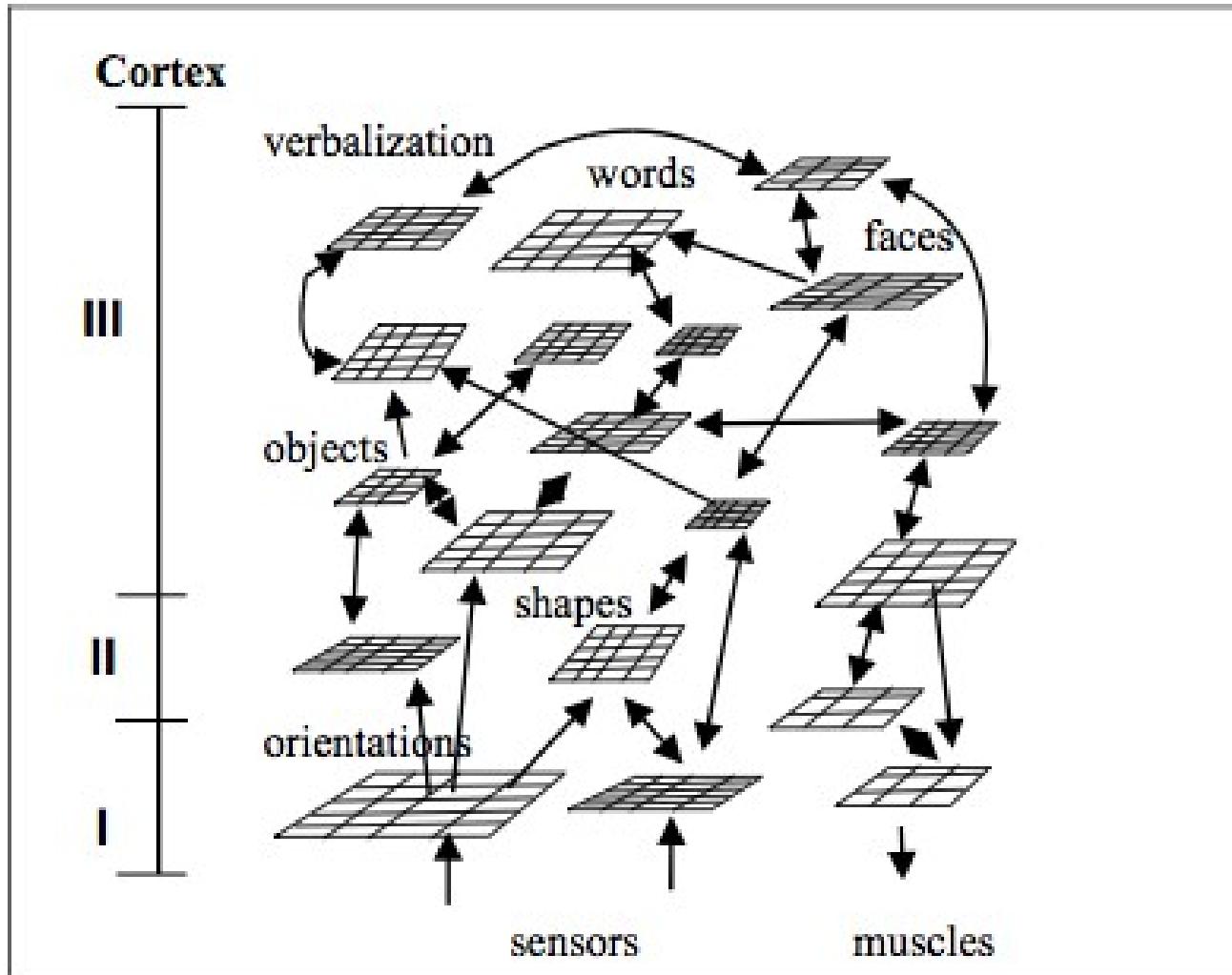


C. Touzet, K. Kermorvant and H. Glotin, "A Biologically Plausible SOM Representation of the Orthographic Form of 50,000 French Words", *WSOM 2014* (10th Workshop on Self-Organizing Maps), July 2014, Mittweida, G.

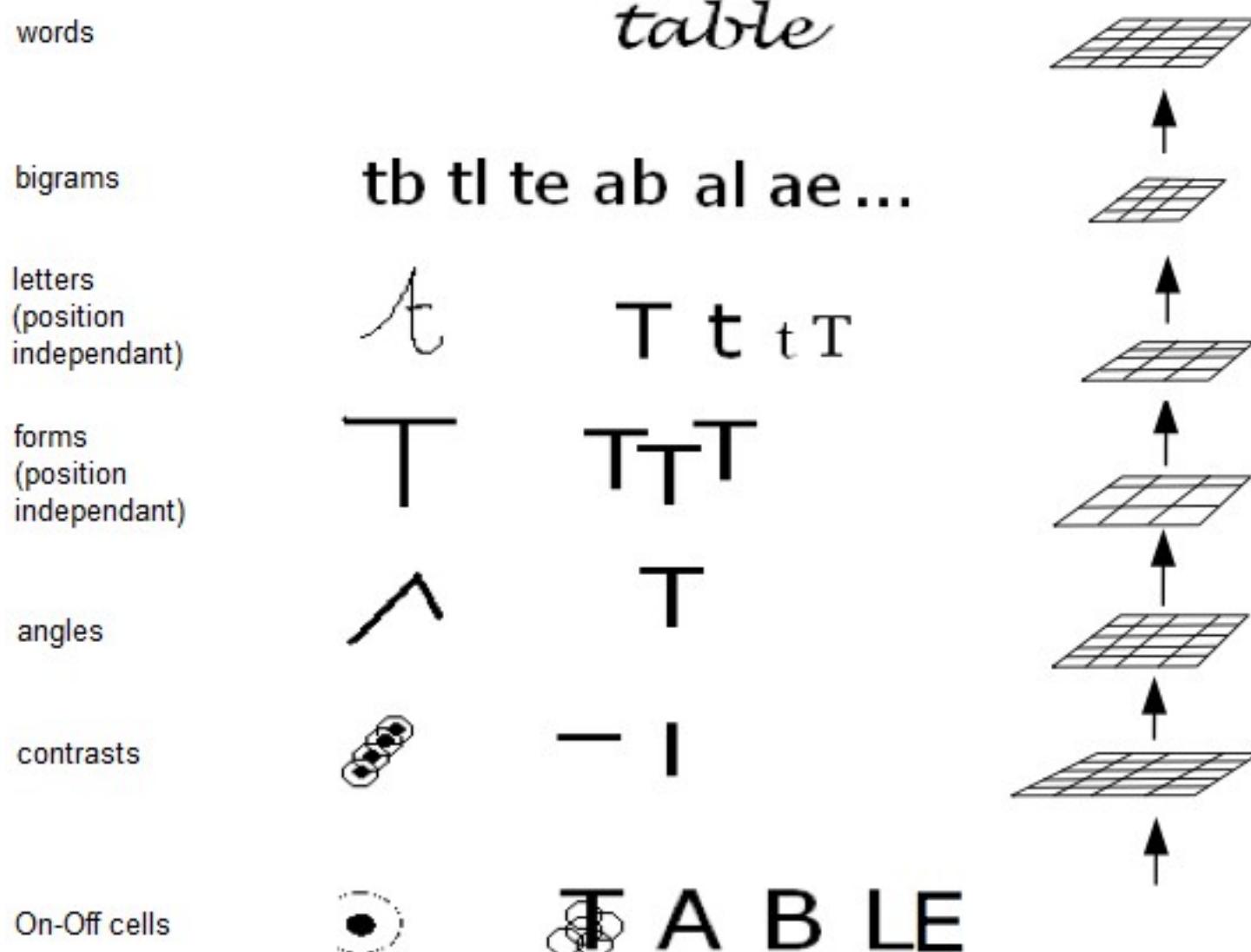
2.2 Orthographic word form map

retentiment	volontiers	position	dispositions	dispositives	répartissons	terminale	intronisme	sabotageuse	percutantes
entretiennent	porte-avions	exposition	disposition	respirait	alimenter	barcelone	banderole	protagonistes	
porte-savons	porte-savon	proposeront	expositions	dispositive	prairies	élémentaire	obligence	protections	
retiennent	avant-propos	proposons	suppositions	positions	improvisaient	élémentaires	inconcevable	vendable	protection
	apportons	proportion	superpositions	oppositions	improvisation	convenable		construction	tricots
	proposaient	rapportions	prévention	prépositions	proposition	convalescence	souvenance	soulignés	rabatitions
proposent	prospection	piétonnier	prépositionnels	opposition	oculaire	populace	vengeances	contorsions	abattoirs
recopions	prépositionnel	préposition	promotions	populière		renoncule	savonneuse	loing	autorisait
procession	prétentio	préception	morpion	promotion	populaires	parlotes	renonculeacées	prononcions	rationalisation
	tiendront	rétentio	potirons	nimportou	insupportable	parlates	souviennes	reconnaissons	aboutissait
obtiendront	orientant			topinambour	insupportables	cannelures	envisegeons	prolongations	napolitain
obtiendrons	orientant	toumaient		surplombant	insurmontable	incommensurable	vosgienne	plongions	animatio
rendrons	tiendrons	toumante		tambourins	surplombant	peigneron	enseigna	éloignons	manipulations
	entourant	retournant		tambourina	surplombante	laboureament	voisienne	éloignons	émanations
		entouraient	revenait	seraient	commissaires	abonnement	enseigna	ignorions	émanciation
			réveraient	servaient	sommabile	reboisement	pigeonne	girondin	mamonnaie
			enverrait	versaient	cramoisiés	ébrouement		incognito	aimantation
enfermer	renferme	erraient	tavernier	entrerais	commissariat	caquelon		ignico	nationalité
fermenter		raffinement	assomme	assommerait	assommant	volcaniques	lloncea		
enfermement	renfermant	enfermant	terminera	termineras	assommaient	volcanique			
fermément	refermant	refermant	retransmis	massaient	consommateurs	coquines	oceanique	jeackie	
refermérent	refermément	refermément	terminerai	transmis	amassaient	satanique	oceaniques	jean-michel	
refermement	refermeront	enfermerai	fabriquerent	trafiquent	songerait	mécaniques	jacquemin		
renforcement	refermerai	fabriquer	fabriquent	fabriquent	fantasmagorique	sémantique			
compteras	remplacé	fabriquerai	fabriqueras	fabricant	fantasque	cinématique	encourageant		
compléteras	faibilla	fabriquerait		trafiquant	astiguent	édithéâtre	changea	répertoire	
remplacés	antirabique	essentiels		trafiquants	fantastique	encourageante	changeant	reporter	impératoire
remplacées	vaisselle	ustensiles	souhaitais	spationautes	pharmacie	médiathèques	changeant		
remplace	versailles	ruisselets	souhaitait	pasteurisation	fantastiques	encourageants	changeants	reprises	postérieure
remplacées	tressaille	ruisselets	souhaitait	rehausser	parachutisme	domestiqué	changeants	supérieures	postérieure
remplacées	ruisselet		souhaiterait	parachutistes	pathétique	schématiquement	changeantes	reprise	postérieure
respectable	flétrissants	souterraine	sauterais	poucharrait	anatomiques	cinématique	changeantes	supérieurs	postérieure
redoutable	bracelets	neutraliser	assuraient	croassait	sémantiques	encourageante	changeantes	supérieurs	postérieure
redoutables	rentable	feuillissaient	ralentisseur	aristochats	édithéâtre	encourageants	changeants	reprises	postérieure
abordette	bateleurs	neutralise	ruisselaient	rituellement	phantomiques	encourageants	changeants	supérieures	postérieure
subalterne	reluisantes	ruisselante	ruissellent	guillerette	encourageants	changeants	changeantes	supérieurs	postérieure
cultivateurs	reluisaient	ruisselants	industrielles	guillerette	changeantes	changeantes	changeantes	supérieurs	postérieure
viticulteurs	tranquille	surveillants	surveillaient	guillerette	changeantes	changeantes	changeantes	supérieurs	postérieure
ructuralistes	tranquilles	villeratus	surveillante	guillerette	changeantes	changeantes	changeantes	supérieurs	postérieure
illustrer	artilleurs	taillleur	surveillant	guillerette	changeantes	changeantes	changeantes	supérieurs	postérieure
illustrer	travaileurs	trouvalles	intervalle	spirituelle	changeantes	changeantes	changeantes	supérieurs	postérieure
minularistes	tranquillisez	travailleur	entailleur	spirituel	changeantes	changeantes	changeantes	supérieurs	postérieure
tranquillisa	touller	trouille	interpell	rassemble	changeantes	changeantes	changeantes	supérieurs	postérieure
antillais	installai		perlaient	remblais	changeantes	changeantes	changeantes	supérieurs	postérieure
			remplaient	rassemble	changeantes	changeantes	changeantes	supérieurs	postérieure
			remplaient	rassemble	changeantes	changeantes	changeantes	supérieurs	postérieure

3. Hierarchy of SOMs

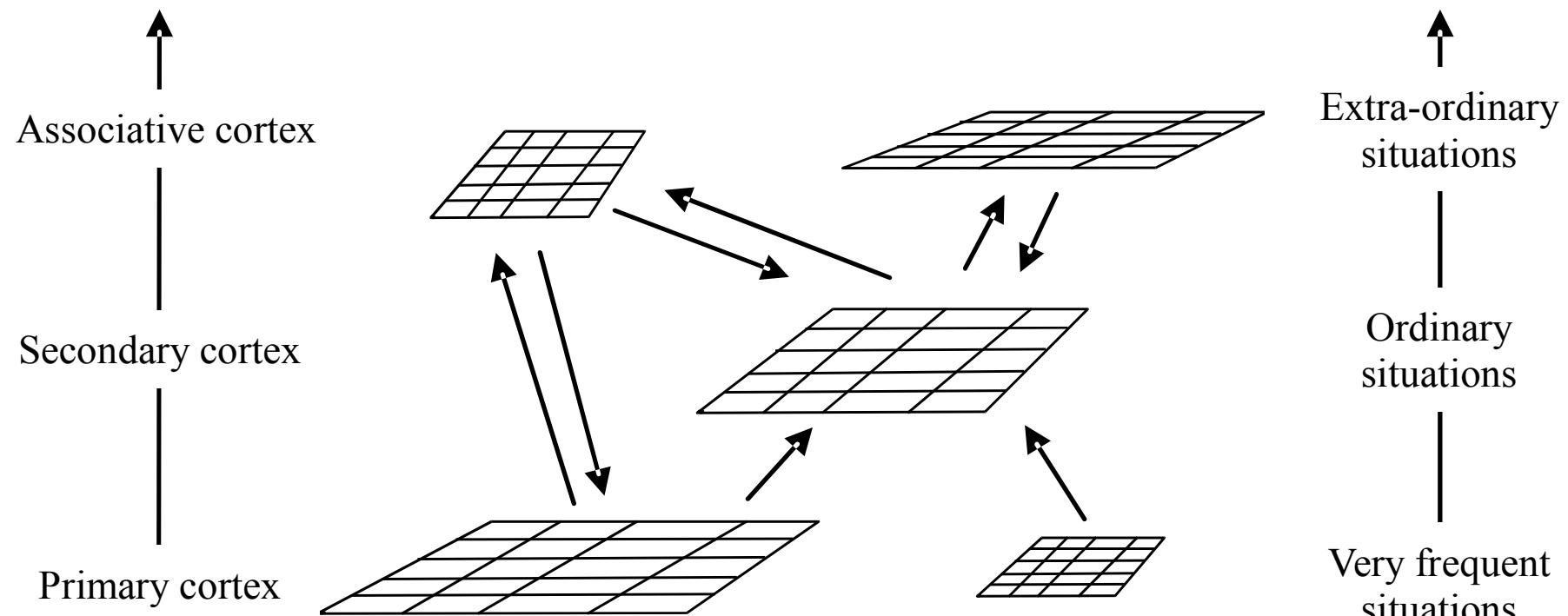


3.1 Reading orthographic hierarchy



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

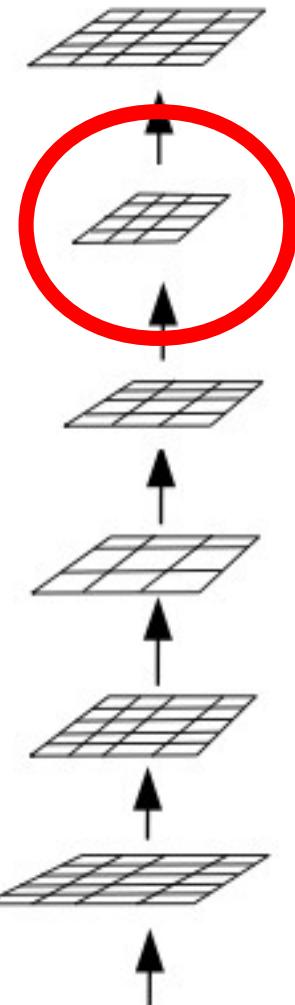


<i>l</i>	1	2	3	4	10	12
%	100	20	4	0.8	$5 \cdot 10^{-5}$	$4 \cdot 10^{-7}$

5. Supervised learning (syllabic method)

words

table



bigrams

tb tl te ab al ae...

letters
(position
independant)

t T t tT

forms
(position
independant)

T TT T

angles

↗ T

contrasts

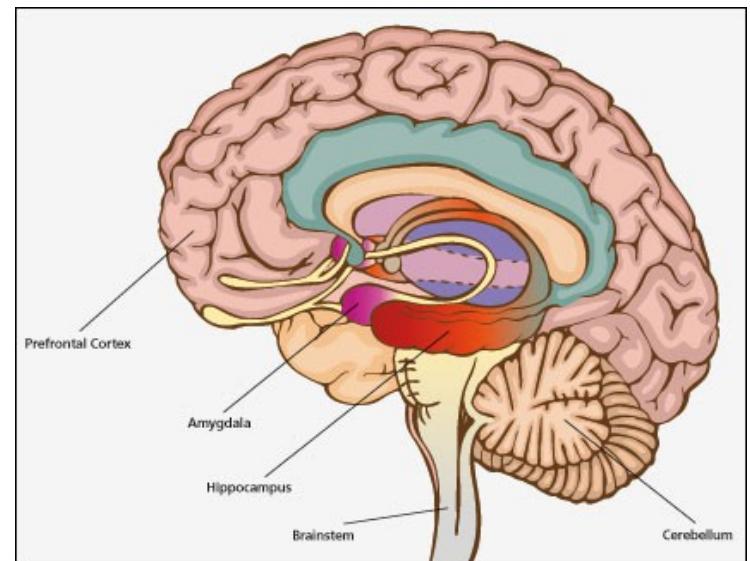
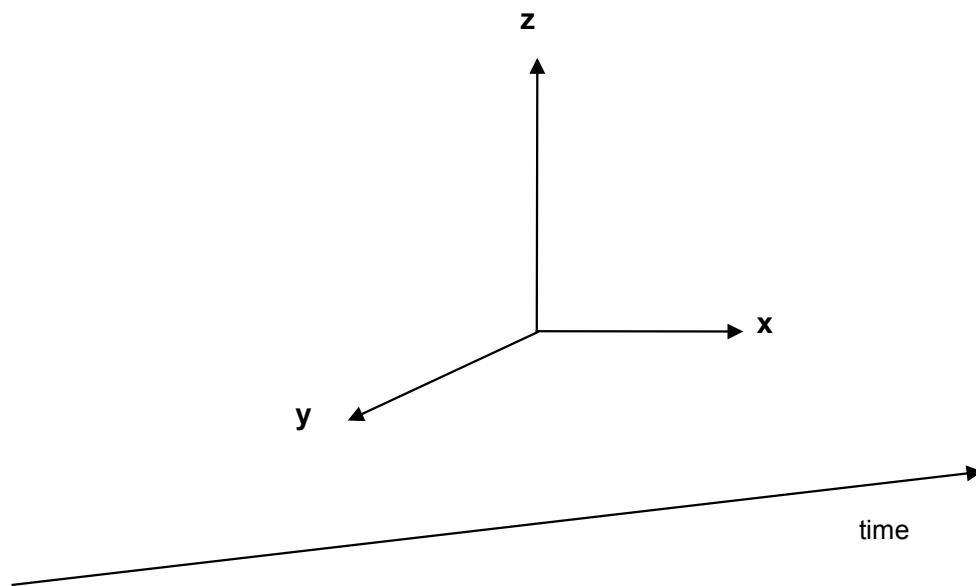
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On-Off cells

● TABLE

6. Episodic, cultural and implicit memories

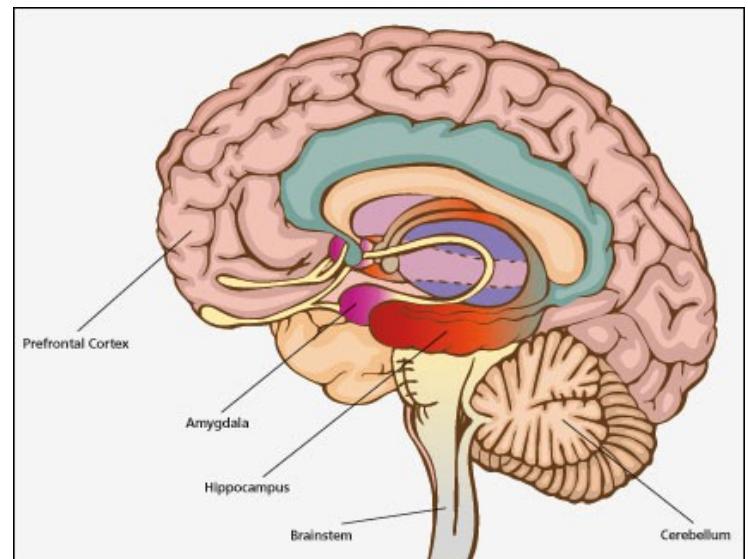
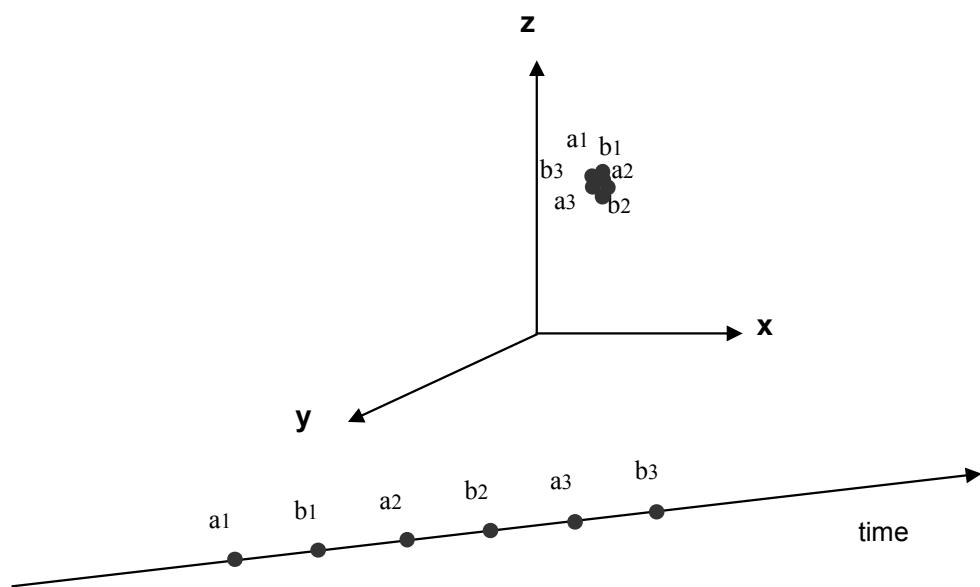
- time and space coordinates



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

6. Episodic, cultural and implicit memories

- time and space coordinates

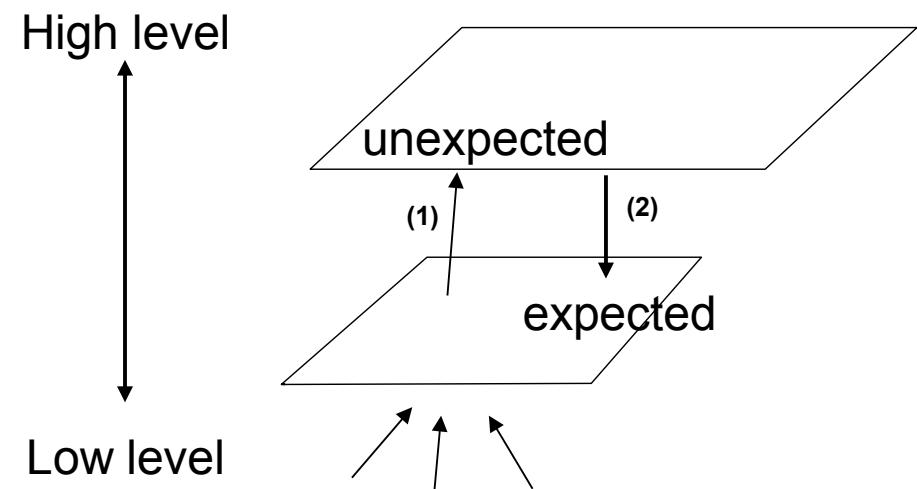
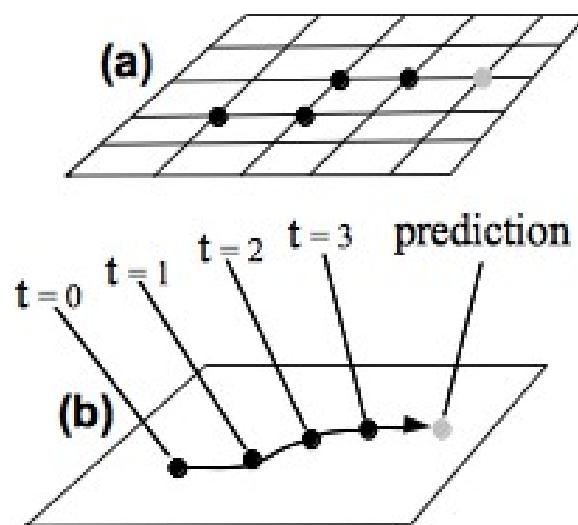


Charles R. Gallistel, *The Organization of Learning*, MIT Press, 1993.

7.1 Exogenous attention - bottom-up

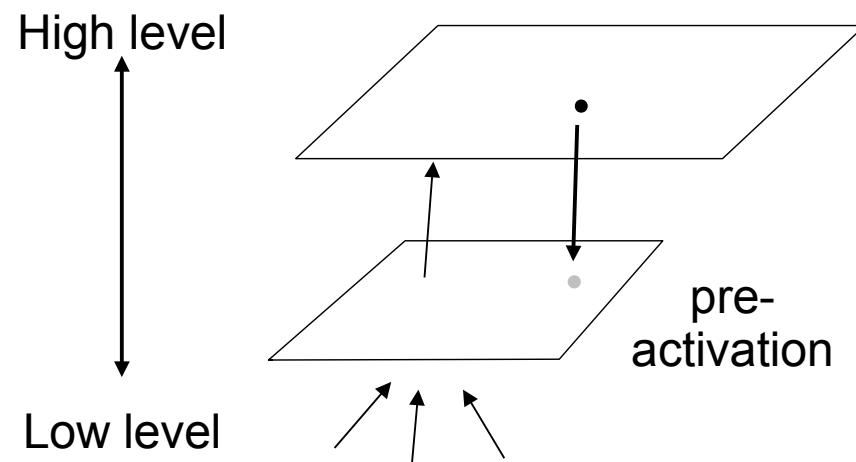
« Selecting one aspect of the environment while ignoring other things »

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



7.2 Endogenous attention - top-down

- Priming



8. Acting in the environment

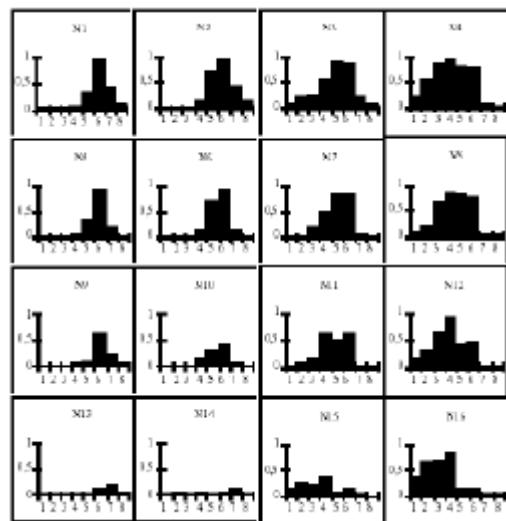


Khepera (8 IR)

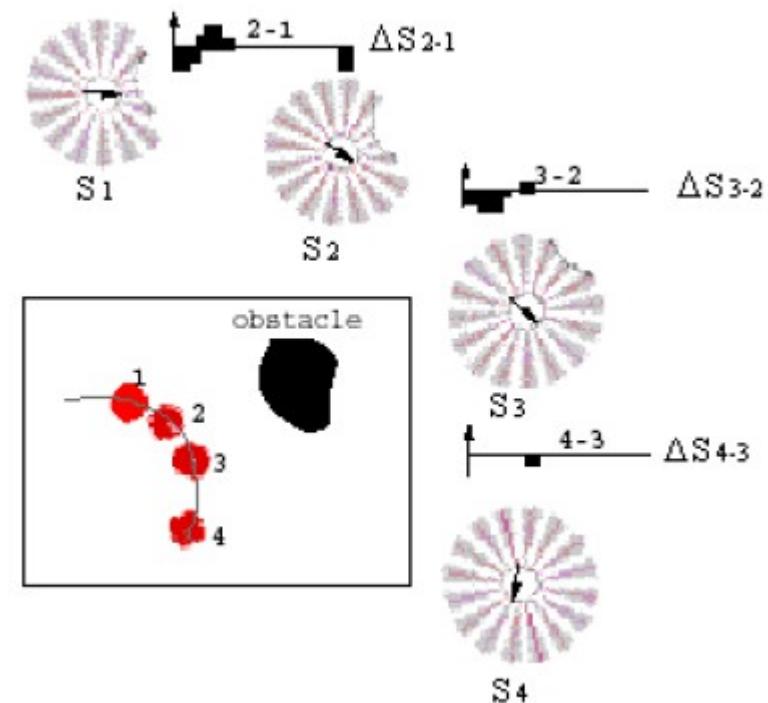


Nomad (16 sonar)

8.1 Sensory and sensory-motor maps

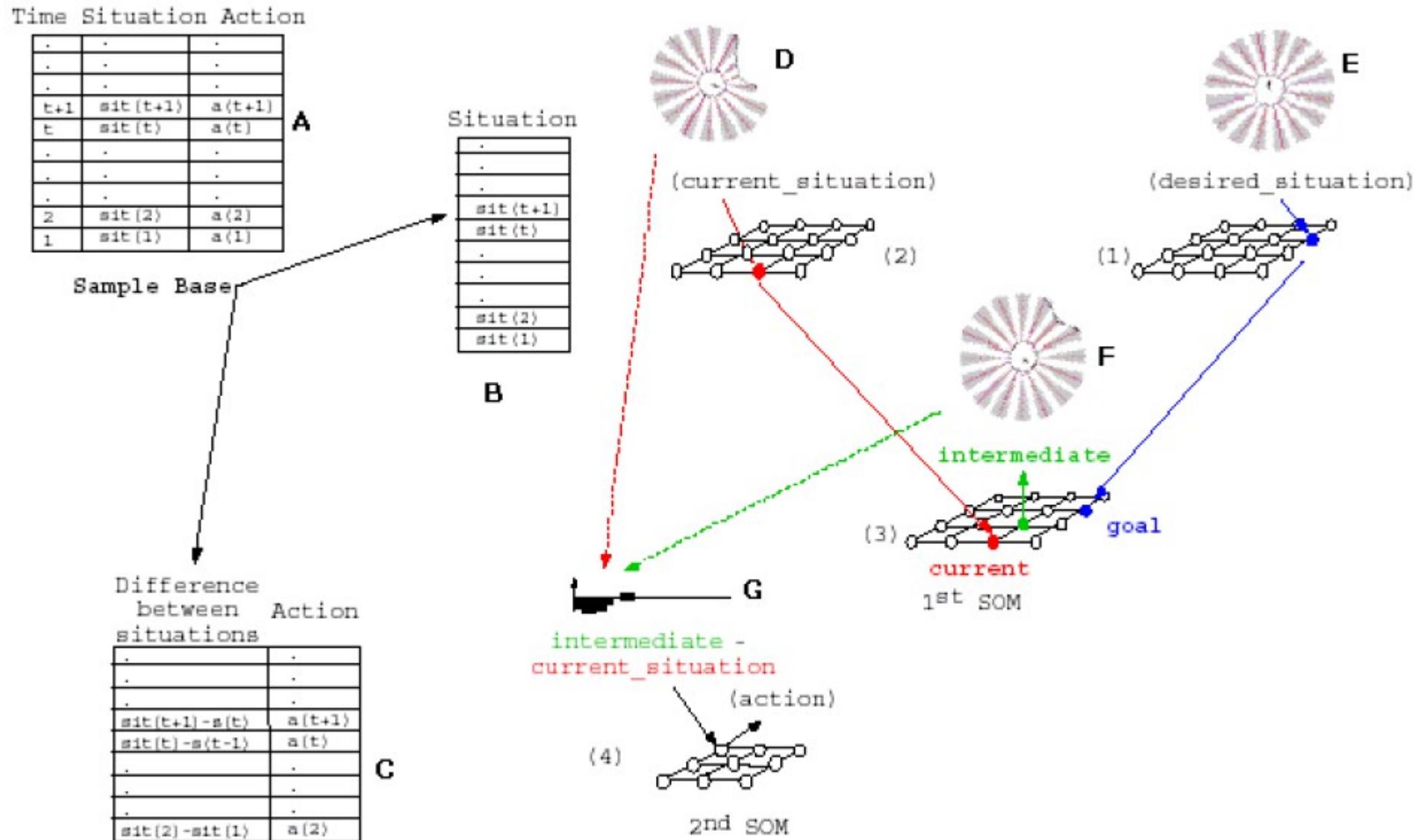


100 learning iterations
(16 neurons SOM)

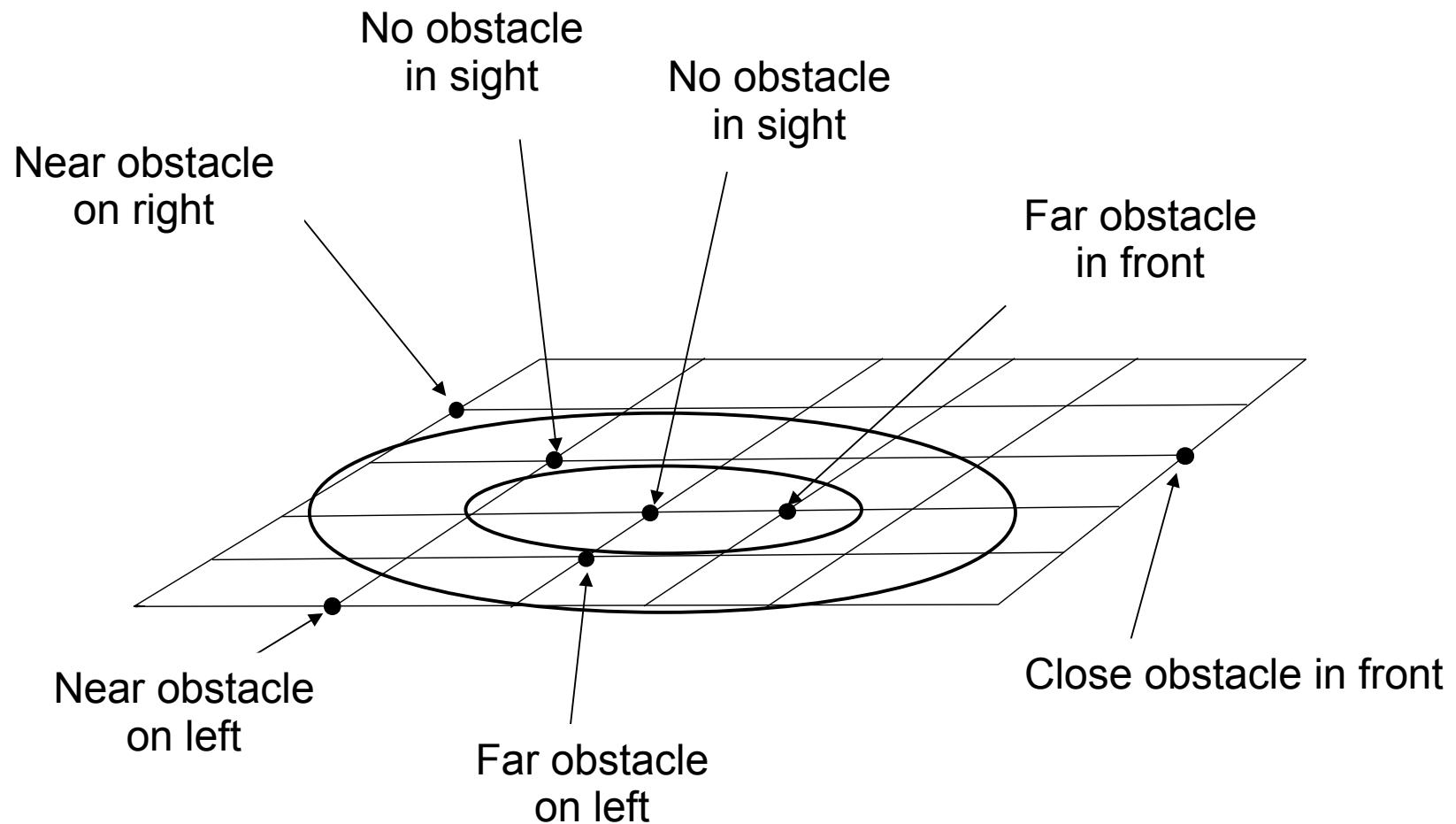


Variations of situations

8.2 Synthesizing a sequence of actions respectively to a goal

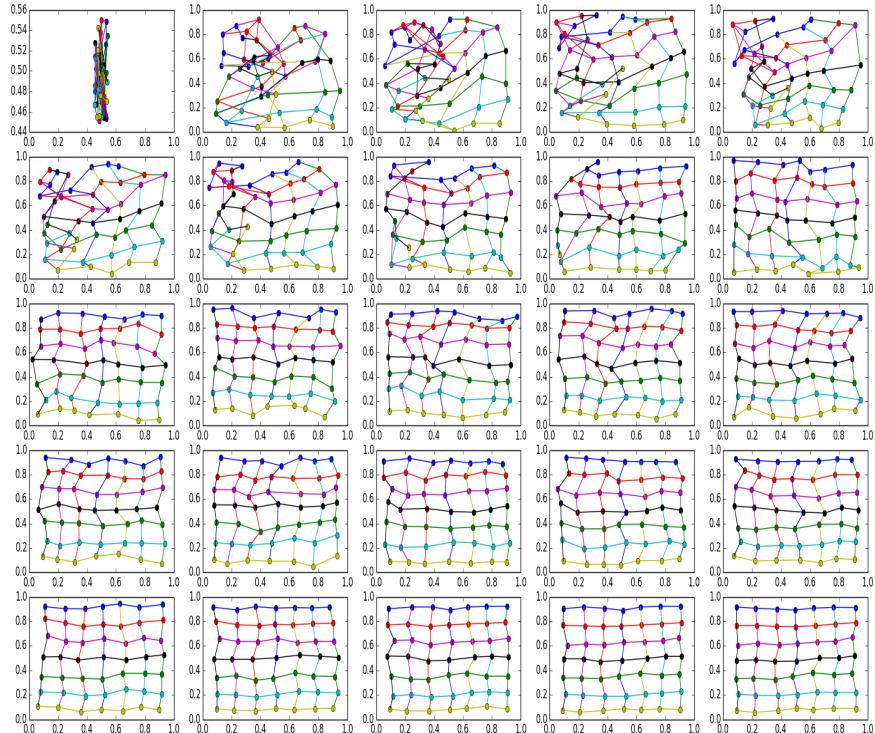


8.3 Immediate synthesis of multiple behaviors



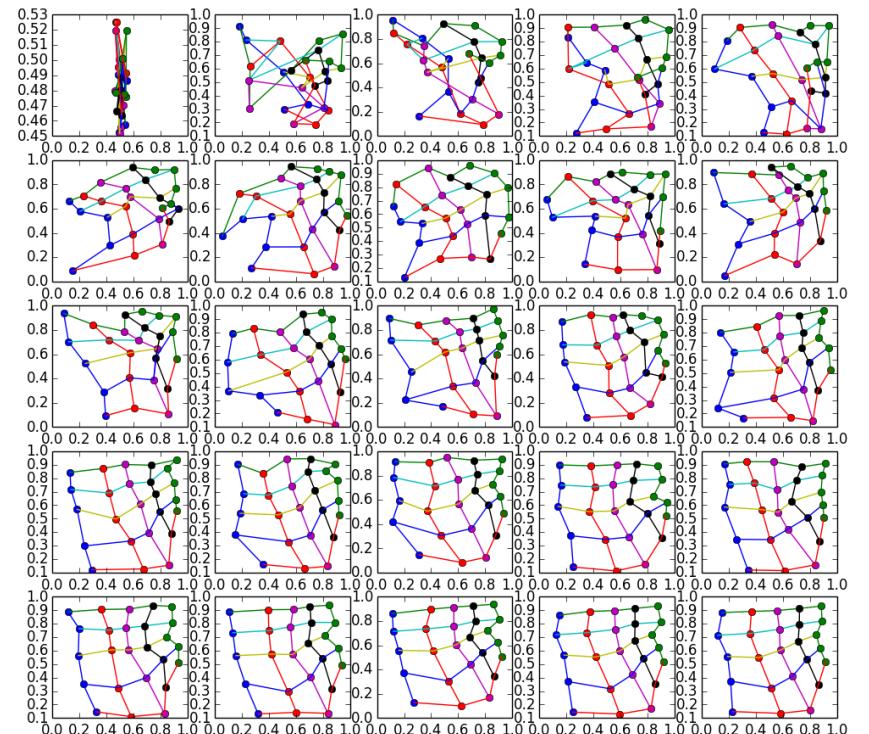
- Hunting, avoiding, following, ...

8.4 Improving by doing

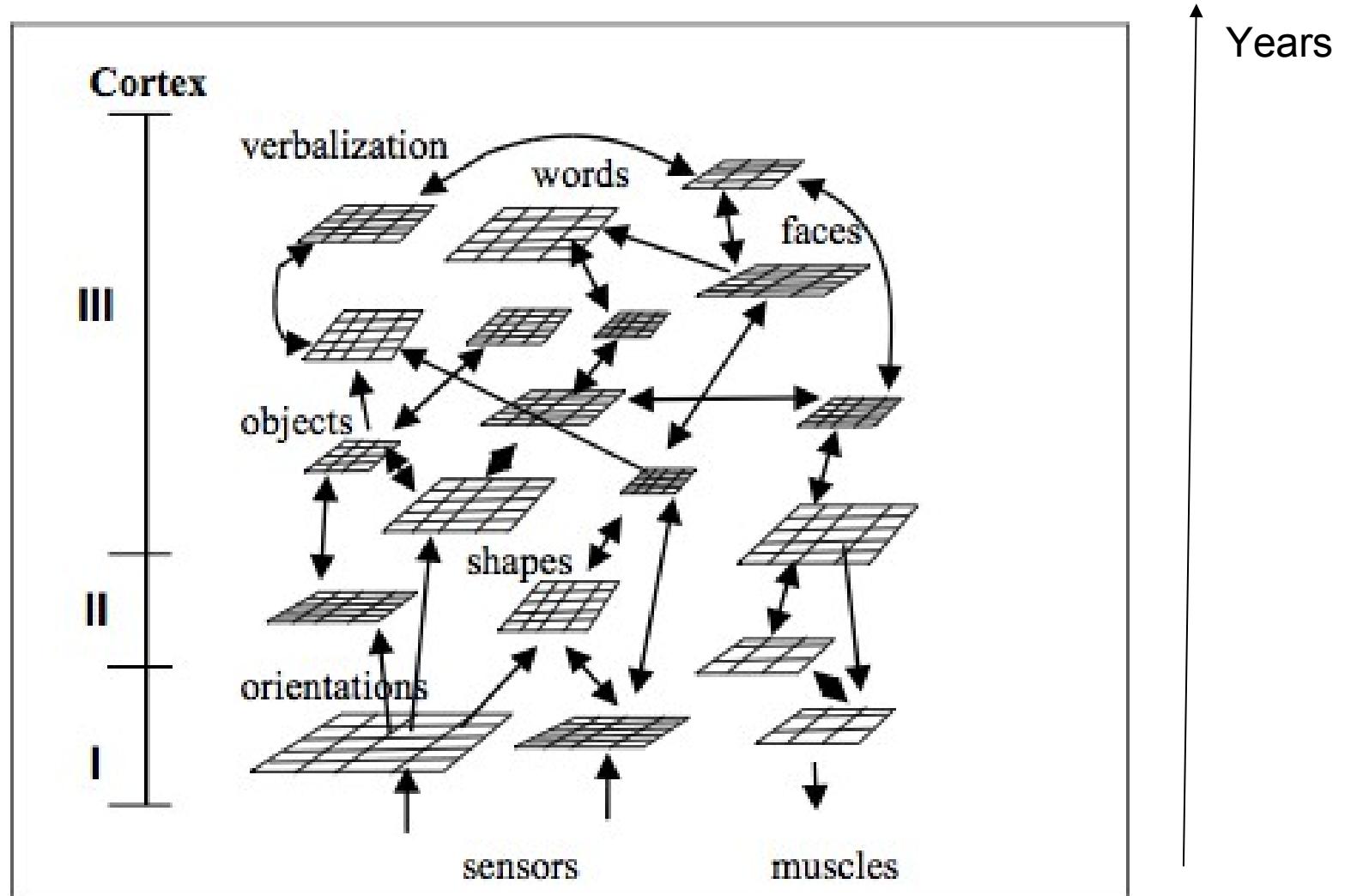


Uniform distribution

Non uniform distribution



8.5 To write or to speak : set a goal

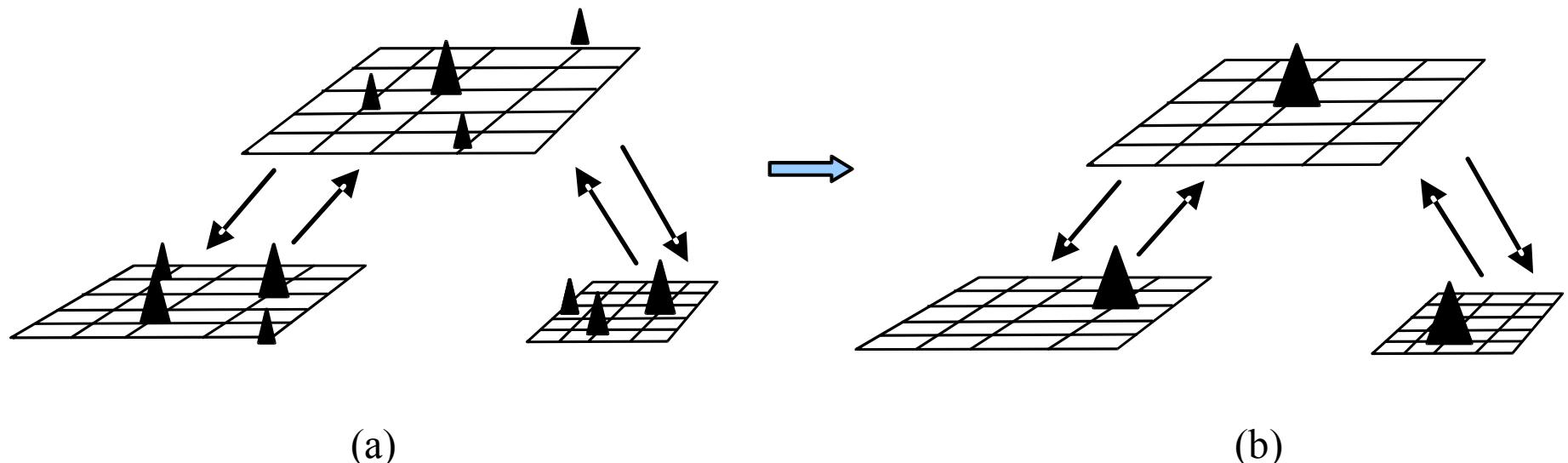


9. Hierarchy of goals : complex behaviors

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 define 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.



Touzet C (2011) « The Illusion of Joy » In : J. Schmidhuber, K.R. Thórisson, and M. Looks (Eds.) *Artificial General Intelligence 2011*, Springer LNAI 6830, pp. 357-362.

11. No goal (homeostasis)

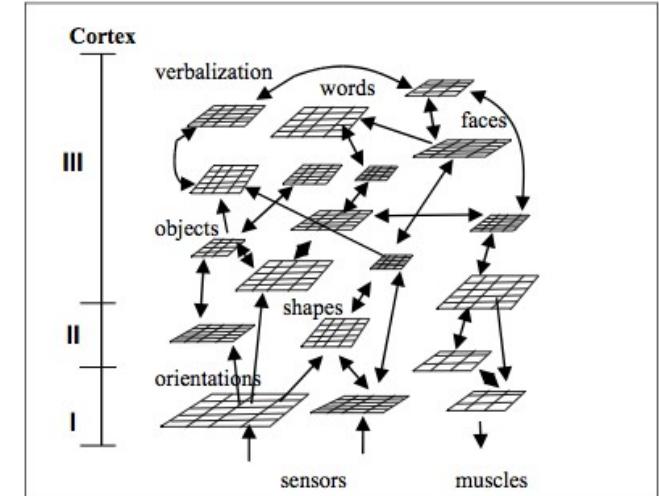
The equilibrium is defined by the fact that the frequency of changes is particularly low. The last “action” of the neurons will be well recorded, and therefore will be easily replayed next time the situation is similar. This learning – by only allowing complete synaptic modification for the associations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

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

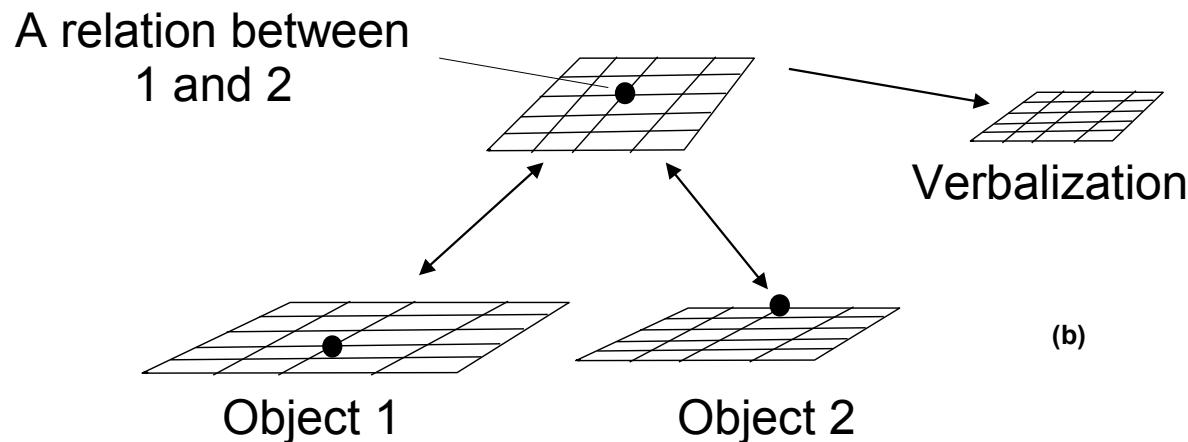
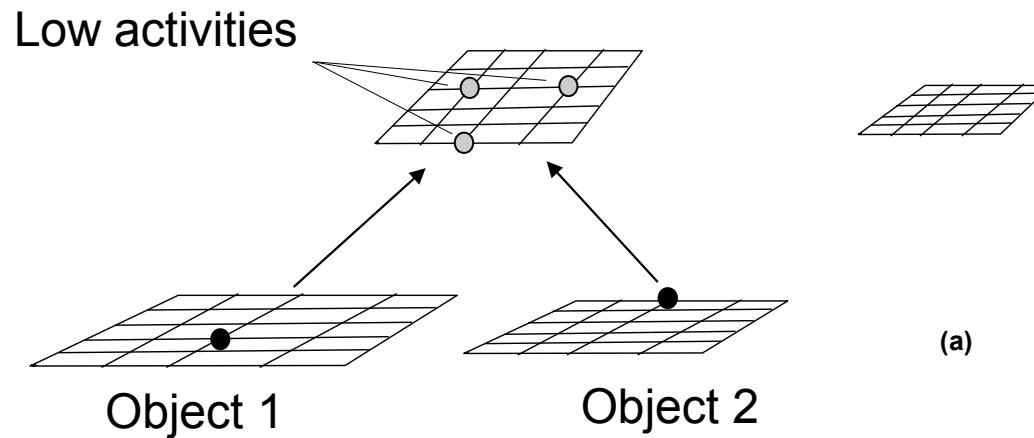
12. Global coherence and matching

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

- Toussaint, M. 1983. *Contre l'arbitraire du signe*. : Didier Eruditio.
- 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.

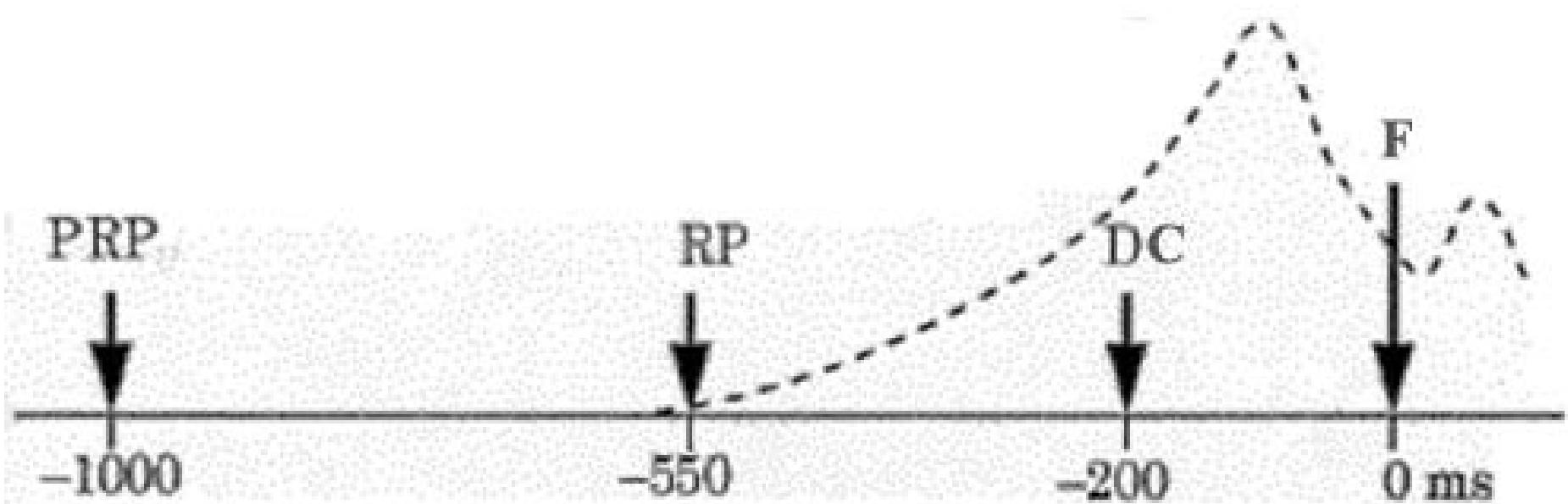


13. Intelligence : A (hierarchical) matching



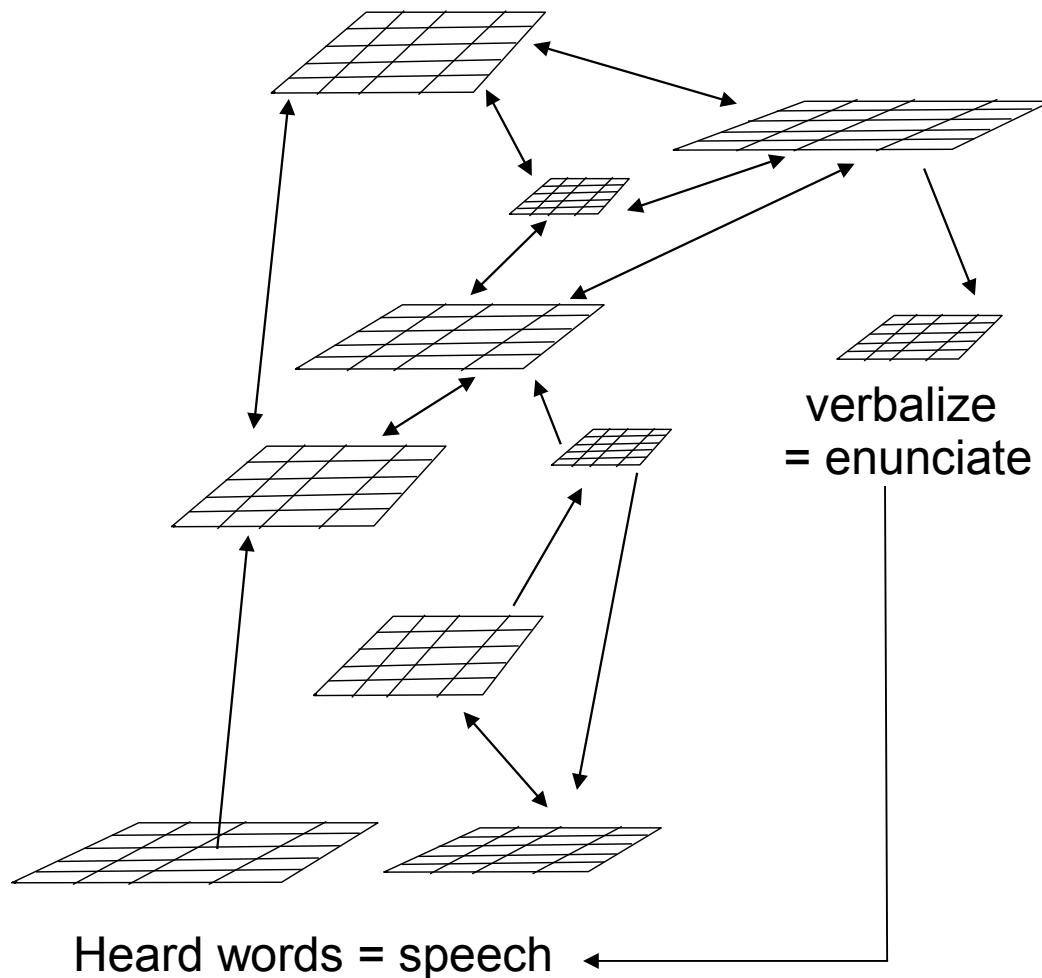
Something is (or isn't) « intelligent » depending on the knowledge of the observer.

14.1 Acting before (automatic) verbalizing



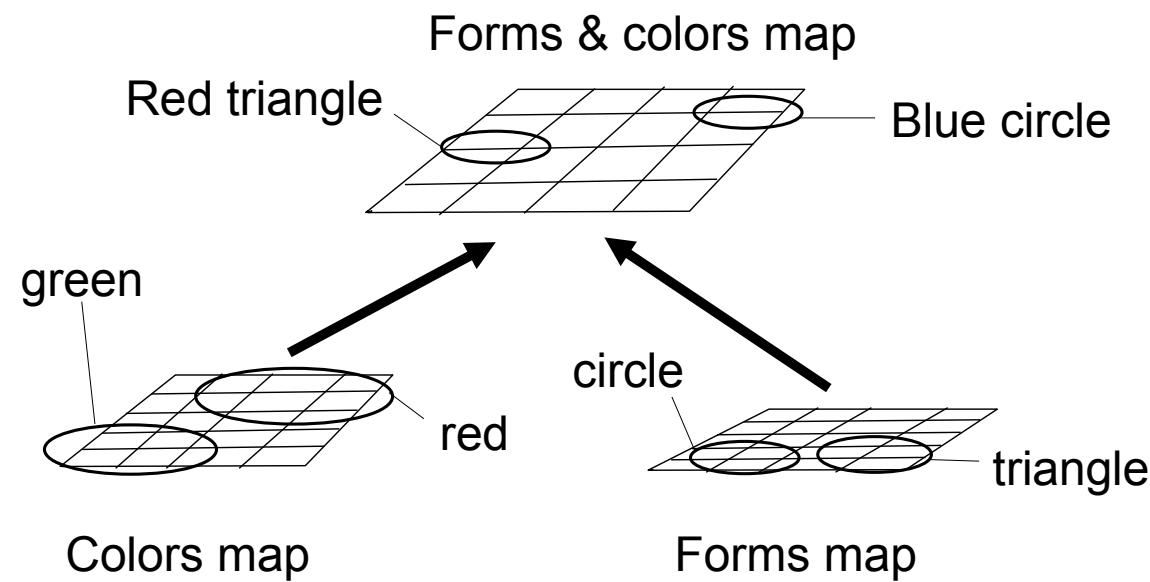
Libet, Benjamin (1985). "Unconscious Cerebral Initiative and the Role of Conscious Will in Voluntary Action". *The Behavioral and Brain Sciences* 8: 529–566.

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.