EUSKAL PSIKOLINGUISTIKA

3. EGUNA

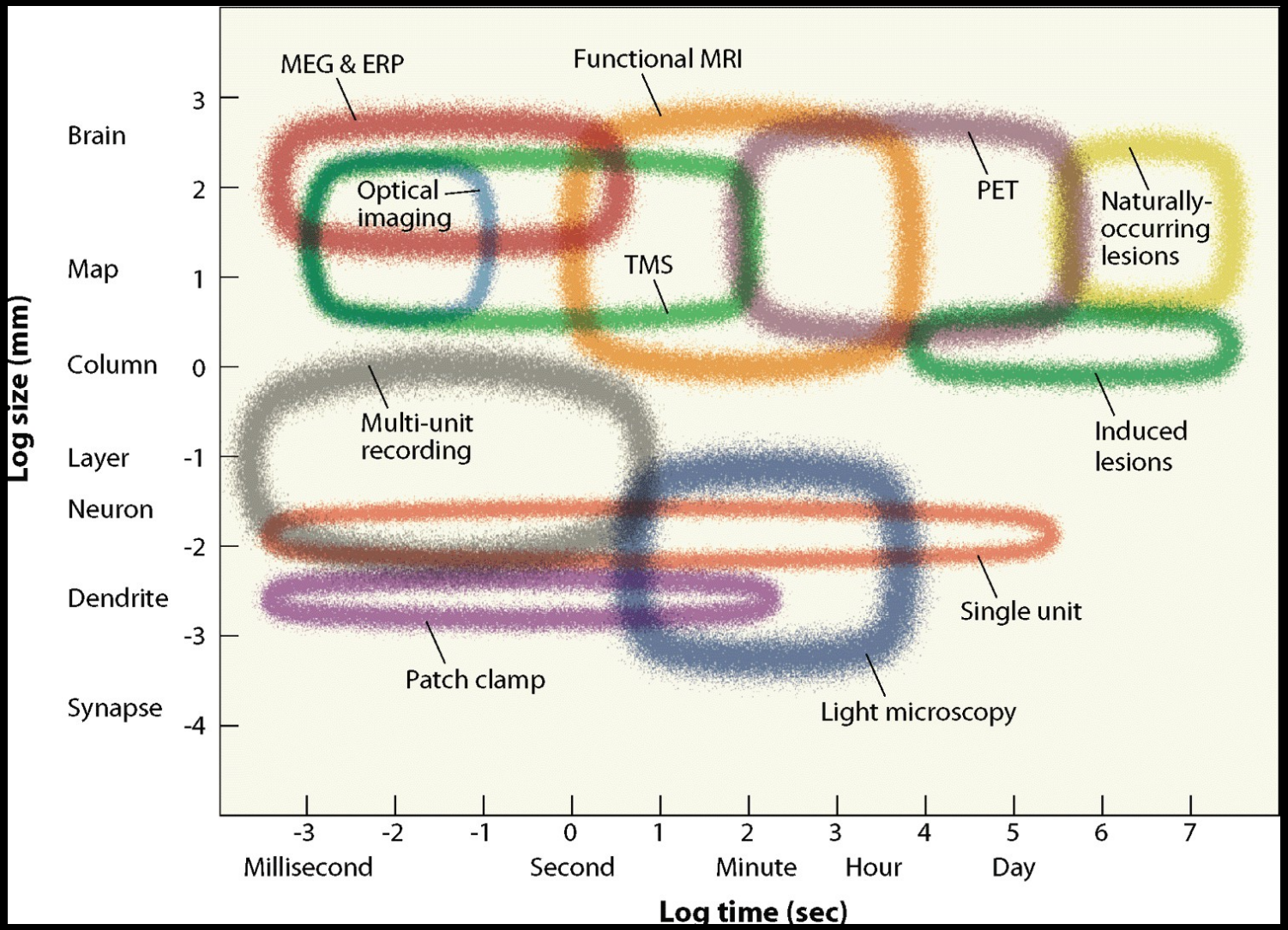
Aurreko egunetako errepasoa

Neuro-irudiak: fMRI teknika
TMS

Hizkuntza Artifizialak

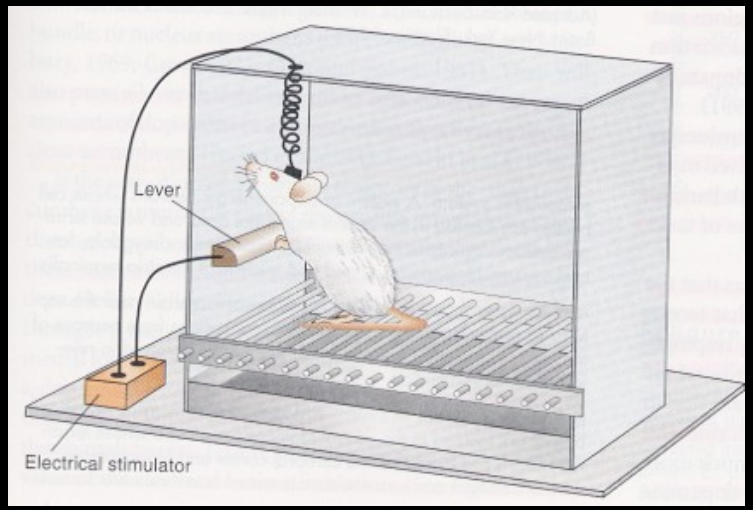
Hizkuntza Artifizialak eta Buru Parametroa

Cognitive neuroscience methods can be categorised according to their spatial and temporal resolution and invasiveness

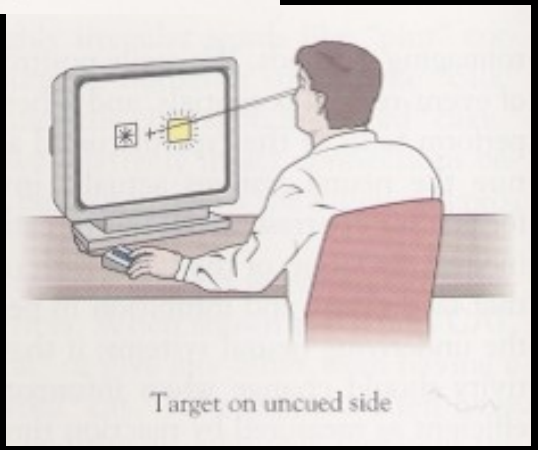


Jokabidezko esperimetnuak

Jokabidearen oinarri neuralak ikertzeko,
a) jokabidearen funtzioen definizio operazionalak eta
b) kuantiatiboki aztertu ditzakegun neurriak behar ditugu



e.g., Skinner box



e.g., reaction-time studies

Jokabidezko esperimentuak

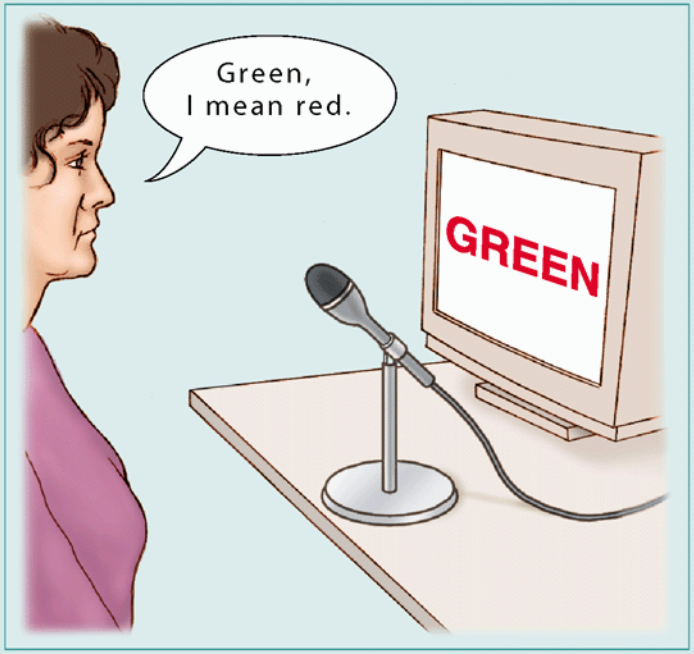
Psikologia Kognitiboak ondoren baieztapenak jarraitzen ditu:

- Mundua ez dugu zuzenea pertzibitzen
- Informazioa barne-errepresentazioen menpe dago
- Gogo-errepresentazioak tranformazioen menpe daude

ADIBIDEA:

STROOP EFEKTUA

Color matches word	Random colors	Color doesn't match word
RED	XXXXX	GREEN
GREEN	XXXXX	BLUE
RED	XXXXX	RED
BLUE	XXXXX	BLUE
BLUE	XXXXX	GREEN
GREEN	XXXXX	RED
BLUE	XXXXX	GREEN
RED	XXXXX	BLUE



Jokabidezko esperimentuak
pros & cons

-Errazak prestatu eta aztertzeko

-Burmuinaren funtzioei buruzko inferentziak egiteko tresna egokia

-Ezin da frogatu burmuinaren benetazko jokabidea (nola konpontzen duen planteatutako arazoa)

-Ez dago lotura neuroanatomiko zuzenik

NEUROLINGUISTICS

Hizkuntza mekanismo biologikoen bidez prozesatzen da

Knowledge of Language:

- Izaera
- Jabekuntza
- Erabilera
- Neurolinguistika

"Linguists seek a characterization of the nature of linguistic knowledge; psycholinguists are after modeling the algorithms that implement this knowledge when language users speak and understand; and neurolinguists are interested in neural mechanisms that realize these algorithms, and their cerebral localization. "
(Grodzinsky 2003)

ERP ESPERIMENTUAK

Nola jasotzen diren

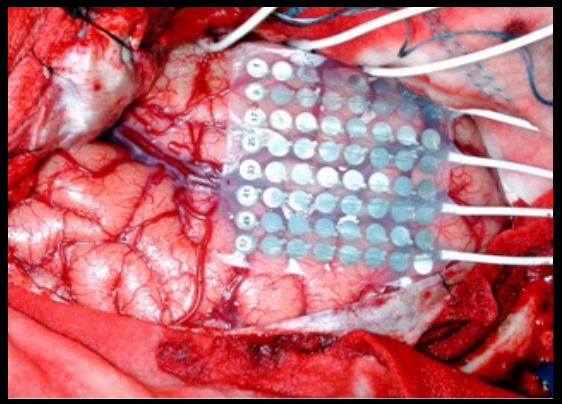
Bataz bestekoak

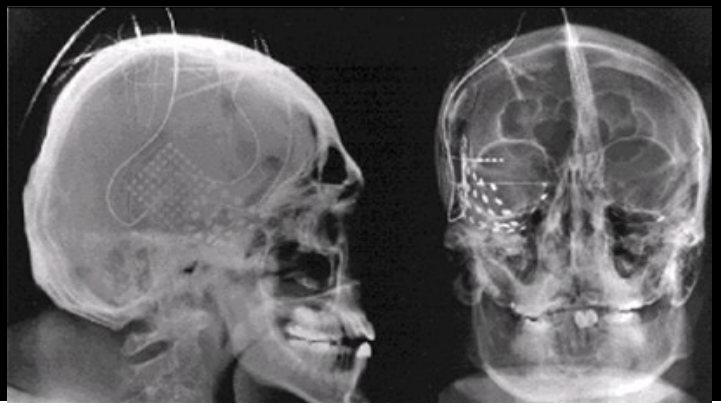
Hizkuntzazko ERP efektuak

- ELAN: Early Left Anterior Negativity
- LAN: Left Anterior Negativity
- N400
- P600

Event related brain potentials (ERP)

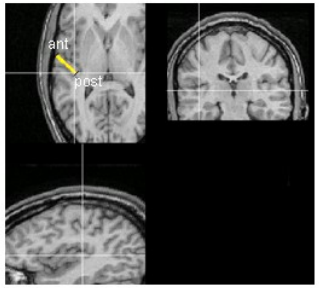
Intracranial EEG

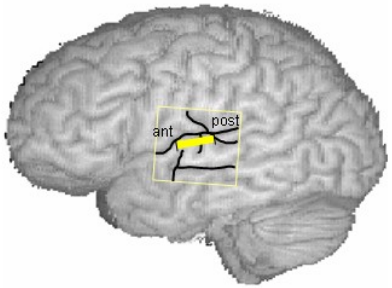




Location of Heschl's Gyrus

S106

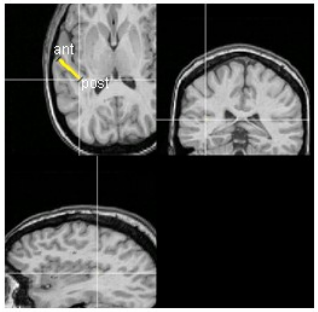


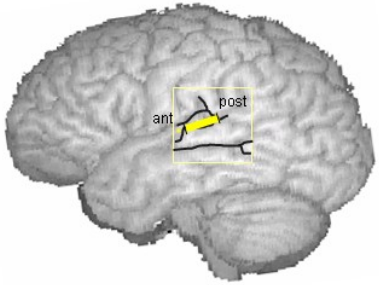


cortical distances

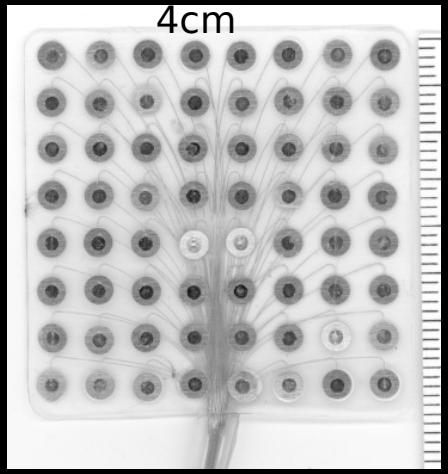
Δ post / ant:	34 mm
Δ post / surface:	26 mm

S100

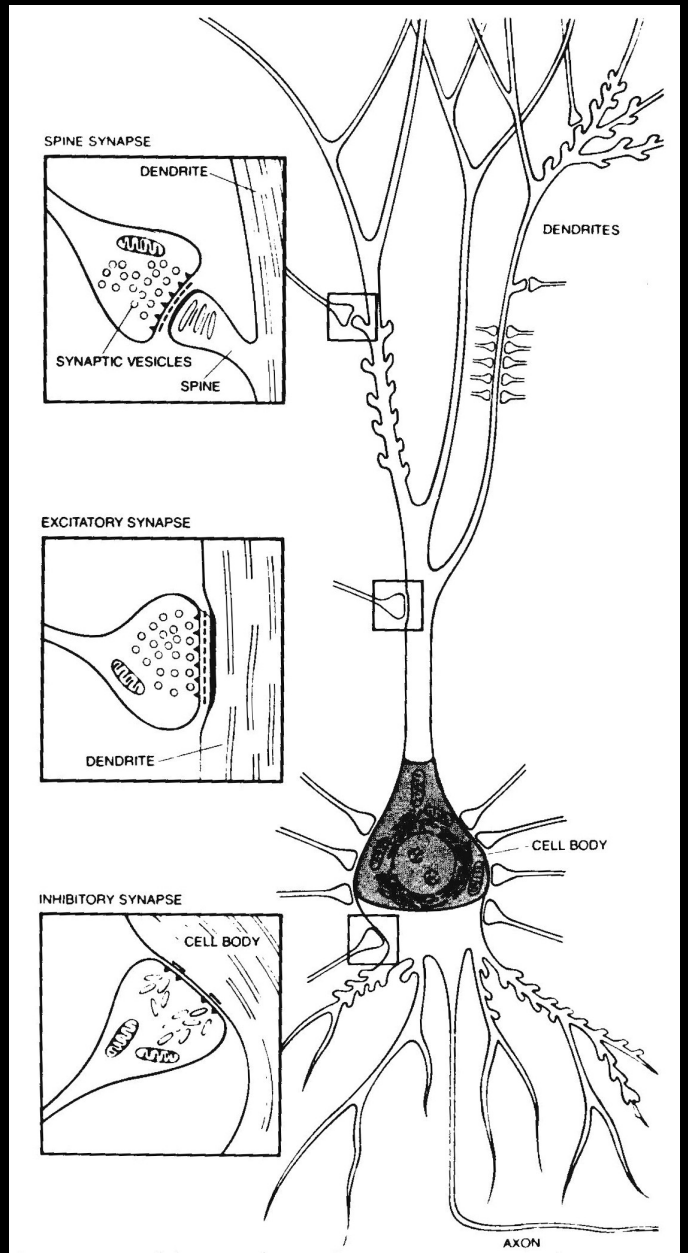




Δ post / ant:	32 mm
Δ post / surface:	27 mm



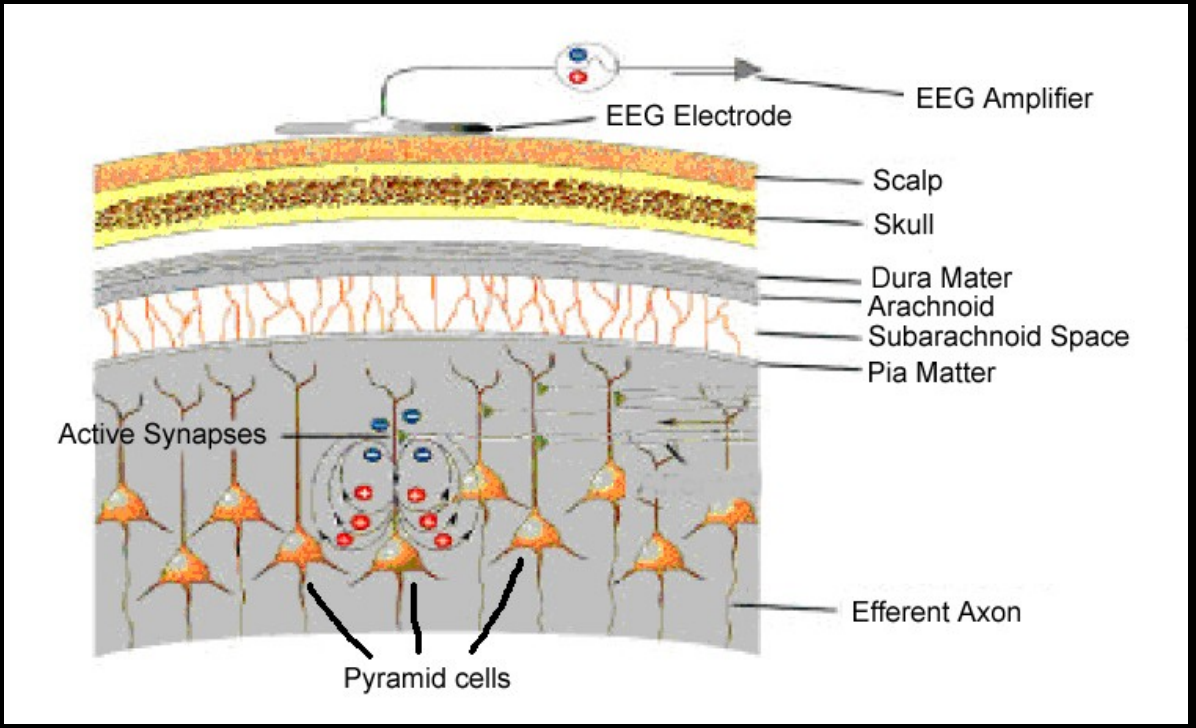
EVENT RELATED BRAIN POTENTIALS



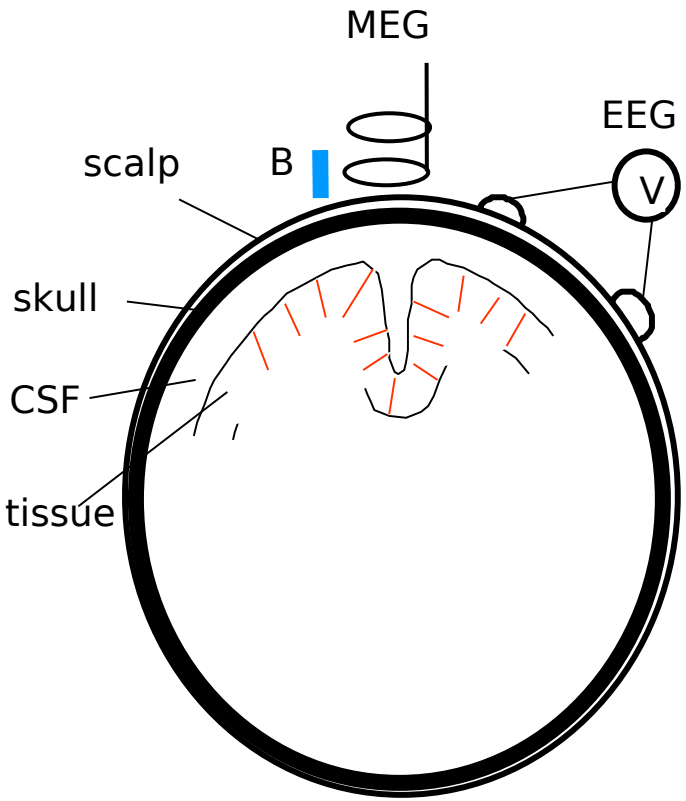
ELECTROENCEPHALOGRAM

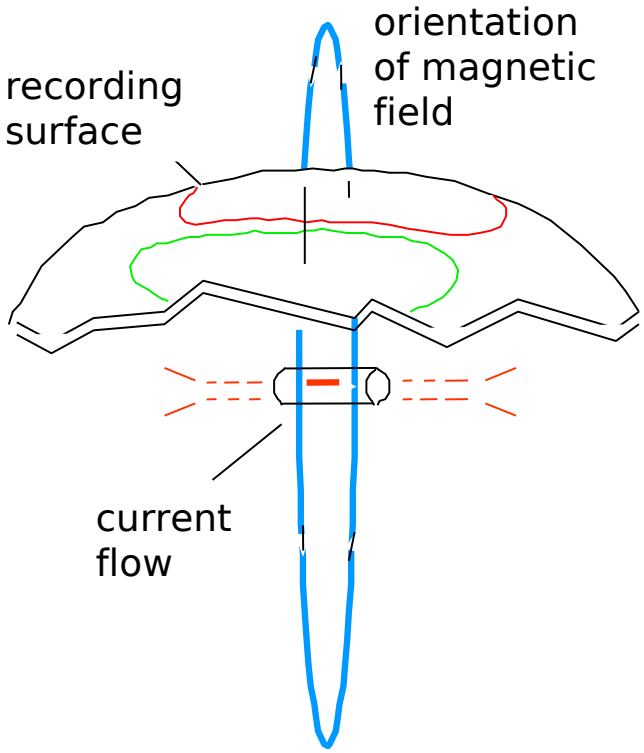
Aktibitate elektriko post-sinaptikoa

Polaritate aldaketak

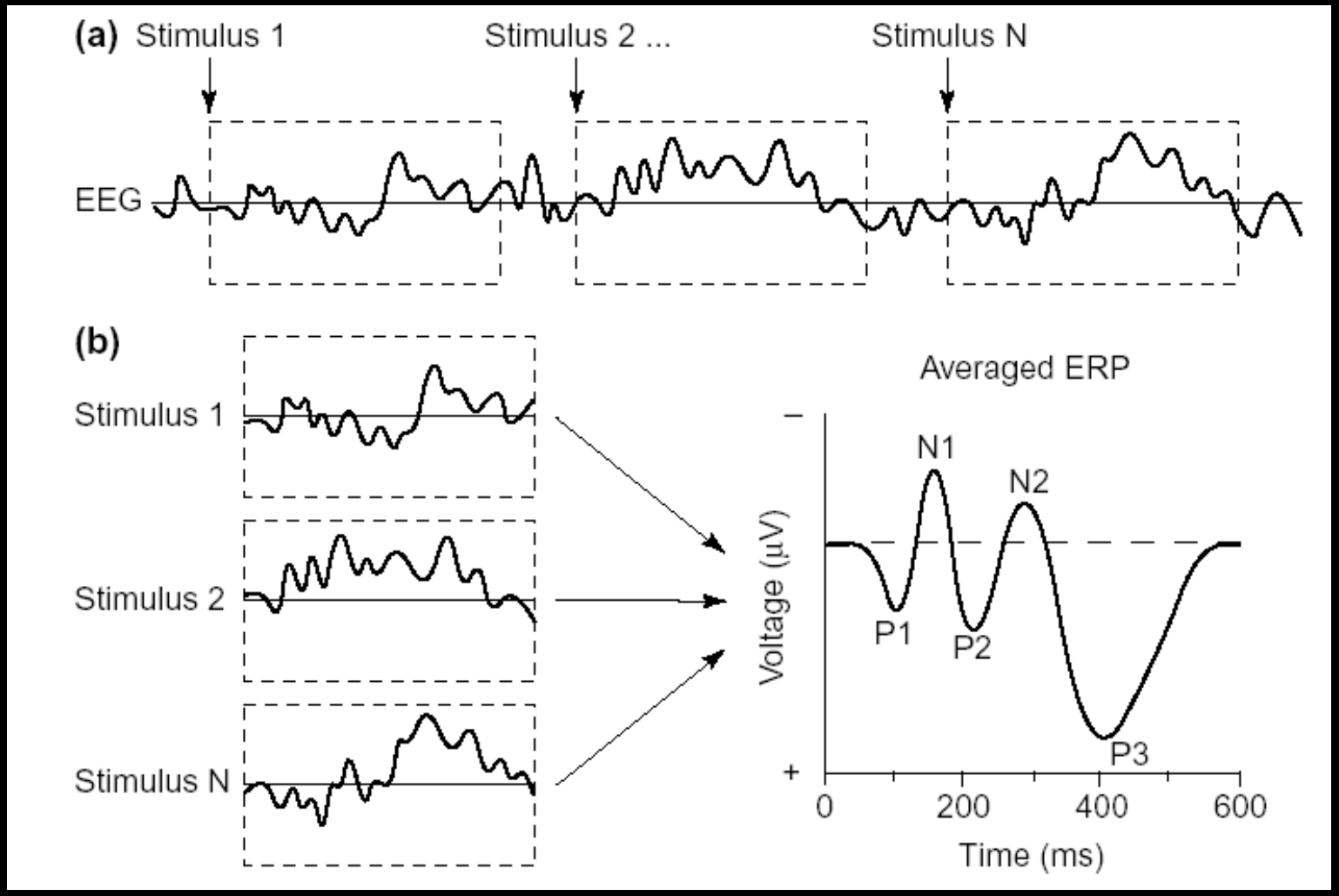


Origin of the signal





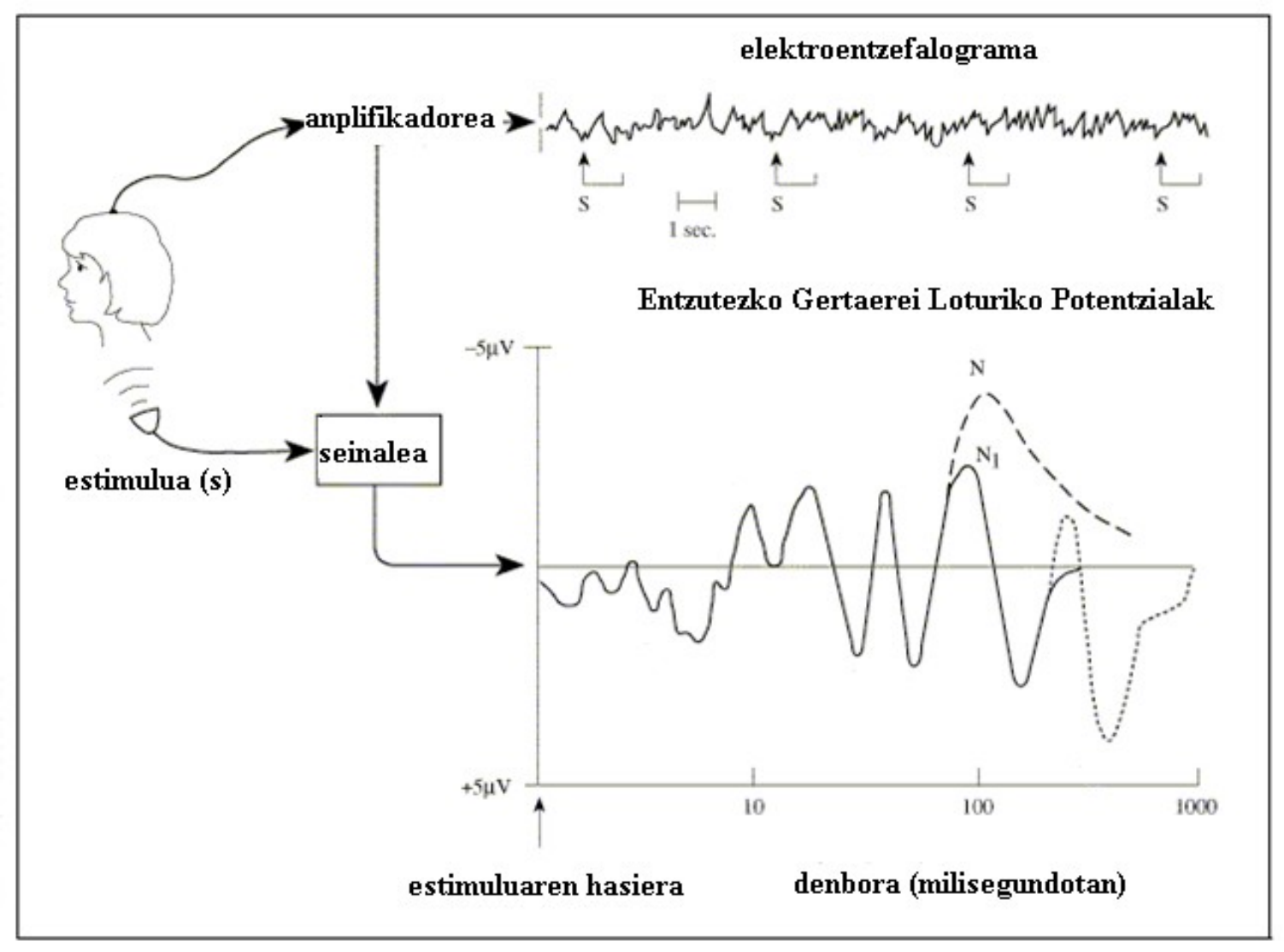
ERP: Event Related brain Potentials



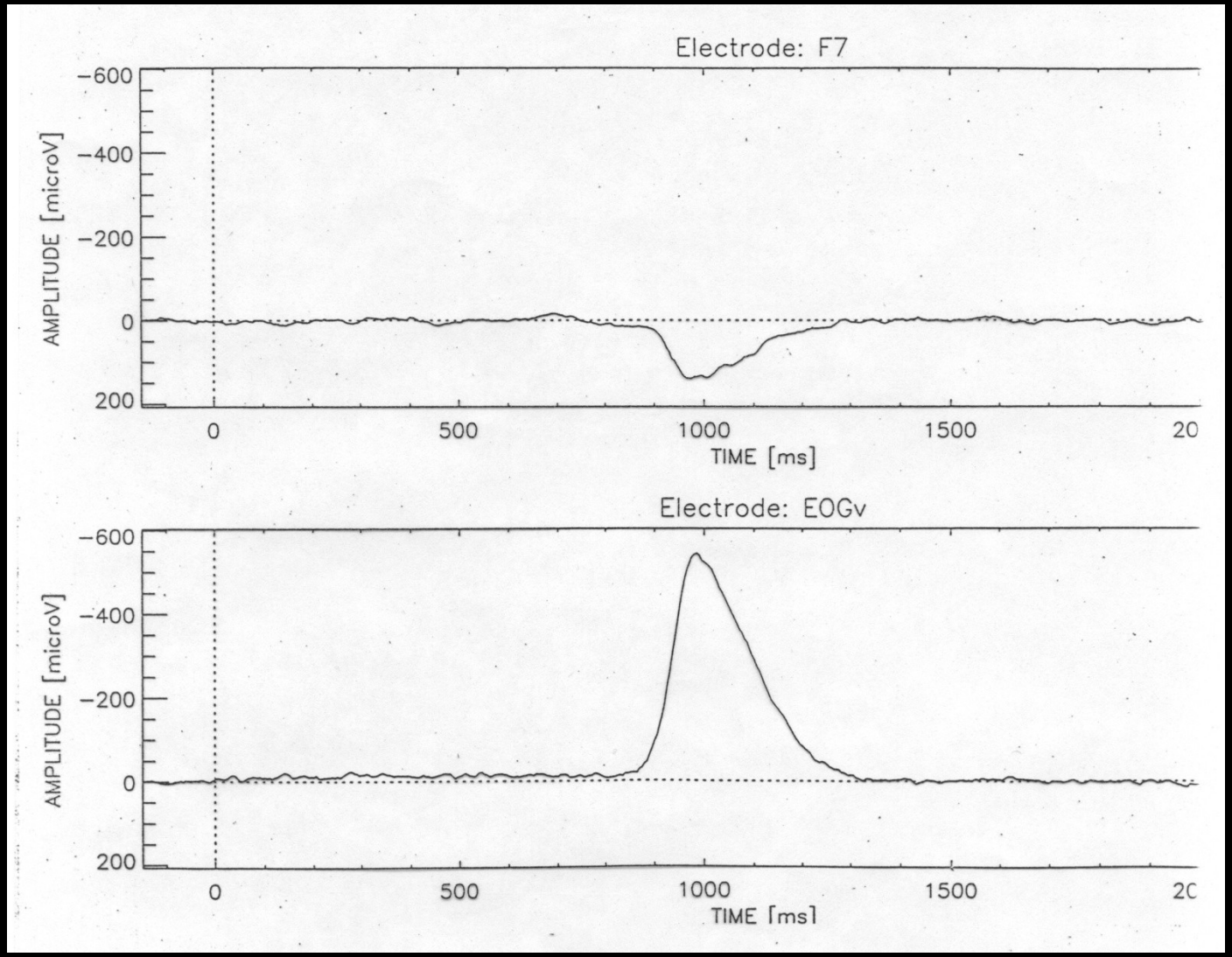
From Luck et al., 2000

EVENT RELATED BRAIN POTENTIALS

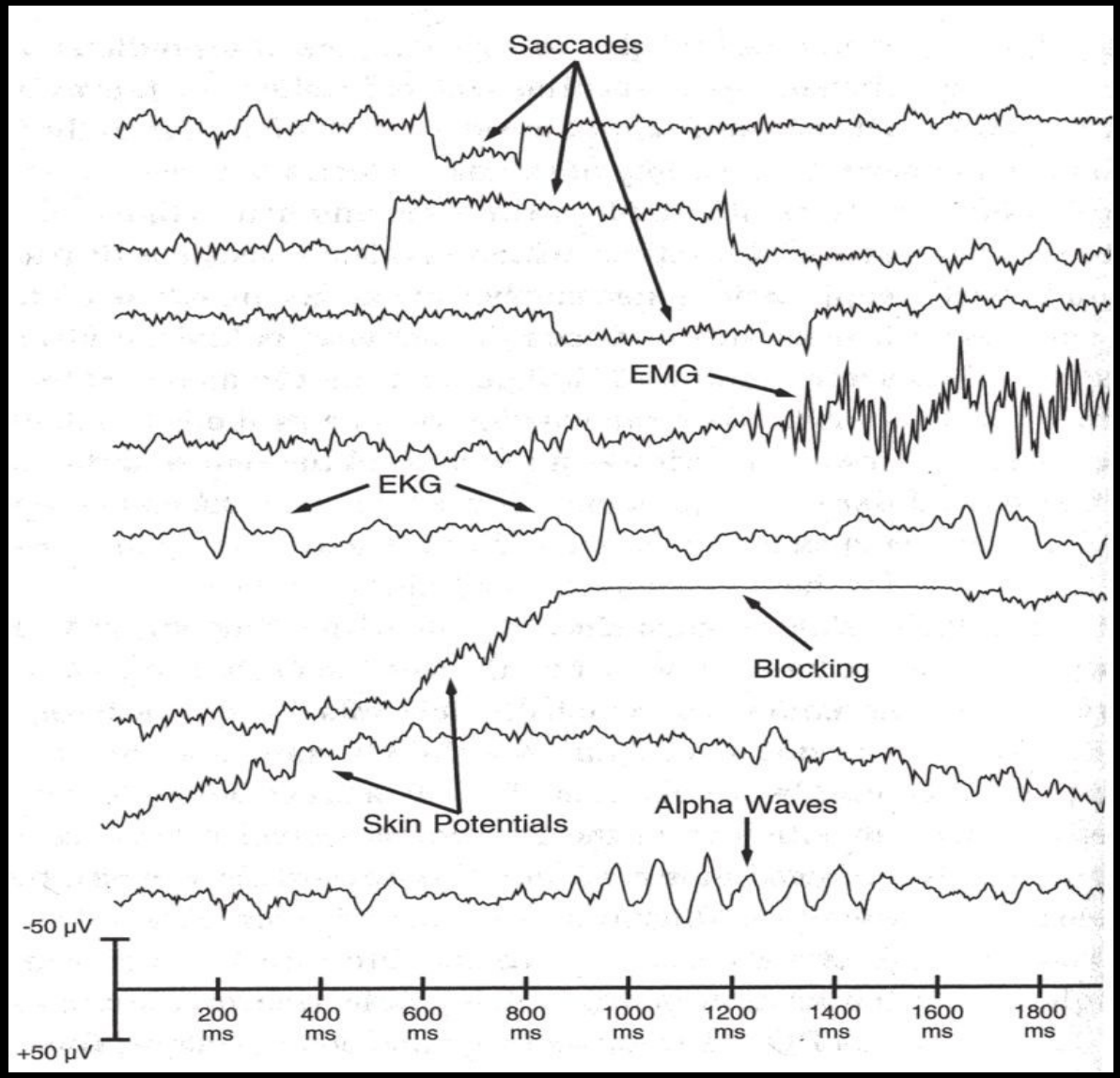
ERP



Signal artifacts



Artifacts in EEG signal



Multidimensional nature of ERPs

Polaritatea: Negatibotasuna
Positibotasuna

Latentzia

Osagai Exogenoak

Osagai Endogenoak

Uhinen amplitudea

Banaketa Topografikoa

ERP Components Related to Language

Early Left Anterior Negativity

Left Anterior Negativity

N400

P600

ERP Components Related to Language

Early Left Anterior Negativity

Left Anterior Negativity

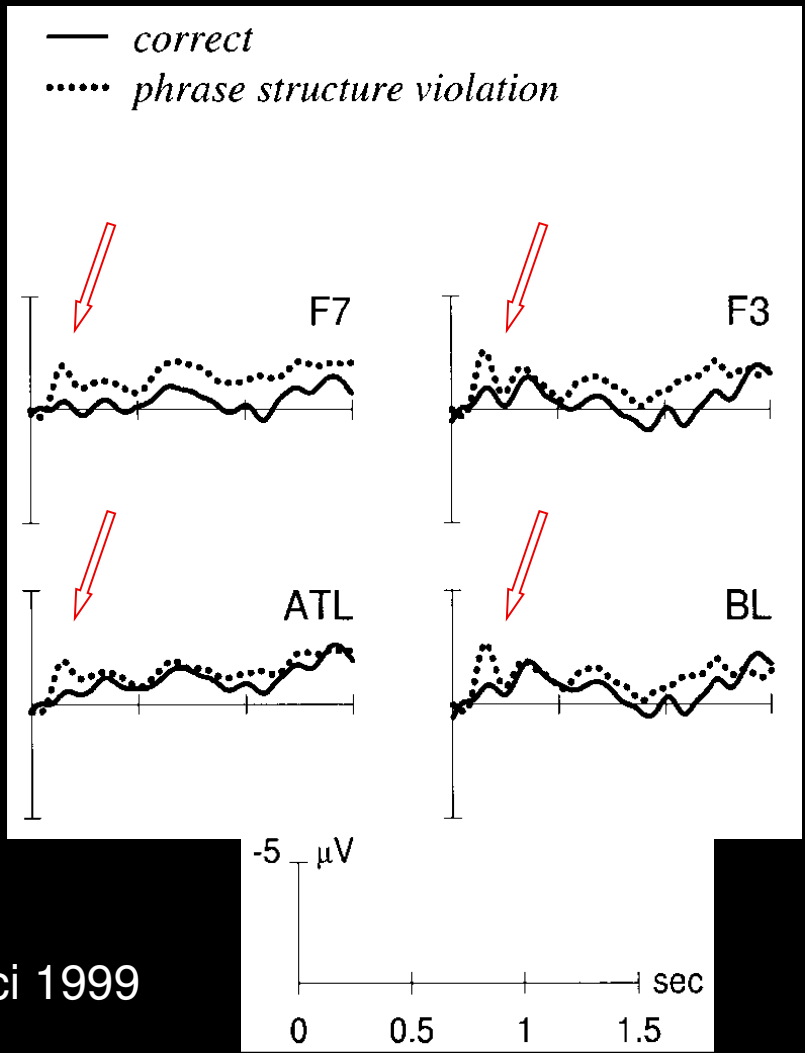
N400

P600

Phrase Structure Violations

Das Baby wurde gefüttert
The baby was fed

*Das Baby wurde im gefüttert
The baby was in the fed



Hahne & Friederici 1999

ERP Components Related to Language

Early Left Anterior Negativity

Left Anterior Negativity

N400

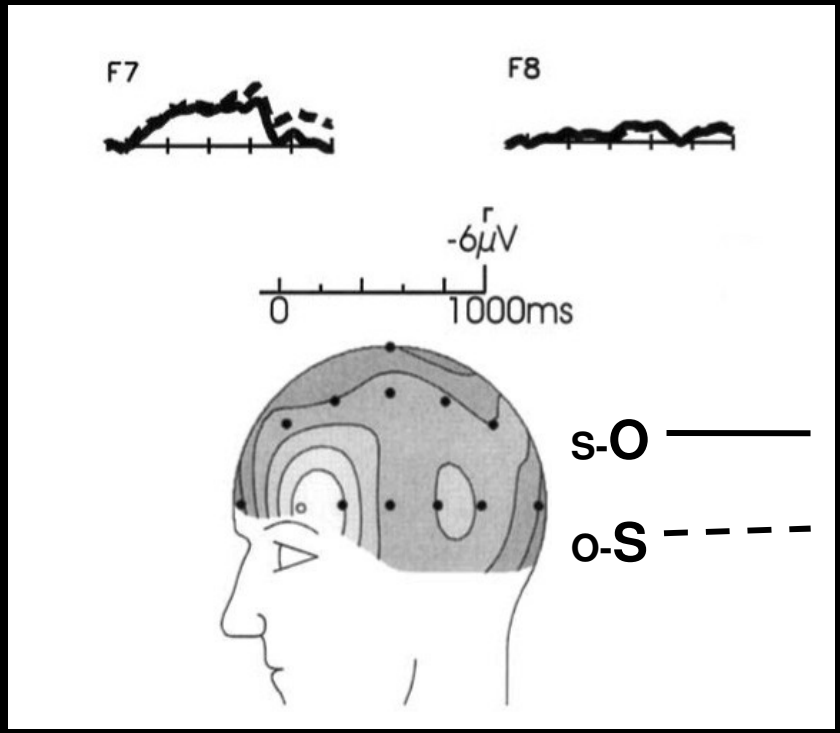
P600

Agreement and Case Violations

Object relatives vs Subject relatives

Object questions vs Subject questions

Word Order variation in German relatives: SOV vs OSV



Matzke et al 2002

ERP Components Related to Language

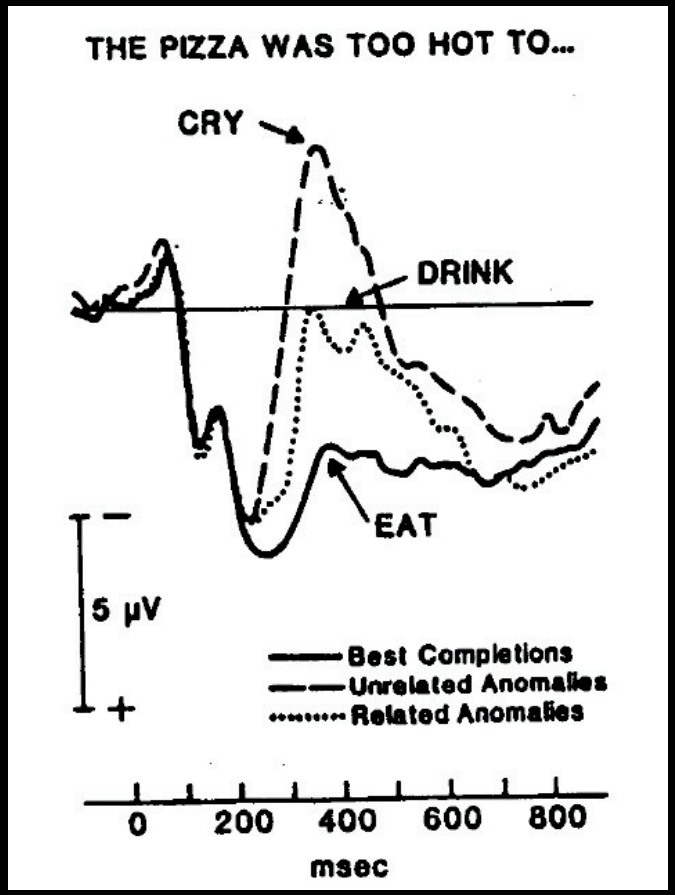
Early Left Anterior Negativity

Left Anterior Negativity

N400

P600

Semantic Component



Kutas & Van Petten 1988

ERP Components Related to Language

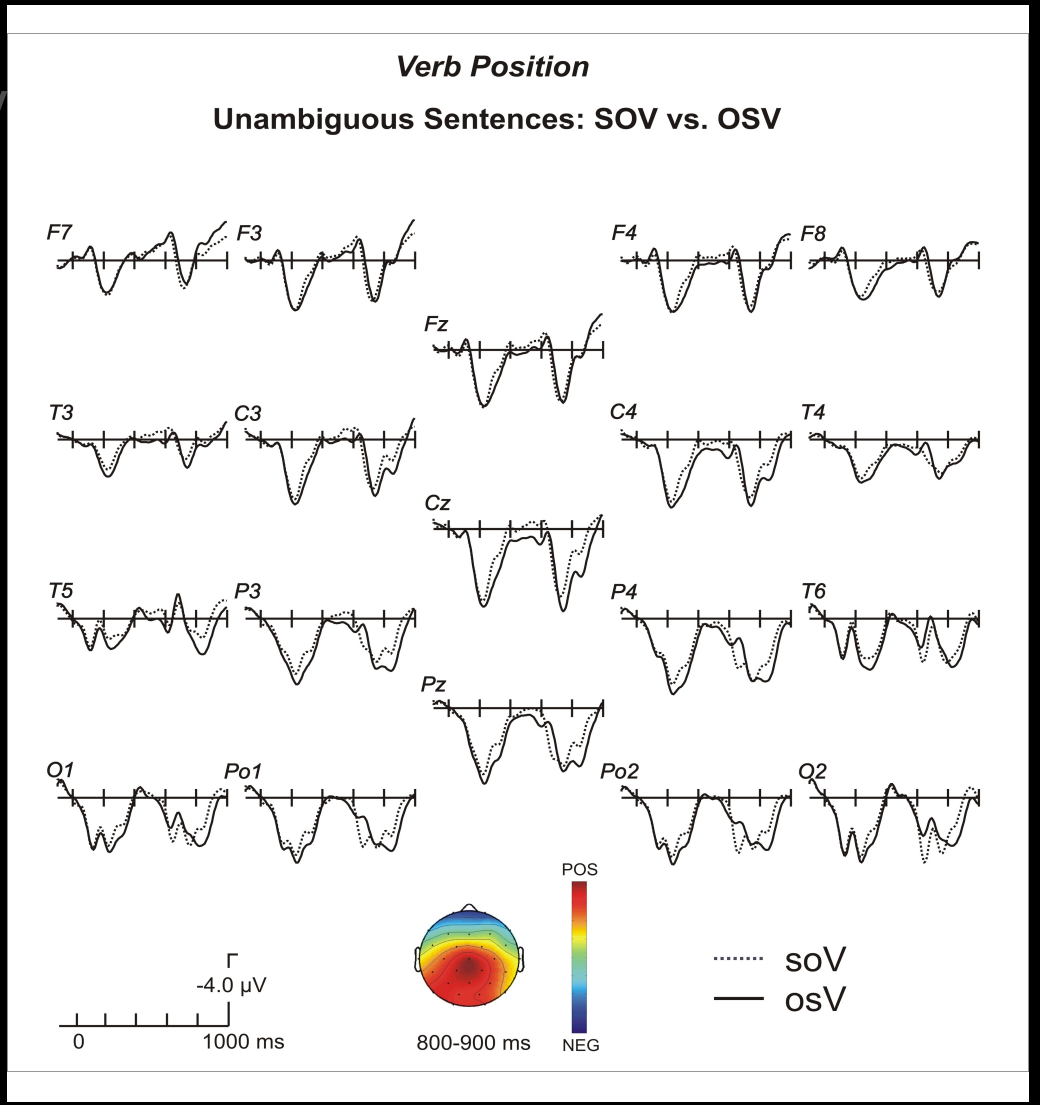
Early Left Anterior Negativity

Left Anterior Negativity

N400

P600

- Syntactic Violations
- Syntactic Reanalysis



Erdocia et al 2009

ERPs vs. Erreakzio Denborak

Seinalearen izaera multidimensionala

Seinalearen izeara kontinuoa

Ariketa extra beharrik ez

EEG pros & cons

-Prozesu kognitiboen gertaera denbora eta iraupena burmuin-ehunetan ikertzeko egokia

-Lokalizaziorako gabezia ugari

CONCLUSIONS

PREVIOUS RESEARCH ON WORD ORDER IN BASQUE

	Basic word order	Canonical word order
Most linguists:	SOV	SOV
Antisymmetrists:	SVO	SOV

Acquisition

Earliest acquired word order

SOV/SVO

BEHAVIORAL EXPERIMENTS

Experiment 1: In derived OSV a syntactic reanalysis process

Experiment 2: Ambiguous chains are processed like SOV sentences

Experiment 3: Verb-medial sentences didn't show differences indicating that they could be derived in Basque

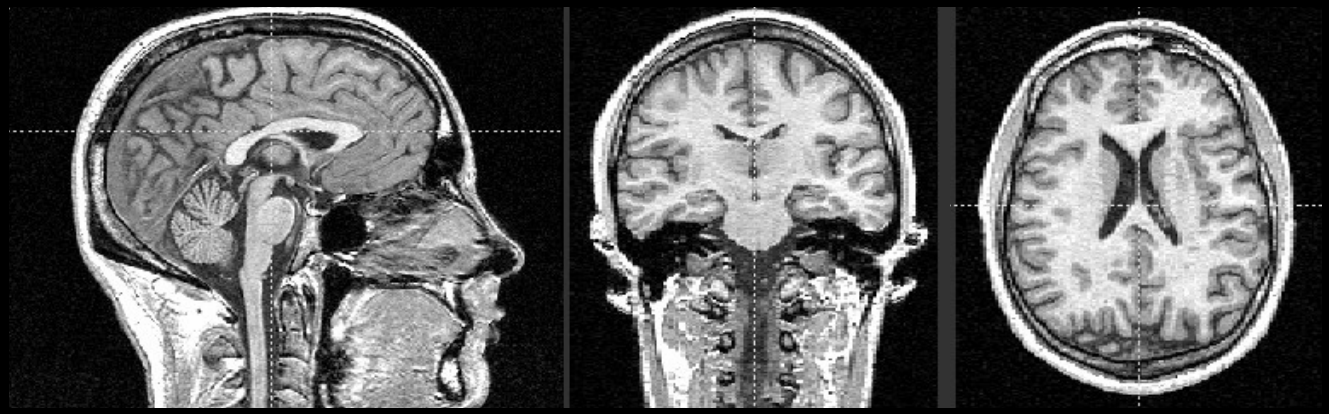
ERP EXPERIMENT

Ergatives and absolutives are processed differently, LAN/N400

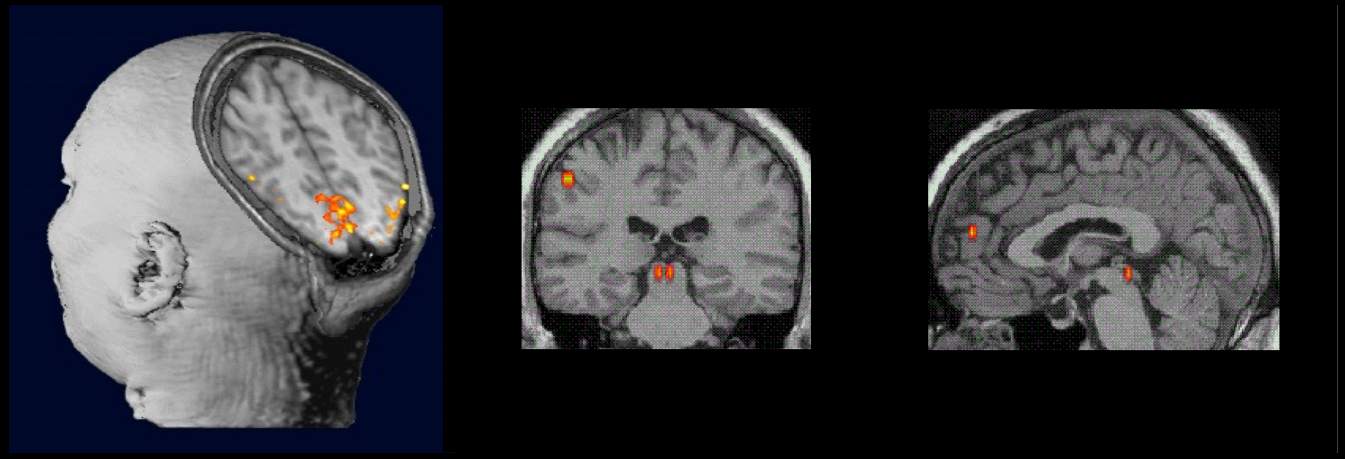
Verb position of derived OSV required a syntactic reanalysis, P600

Temporally ambiguous chains disambiguated by means of world knowledge and posterior syntactic reanalysis elicited a Frontal Negativity

functional Magnetic Resonance Imaging (fMRI)



MRI Images

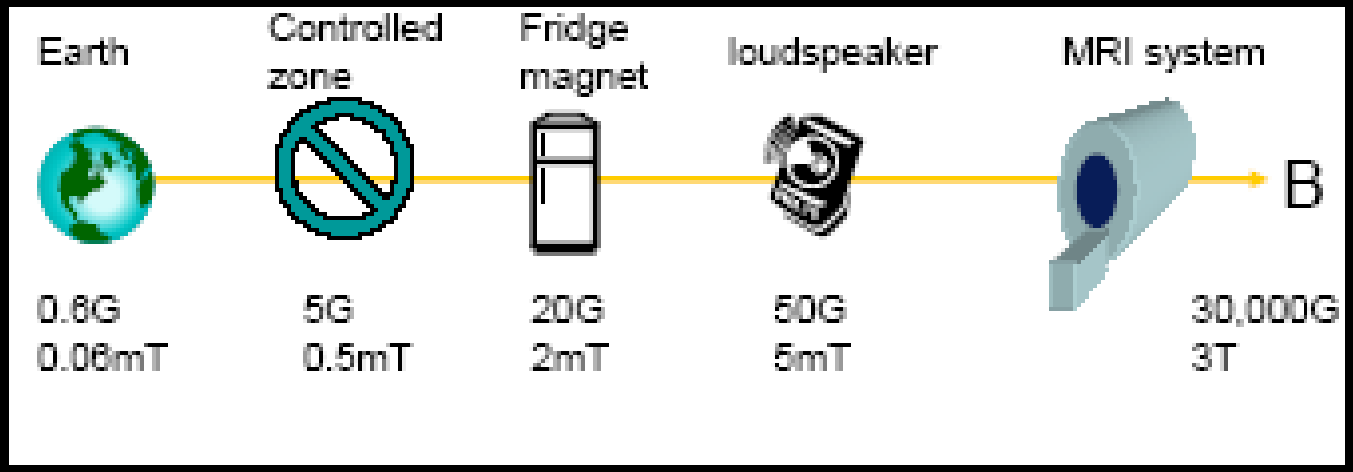


FMRI Image

Static magnetic fields

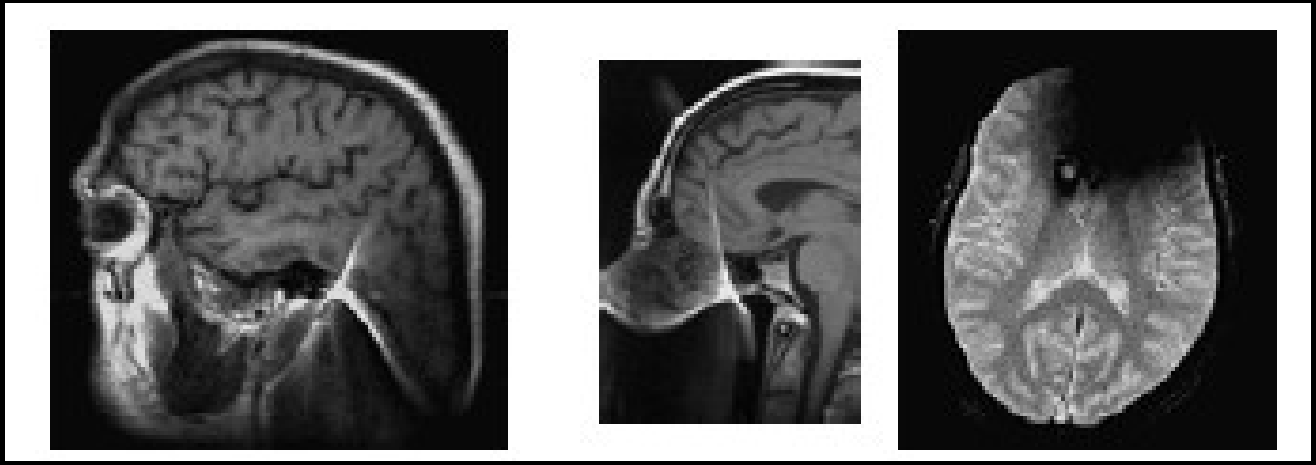
Units:

- Tesla – SI Unit of magnetic flux density
- Gauss – Old measure
- 1 Tesla = 10,000 Gauss



Artefaktoak

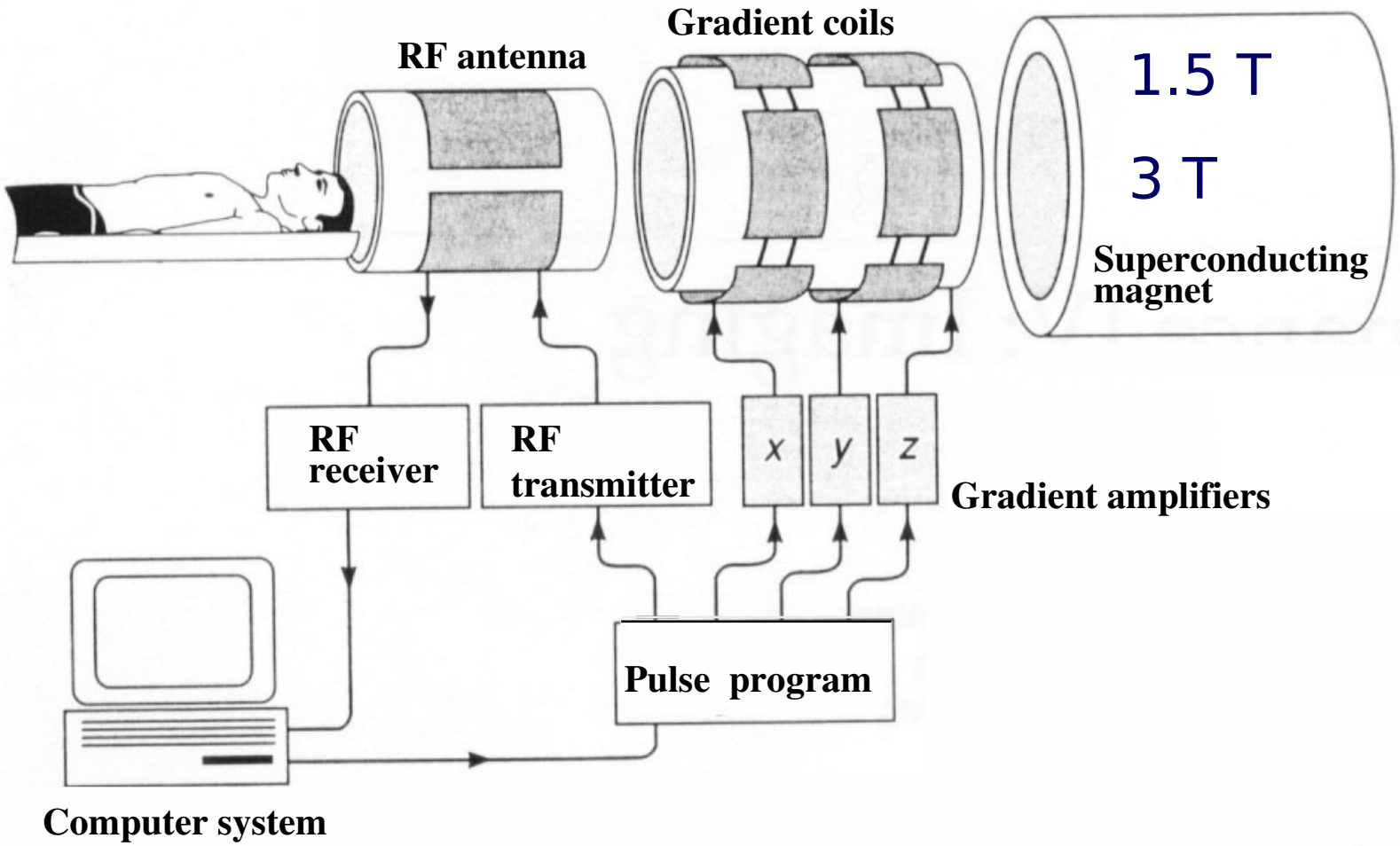
Objektu metalikoek eremu magnetikoa distorsionatzen dute eta irudien itxura deformatzen dute



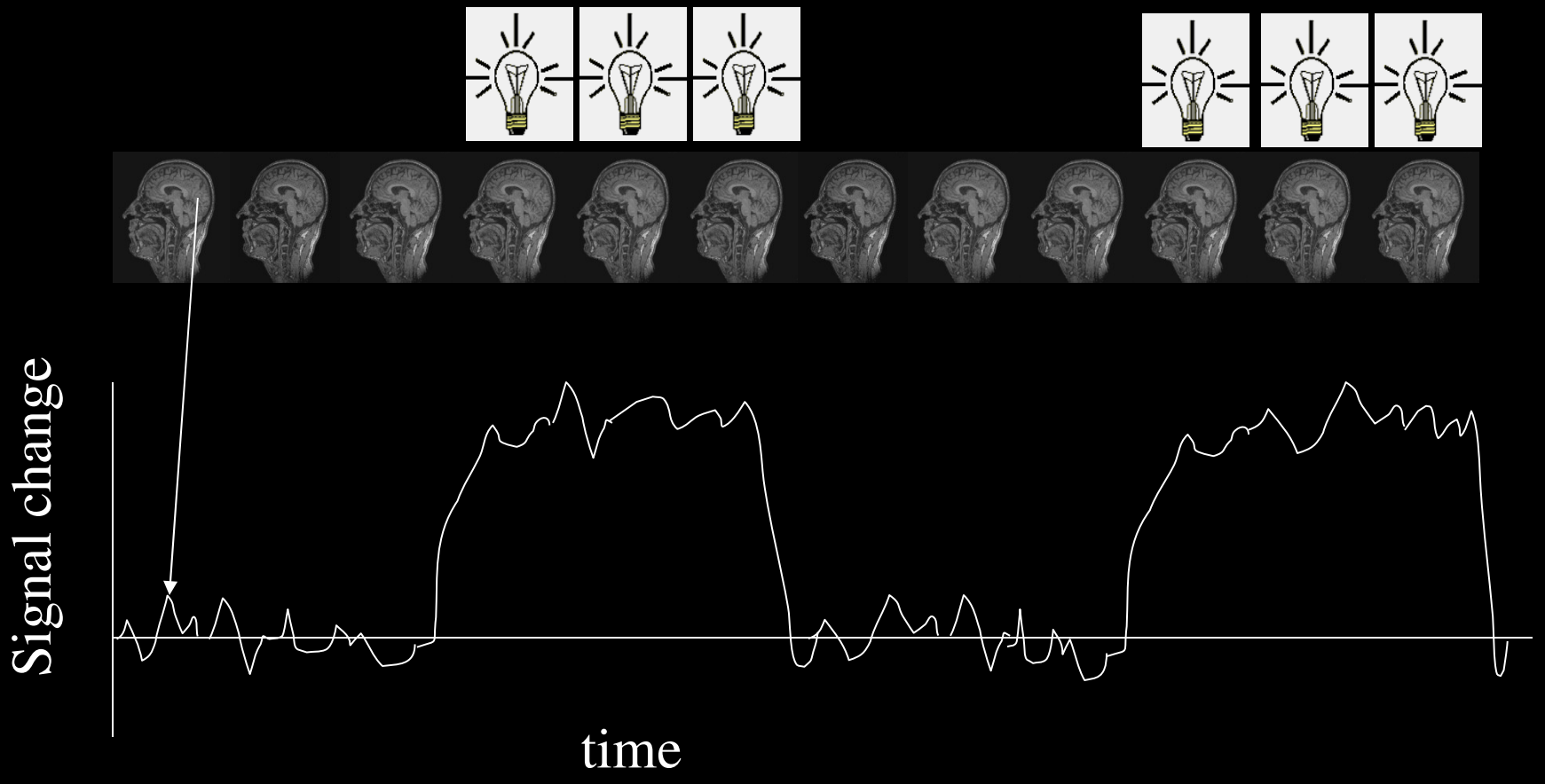
Hair grip

Dental metal work

MRI-scanner


RF antenna
Gradient coils
1.5 T
3 T
Superconducting magnet
RF receiver
RF transmitter
x
y
z
Gradient amplifiers
Pulse program
Computer system

The fMRI experiment



Imaging technique

Teknikaren baldintzak:

Azkartasuna: Burmuin osoa segundu gutxitan jasotzeko.

Sentikortasuna: Seinale aldaketak txikiak dira, batez ere kortex oinarrizkoetan.

Zehaztasuna: Irudiek benetako objektuaren (burmuinaren) irudia eman behar dute.

Zer da BOLD?

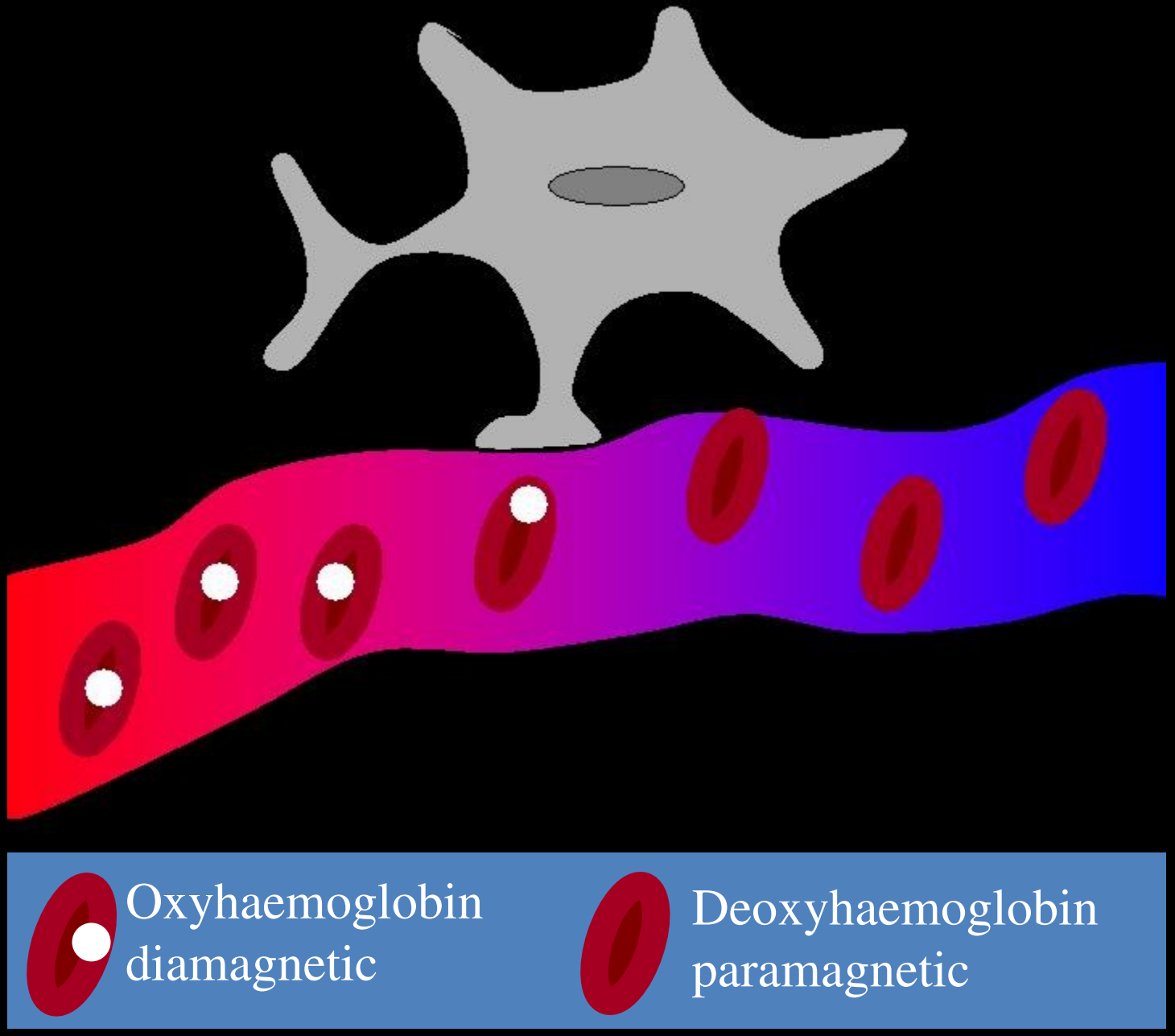
-Burmuineko zelulek oxigenoa behar dute

-Oxigenoa hemoglobinak garraiatzen du odol zainetatik.

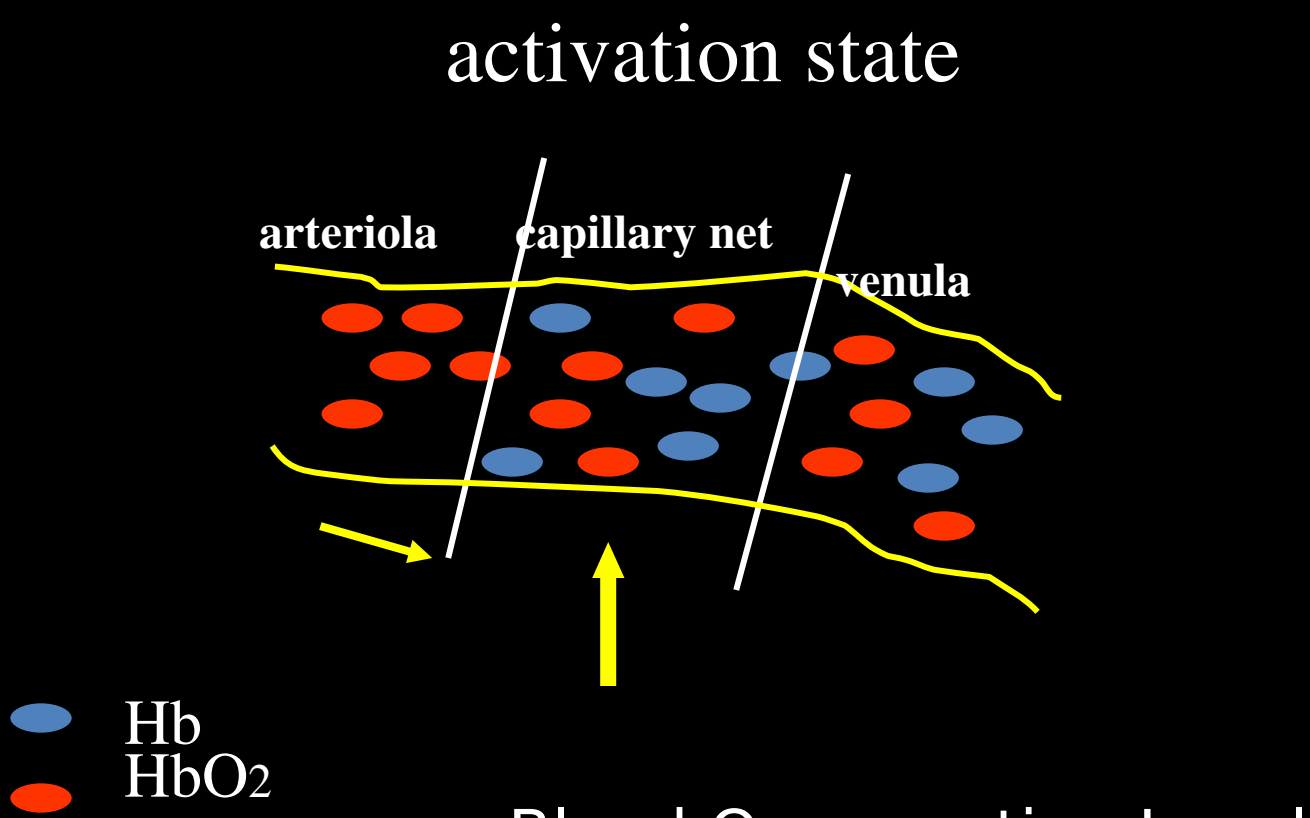
-MRI teknika deoxyhemoglobinarekiko sentibera da

-Burmuina aktibatuta dagoen bitartean odoleko deoxihemoglobinaren maila aldatu egiten da

Zer da BOLD?

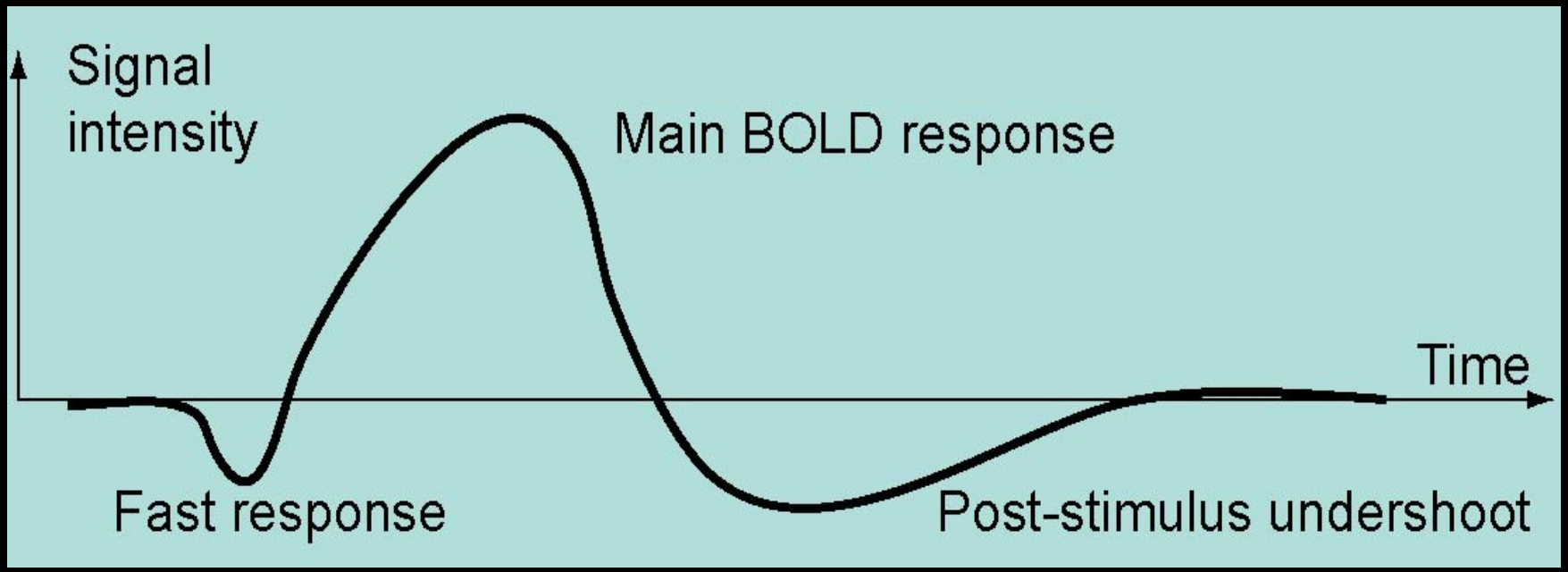

Oxyhaemoglobin
diamagnetic
Deoxyhaemoglobin
paramagnetic

fMRI-BOLD technique



BOLD seinalearen hiru osagaiak denboran zehar:

Haemodynamic response function (HRF)



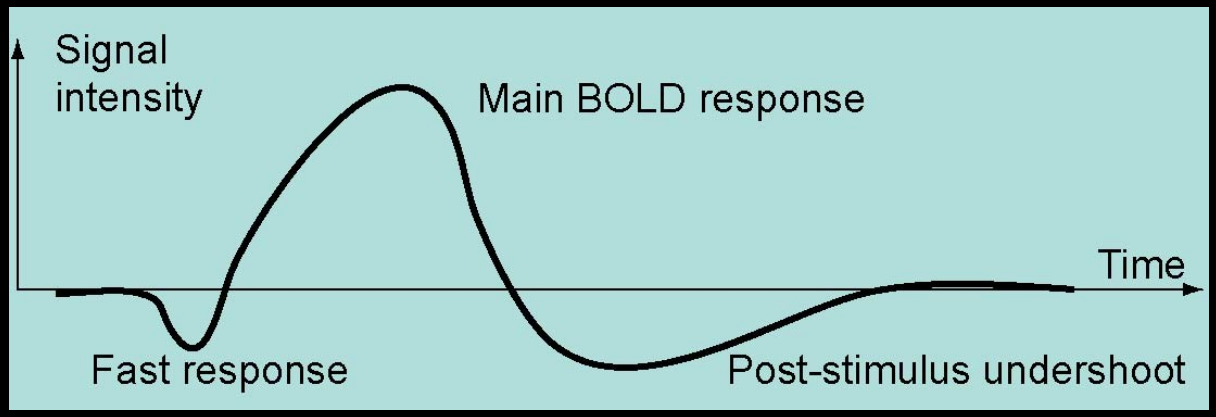
Fast Response: Initial Dip

-Metabolismoaren oxigeno kontsumoa handitzen odol isuria iritsi aurretik

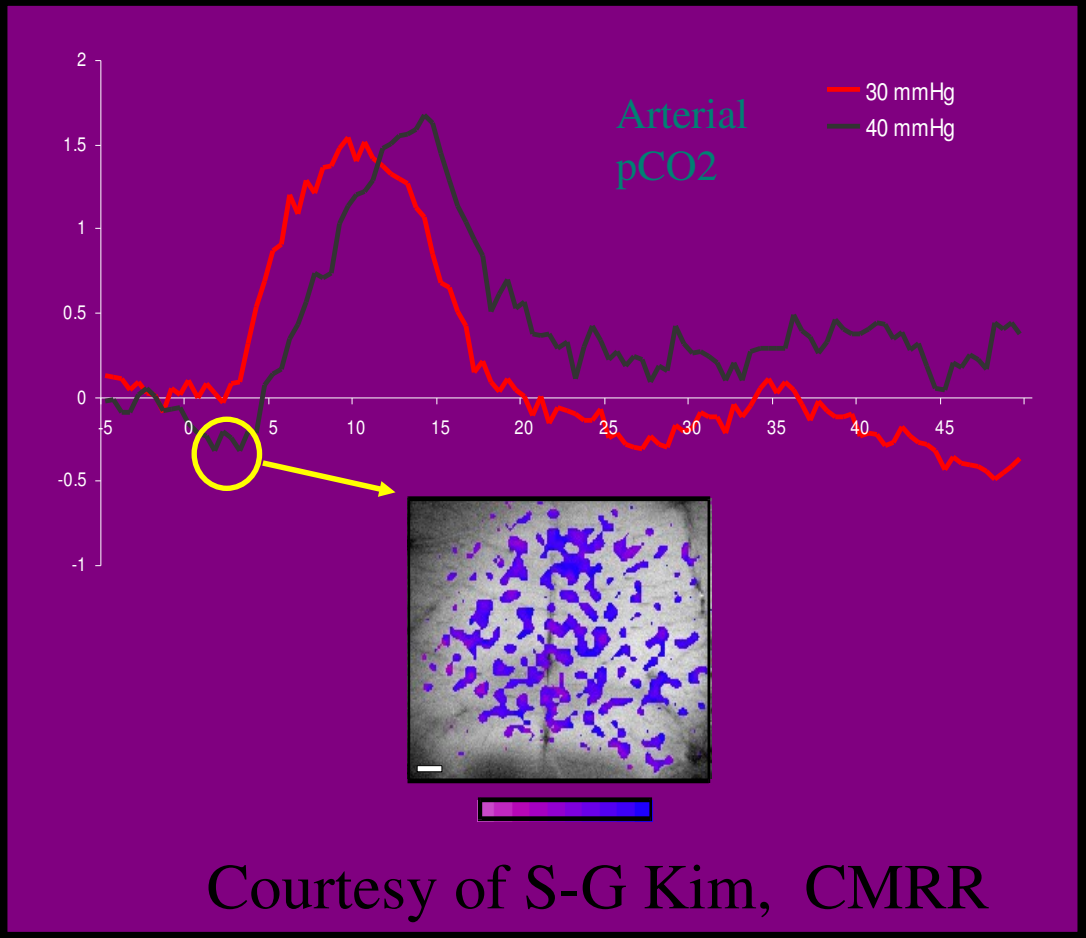
-Oso zaila da detektatzen 4T baino beheragotik

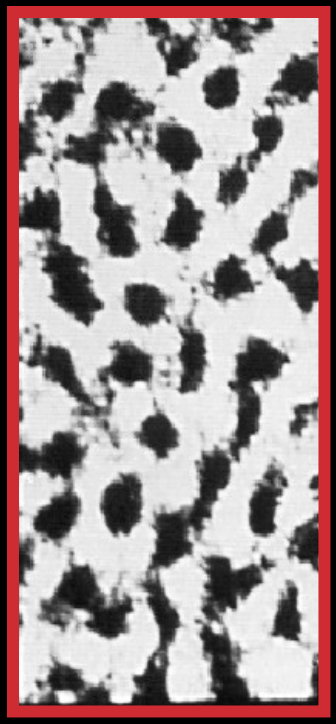
-Pikoa, estimulazioa gertatu eta 1-2 segundu beranduago

-Erresoluzio espazial handia (0.5 mm)



The Fast Response at 4.7T
Can Distinguish the Orientation Columns in the Cat Visual Cortex





(Frostig *et al.*)

Size of columns = ~0.5 mm

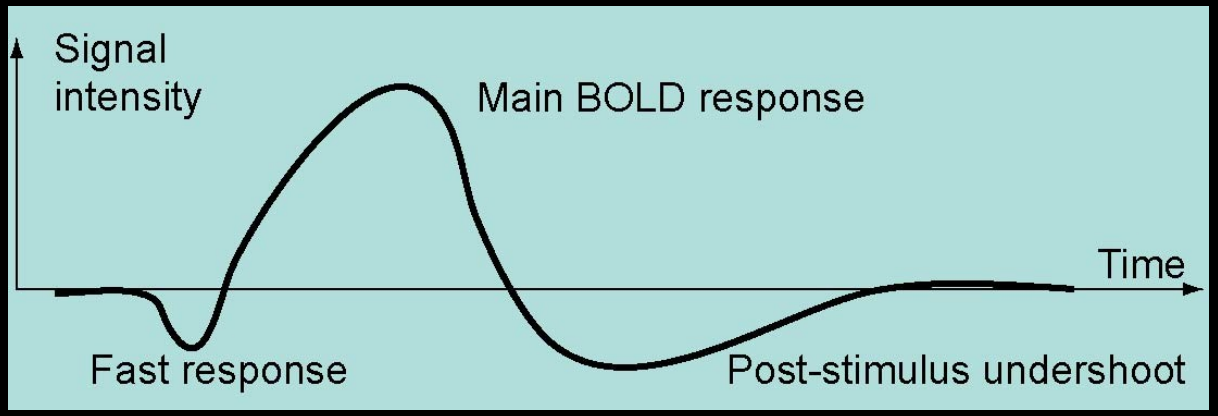
The Main BOLD Response

-Odol isuriaren handitzeagatik gertatzen da

-Erraz ikus daiteke 1.5T makinarekin

Pikoak estimulazioa gertatu eta 6-8 segundu beranduago

Zainen seinaleagatik erresoluzio espazial mugatua (3-5 mm 1.5T)

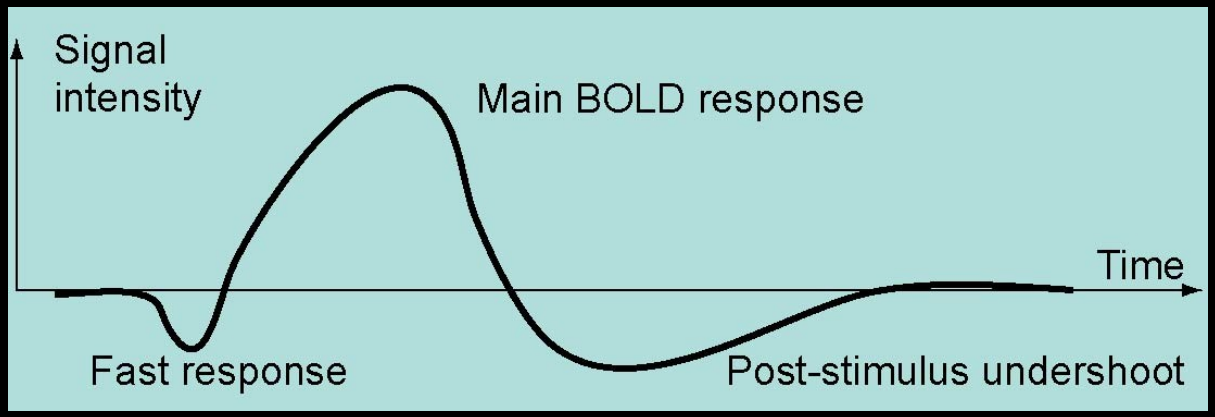


The Post-stimulus Undershoot

-Odol bolumena linea-basera itzultzen da poliki

-Erraz ikus daitekeen efektua da

-40 segundu behar dira linea-basera itzultzeko



fMRI – pros & cons

-Erresoluzio espazial bikaina

-Aldaketa kuantitatiboak esparru jakinetan

-Teknika Globalak (neural network)

-Erresoluzio tenporal eskasa

-Scannerra oso zaratatsua

-Tokia mugatua magnetoaren barnean

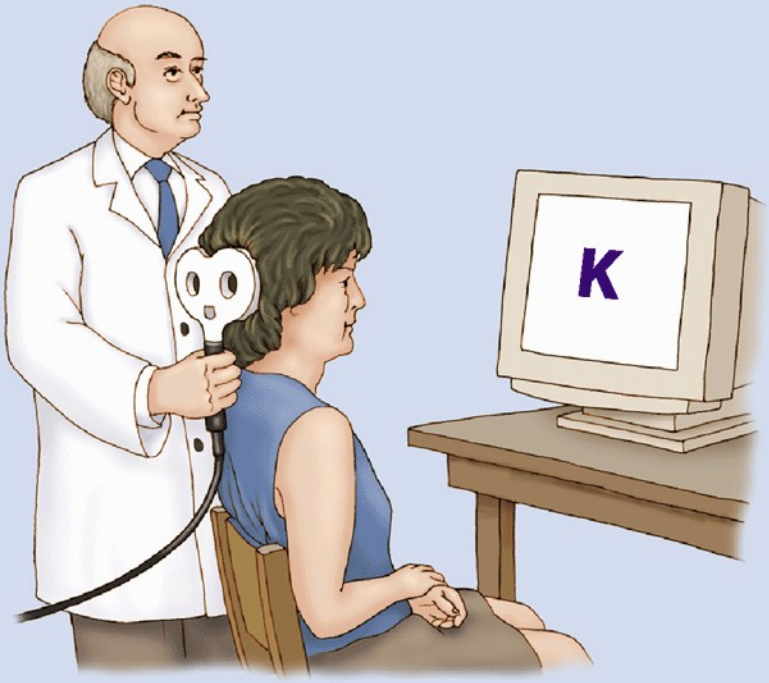
Transcranial magnetic stimulation (TMS)

Disrupt neural function in a selected region of human cortex – comparable to invasive animal experiments

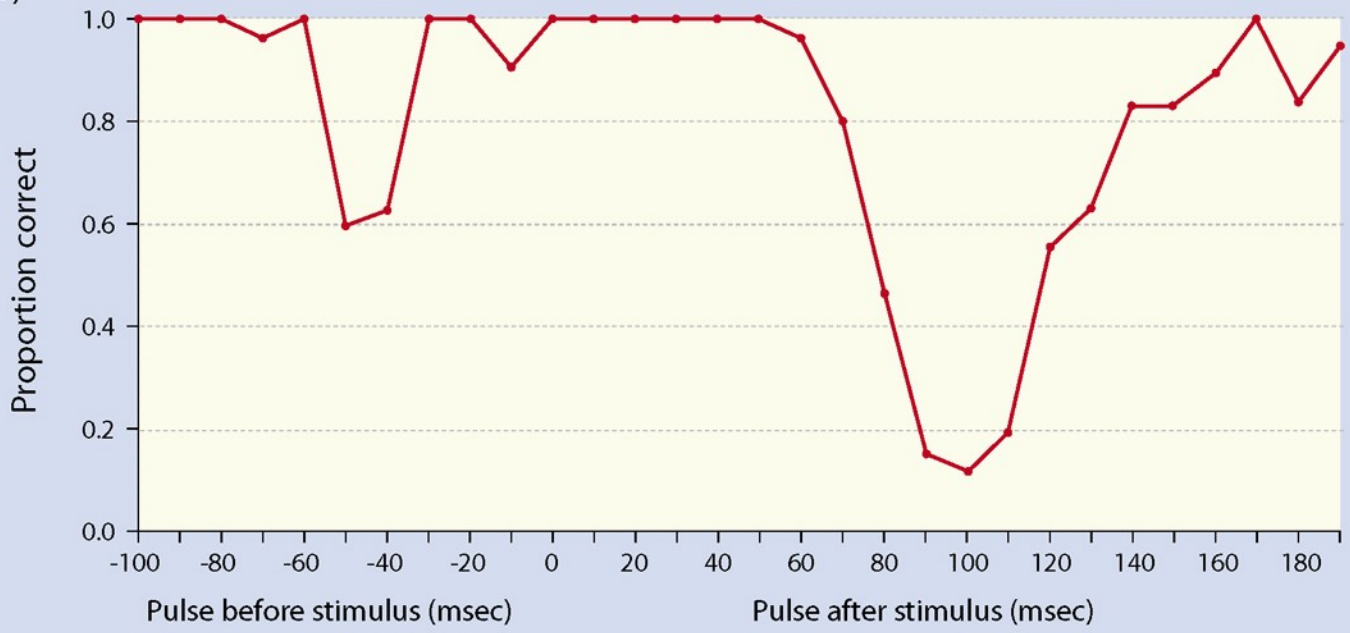
Safe and non-invasive

Used in neurologically healthy individuals (avoids confounds associated with brain injured patients)

(a)


K

(b)


Proportion correct
1.0
0.8
0.6
0.4
0.2
0.0
-100
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
Pulse before stimulus (msec)
Pulse after stimulus (msec)

Transcranial magnetic stimulation

- not a correlational procedure
- momentarily disrupts brain activity
- Informative both in time and location

Disadvantages:

- stimulation effects brief
- unsuitable for tasks with lengthy processing
- restricted area of cortex
- not suitable for deep structures

Artificial Grammar Learning and Syntactic Movement: a review

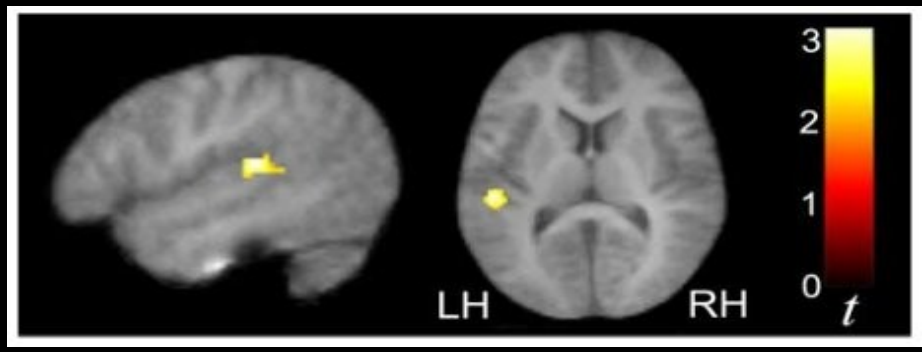
Language learning processes and strategies in an artificial language

SEGMENTING WORDS FROM A STRING

Saffran et al. 1996 → Transitional Probability. 8 m.o. babies, 2 min. of training

1. "pabikudaropitibudogolatudaropipabiku..."
2. "pofimubafuginovukavikogabafugiviko..."
3. "manutonimoluvorifaliduranimolulidura..."

McNealy et al. 2006 →



NON-HUMAN SPECIES LEARNING LANGUAGE

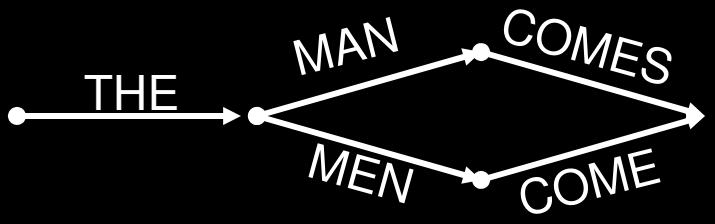


1. "pabikudaropitibudogolatudaropipabiku..."
2. "pofimubafuginovukavikogabafugiviko..."
3. "manutonimoluvorifaliduranimolulidura..."

HUMAN GRAMMARS CLASIFICATION

Chomsky 1957

Finite State Grammars



Phrase Structure Grammars

Sentence → NP + VP

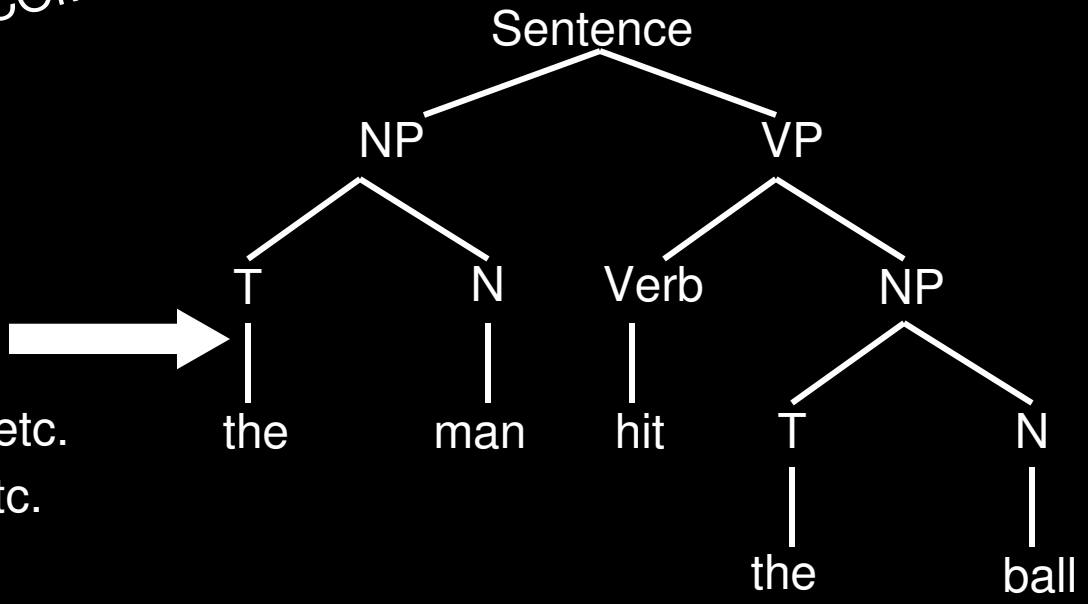
NP → T + NP

VP → Verb + NP

T → the

N → man, ball, etc.

Verb → hit, took, etc.



Transformational Grammars

Transformational Rule: Put the WH-word at the begining of the sentence

The man hit the ball → What did the man hit __ ?

WORKS ON ARTIFICIAL LANGUAGES

Moro et al 2001 Tettamanti et al 2002 Musso et al 2003 Friederici et al 2006

PREVIOUS WORKS ON ARTIFICIAL LANGUAGES

Moro et al 2001 Tettamanti et al 2002 Musso et al 2003 Friederici et al 2006

NO OPEN-CLASS WORDS

NONWORDS in order to neutralize the access to semantic component

INFLECTIONS AND FUNCTION WORDS OF ITALIAN

FUNCTIONAL WORDS (art., aux., prep., pl., etc.) fully preserved

BASELINE

"Il gulco gianigeva le brale."

Dm/sing Nm/sing V- AGR/T3rd sing Df/plur Nf/plur

PHONOLOGICAL ANOMALIES: Italian illegal consonant strings

* "Il gulco gianigzleva le brale."

MORPHOSYNTACTIC ANOMALIES: Agreement errors

* "Il gulco ha gianigiata questo bralo."

SYNTACTIC ANOMALIES: Wrong linear order

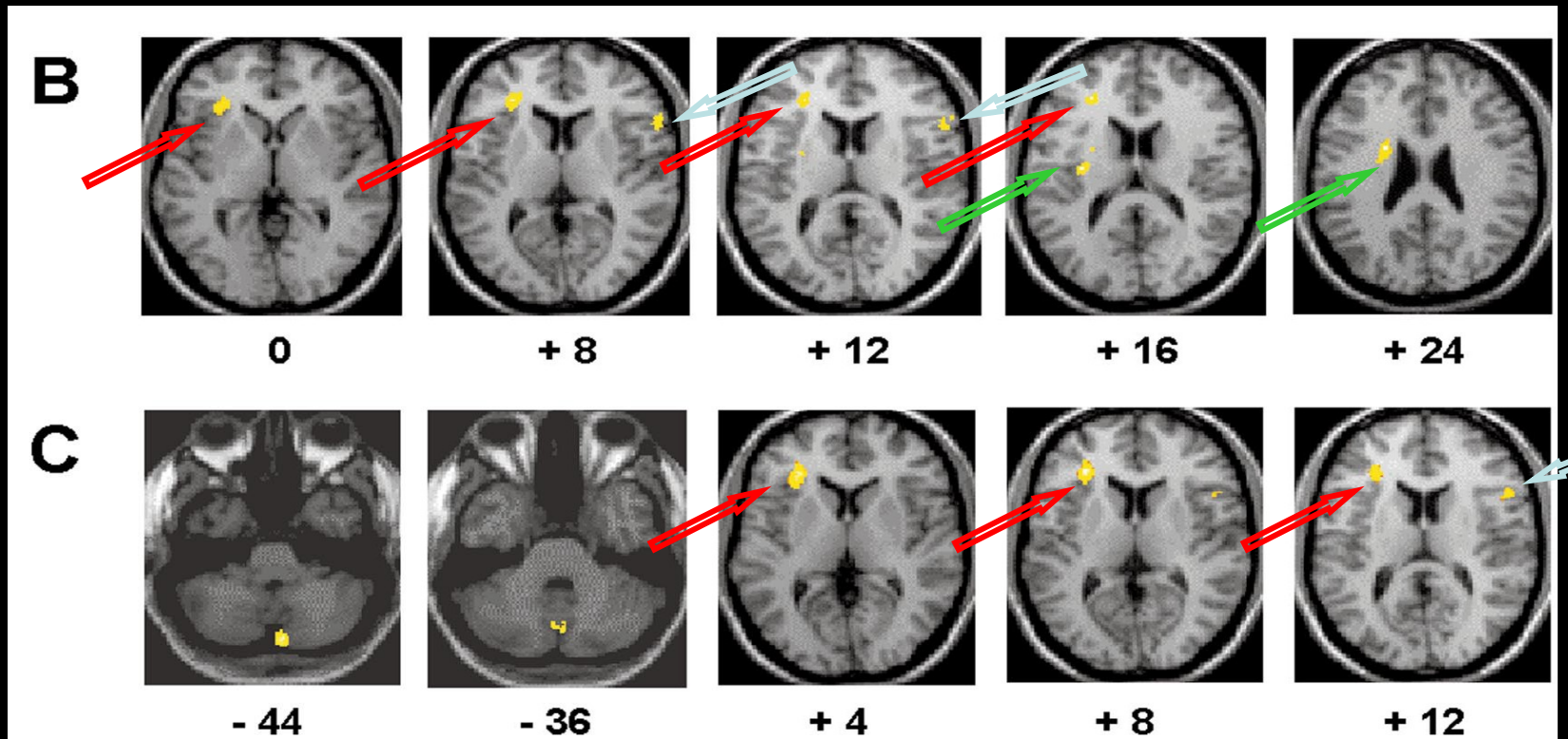
* "Gulco il gianigeva le brale."

PREVIOUS WORKS ON ARTIFICIAL LANGUAGES

Moro et al 2001 Tettamanti et al 2002 Musso et al 2003 Friederici et al 2006

Syntactic and Morphosyntactic processing detected in deep component of Broca's area and in right inferior frontal region

Only for Syntactic processing: Left caudate nucleus and insula



PREVIOUS WORKS ON ARTIFICIAL LANGUAGES

Moro et al 2001 **Tettamanti et al 2002** Musso et al 2003 Friederici et al 2006

✓ GRAMMATICAL RULES (G)

Hierarchical phrase structure.

G-RULE: The article immediately follows the noun it refers to.

✓ NONGRAMMATICAL RULES (NG)

Absolute position of some element within the linear sequence of words.

NG-RULE: Articles immediately follow the second word in the sentence

PREVIOUS WORKS ON ARTIFICIAL LANGUAGES

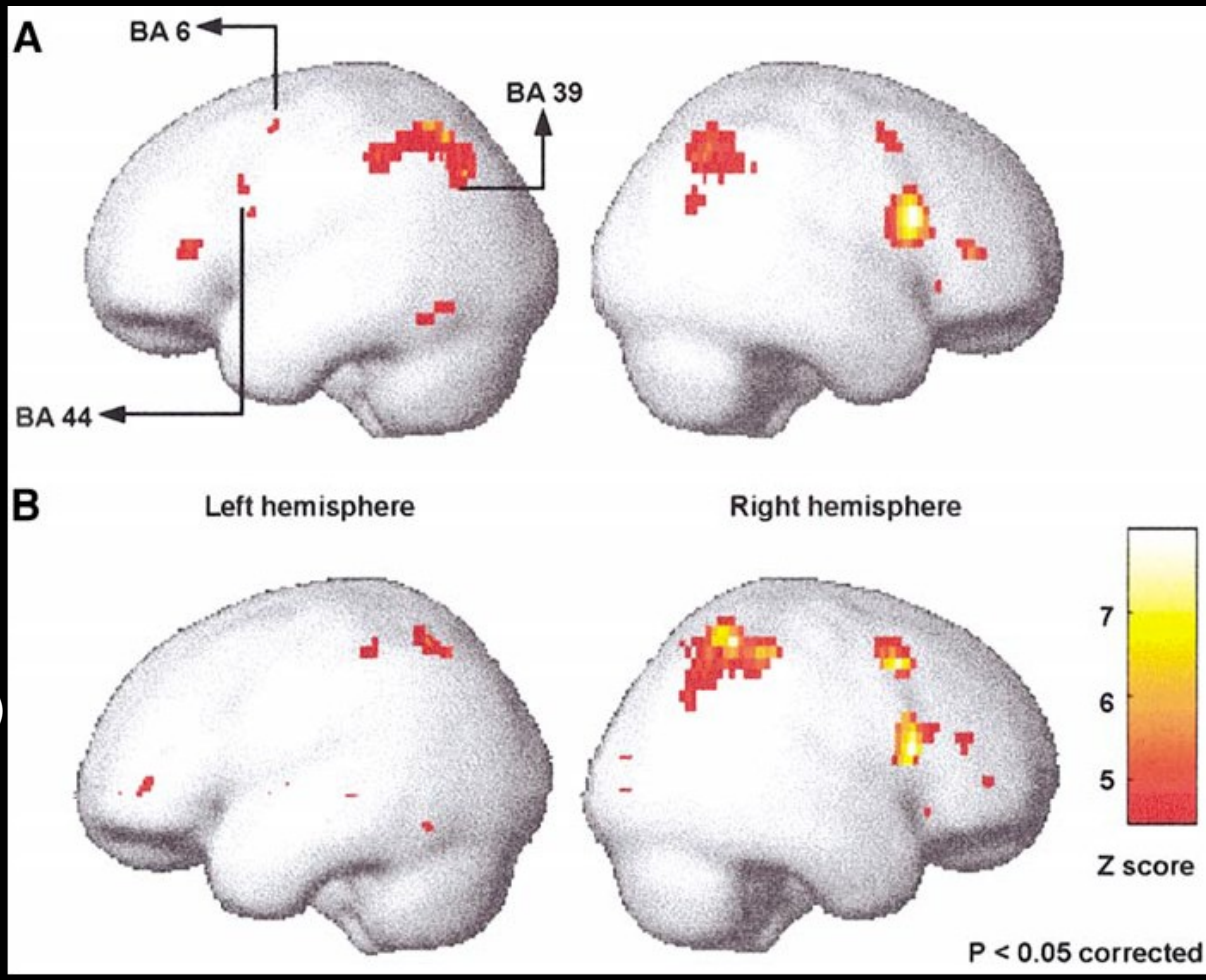
Moro et al 2001 **Tettamanti et al 2002** Musso et al 2003 Friederici et al 2006

Grammatical rules

Opercular portion of Broca (BA 44)
Left Dorsal Premotor area (BA 6)
Left Angular Gyrus (BA 39)

NonGrammatical rules

Right Middle Frontal Gyrus (BA 46)
Right Superior Parietal Lobule (BA 7)



PREVIOUS WORKS ON ARTIFICIAL LANGUAGES

Moro et al 2001 Tettamanti et al 2002 **Musso et al 2003** Friederici et al 2006

3 rules of real and 3 rules of unreal Italian

Real Italian: Hierarchical relations

Unreal Italian: Lineal order of words

3 rules of real and 3 rules of unreal Japanese

Real Japanese: Hierarchical relations

Unreal Japanese: Lineal order of words

PREVIOUS WORKS ON ARTIFICIAL LANGUAGES

ettamanti et al 2002 **Musso et al 2003** Friederici et al 2006

[–45, 21, 6] Italian experiment (yellow)
[–45, 33, 3] Japanese experiement (red)

Specific activation in Broca's area for 'real' language acquisition only, independent of the language type

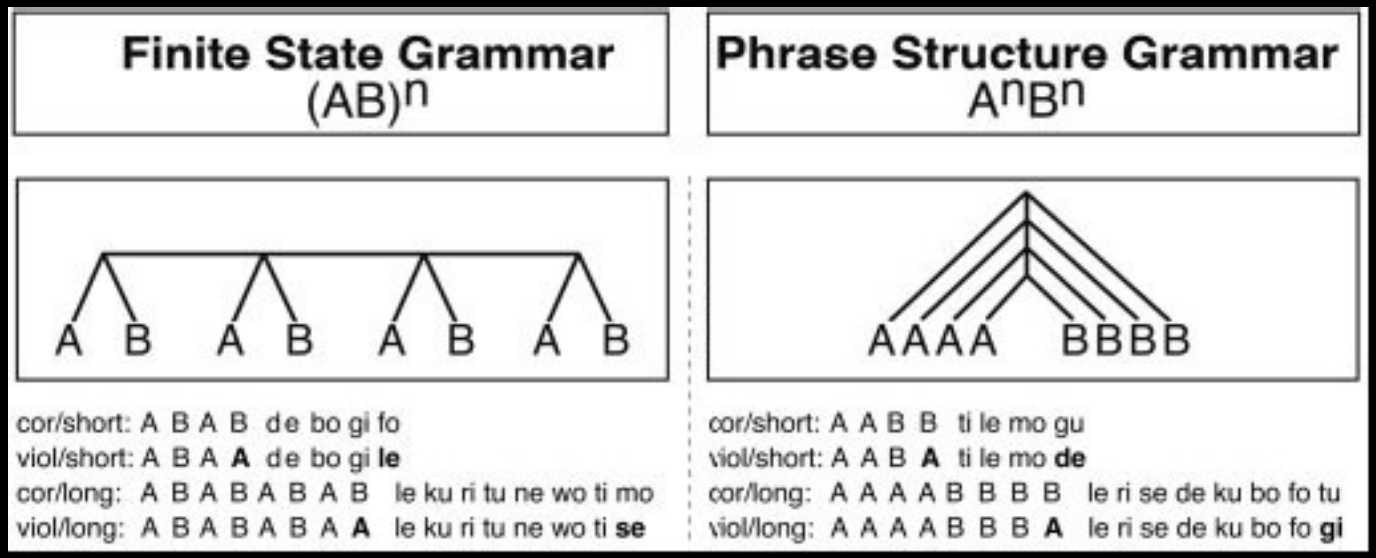
Red Real vs Unreal Japanese

Yellow Real vs Unreal Italian

PREVIOUS WORKS ON ARTIFICIAL LANGUAGES

Moro et al 2001 Tettamanti et al 2002 Musso et al 2003 **Friederici et al 2006**

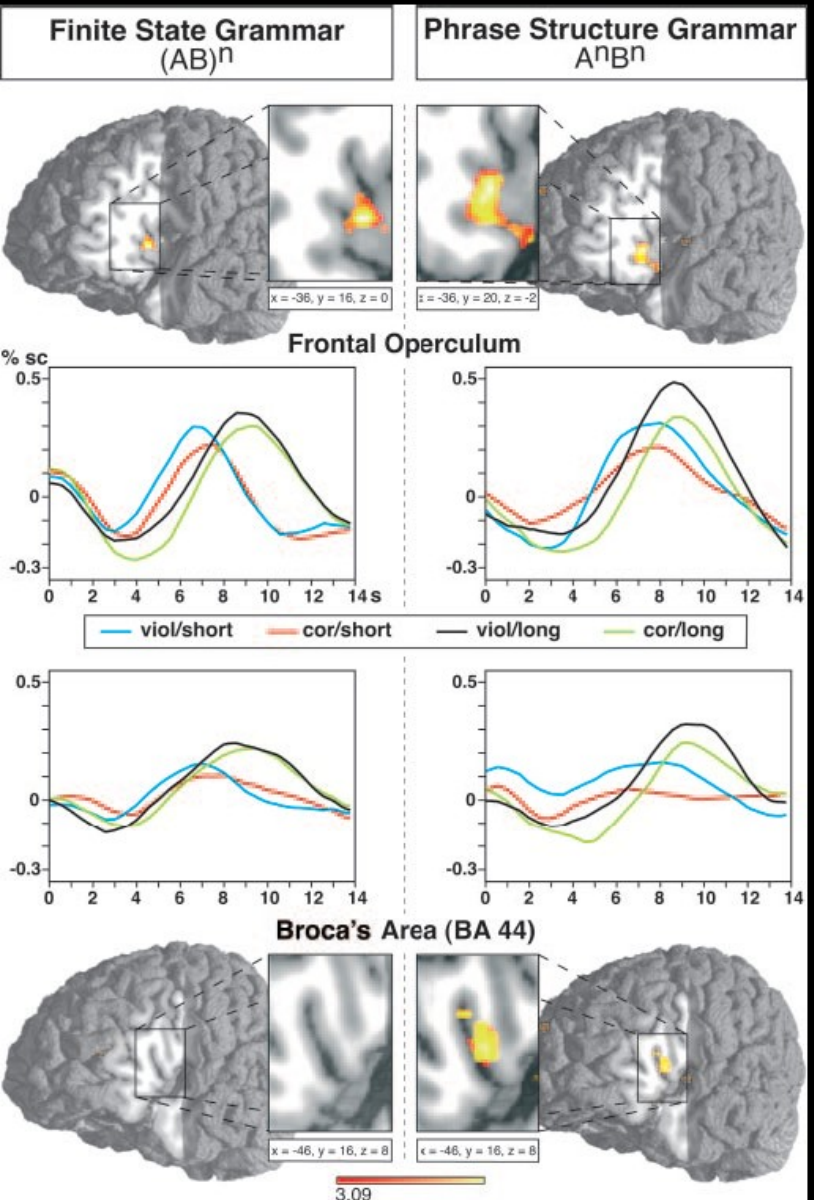
Two grammars were created to compare local probabilities (FSG) and hierarchical structures (PSG)



The weakest rule system capable to generate infinite sets of sequences.

PSG can create complex hierarchical structures and long distance dependencies.

PREVIOUS WORKS ON ARTIFICIAL LANGUAGES



2002 Musso et al 2003 **Friederici et al 2006**

FOP: activation for both grammars

BROCA: Activation only for PSG

HUMAN GRAMMARS CLASIFICATION

Finite State Grammars

Fitch & Hauser 2004

Phrase Structure Grammars

European starling

Gentner et al. 2006

Transformational Grammars

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