limbo

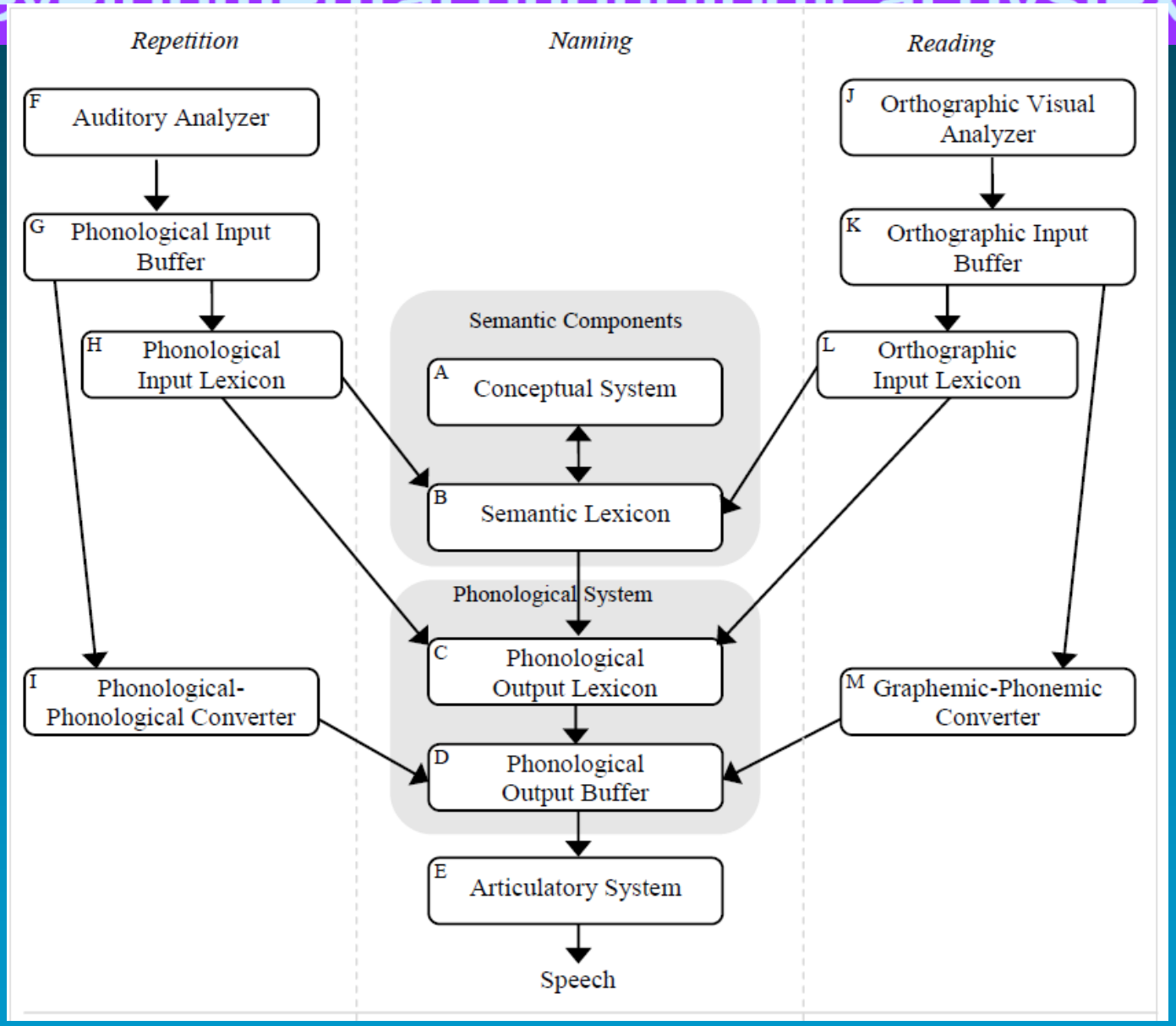
SISSA

Neuronal dynamics to navigate vowel space

(approaching language processes with cortical computation)

HFSP

Developmental phonological dyslexia



Performance in phonological working memory tasks

Participants

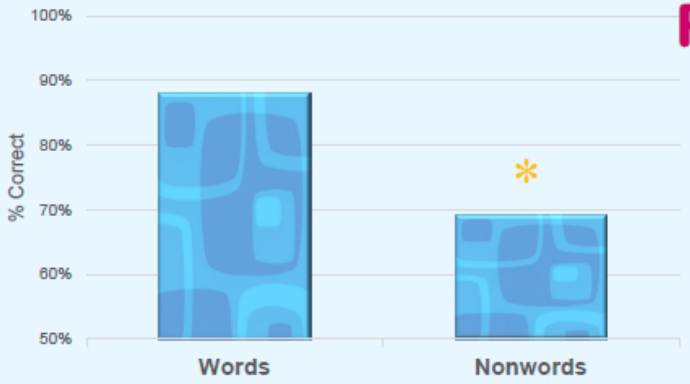
- 15 Hebrew speakers with a deficit in the phonological buffer, 4 boys and 11 girls, aged 12;8 – 15;0 (N=11) and aged 21;10 – 28;10 (N=4).
- None of them had a history of neurological disease or head trauma.
- 13 of them were born in Israel and were native speakers of Hebrew.
- 3 of them studied in special education school for children with learning disabilities.

		Recall			Recognition	Nonword Repetition	Parsing and blending of phonemes (spoonerism)
	name	Short Words Span	Long Words Span	Nonwords Span	Matching Span	% correct	% correct
Input phonological buffer deficit (N=2)	TP	4	3	2.5	4	85	98
	GBN	4.5	3.5	2.5	5	79	95
Input-Output phonological buffer deficit (N=5)	GR	3	3	2	3	46	80
	NH	4	3	2	4	69	53
	RA	3.5	3	1.5	4	52	40
	DSH	4	3	2.5	5	69	83
	KSH	4	2.5	3	4	54	50
Output phonological buffer deficit (N=8)	YH	3.5	3.5	2	6	73	53
	YK	3.5	3	3	5	81	88
	YL	3	2.5	0	5	69	83
	LD	3.5	3	3	5	69	75
	DL	3.5	2.5	2	5	60	8
	HA	3.5	3.5	2	5	73	75
	LBM	3.5	3	2	5	71	48
	AT	3.5	2.5	0	5	48	55

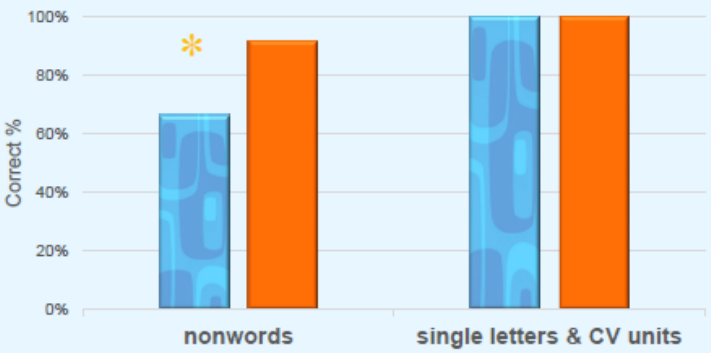
Blue cells present performance that is significantly below that of control group, accordi
of a single subject to a group, with an alpha level of 0.05

Revital Guggenheim and Naama Friedmann
Tel Aviv University

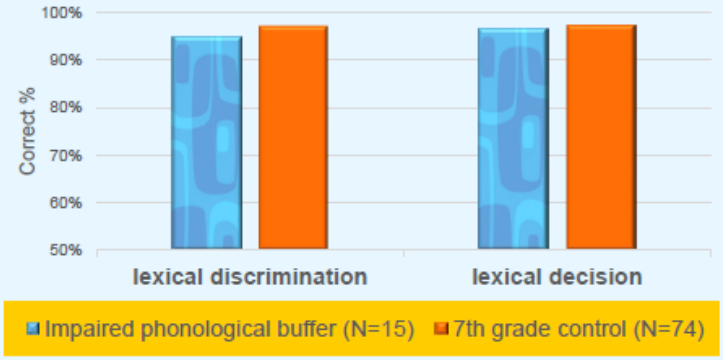
Results



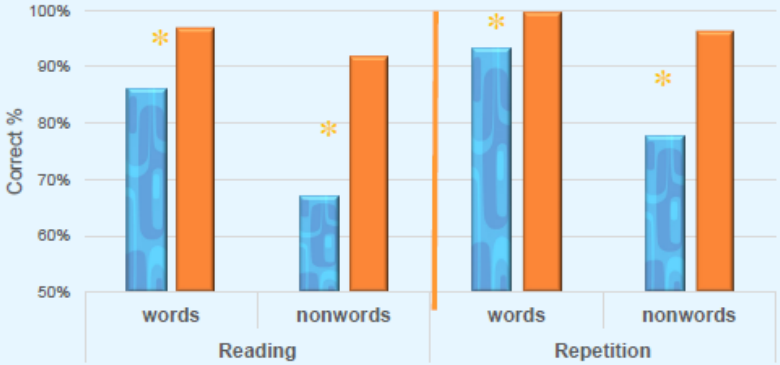
↑ Participants with deficit in the phonological output buffer reading aloud of nonwords was poorer than that of words.



↑ Participants with deficit in the phonological output buffer were able to read single letters and CV units when presented separately, but not long nonwords that include exactly the same units, indicating a deficit in blending rather than conversion.

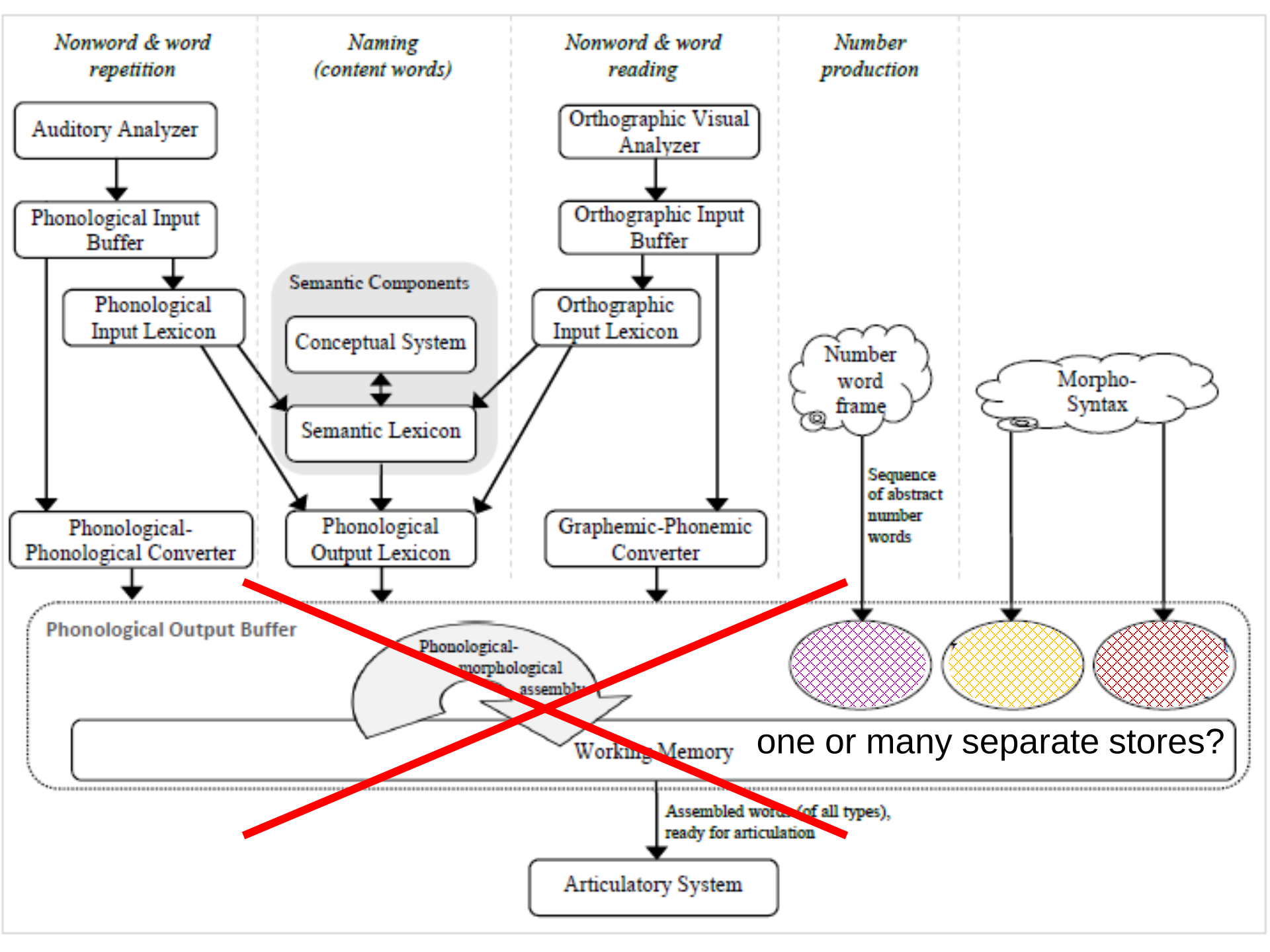


↑ Participants with deficit in the phonological output buffer show normal reading ability when the task does not require verbal output.



↑ Participants with deficit in the phonological output buffer show impaired reading and repetition of morphologically complex words and nonwords.

Revital Guggenheim and Naama Friedmann
Tel Aviv University


Nonword & word repetition
Naming (content words)
Nonword & word reading
Number production
Auditory Analyzer
Phonological Input Buffer
Phonological Input Lexicon
Semantic Components
Conceptual System
Semantic Lexicon
Orthographic Visual Analyzer
Orthographic Input Buffer
Orthographic Input Lexicon
Number word frame
Morpho-Syntax
Sequence of abstract number words
Phonological-Phonological Converter
Phonological Output Lexicon
Graphemic-Phonemic Converter
Phonological Output Buffer
Phonological-morphological assembly
Working Memory
one or many separate stores?
Assembled words (of all types), ready for articulation
Articulatory System

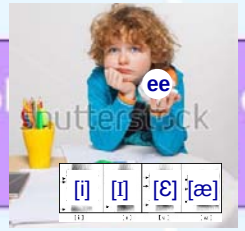
The dual-route model of reading aloud

written word

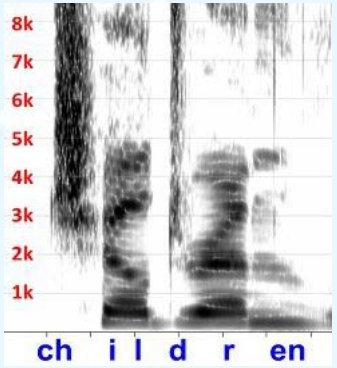
orthographic-visual analysis

c h e e l d r e n

graph eme



phonological output lexicon



speech

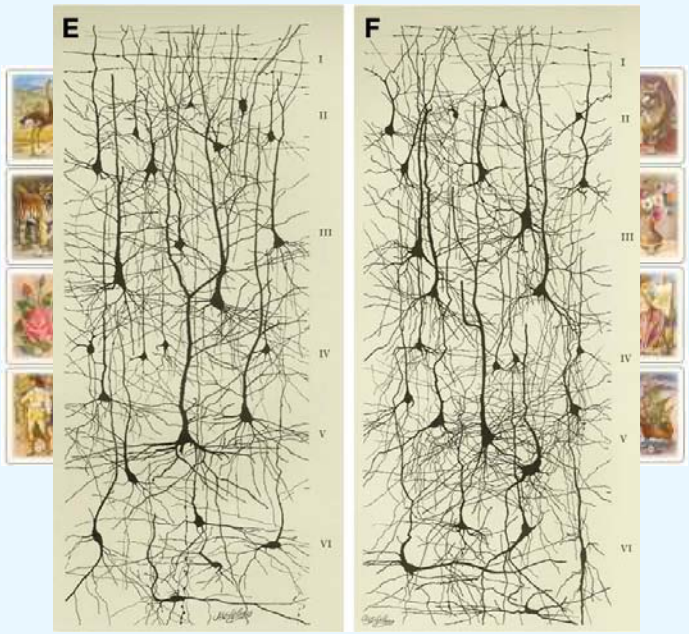
Revital Guggenheim and Naama Friedmann
Tel Aviv University

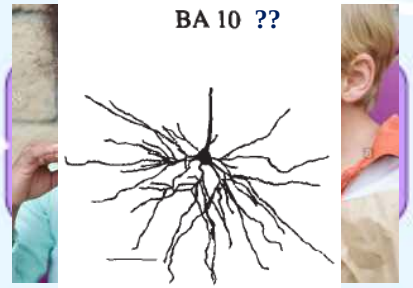
The dual-route model of reading aloud

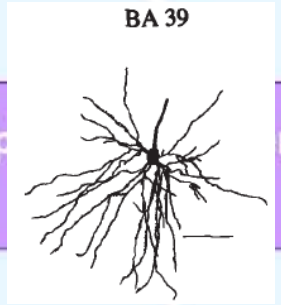
written word

orthographic-visual analysis

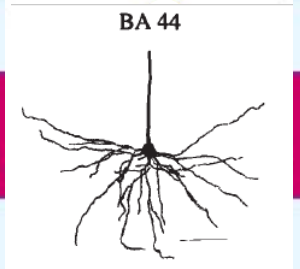
c h e e l d r e n



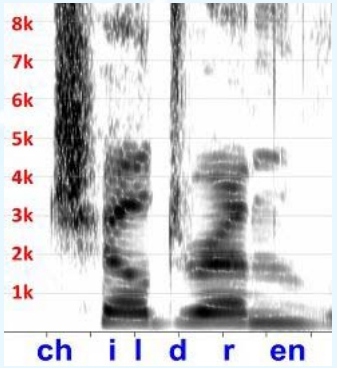




phonological output lexicon

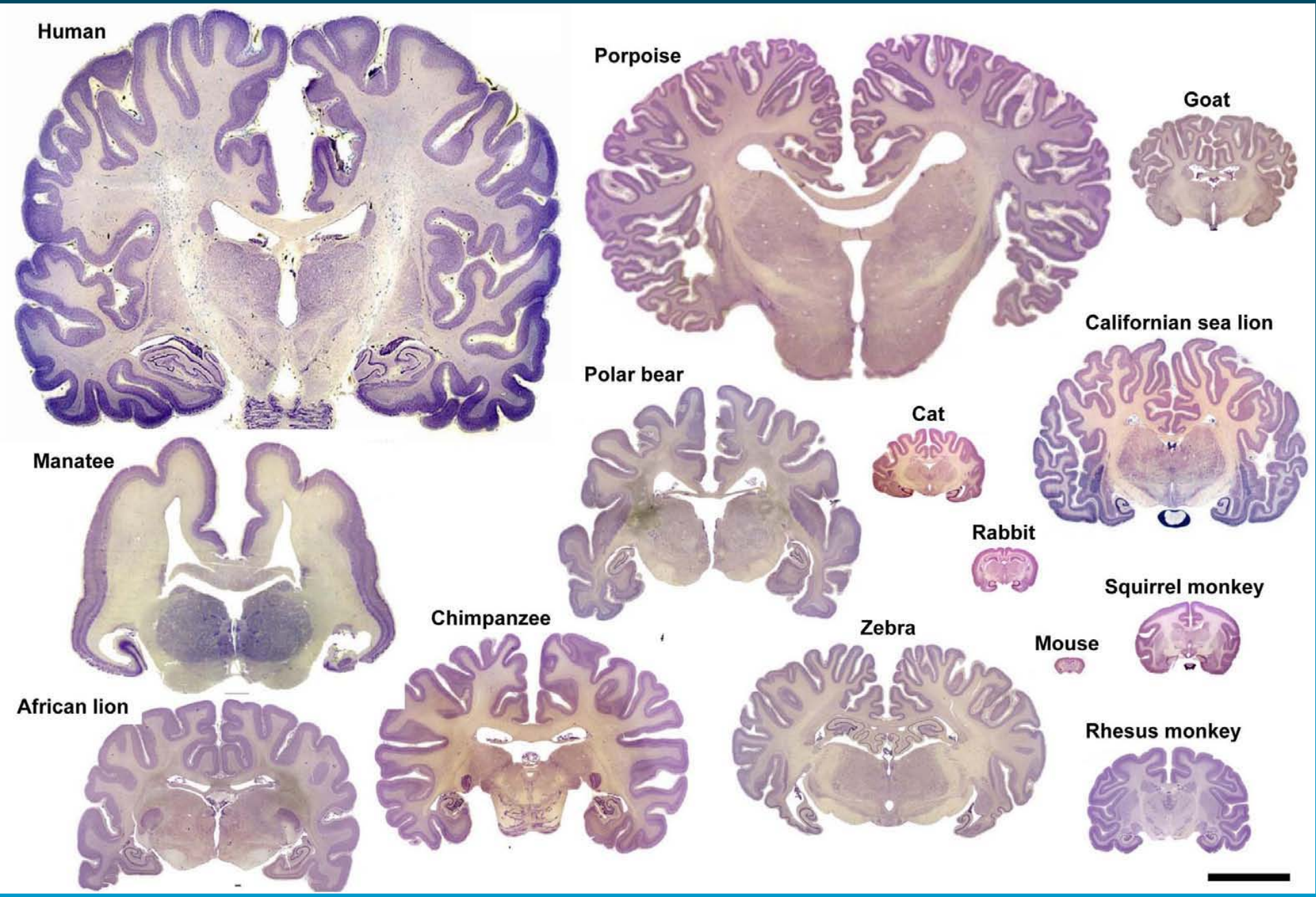


speech



The evolution of the brain, the human nature of cortical circuits, and intellectual creativity. Javier DeFelipe, Front Neuroanat (2011)

Regional Dendritic and Spine Variation in Human Cerebral Cortex: A Quantitative Golgi Study. Jacobs et al, Cereb Cortex (2001)


Human
Porpoise
Goat
Californian sea lion
Polar bear
Cat
Manatee
Rabbit
Squirrel monkey
Chimpanzee
Zebra
Mouse
African lion
Rhesus monkey

F2

VOWELS

F1

Close

Near cl

Close m

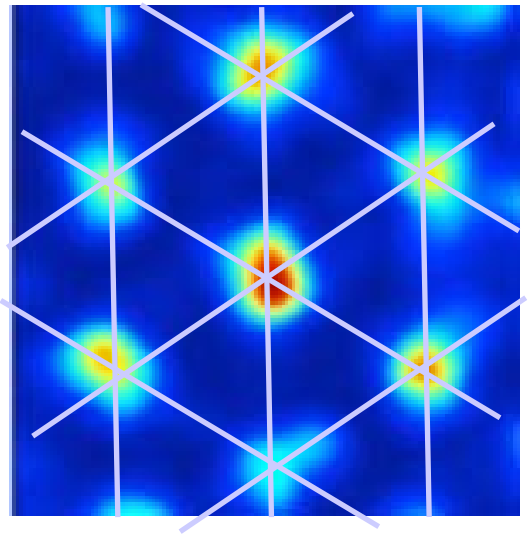
Mid

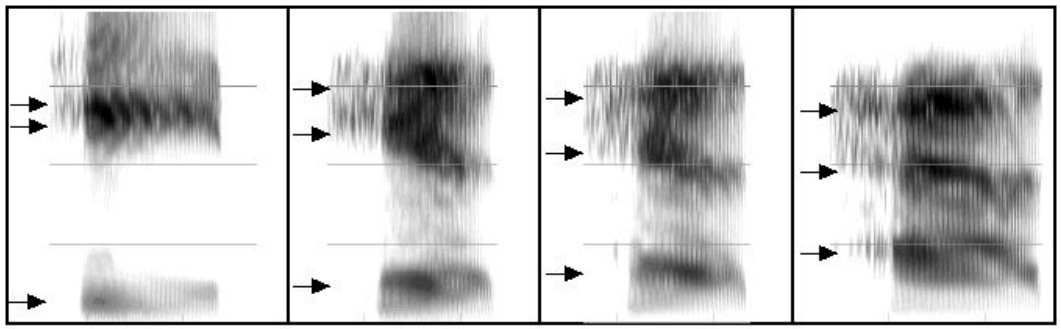
Open m

Near op

Open

Vowels at right & left of bullets are rounded & unrounded.





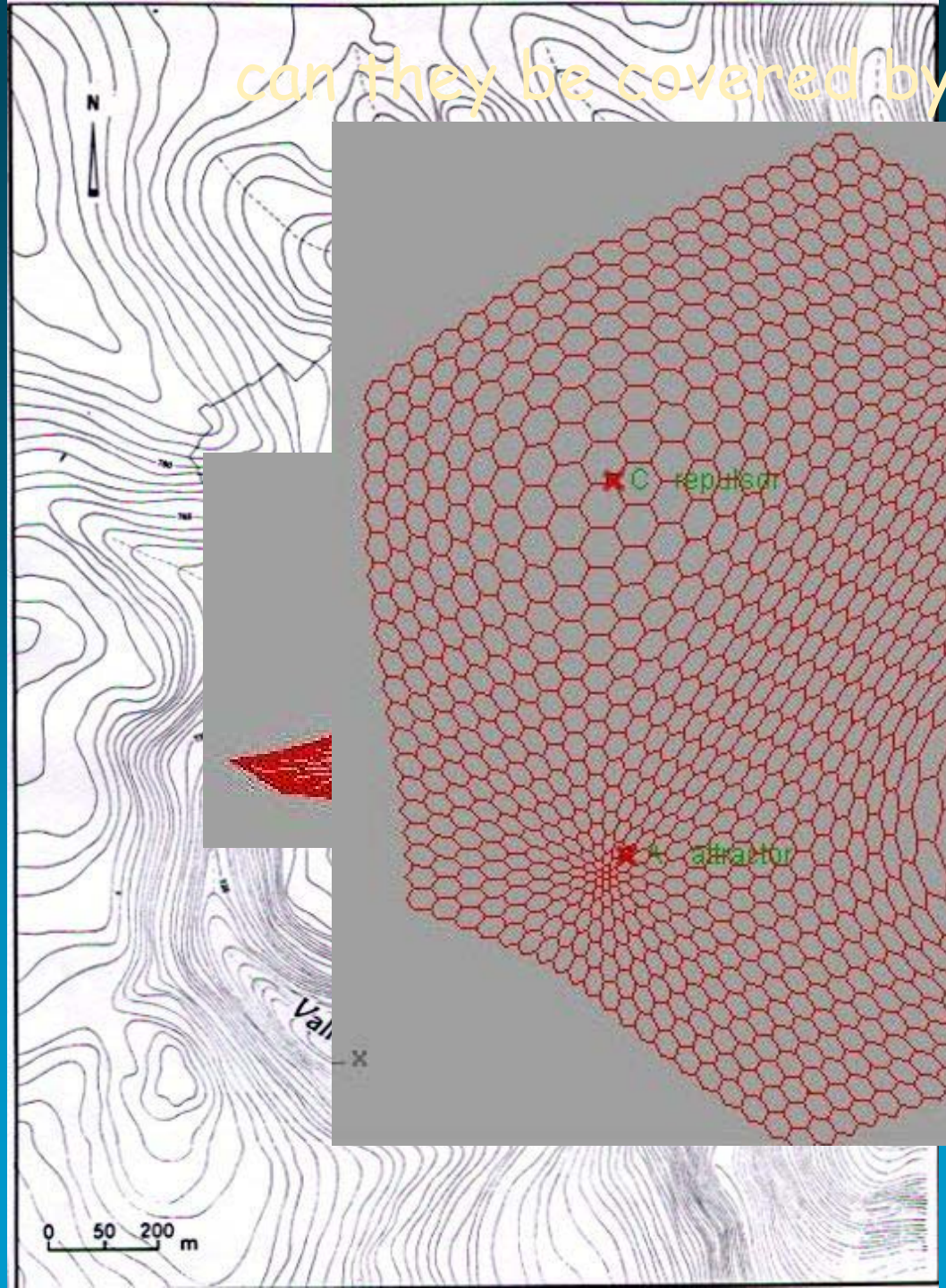
May-Britt and Edvard Moser

..and not just rats

we have been putting
rats in these boxes...

alessandro
reves

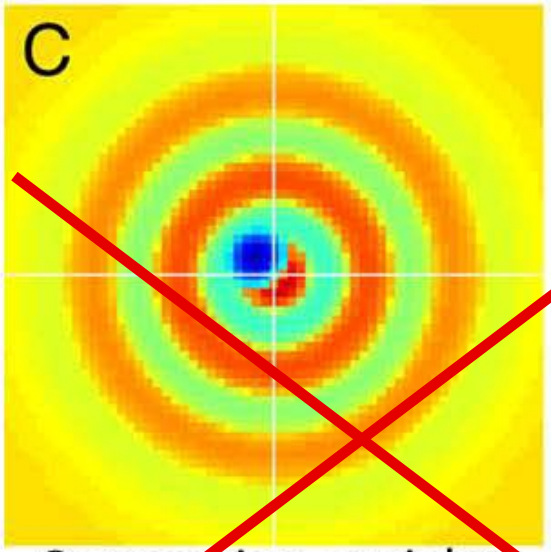
can they be covered by a hexa-quilt ?



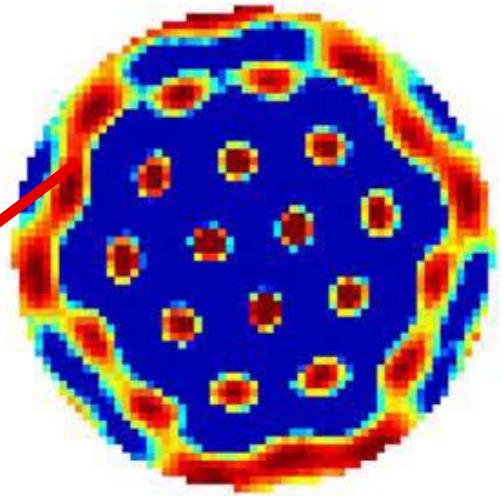
ironments
e no walls
r from flat

Many models have been proposed..

Grid cell model	Position representation	Updating mechanism
Conklin and Eliasmith (2005)	Torus attractor, single bump	Direction-conjunctive cells



Connection weights



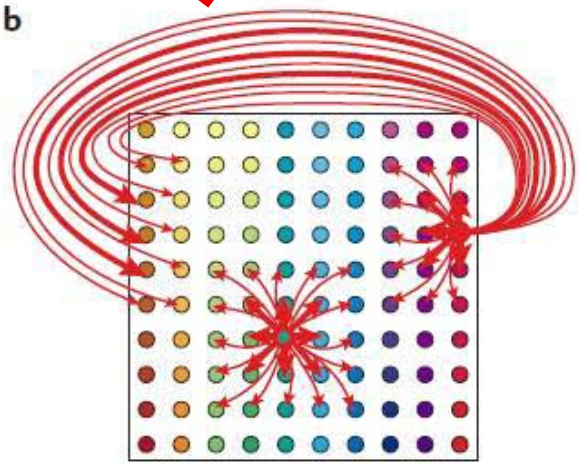
Firing rate map

Recurrent Network

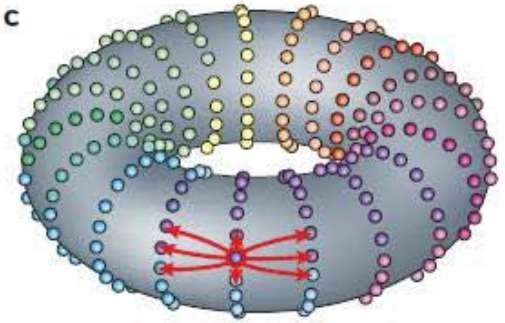
creating a single

Continuous Attractor

Solving both boundary & periodicity problems in one shot

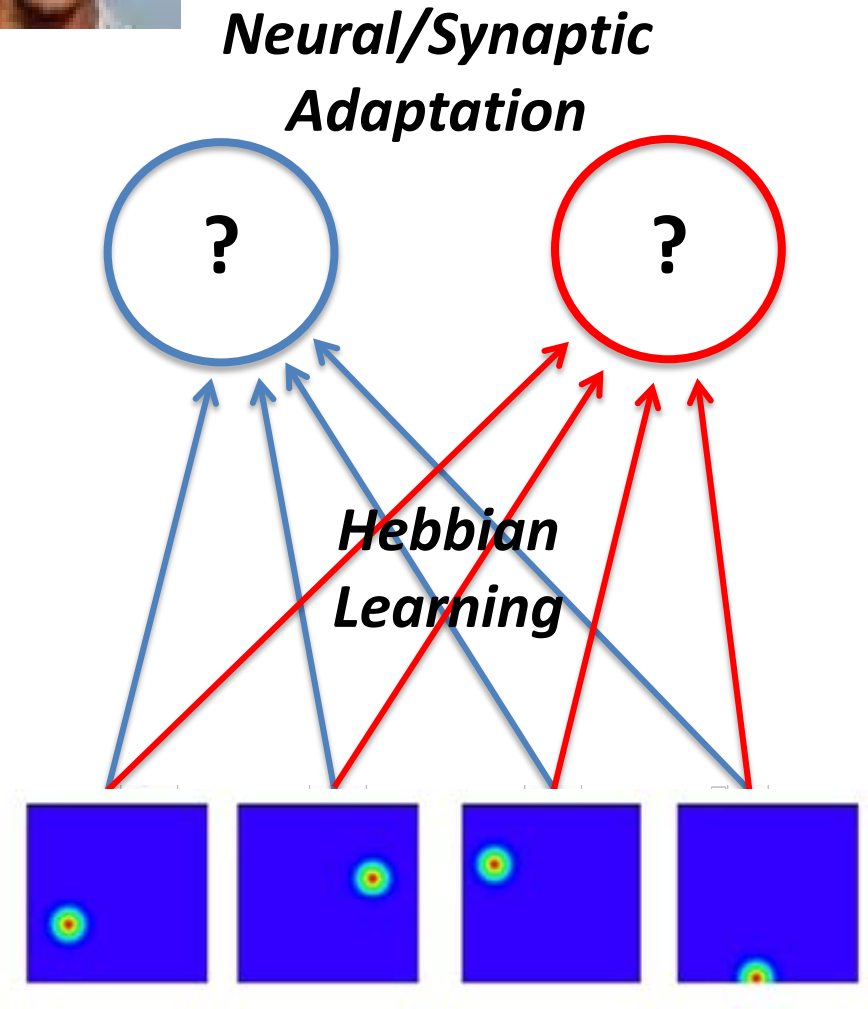


?



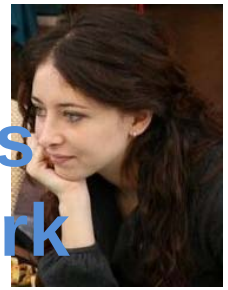
Emilio Kropff

A Model Based on Neural Fatigue



Treves et al, SfN 2005

- The model should generate grid patterns from already existing **spatially modulated activity**.
- It is based on the effects of **neural fatigue** on mEC units.
- The feedforward connections have no pre-wired structure and (should) develop through **self-organization**.



Tiziano D'Albis

spiking network

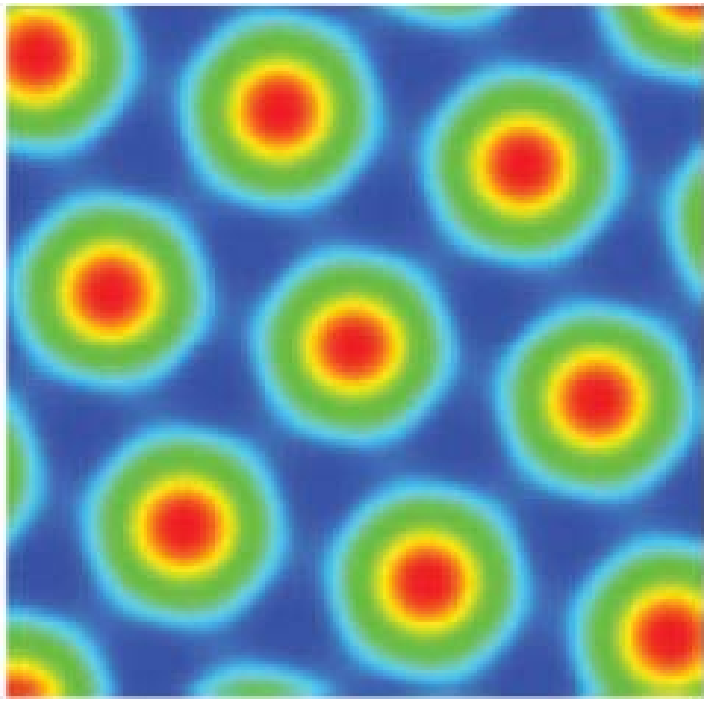
Erika Cerasti

Grid Cell Self-Organization

2D-case

Analytical Solution

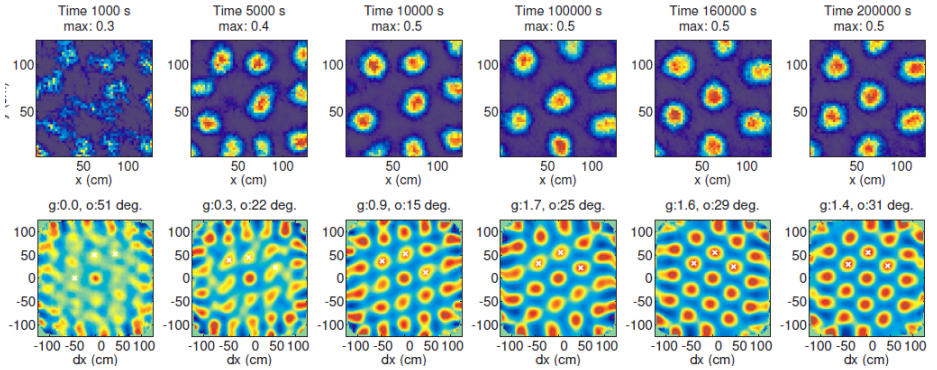
$$L = \int d\mathbf{x}[\nabla\psi(\mathbf{x})]^2 + \gamma \int d\mathbf{x} \int dt' \psi(\mathbf{x}(t))K(t-t')\psi(\mathbf{x}(t'))$$



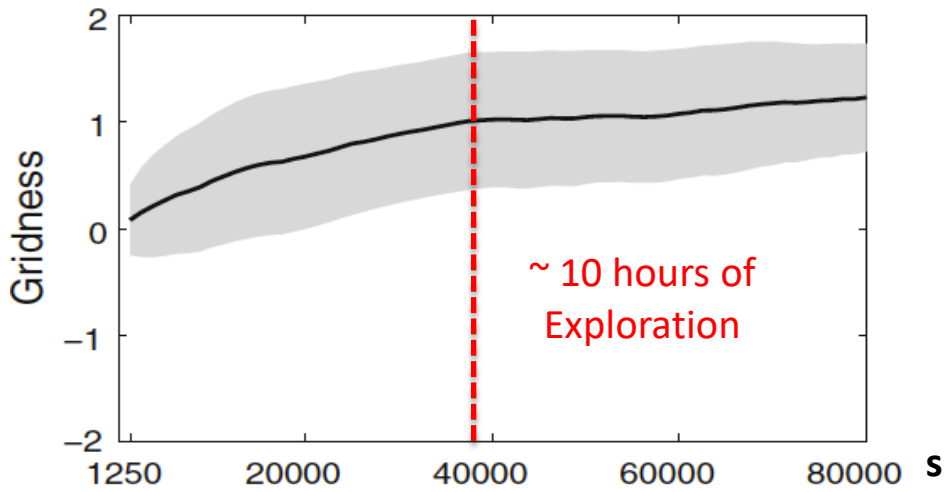
Kropff & Treves 2008

Simulation Results

Si et al. 2012

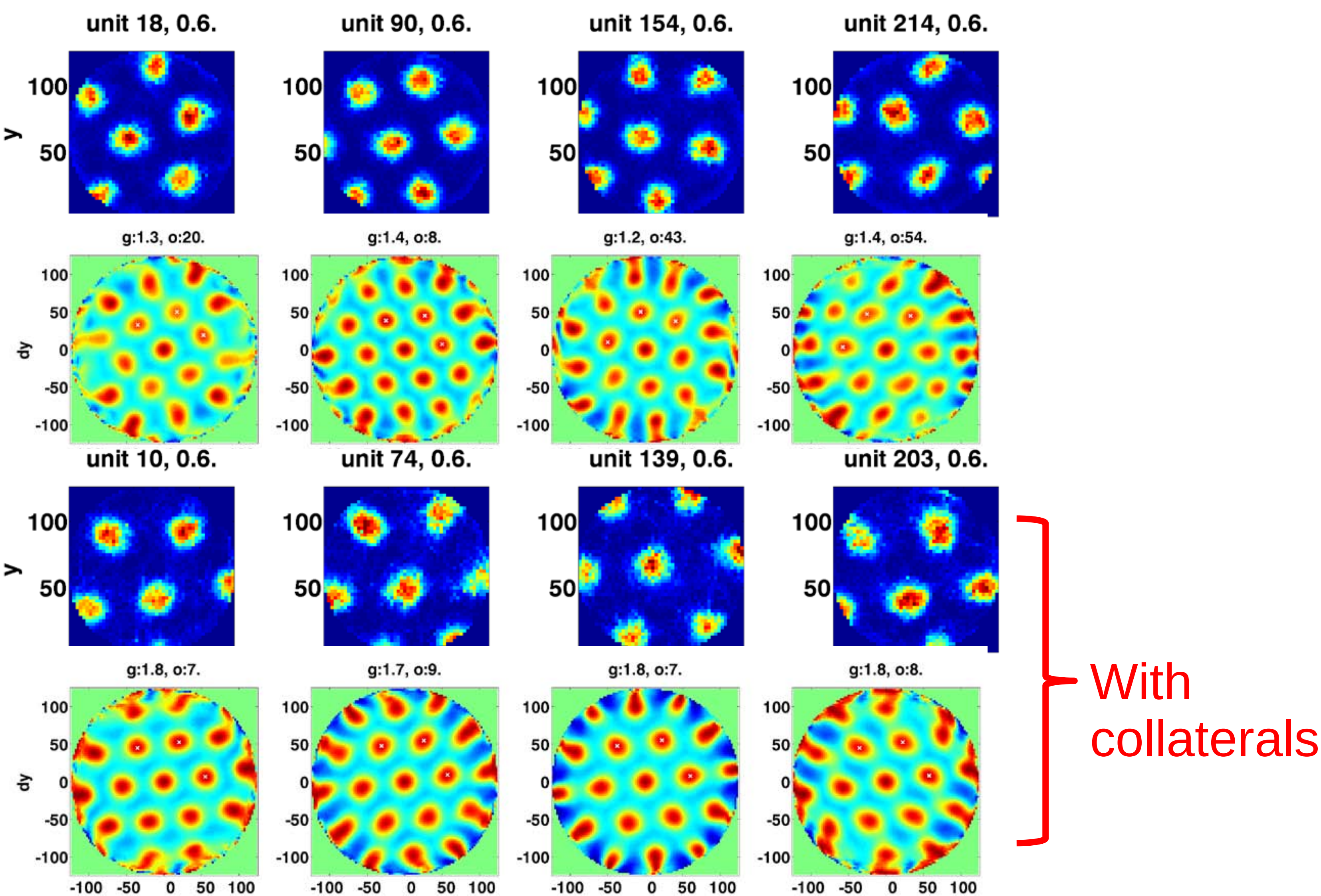


Time →



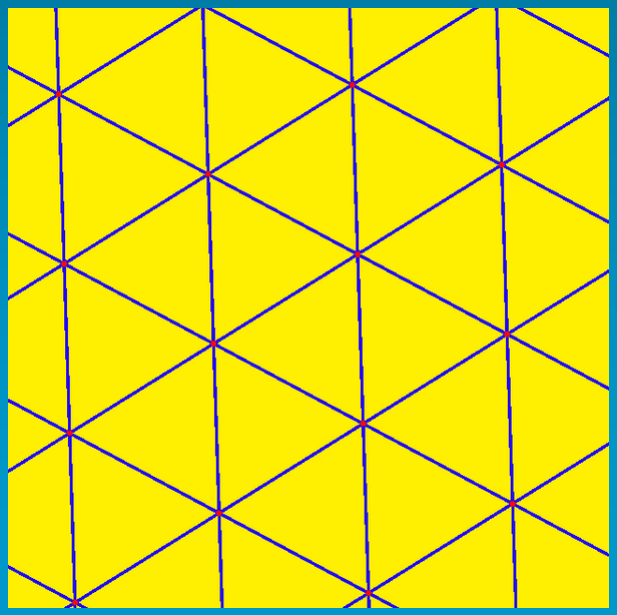
Recurrent connections are needed, in order to align the grid axes in a local network

Out of such a single-cell mechanism, however, different cells align along different axes



How to decide which model is correct?

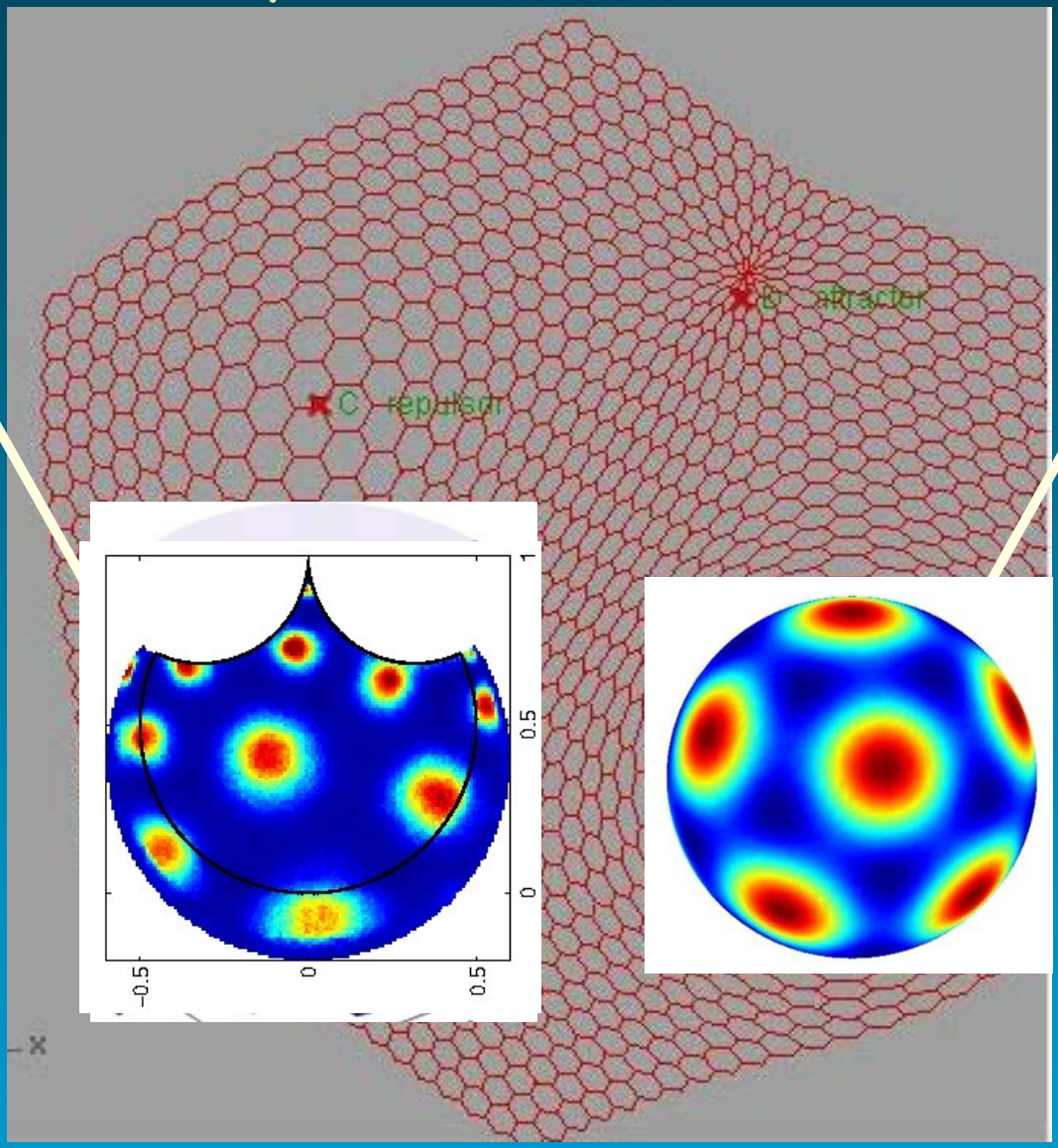
In a plain box,
with nothing inside
all models work fine



we tried our adaptation model on hills and valleys

regions of negative curvature

regions of positive curvature

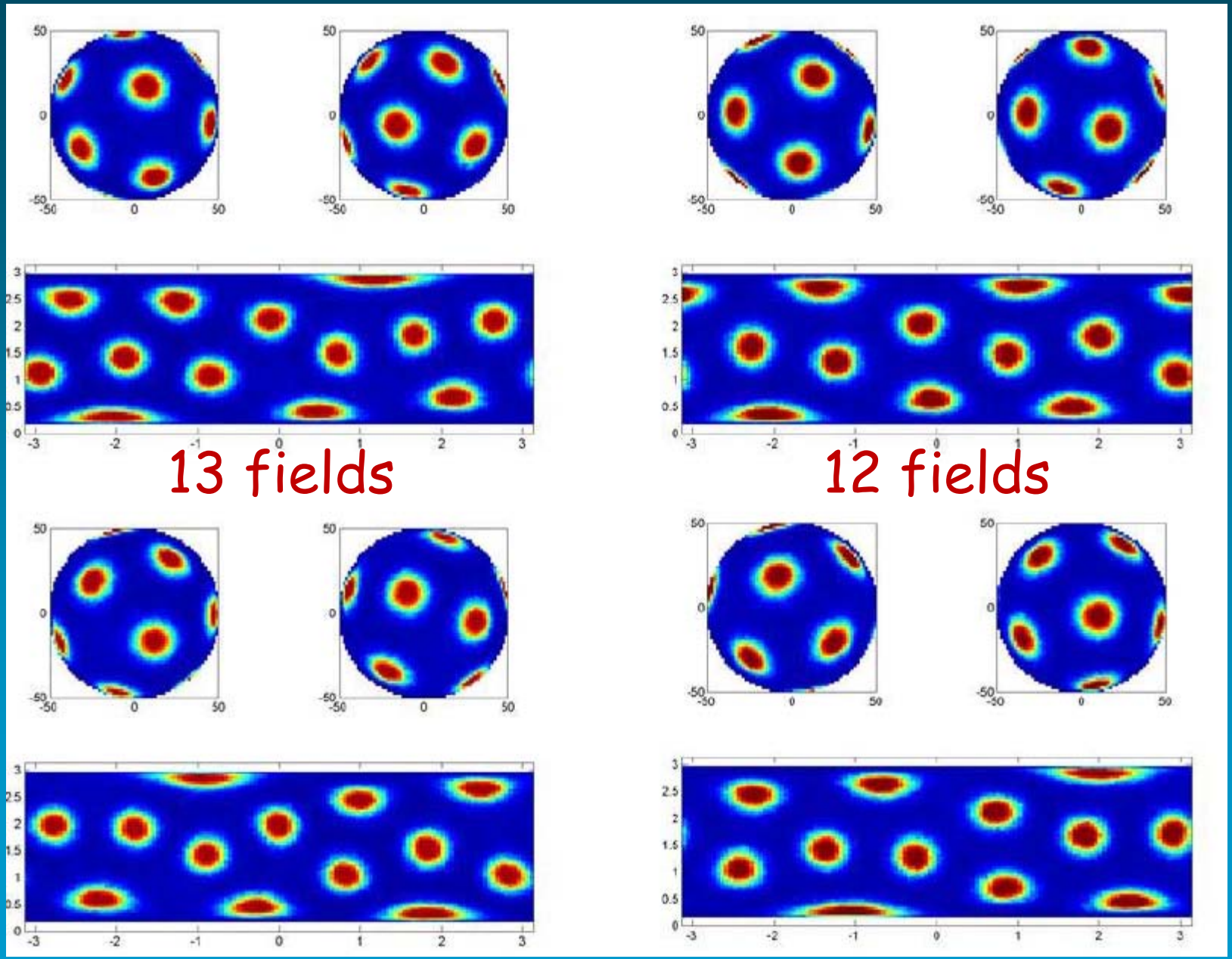


Urdapilleta et al, 2015

Stella et al, 2013

..but what happens to the attractor properties?

can non-planar grids map onto each other?



If they do, is via Euler rotations, not translations

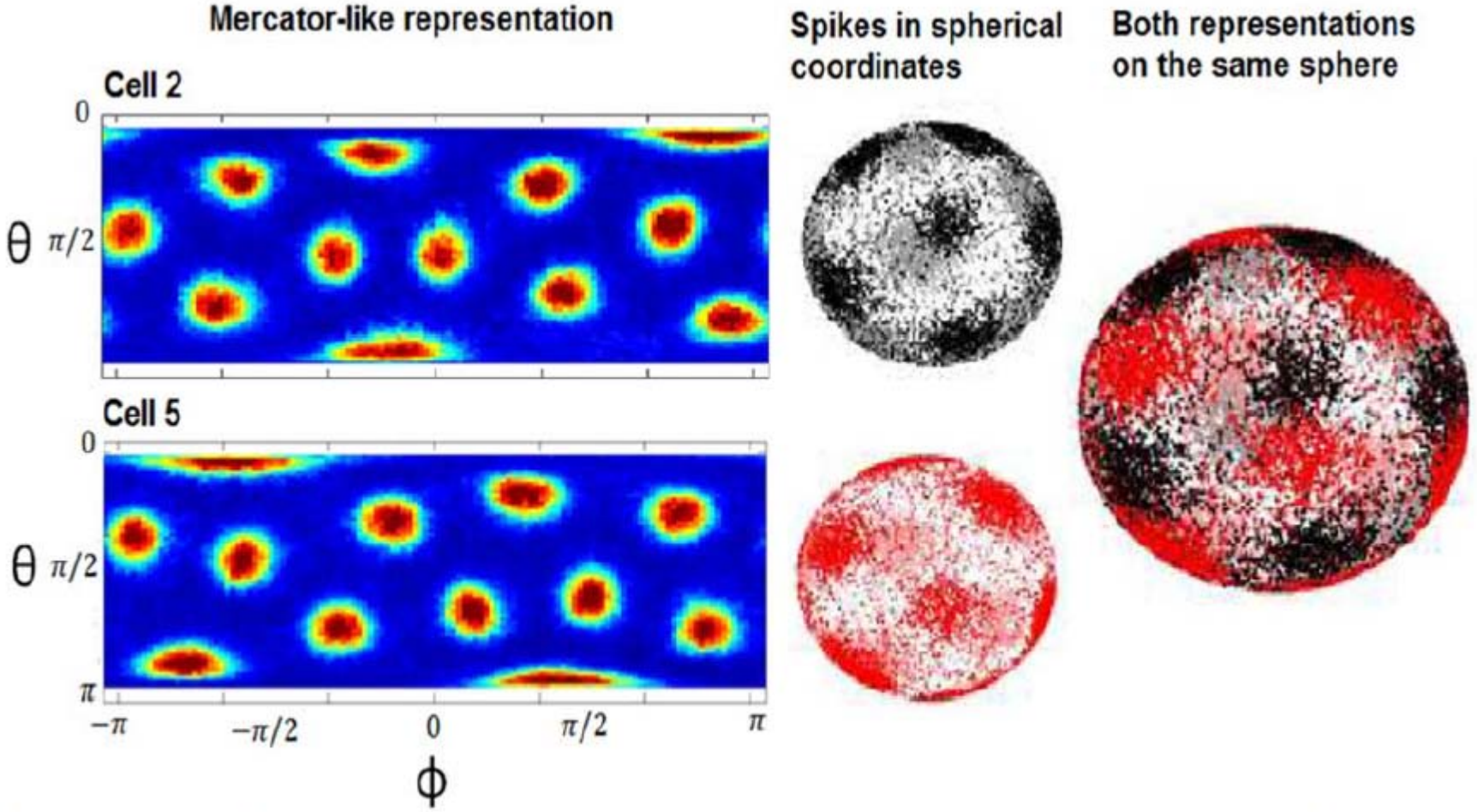
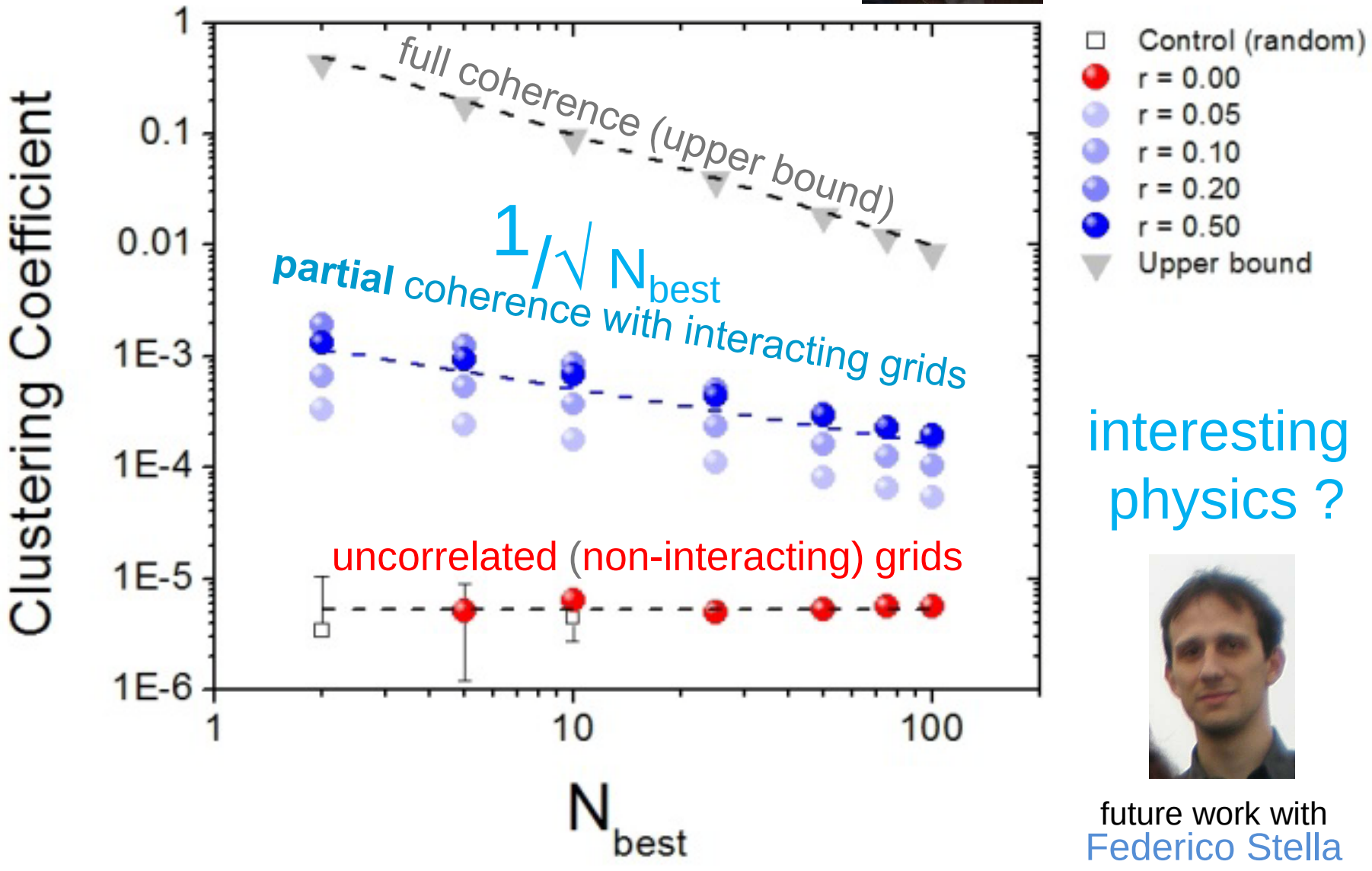


Fig. 3 Two model units, developing precise pentagonal grids on a spherical surface while simultaneously developing recurrent connectivity in a variant of the combined model, cannot maintain phase coherence simply for geometrical reasons: uniform translations are not possible on the sphere.

Eugenio Urdapilleta finds:



interesting physics ?

future work with
Federico Stella

RICERCA / L'OPEN DAY IN VIA BONOMEA

Dai buchi neri alle staminali: i liceali incontrano la Sissa

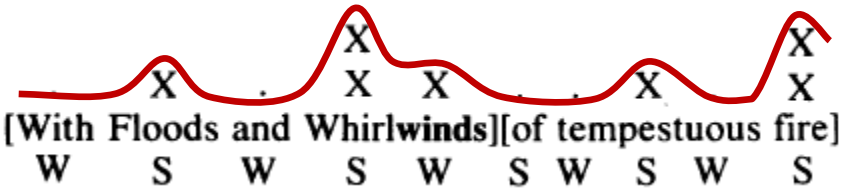
Sono stati più di cinquecento i giovani liceali che hanno partecipato all'evento "Sissa for school" (nella foto), provenienti da Torino e Verona, da Udine e Gemona del Friuli, e dai licei e istituti Oberdan, Galilei e Volta di Trieste. Dai buchi neri alle staminali: un incontro avvicinato con la ricerca che ha colpito molti studenti. SERVIZIO A PAGINA 23

back to Zeynep;
and vowels

Bruce Hayes

A Grid-based Theory of English Meter

Linguistic Inquiry, Vol. 14, No. 3 (Summer, 1983), pp. 357-393



PL 1.77

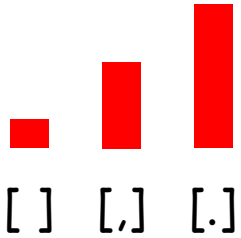
- local adaptation
- driven by fatigue
- affected by walls

[6] A typ… the following, which totals the line-initial inversions in *Julius Caesar:*

(i) *Ty…*

	% of Total Pauses	% of Total Inversions
Pe…	28	42
W… ation	48	43
N…	21	7

Similar results were obtained from a sampling of *Paradise Lost*.



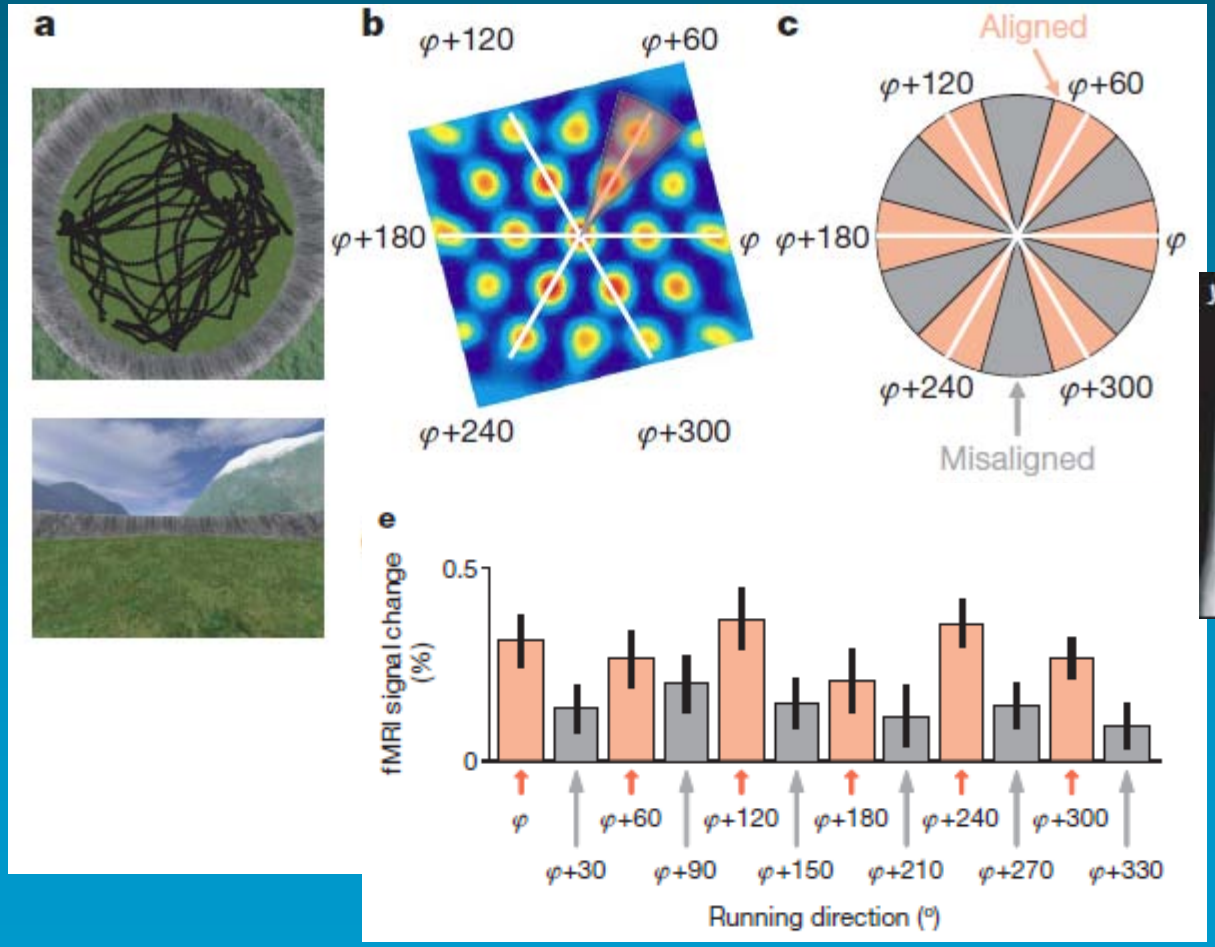
But this filter is insufficiently general, as it fails to rule out similar cadences like those of (23) (below) and (24) (opposite), which are in fact completely missing in Milton:

(23) *The#*bard's*##**visions of God: It was a hill

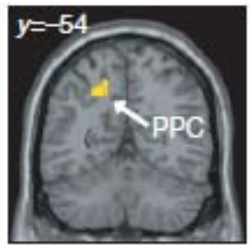
Evidence for grid cells in a human memory network

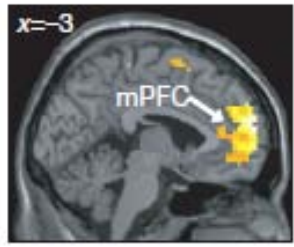
Christian F. Doeller[1,2], Caswell Barry[1,3,4] & Neil Burgess[1,2]

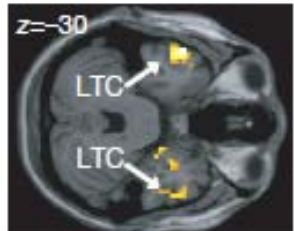
Vol 463|4 February 2010|doi:10.1038/nature08704 nature



and..





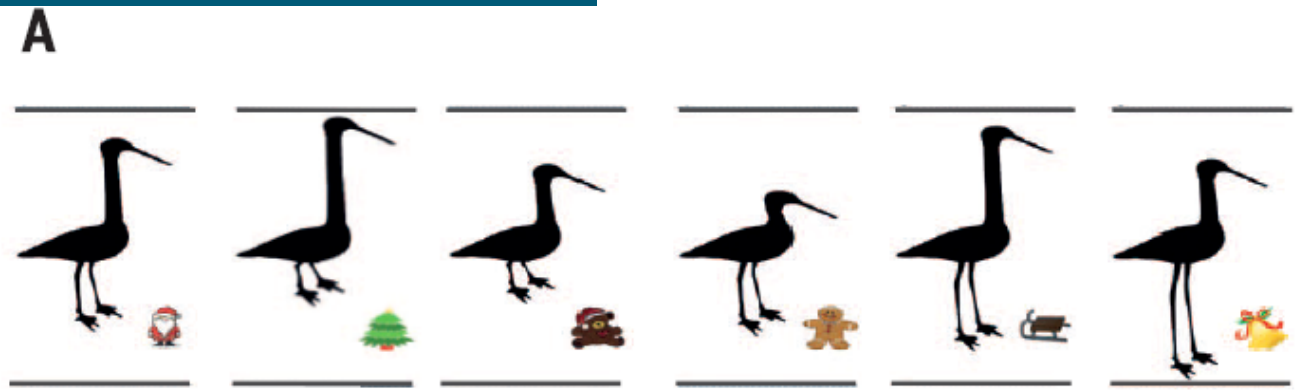


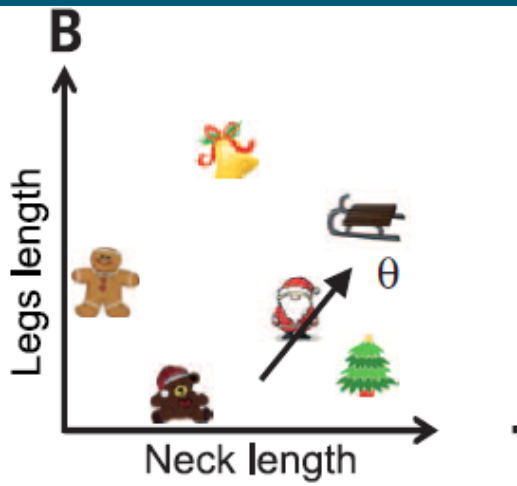
yes, and..

Organizing conceptual knowledge in humans with a gridlike code

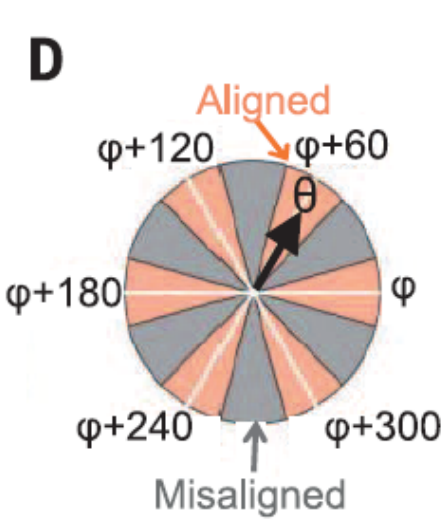
Alexandra O. Constantinescu,[1*]† Jill X. O'Reilly,[1,2,3]† Timothy E. J. Behrens[1,4*]

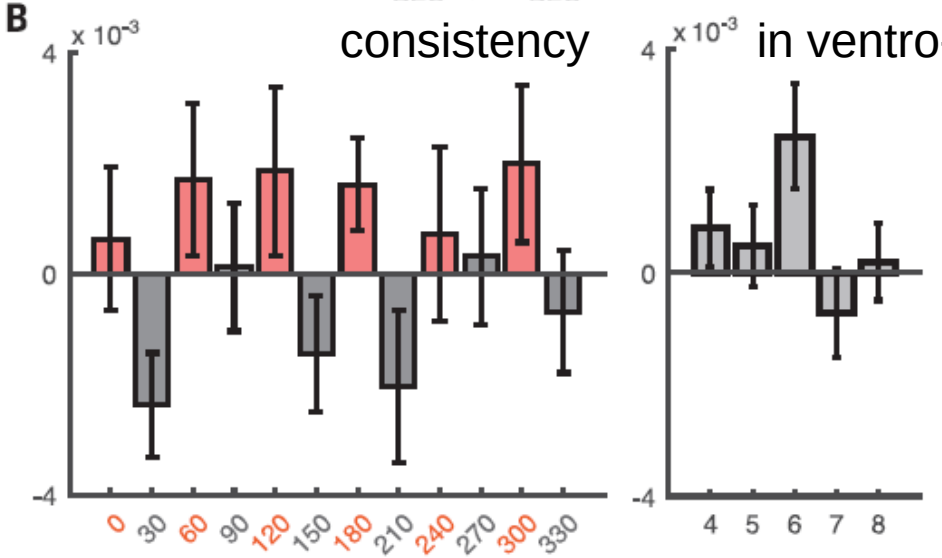
SCIENCE 17 JUNE 2016 • VOL 352 ISSUE 6292

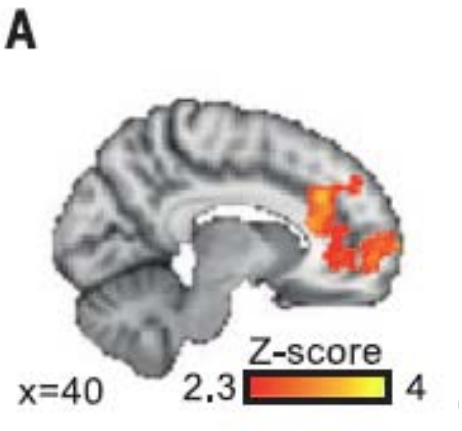




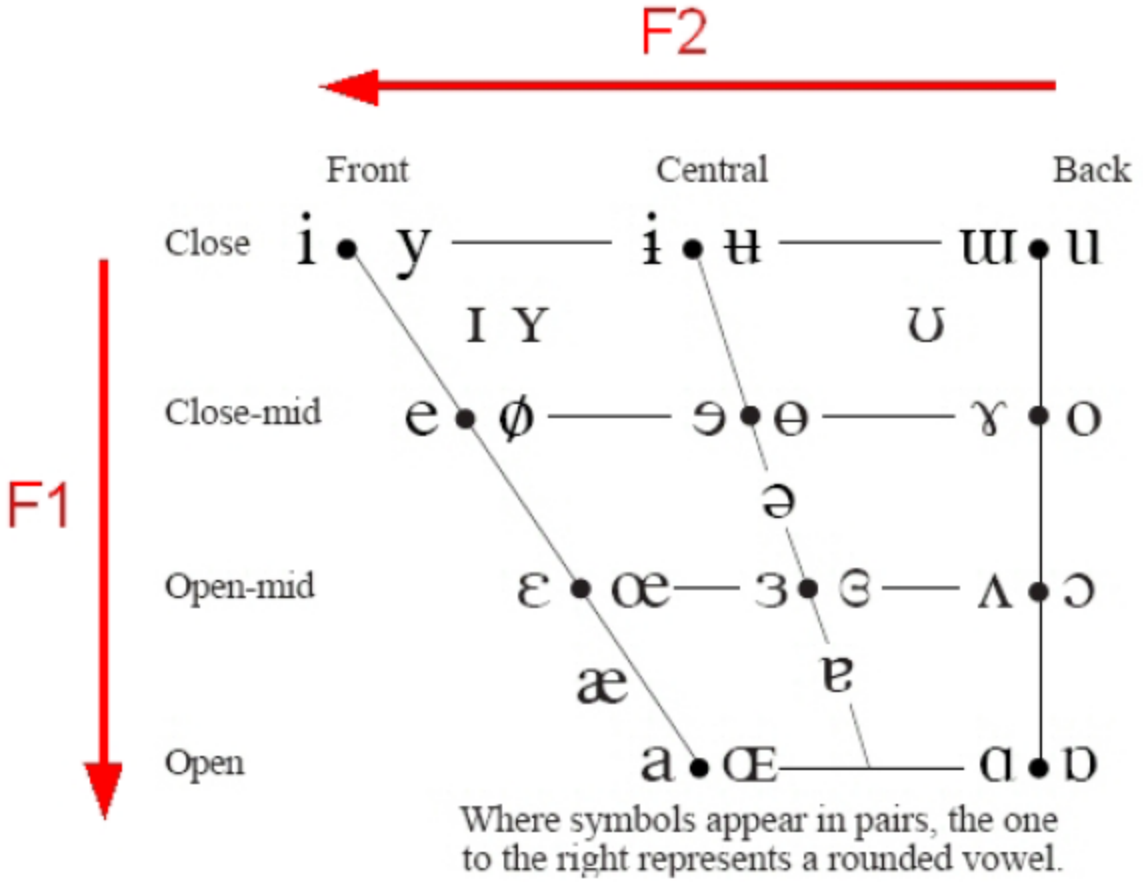
consistency in ventro-medial prefrontal cortex



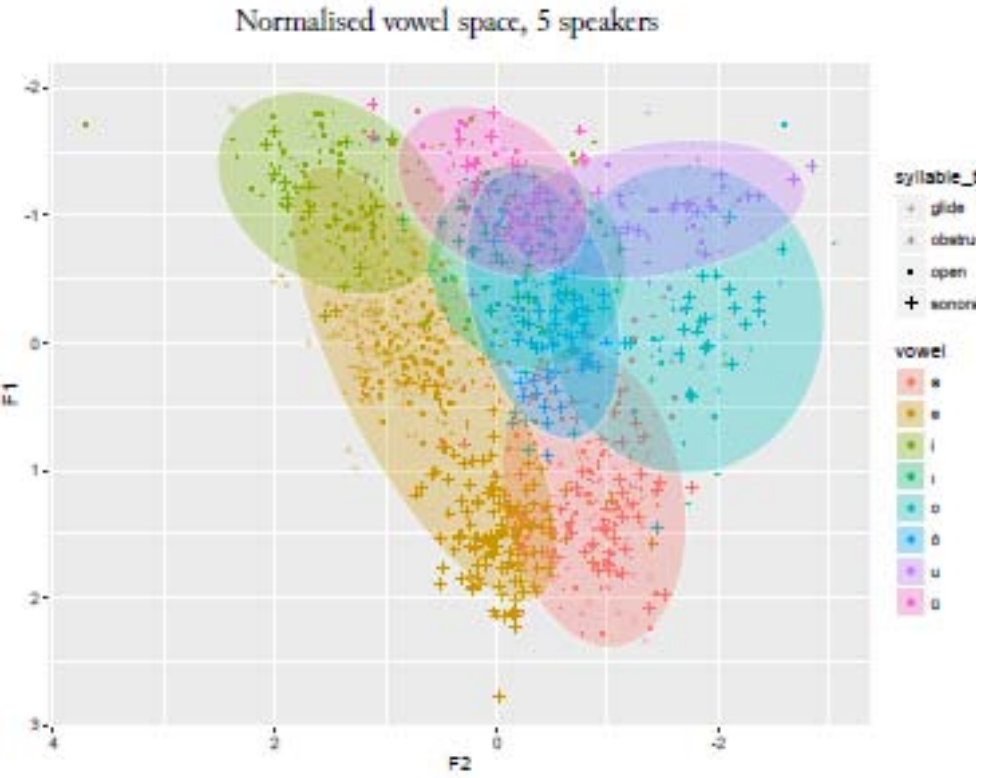




..but if bird drawings, why not vowels?



Turkish


Normalised vowel space, 5 speakers
F1
F2
-2
-1
0
1
2
3
4
2
0
-2
syllable_t
glide
obstru
open
sonori
vowel
a
e
i
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o
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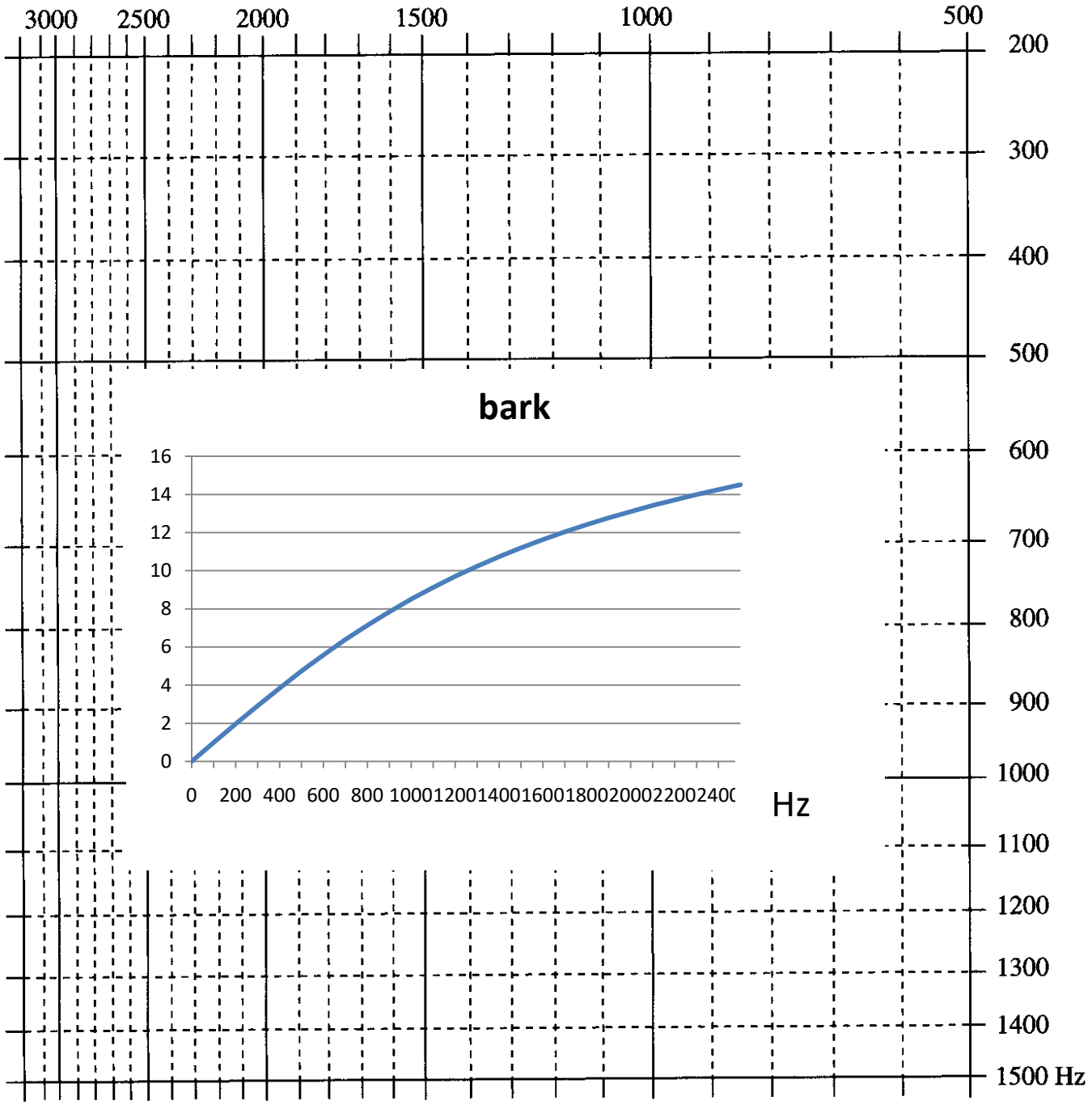
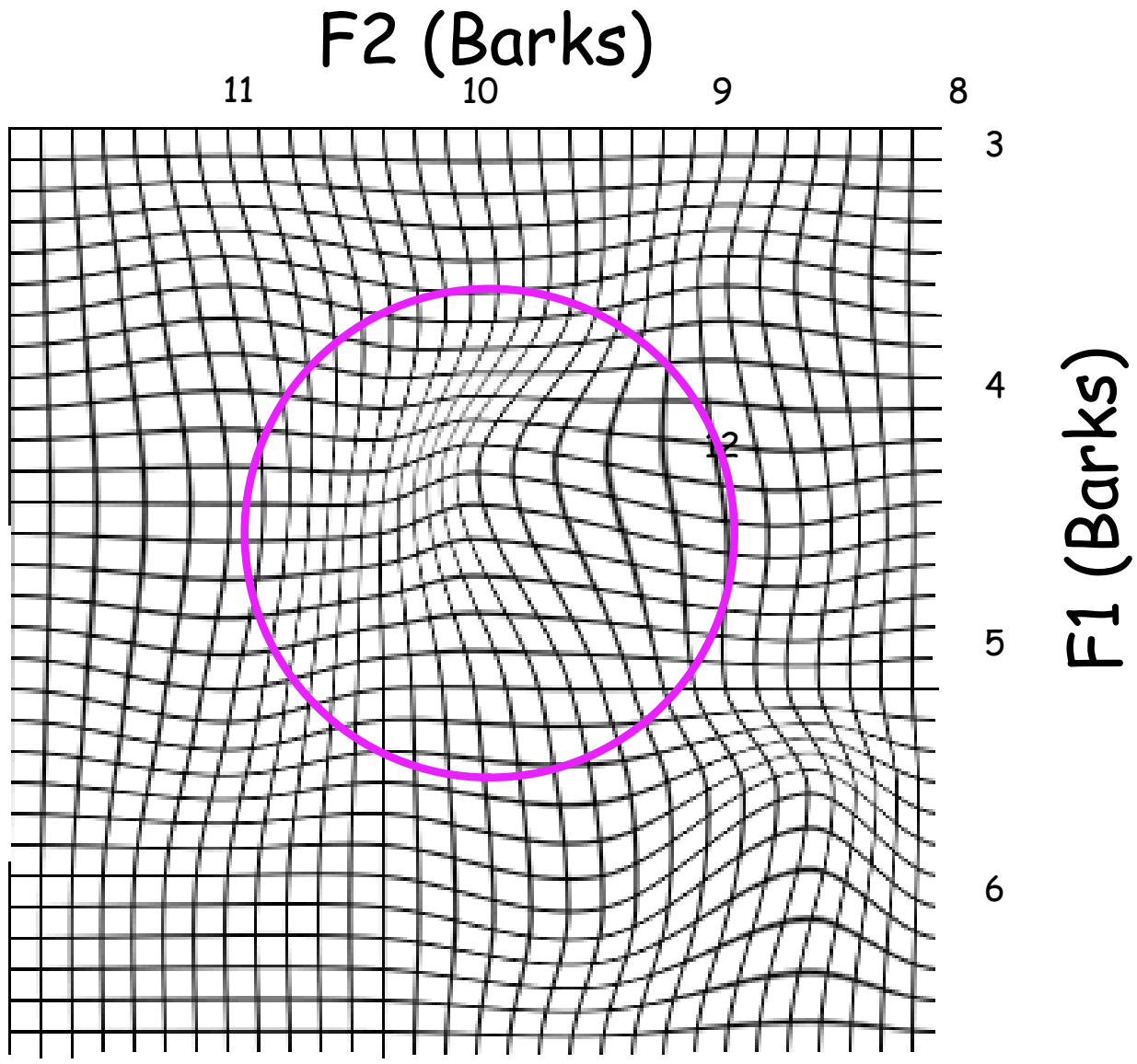
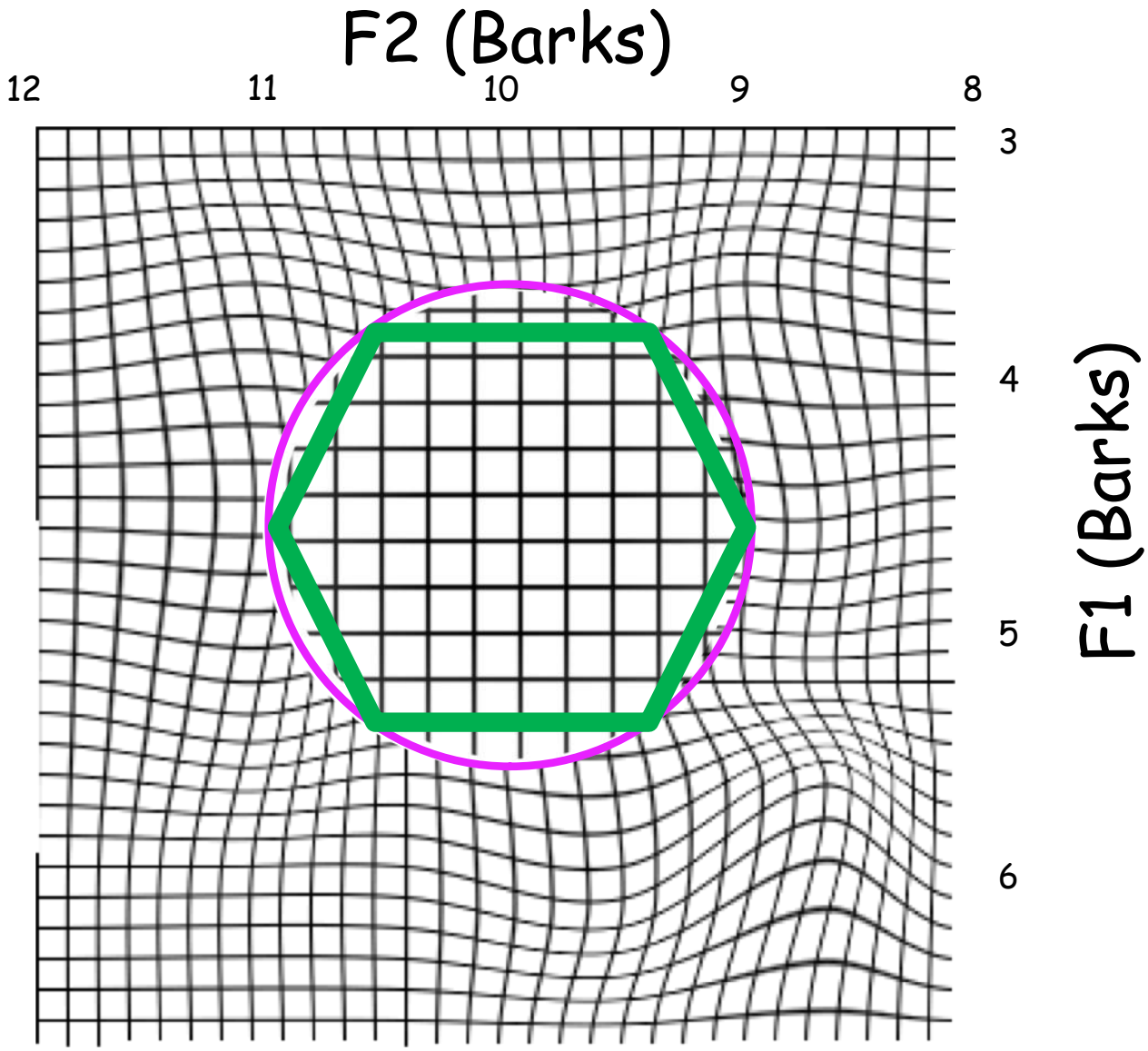
u
ü


3000
2500
2000
1500
1000
500
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500 Hz
bark
16
14
12
10
8
6
4
2
0
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400
Hz

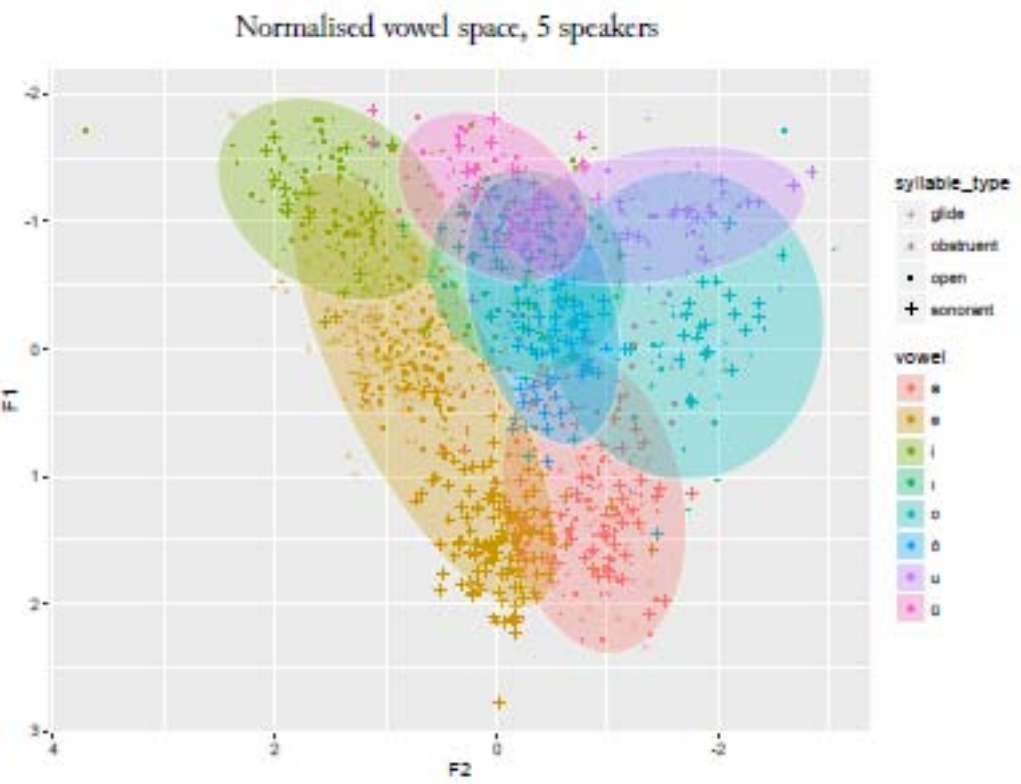


Can we iron the vowel manifold?

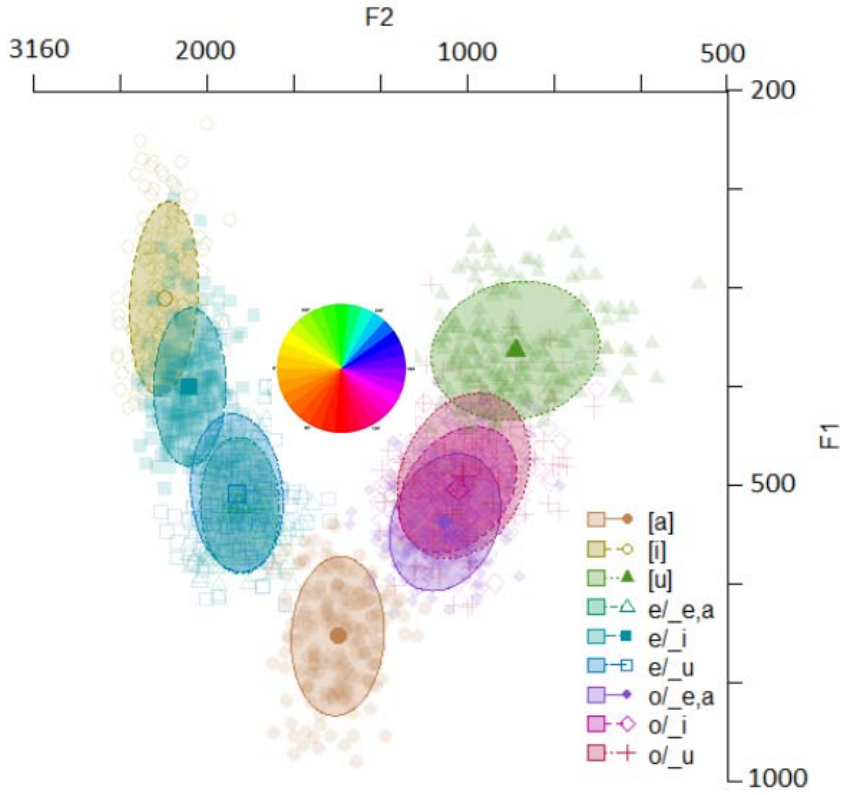

F2 (Barks)
12
11
10
9
8
3
4
5
6
F1 (Barks)

can we stick in the empty space a vowel wheel?

Turkish

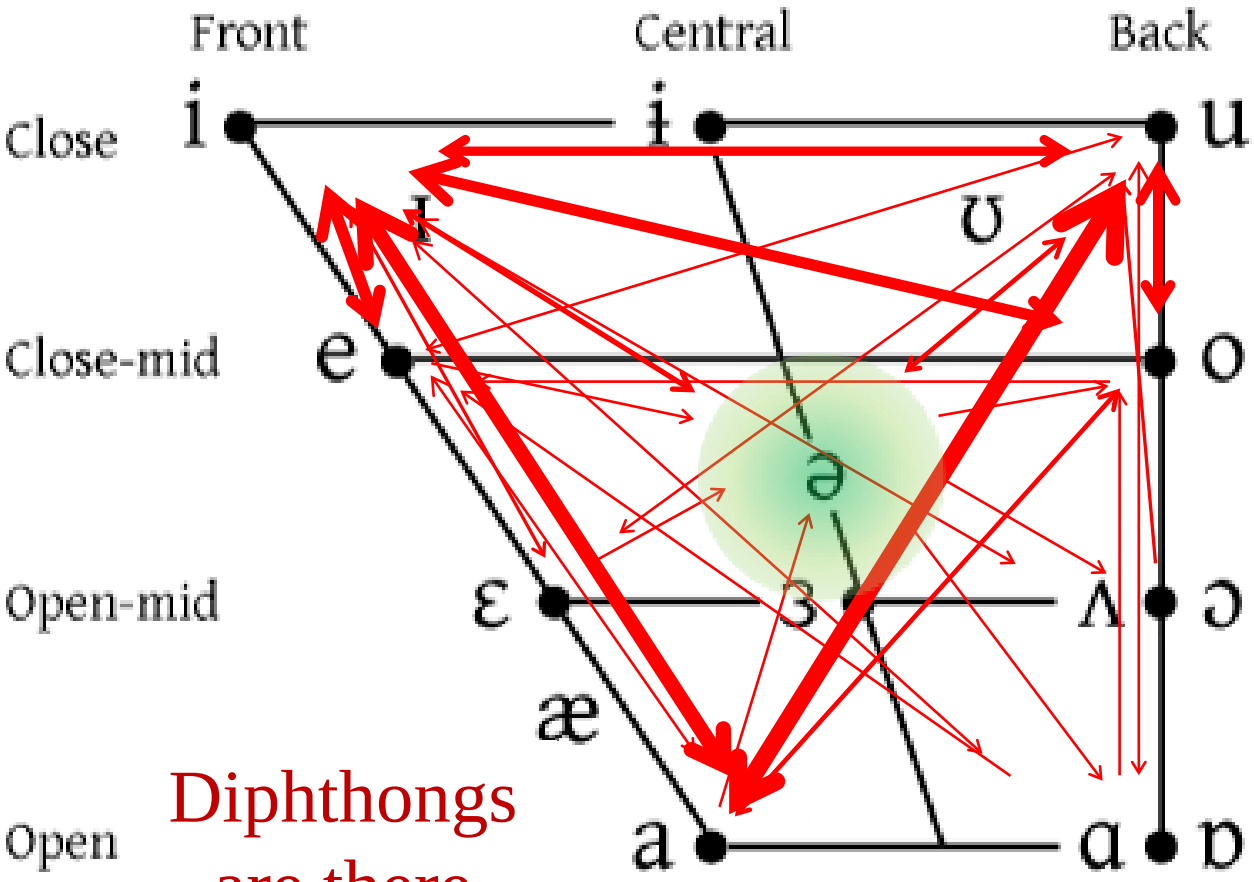


Italian

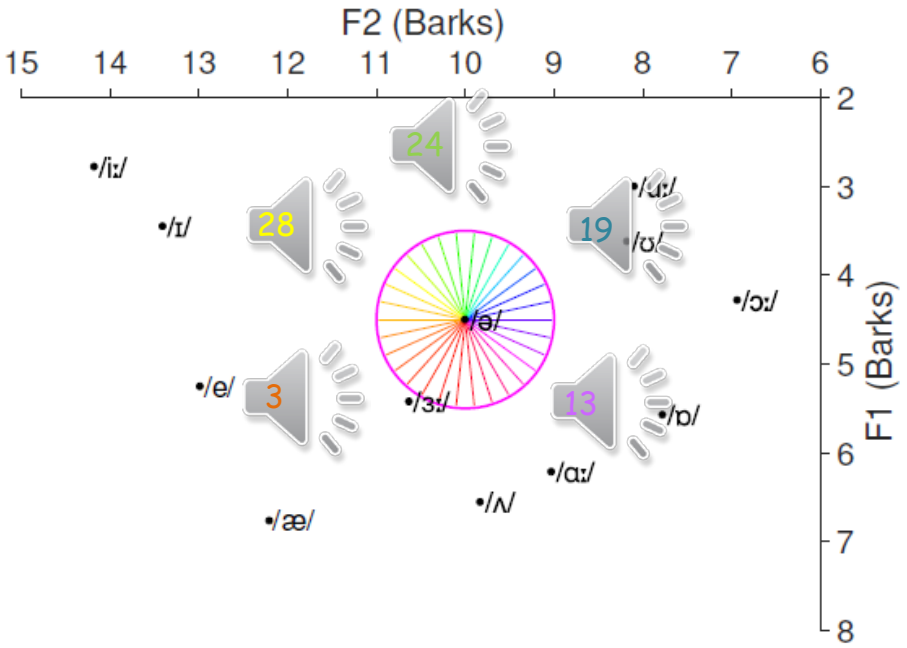


..early ideas
with Zeynep..

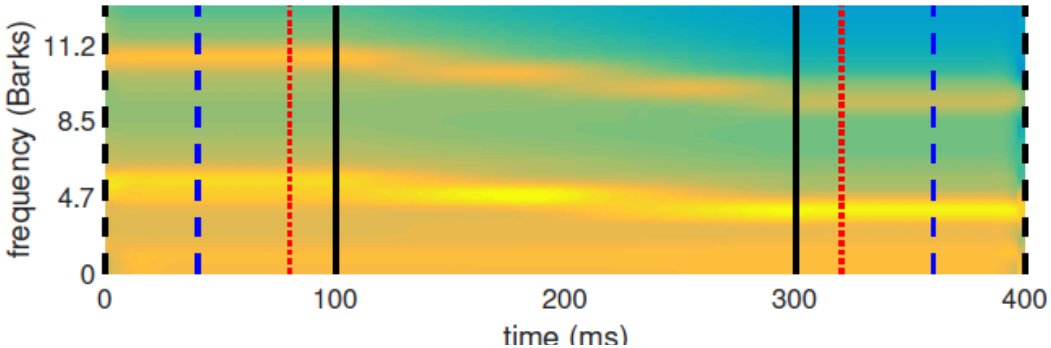
How to test perception on a vowel wheel?



Diphthongs are there to help us..



So here is our quasi-diphthong vowel wheel



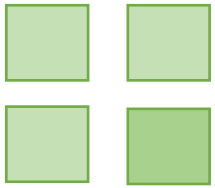
EEG: 64 electrodes

Participants: 22, 19 used
1-2-3 years at most of English at school / no other language

Shade Discrimination

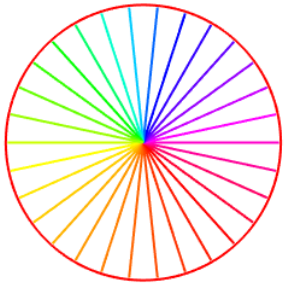
60(30 same, 30 nearby)*3
= 180 trials

Choices on the screen

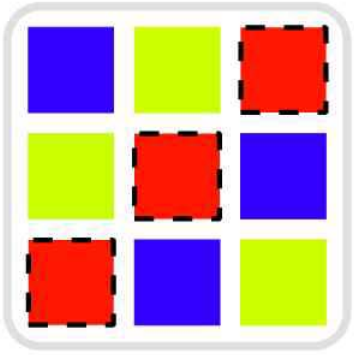


paradigm

Training: 1.5s silence --- 400/320ms trajectory --- 200ms --- 1s color
Test: 1.5s silence --- 240ms trajectory --- 200ms --- Response Screen



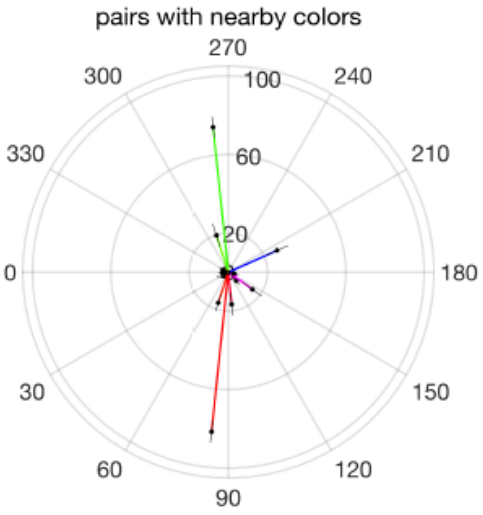
Train #1	--- Test #1	--- Train #2	--- Test #2	--- Train #3	--- Test #3
150(30*5) trajectories: 90: 400ms 60: 320ms ---- 15 quiz trials: 10 apart 400m	90(30*3) trajectories: 10 apart 240ms ---- 1*40secs break	90 trajectories: 30: 400ms 60: 320ms ---- 9 quiz trials: 6 apart	90 trajectories: 6 apart 240ms ---- 1*40secs break	60 trajectories: 30: 400ms 30: 320ms ---- 6 quiz trials: 3 apart	90 trajectories: 4 apart 240ms ---- 1*40secs break

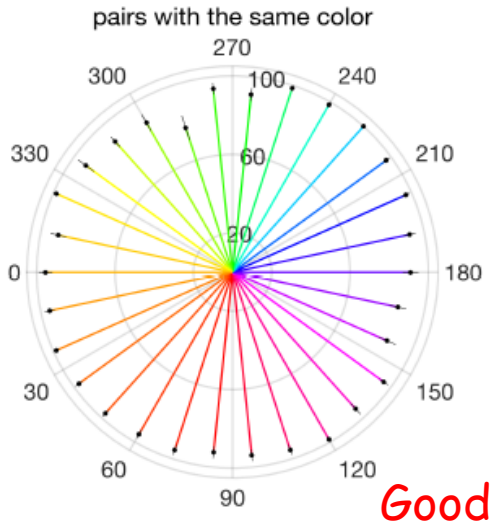


session #1

session #2

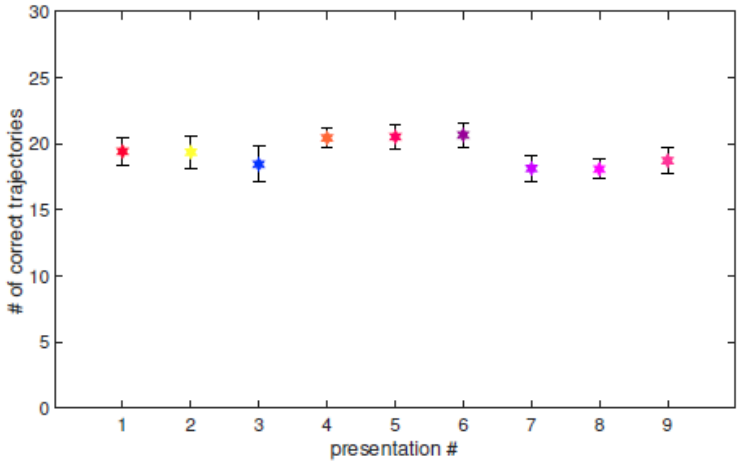
session #3





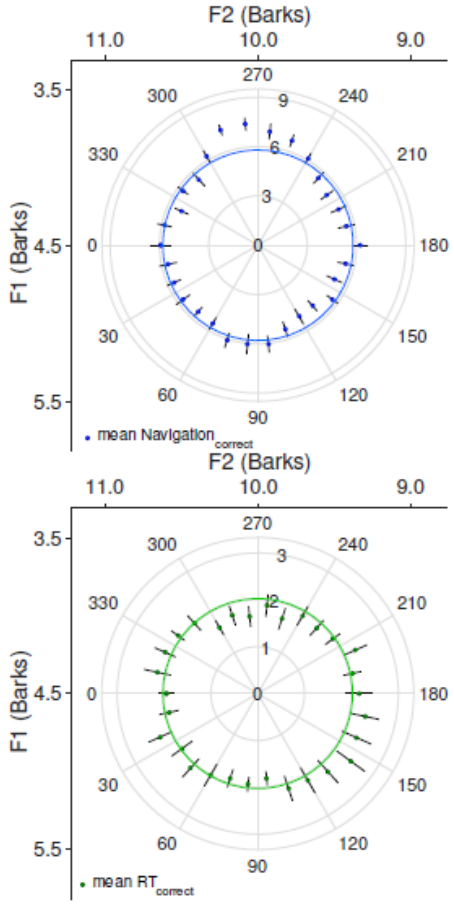
Good discrimination

behavioural results



Decent wheel pairing

Behaviour around the wheel

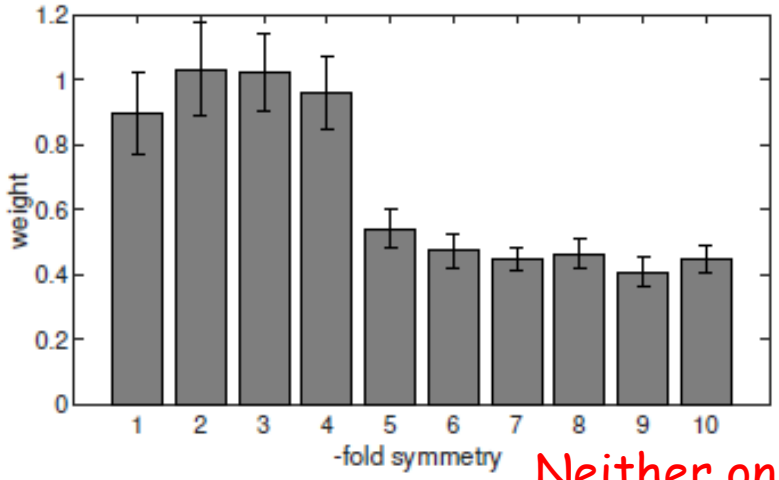


Performance
(out of 9 trials/trajectory)

Reaction Time
(mean around 2 s)

Bulge betw. /i/ and /u/

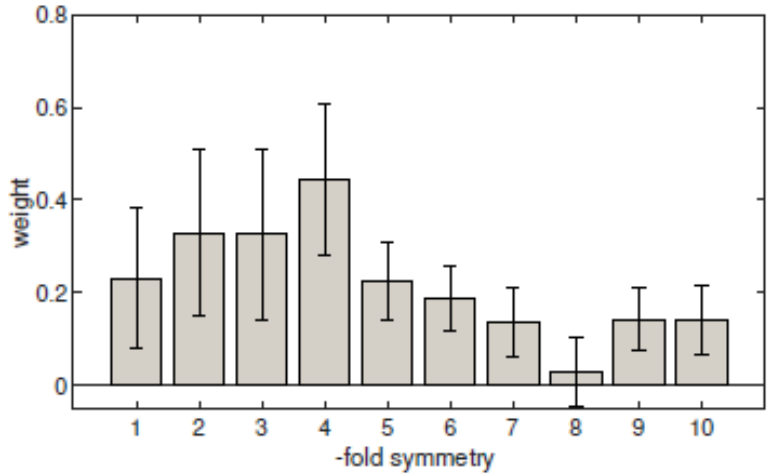
Shorter reaction times

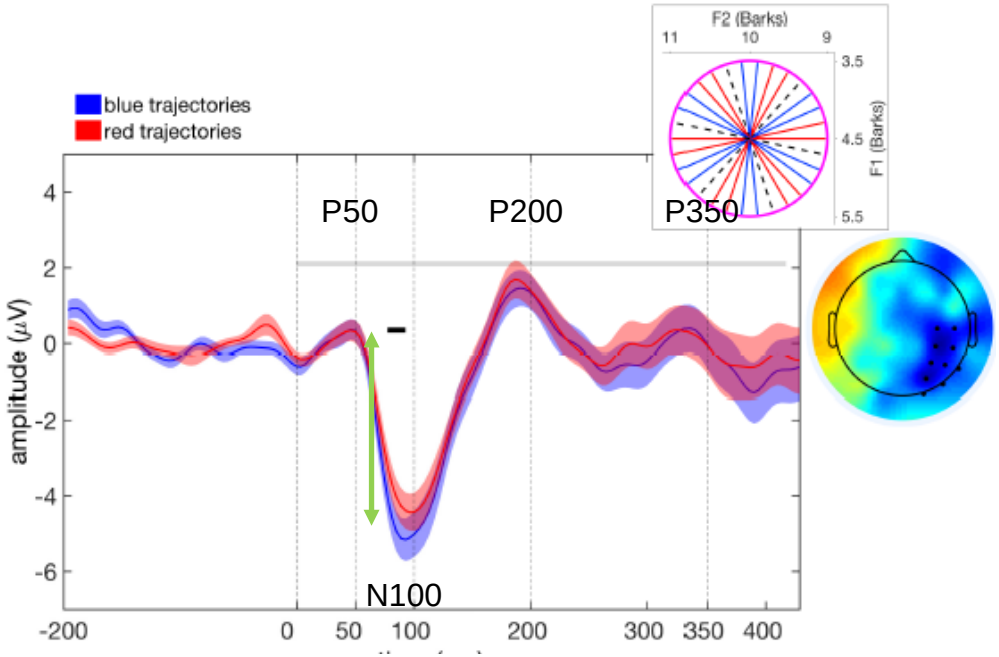


Neither on individual sound wheels
(arbitrary phase)

no salient high-*n* Fourier component (in behaviour)

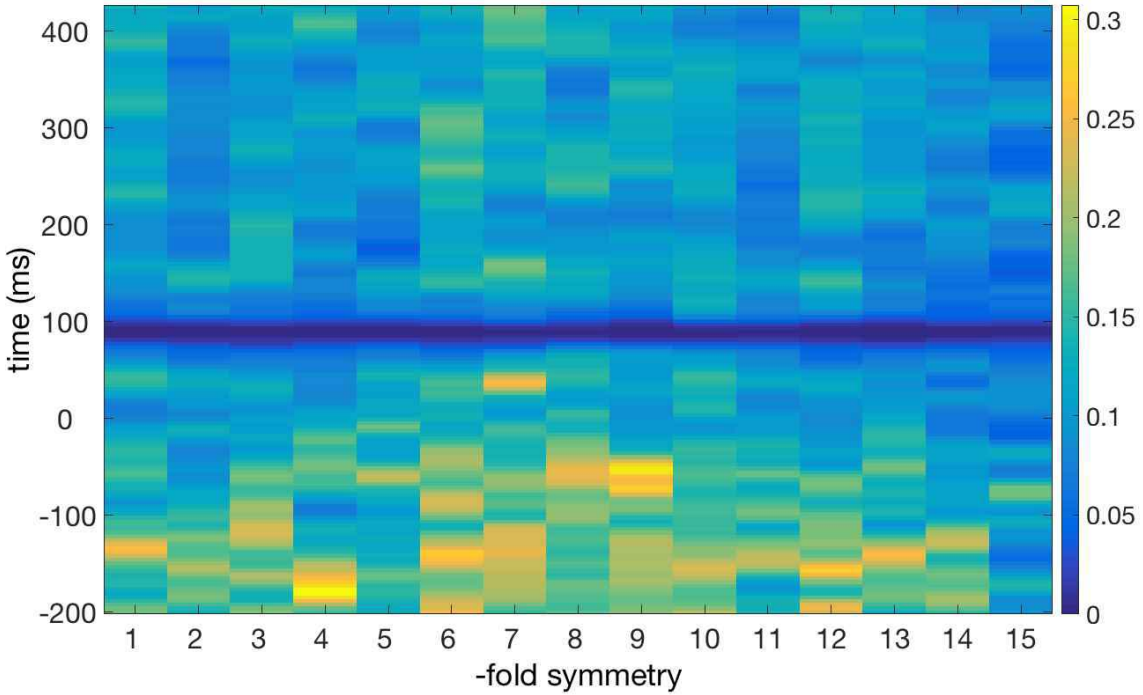
Nor on a common color wheel
(fixing colour phases)

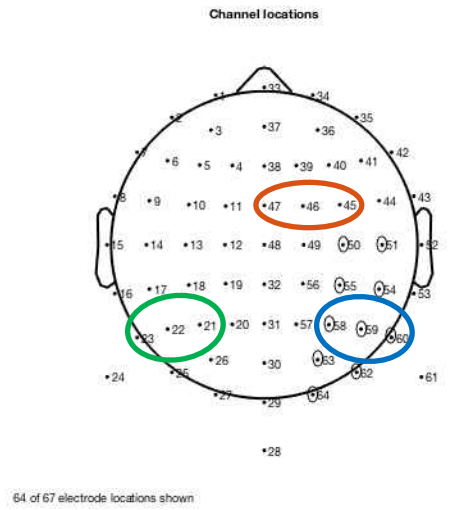




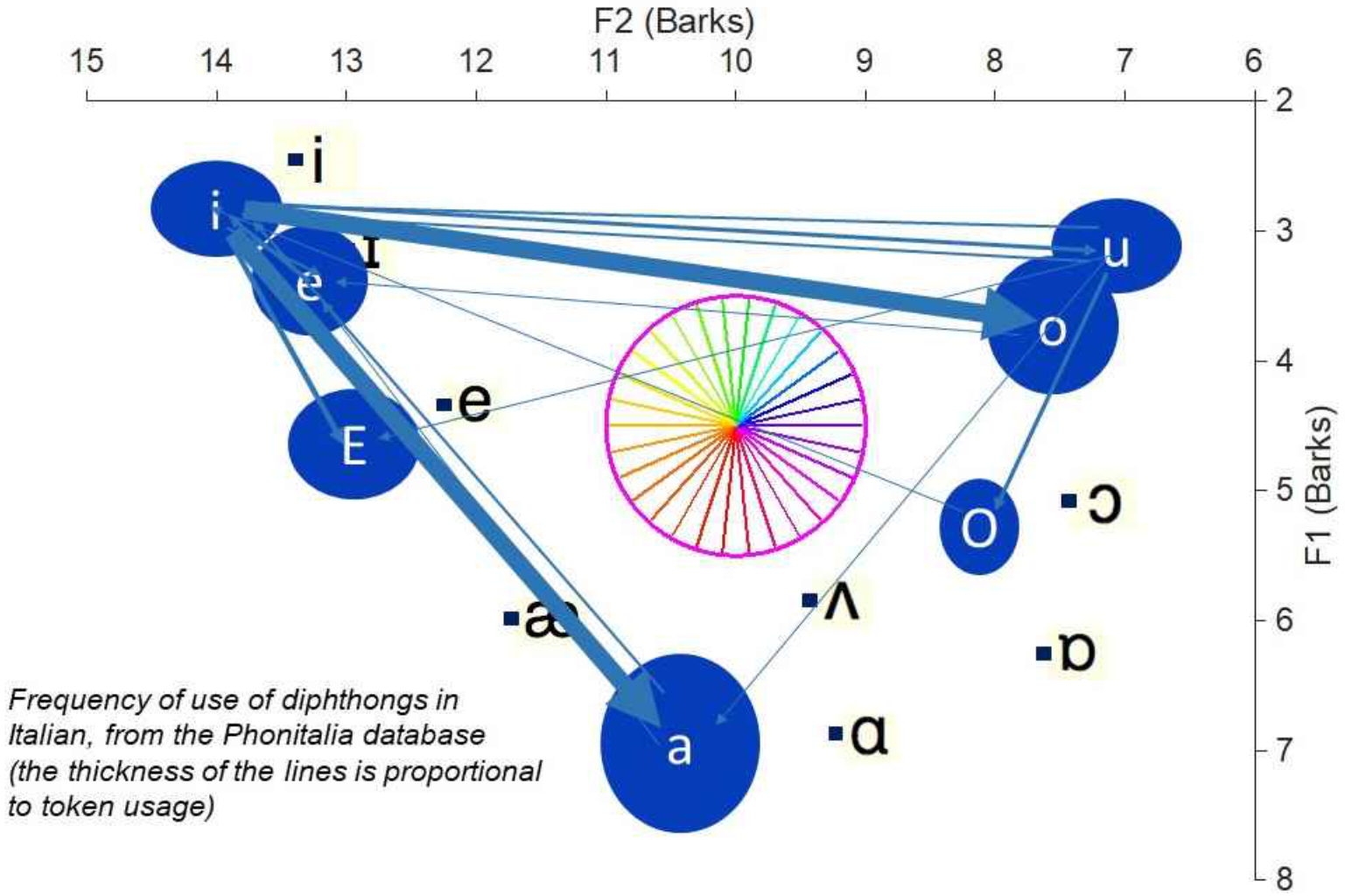
suggestion of a 6-fold component in the ERP signal

the n-fold story unfolds...



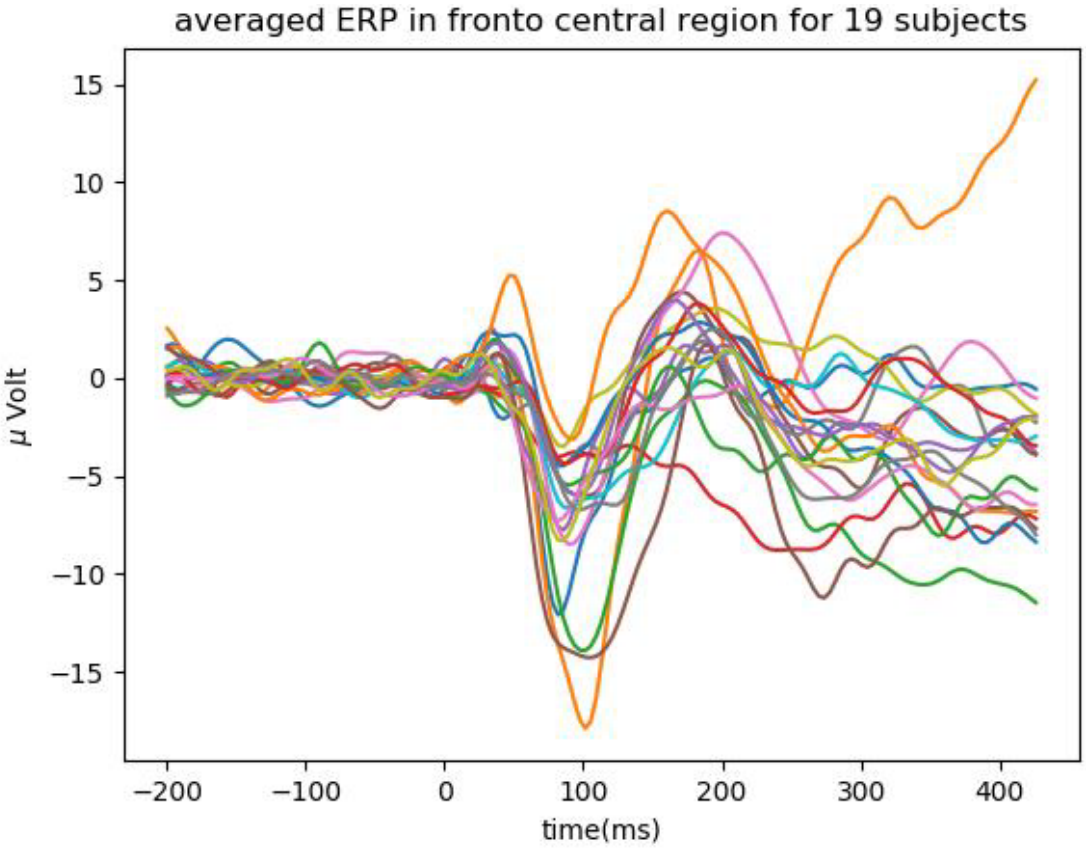


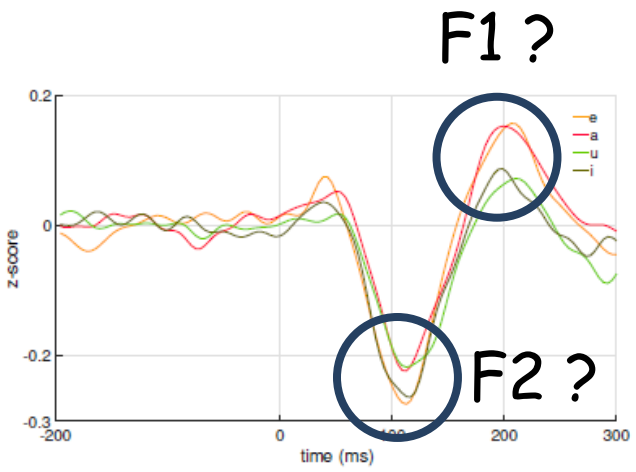
..but what a pity to abandon a plot of land nobody is using..



Frequency of use of diphthongs in Italian, from the Phonitalia database (the thickness of the lines is proportional to token usage)

...besides, there is a lot of variability across subjects, but also something consistent in the temporal patterns...





and something quite interesting from another of Zeynep's experiments..

unfortunately with the vowel wheel things seem to work out a bit differently...

anyway, let us try principal components (with Reza Soltanipour)

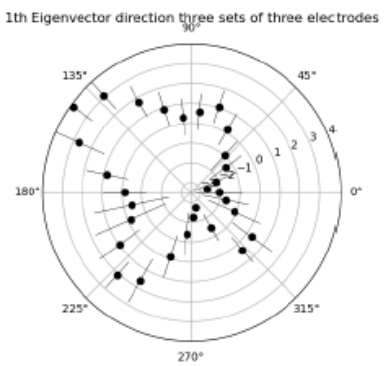
electrode												
45,46,47	P1-N2	0.38	0.24	0.13	0.47	0.08	0.06	-0.02	0.24	0	0.07	-0.04	0.36
	AVG-N2	0.24	0.24	0.17	0.46	0.06	0.07	-0.01	0.26	0.04	0.1	-0.01	0.38
	P3-N2	0.13	0.17	0.29	0.28	0.1	0.07	0.07	0.15	0.07	0.09	0.04	0.28
	P4-N2	0.47	0.46	0.28	0.98	0.1	0.14	-0.08	0.58	0.04	0.19	-0.07	0.77
21,22,23	P1-N2	0.08	0.06	0.1	0.1	0.21	0.07	0.05	0.11	0.16	0.08	0.06	0.22
	AVG-N2	0.06	0.07	0.07	0.14	0.07	0.08	0.08	0.16	0.06	0.07	0.08	0.2
	P3-N2	-0.02	-0.01	0.07	-0.08	0.05	0.08	0.26	0.01	0.04	0.05	0.22	0.05
	P4-N2	0.24	0.26	0.15	0.58	0.11	0.16	0.01	0.52	0.07	0.17	0.05	0.58
58,59,60	P1-N2	0	0.04	0.07	0.04	0.16	0.06	0.04	0.07	0.27	0.14	0.14	0.27
	AVG-N2	0.07	0.1	0.09	0.19	0.08	0.07	0.05	0.17	0.14	0.13	0.12	0.31
	P3-N2	-0.04	-0.01	0.04	-0.07	0.06	0.08	0.22	0.05	0.14	0.12	0.27	0.16
	P4-N2	0.36	0.38	0.28	0.77	0.22	0.2	0.05	0.58	0.27	0.31	0.16	0.95
	Eigen Value	2.8642	0.8298	0.2999	0.2581	0.1624	0.1361	0.0436	0.0297	0.0113	0.0086	0.0012	0.0005
	error	1.13	0.65	0.5	0.61	0.45	0.44	0.33	0.35	0.25	0.2	0.12	0.1

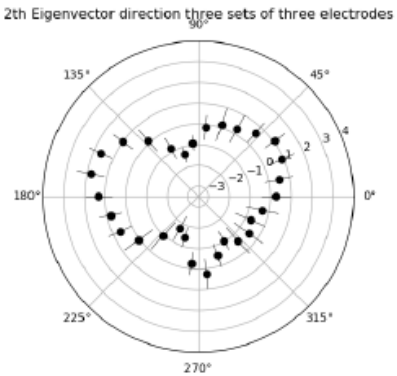
first few (6) eigenvectors

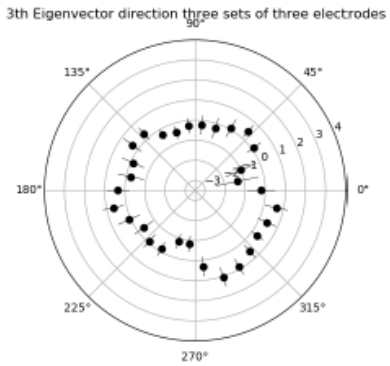
-0.27	-0.23	-0.16	0.3	0.76	-0.11	
-0.27	-0.13	-0.08	0.16	-0.11	-0.12	
-0.19	0.09	-0.22	0.64	-0.53	0.05	
-0.54	-0.36	-0.07	-0.01	-0.15	-0.08	
-0.12	0.23	0.27	0.35	0.25	0.63	
-0.12	0.14	-0.14	-0.09	0.01	0.29	
-0.01	0.41	-0.61	0.05	0.11	0.04	
-0.37	-0.01	-0.11	-0.51	-0.1	0.51	
-0.11	0.4	0.54	0.14	0	-0.09	
-0.16	0.22	0.09	-0.07	-0.02	-0.21	
-0.04	0.52	-0.25	-0.14	0.09	-0.25	
-0.55	0.22	0.21	-0.14	0.02	-0.27	

eigenvalues	61.65%	17.86%	6.45%	5.56%	3.49%	2.93%	< 1%
'effect size' (S/N)	0.34	0.30	0.23	0.23	0.20	0.20	< 0.20

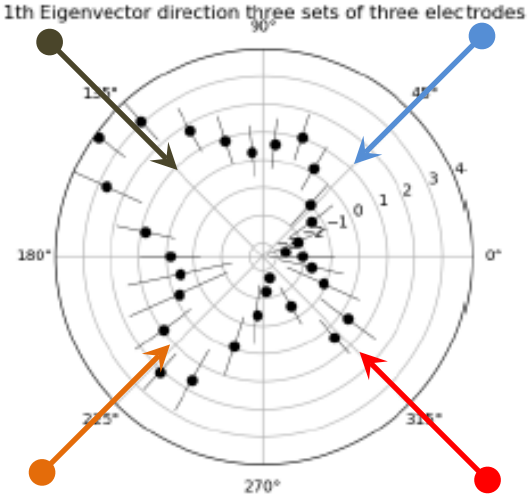
on the wheel

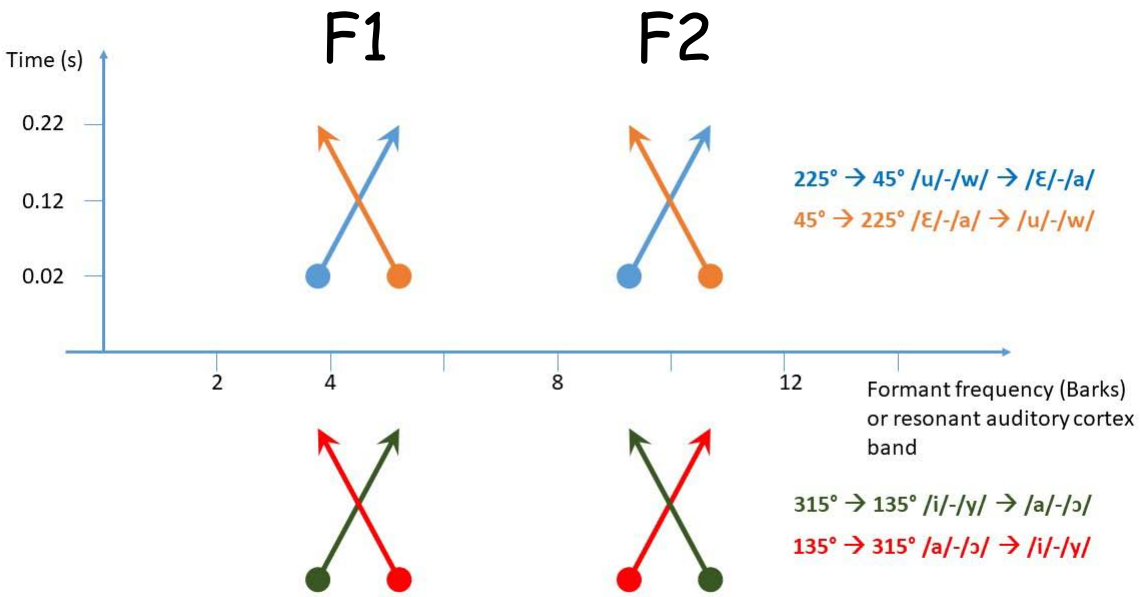






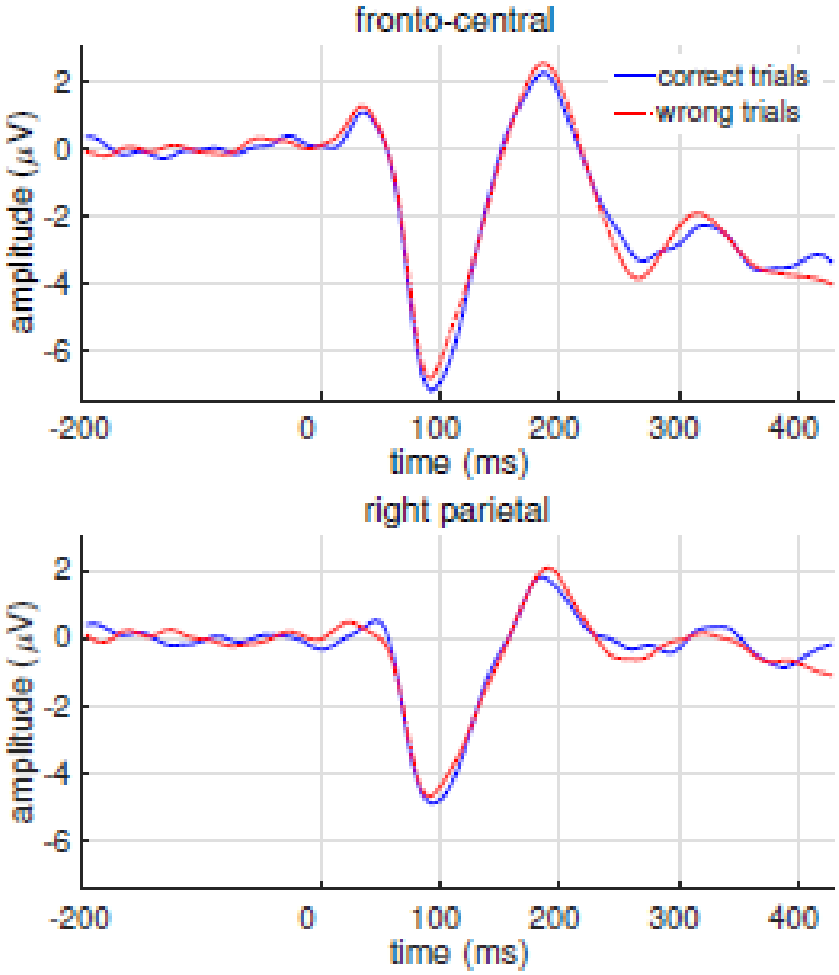
can we see something in the first eigenvector?

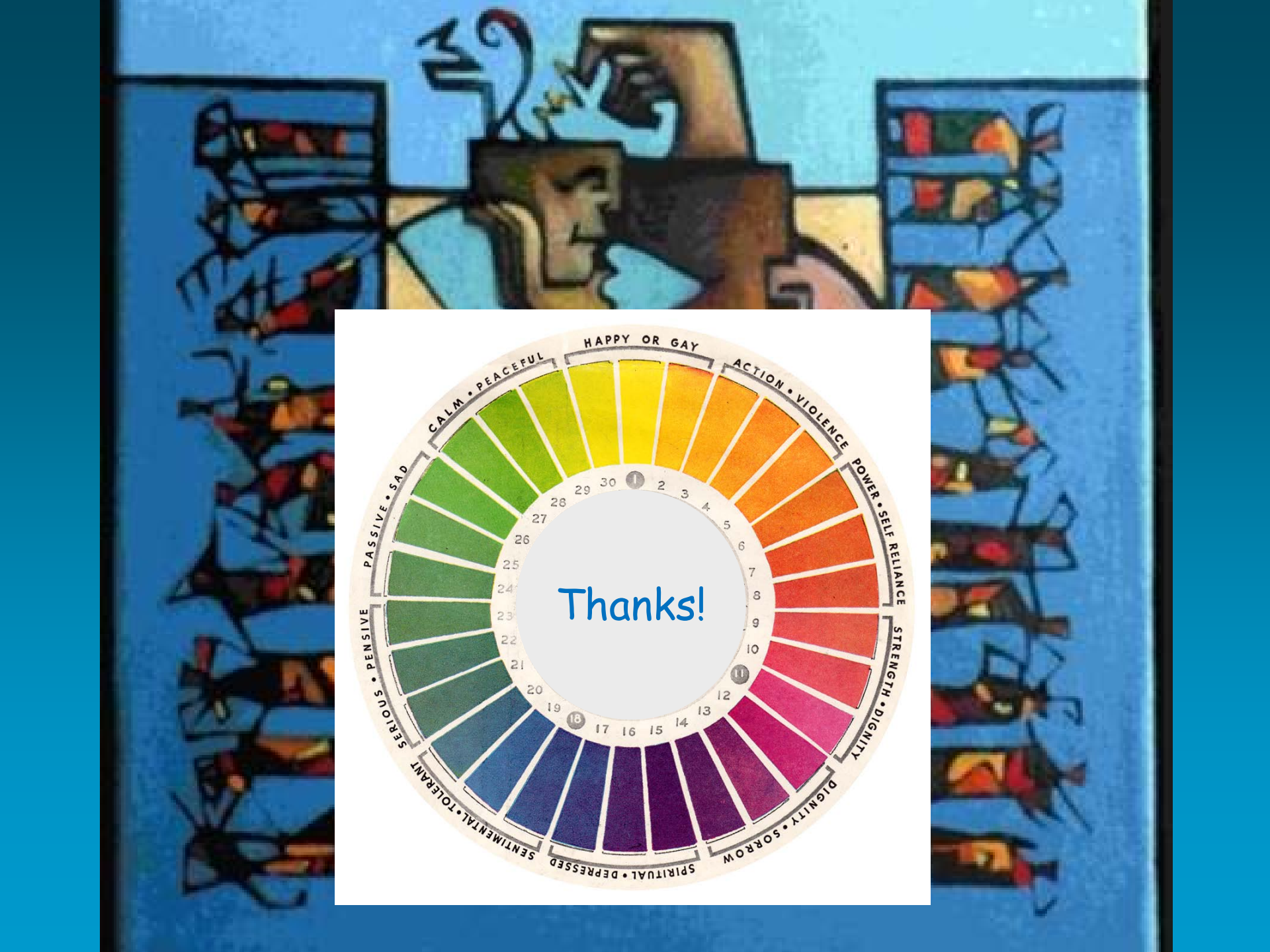




possibly a sensory wave from auditory areas?

and something in the ERPs for wrong choices?




HAPPY OR GAY
ACTION • VIOLENCE
POWER • SELF RELIANCE
STRENGTH • DIGNITY
DIGNITY • SORROW
SPIRITUAL • DEPRESSED
SENTIMENTAL • TOLERANT
SERIOUS • PENSIVE
PASSIVE • SAD
CALM • PEACEFUL
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Thanks!