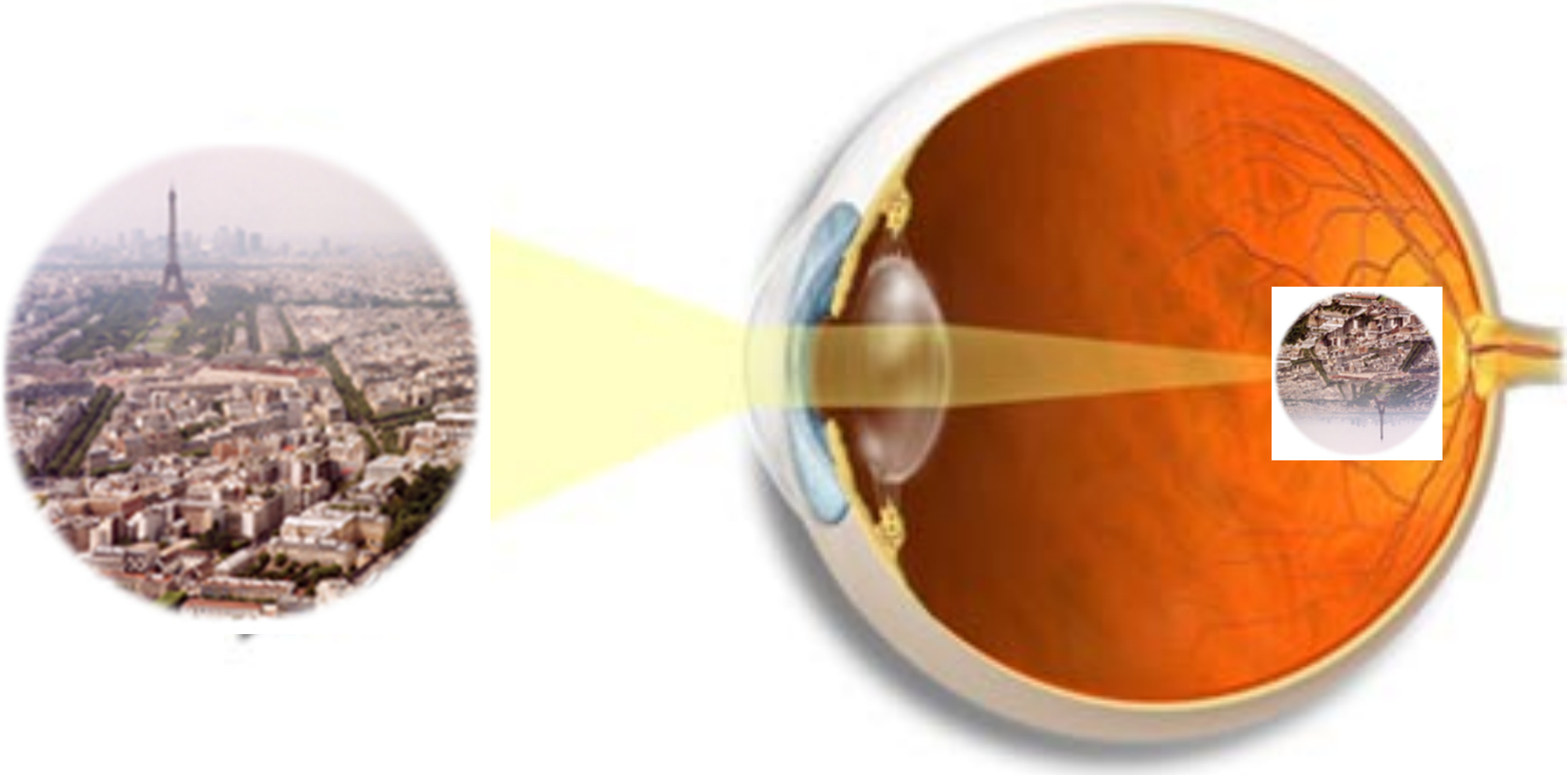
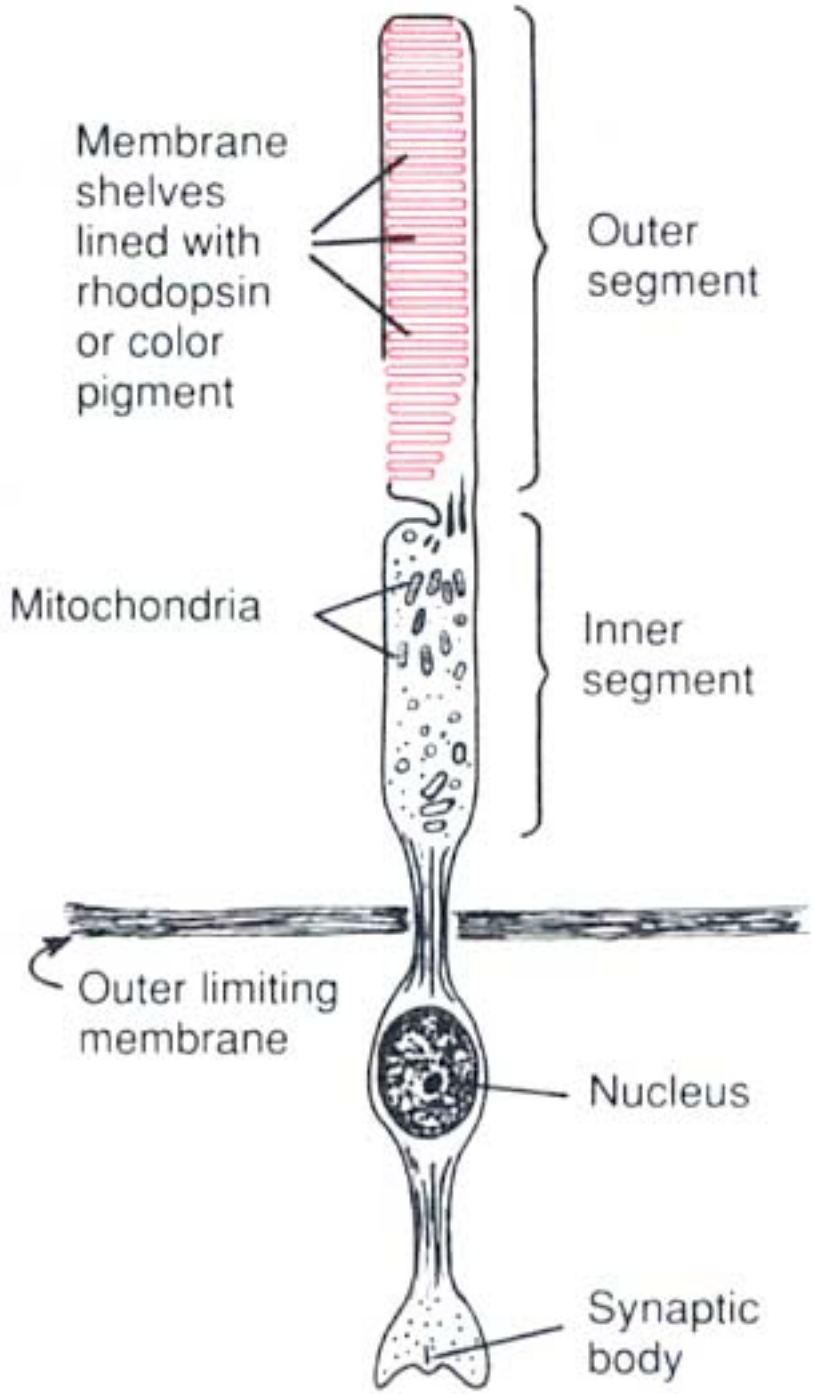
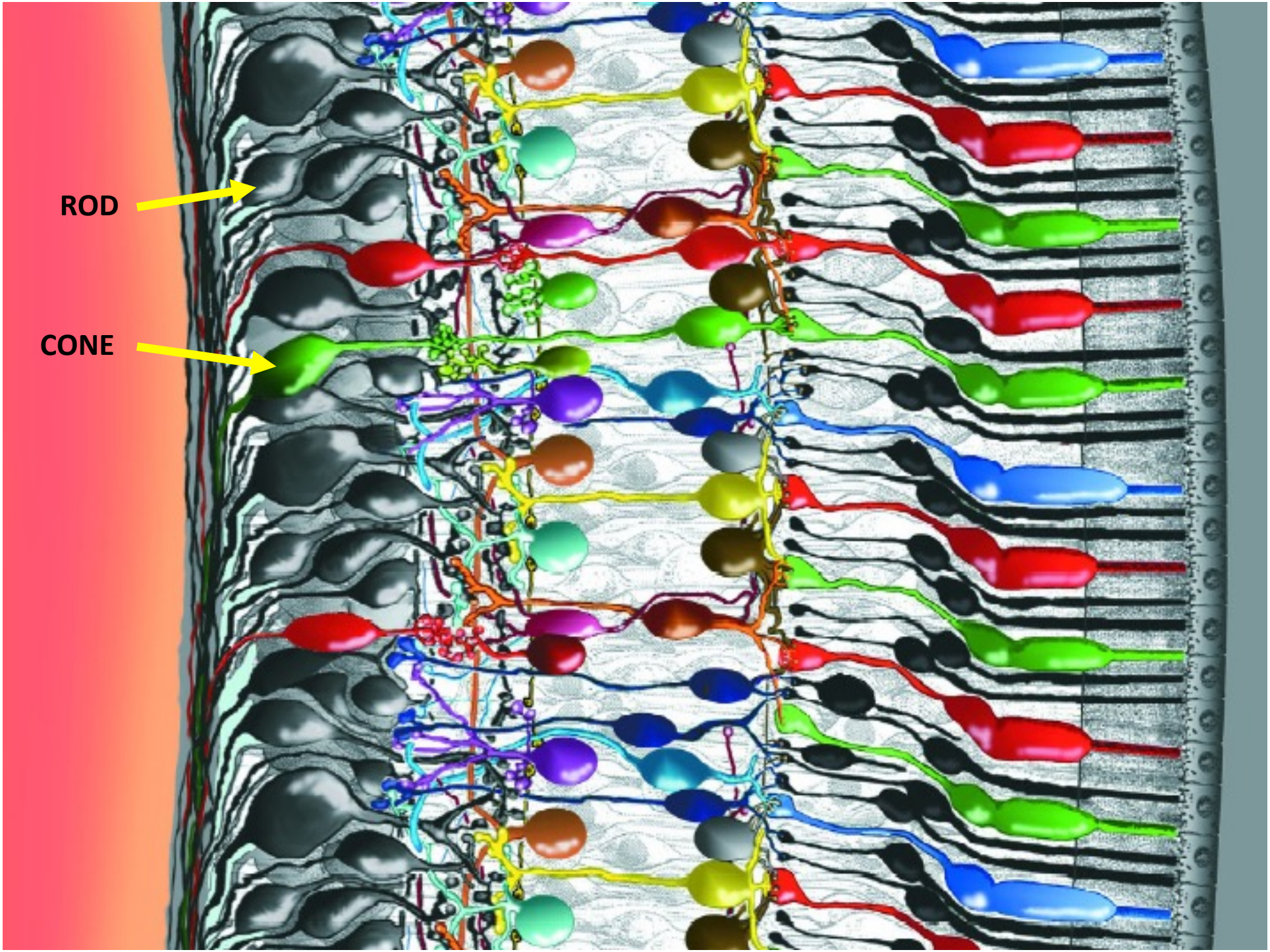
Vision

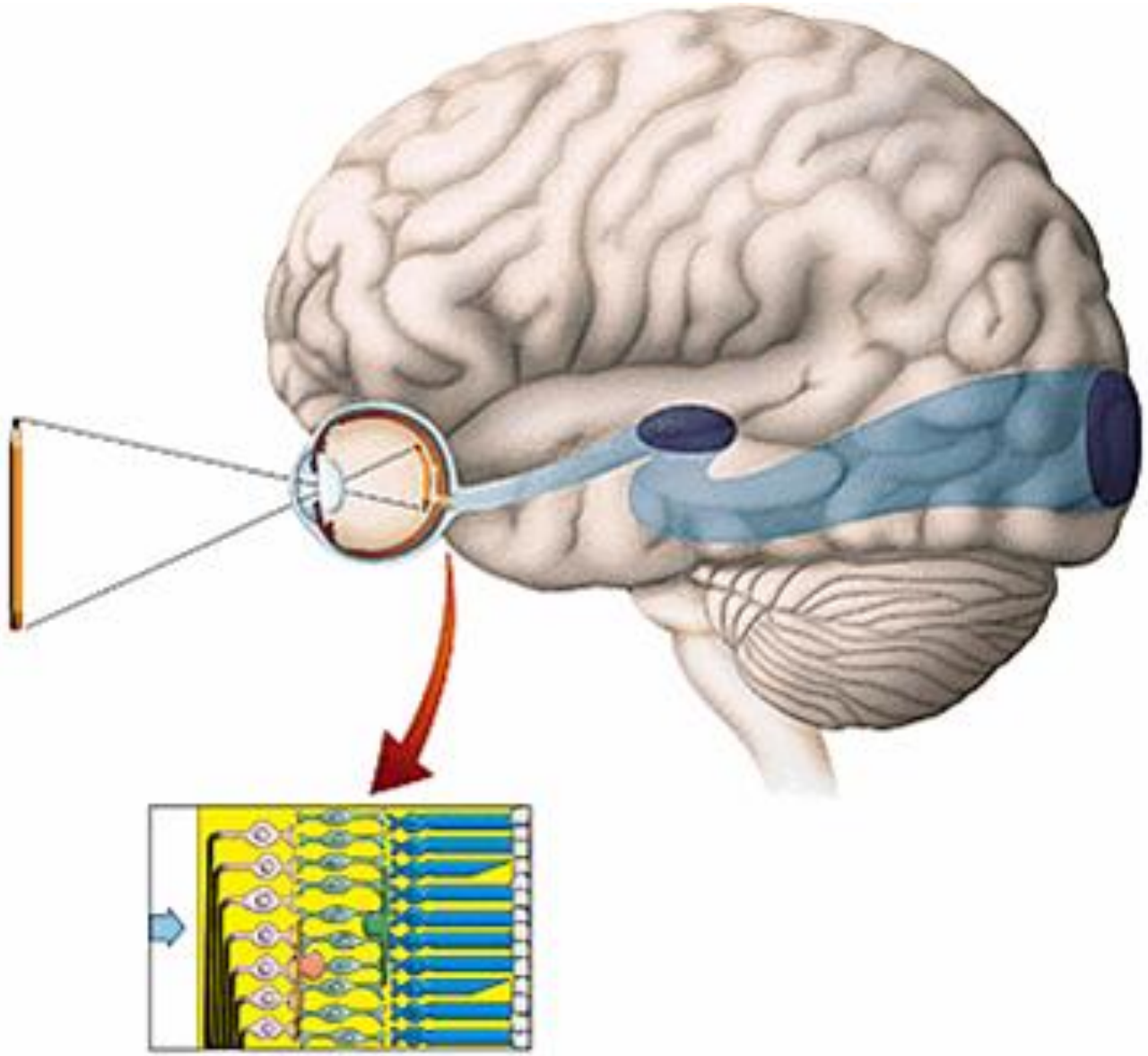
Lesson 4

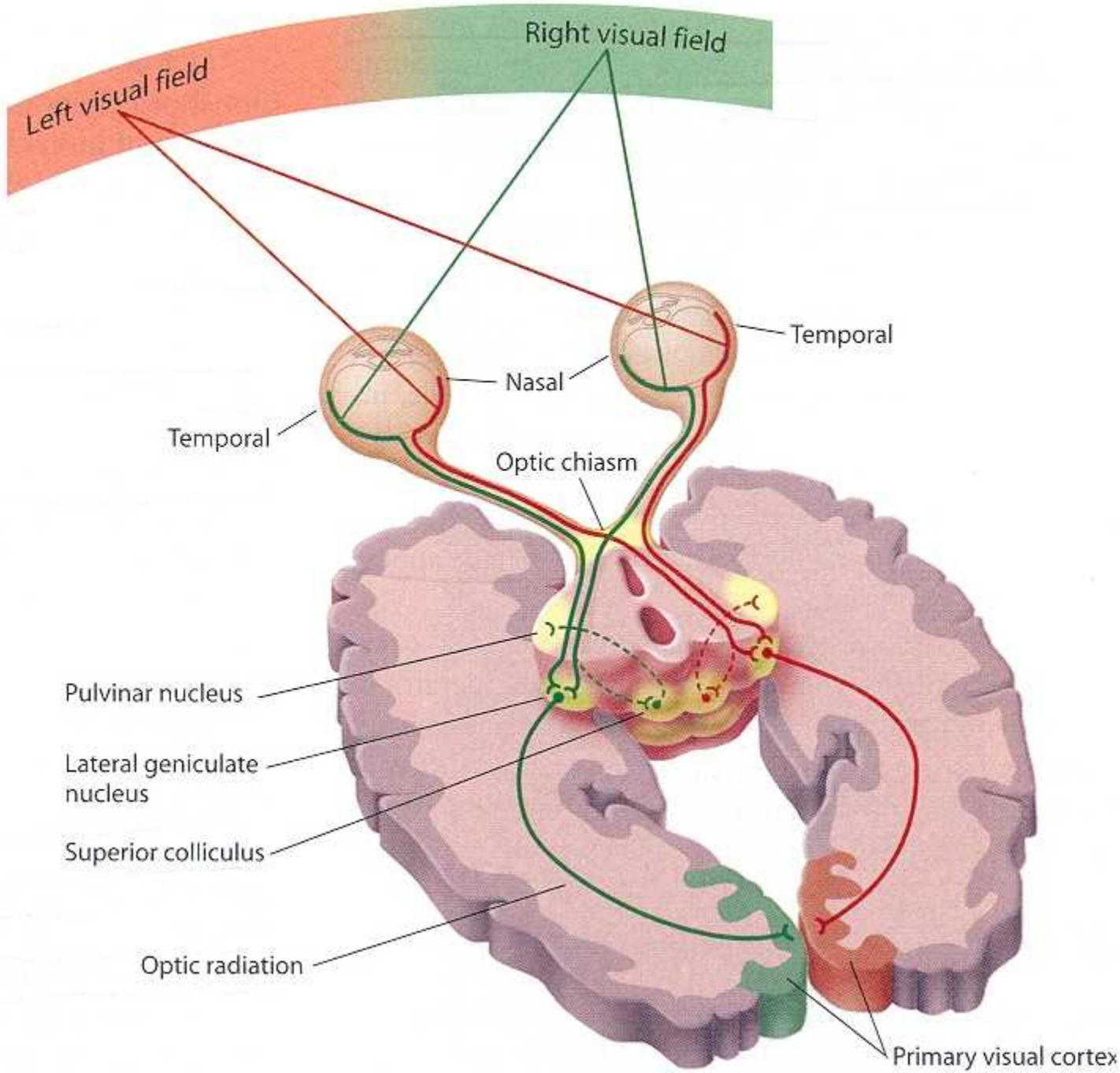
Neuroscience 100

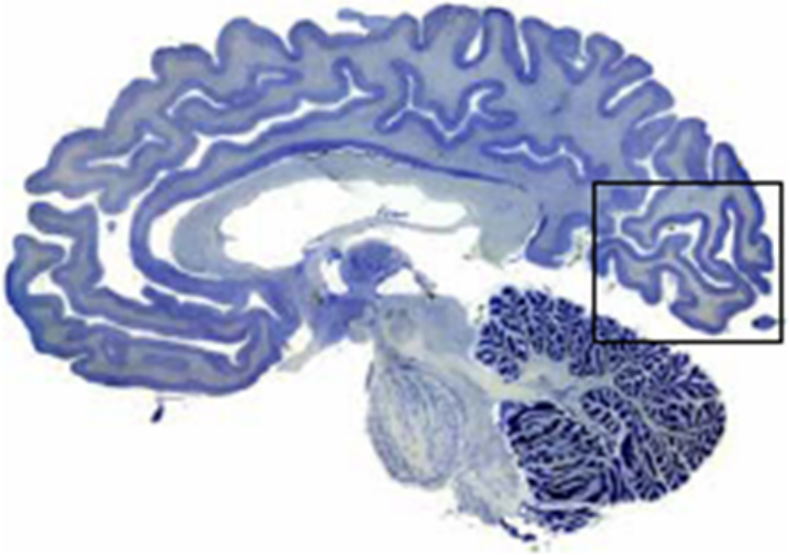


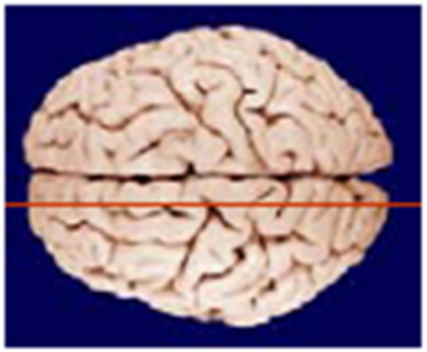

Membrane shelves lined with rhodopsin or color pigment
Outer segment
Mitochondria
Inner segment
Outer limiting membrane
Nucleus
Synaptic body

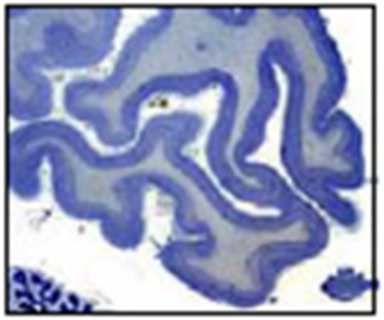

ROD
CONE



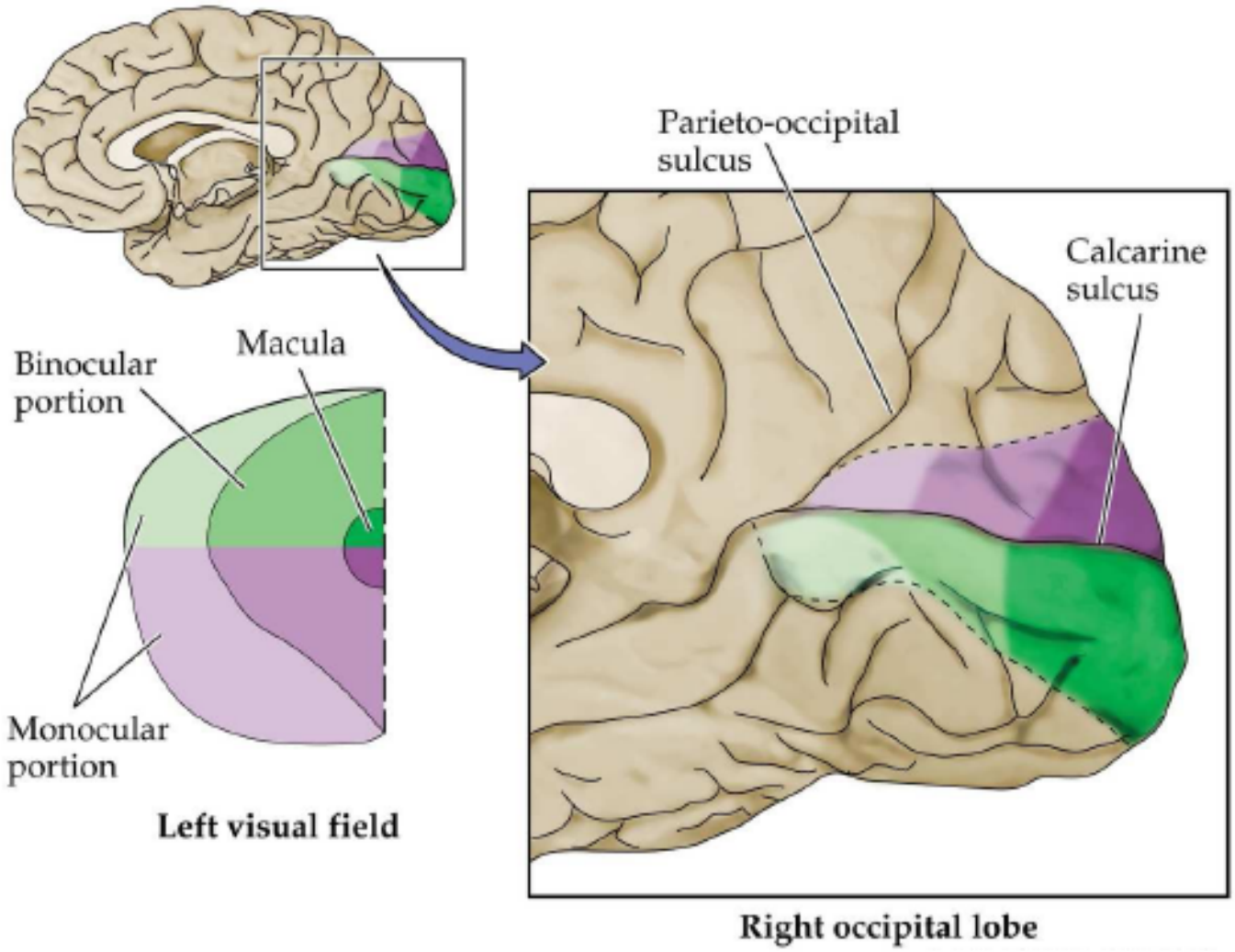

Left visual field
Right visual field
Temporal
Nasal
Temporal
Optic chiasm
Pulvinar nucleus
Lateral geniculate nucleus
Superior colliculus
Optic radiation
Primary visual cortex

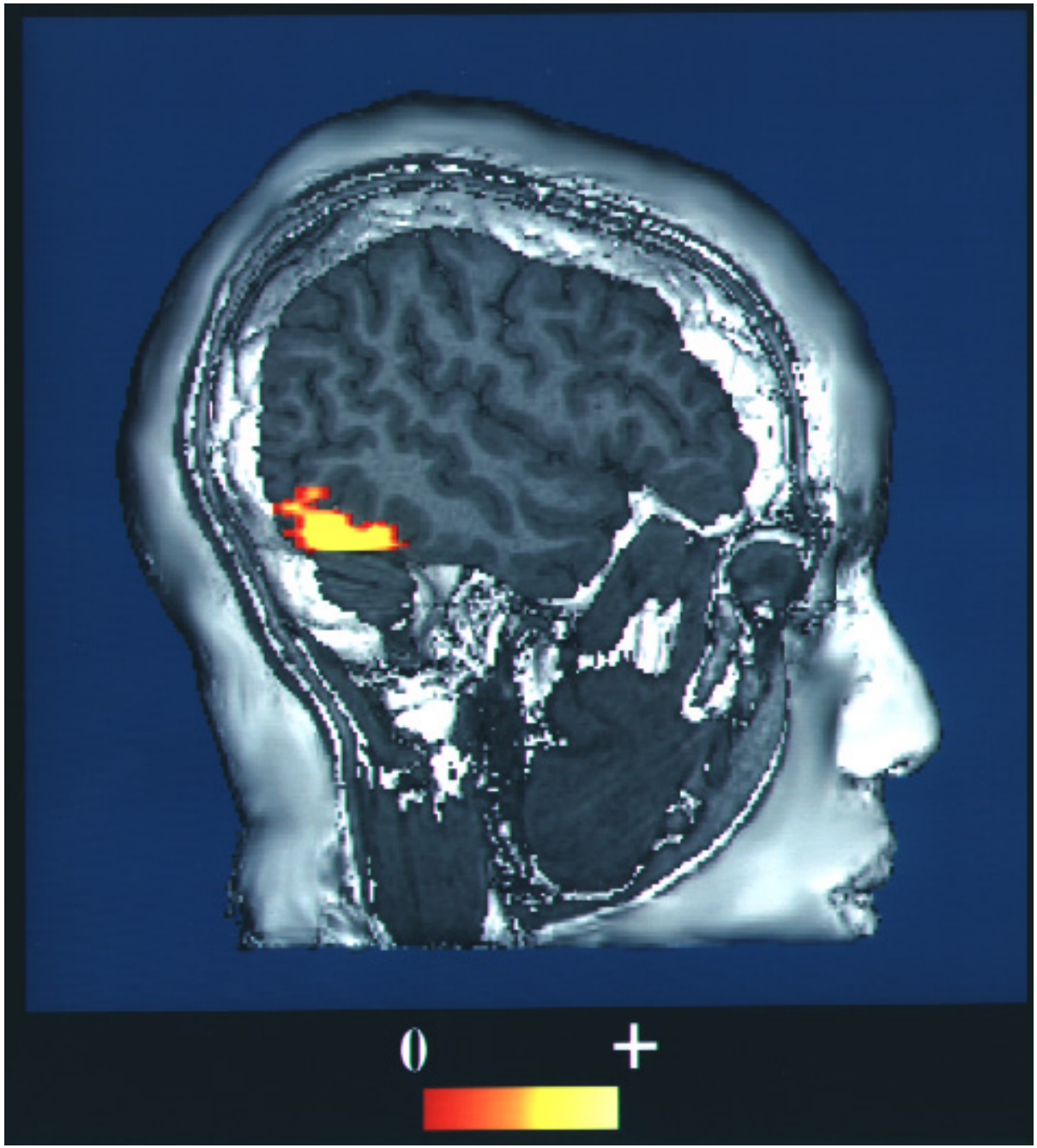




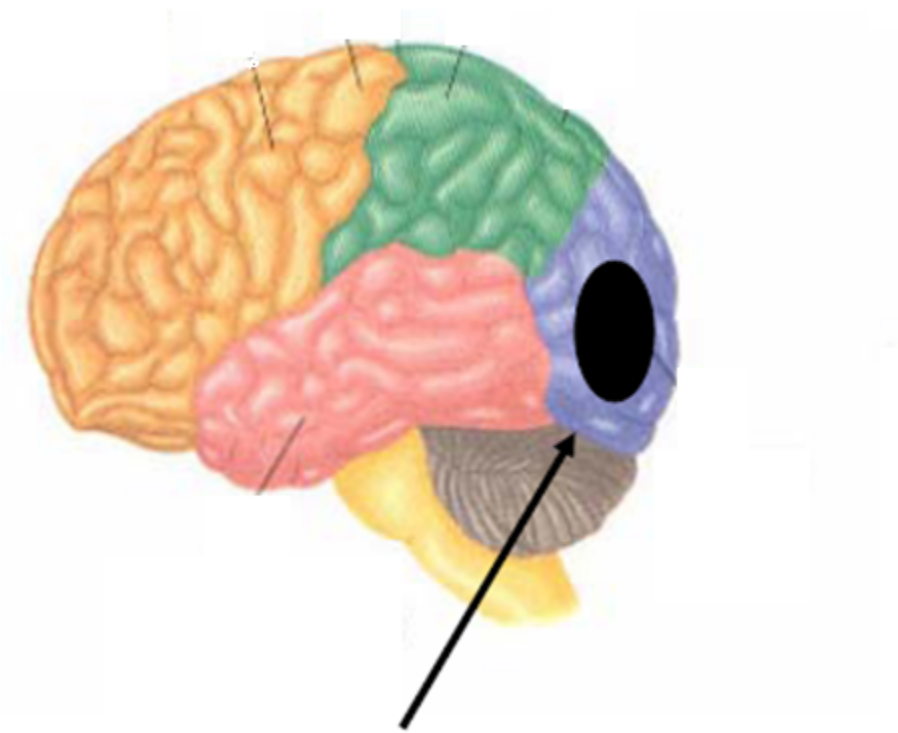


The retinotopic map



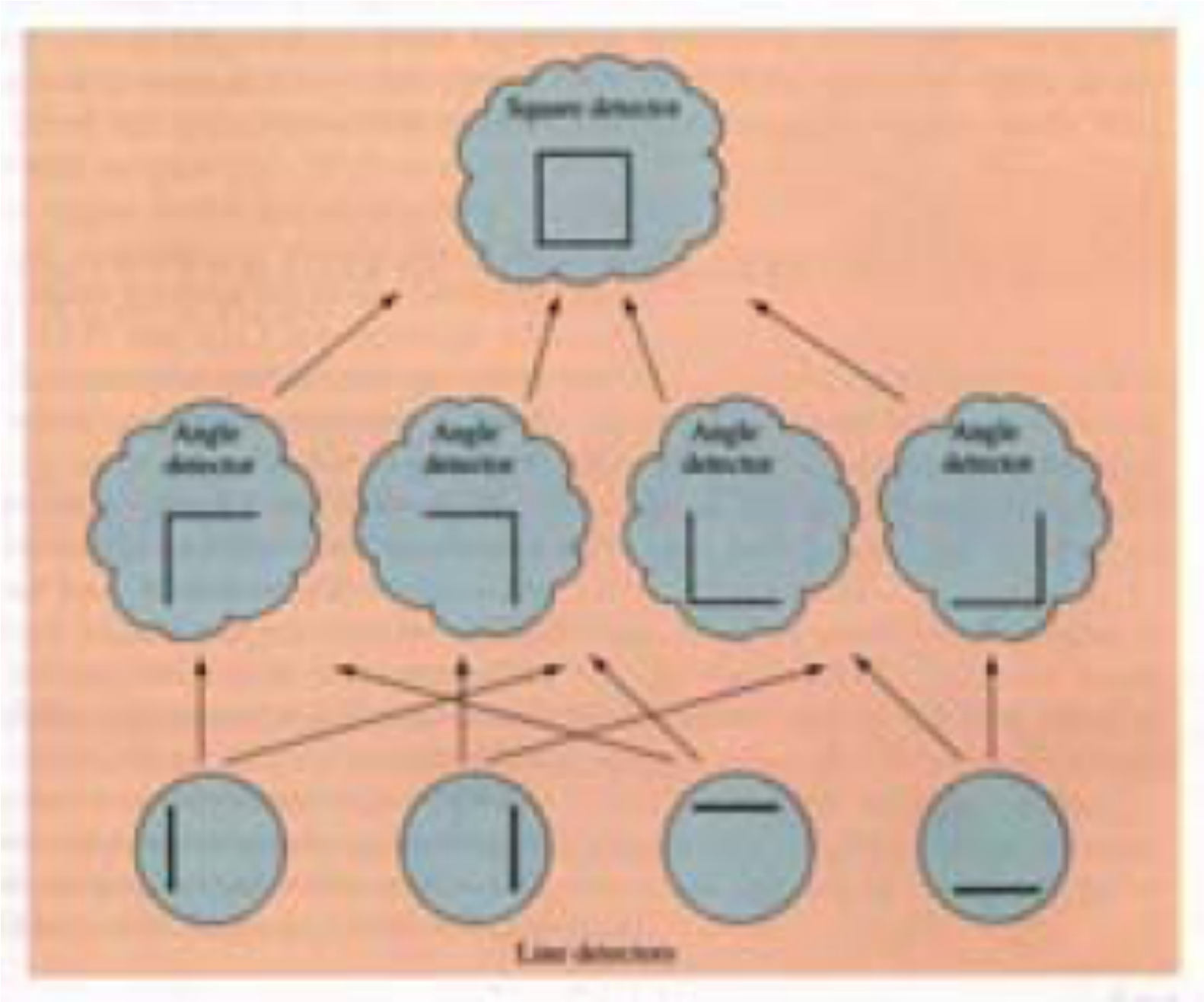

0
+

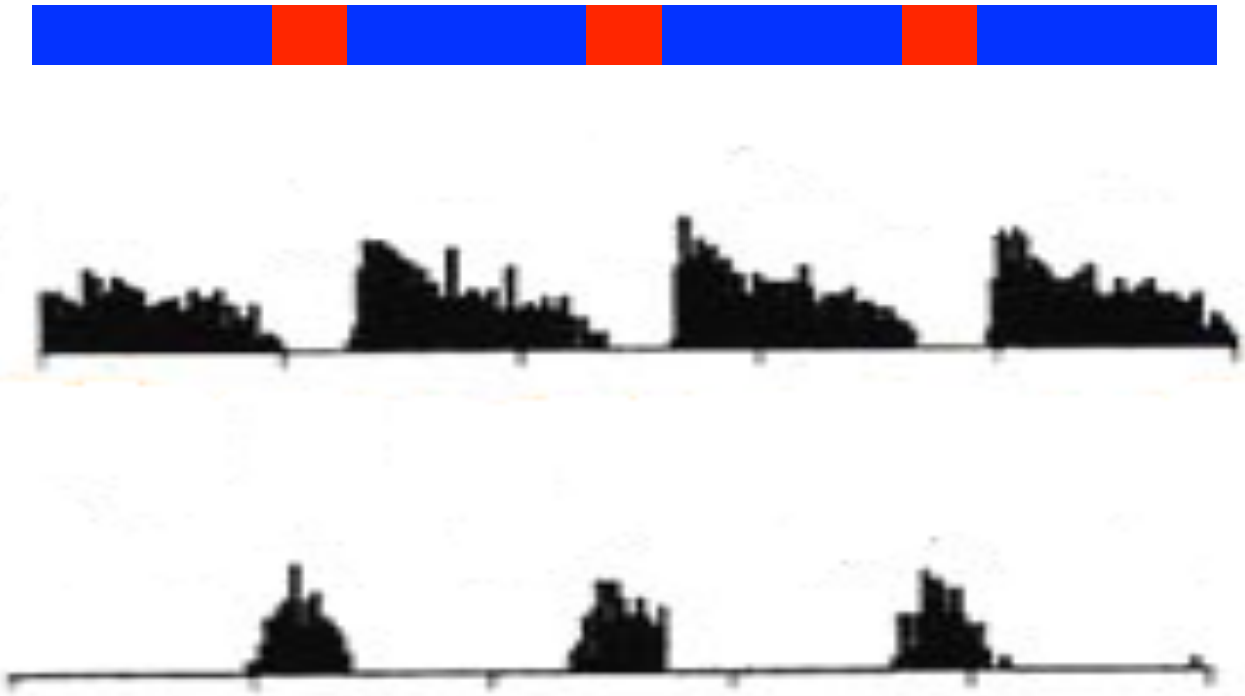
Cortical Blindness

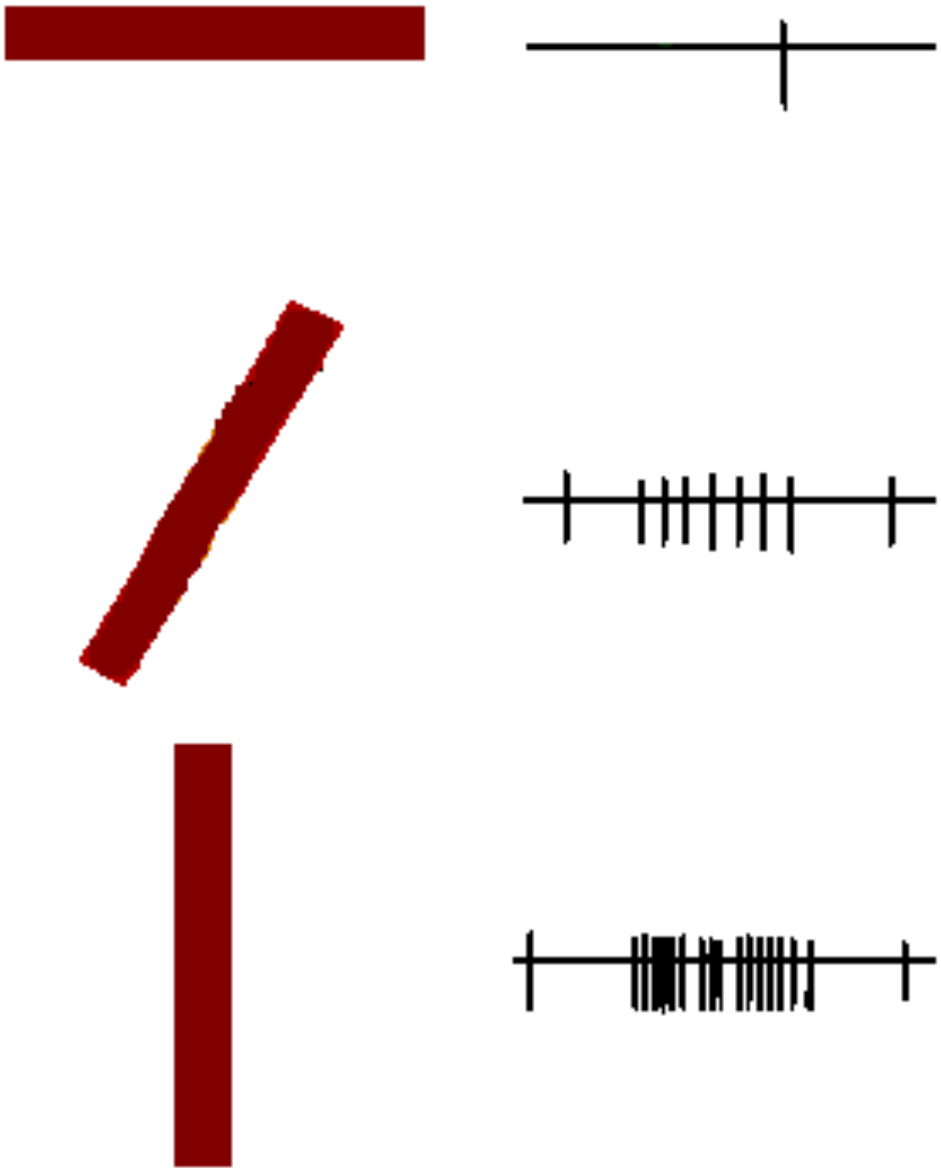


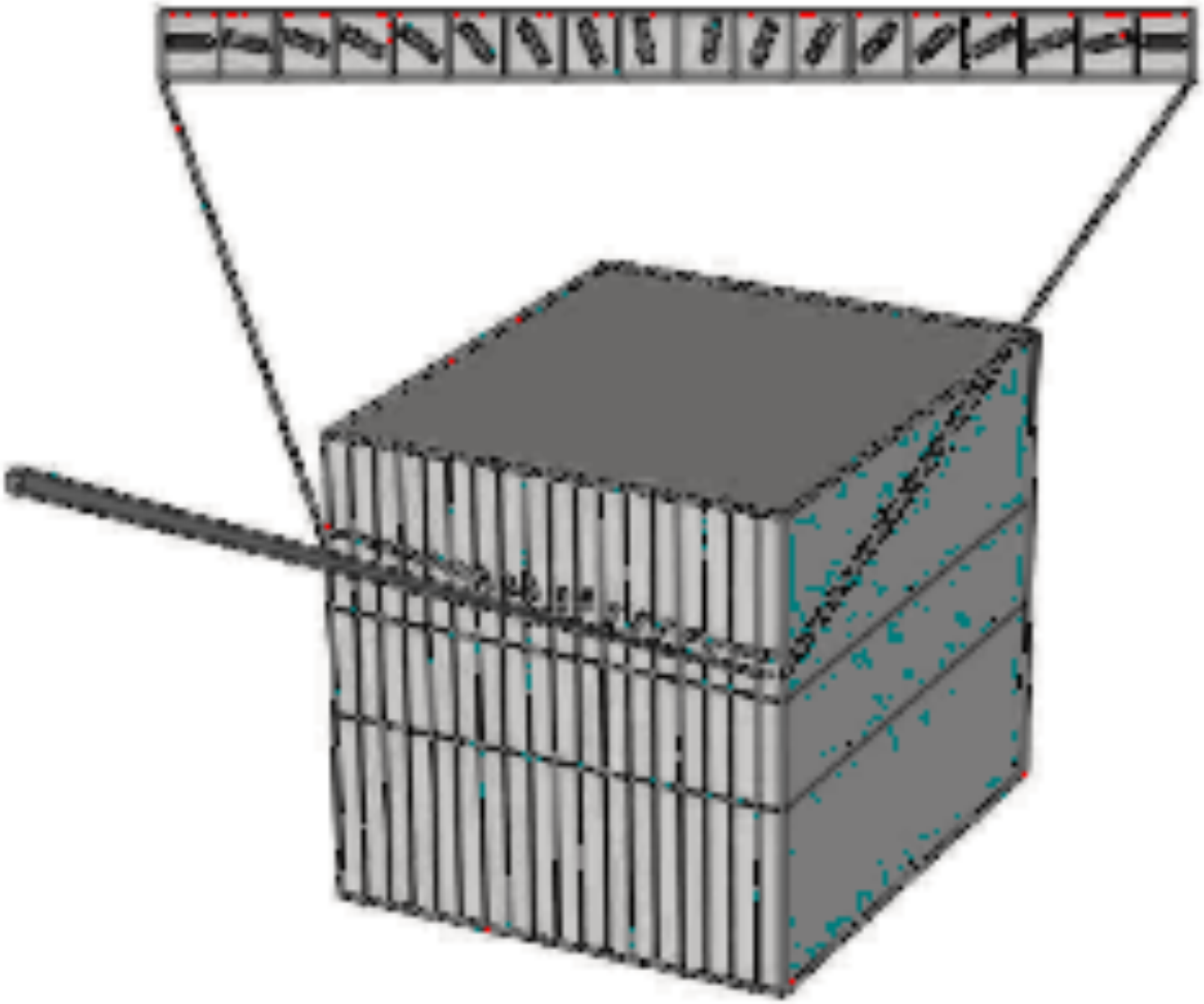
Damage to left occipital cortex causes blindness in right visual field.

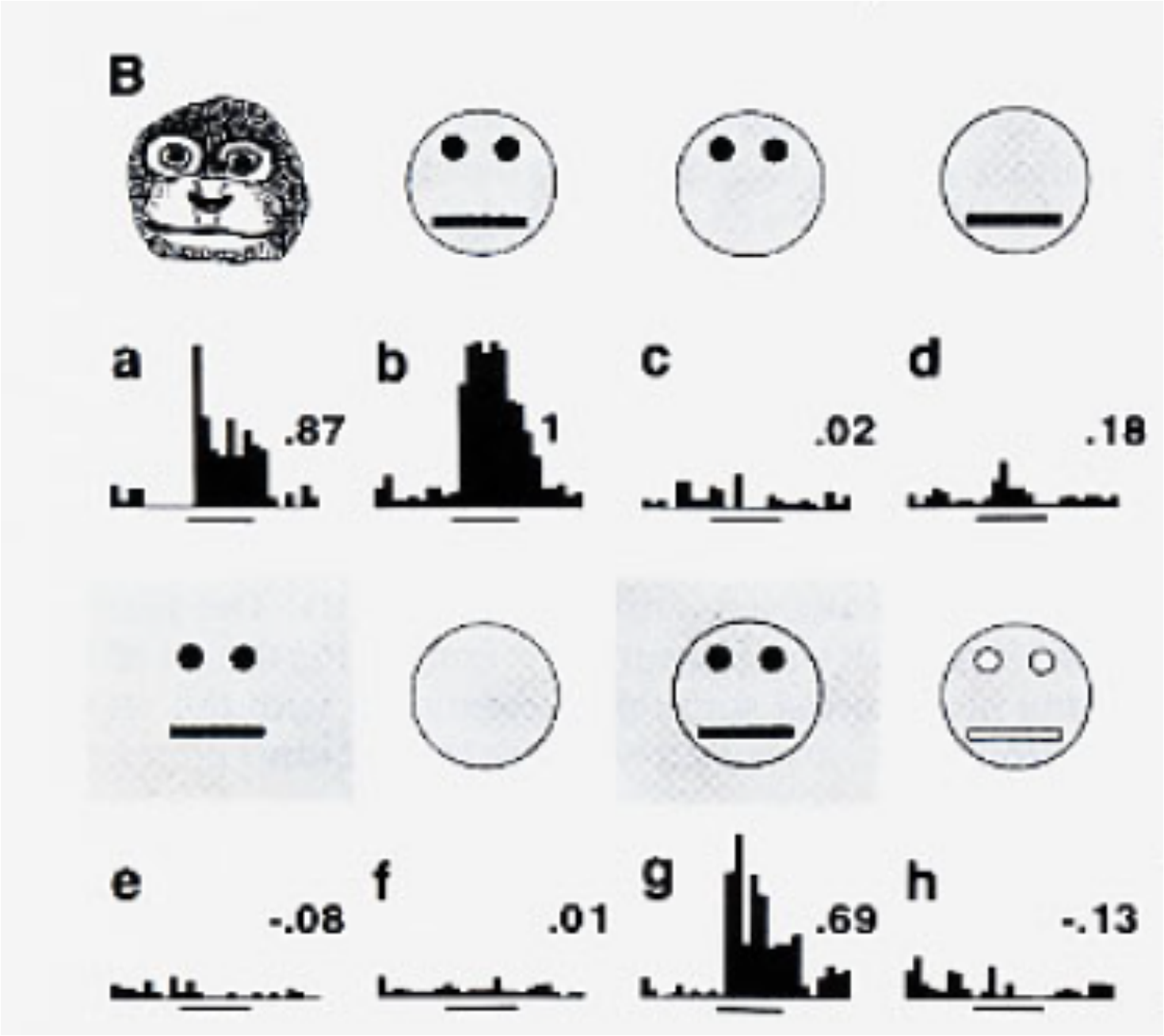
Damage to striate cortex causes **cortical blindness** - people are blind in the part of visual space that is *contralateral* to the lesion.

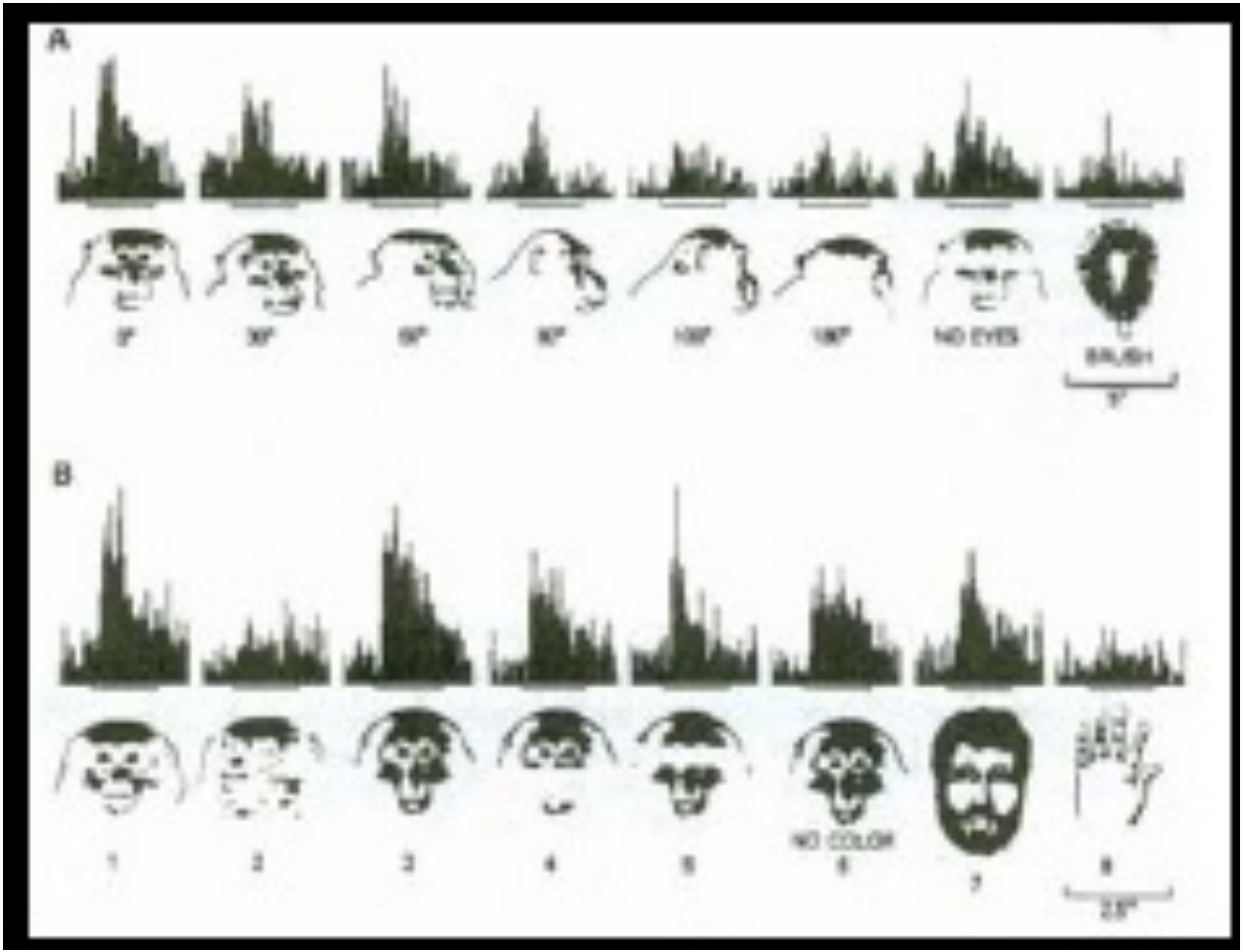

Square detector
Angle detector
Angle detector
Angle detector
Angle detector
Line detectors

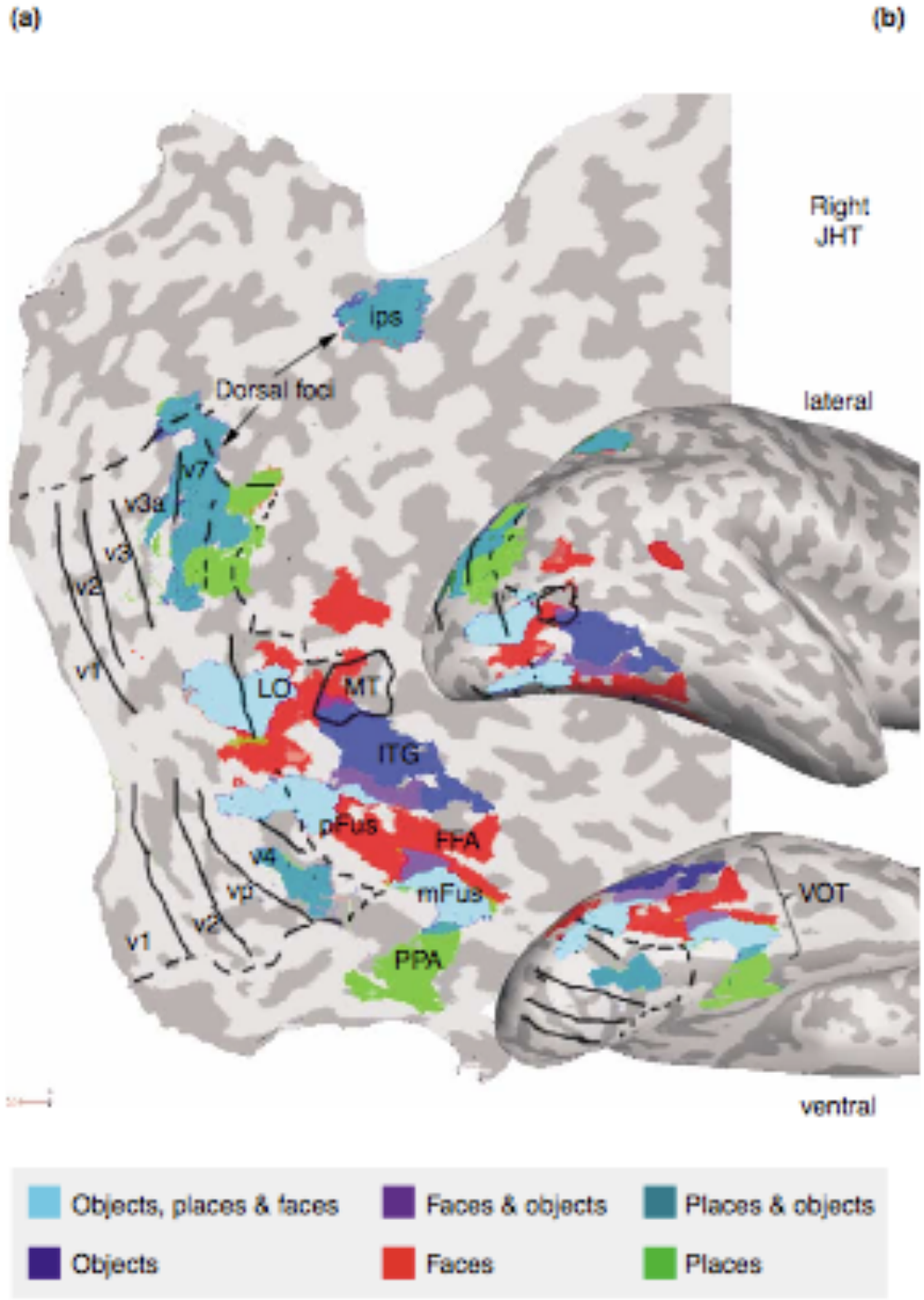




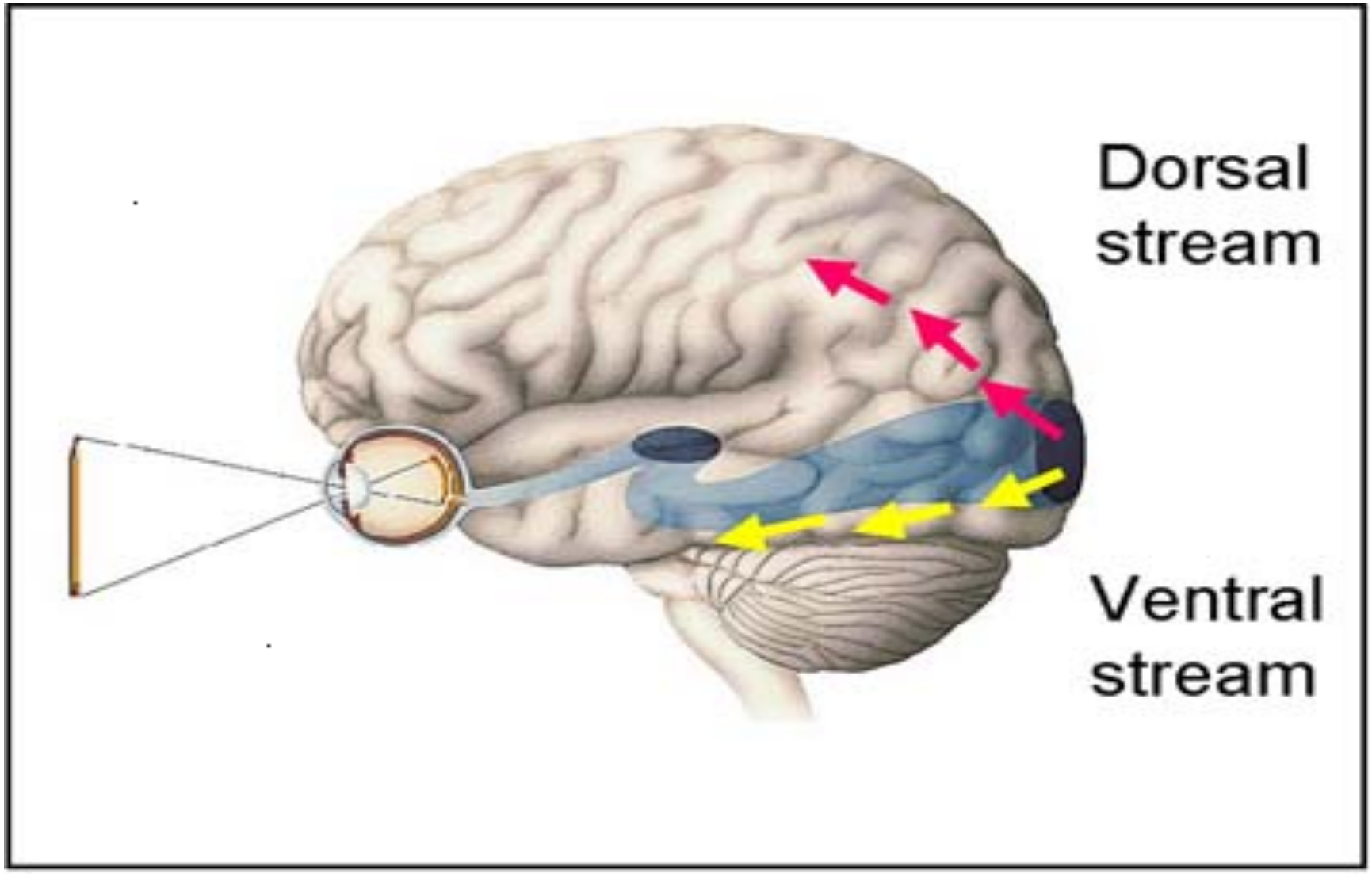



B
a
.87
b
1
c
.02
d
.18
e
-.08
f
.01
g
.69
h
-.13


A
NO EYES
B
NO COLOR


(a)
(b)
Right
JHT
ips
Dorsal foci
lateral
v7
v3a
v3
v2
v1
LO
MT
ITG
pFus
FFA
v4
vp
mFus
VOT
v1
v2
PPA
ventral
Objects, places & faces
Faces & objects
Places & objects
Objects
Faces
Places

The Case for Two Visual Streams

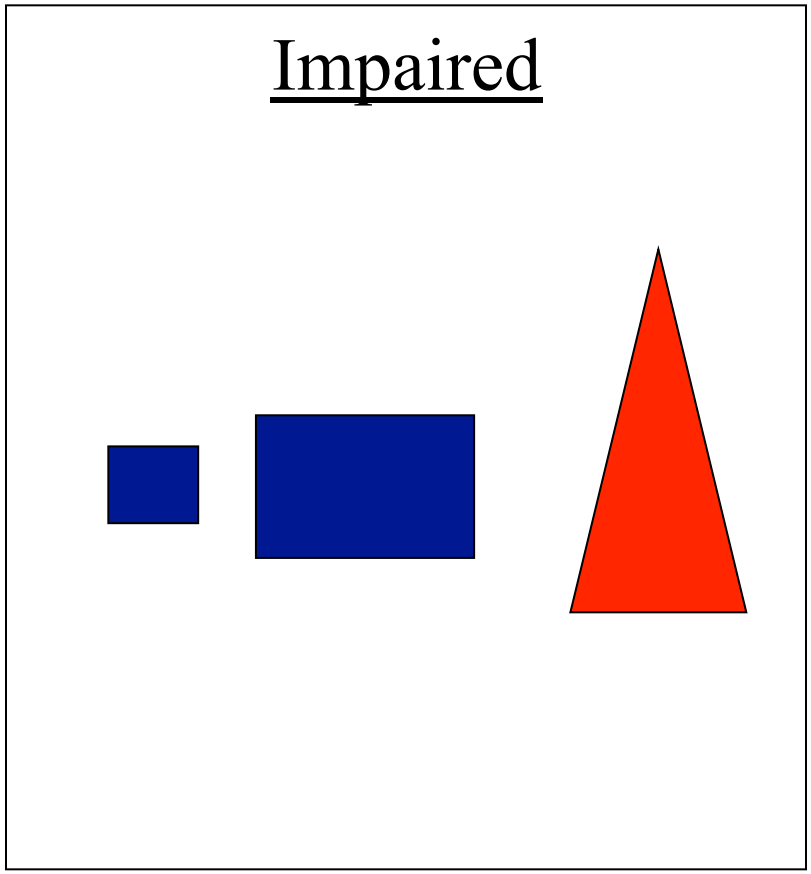

Dorsal
stream
Ventral
stream

Evidence of Cortical Streams: Patient DF

carbon monoxide poisoning in temporal lobe leading to object agnosia

Evidence of Cortical Streams: Patient DF

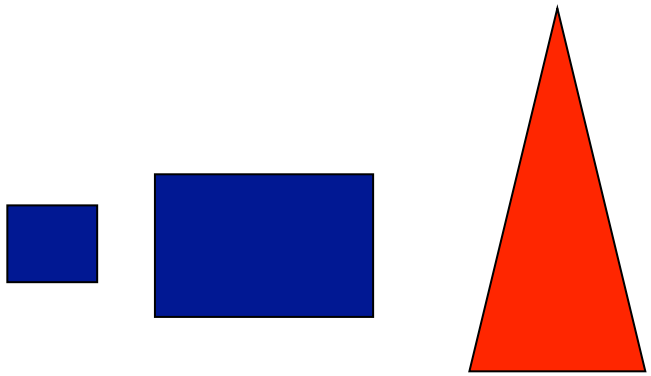
carbon monoxide poisoning in temporal lobe leading to object agnosia



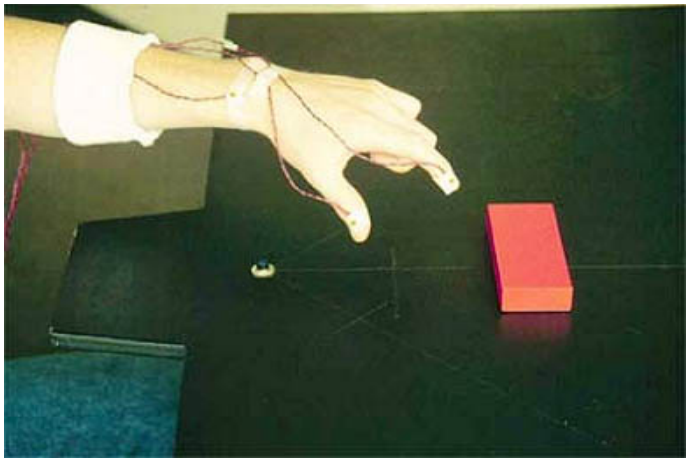
Evidence of Cortical Streams: Patient DF

carbon monoxide poisoning in temporal lobe leading to object agnosia

Impaired



Unimpaired

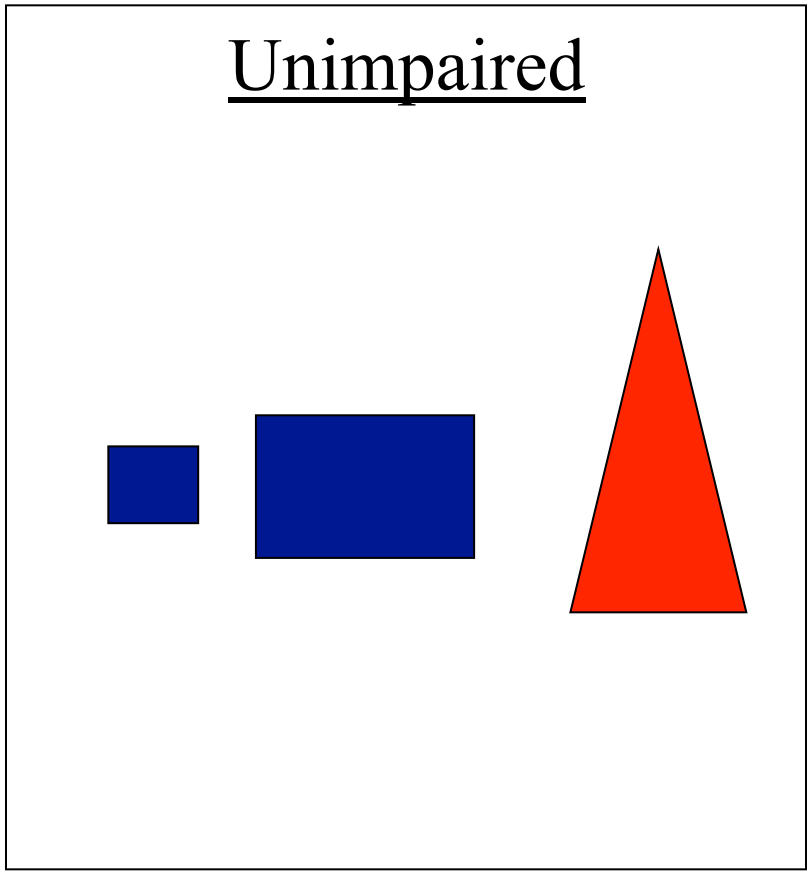


Evidence of Cortical Streams: Patient RV

stroke in parietal cortex causing visual ataxia

Evidence of Cortical Streams: Patient RV

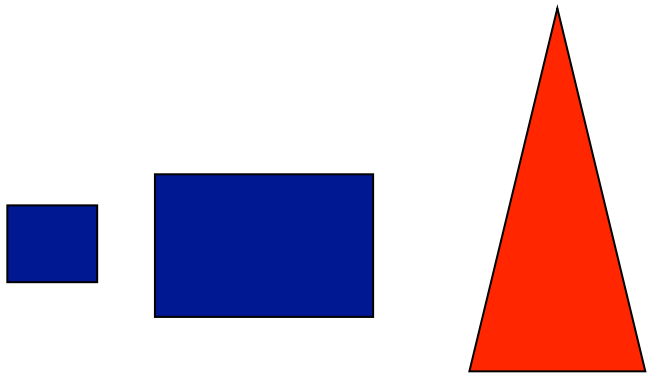
stroke in parietal cortex causing visual ataxia



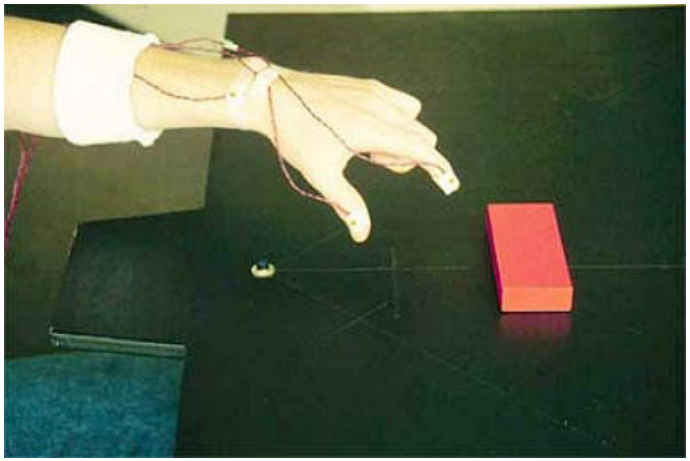
Evidence of Cortical Streams: Patient RV

stroke in parietal cortex causing visual ataxia

Unimpaired



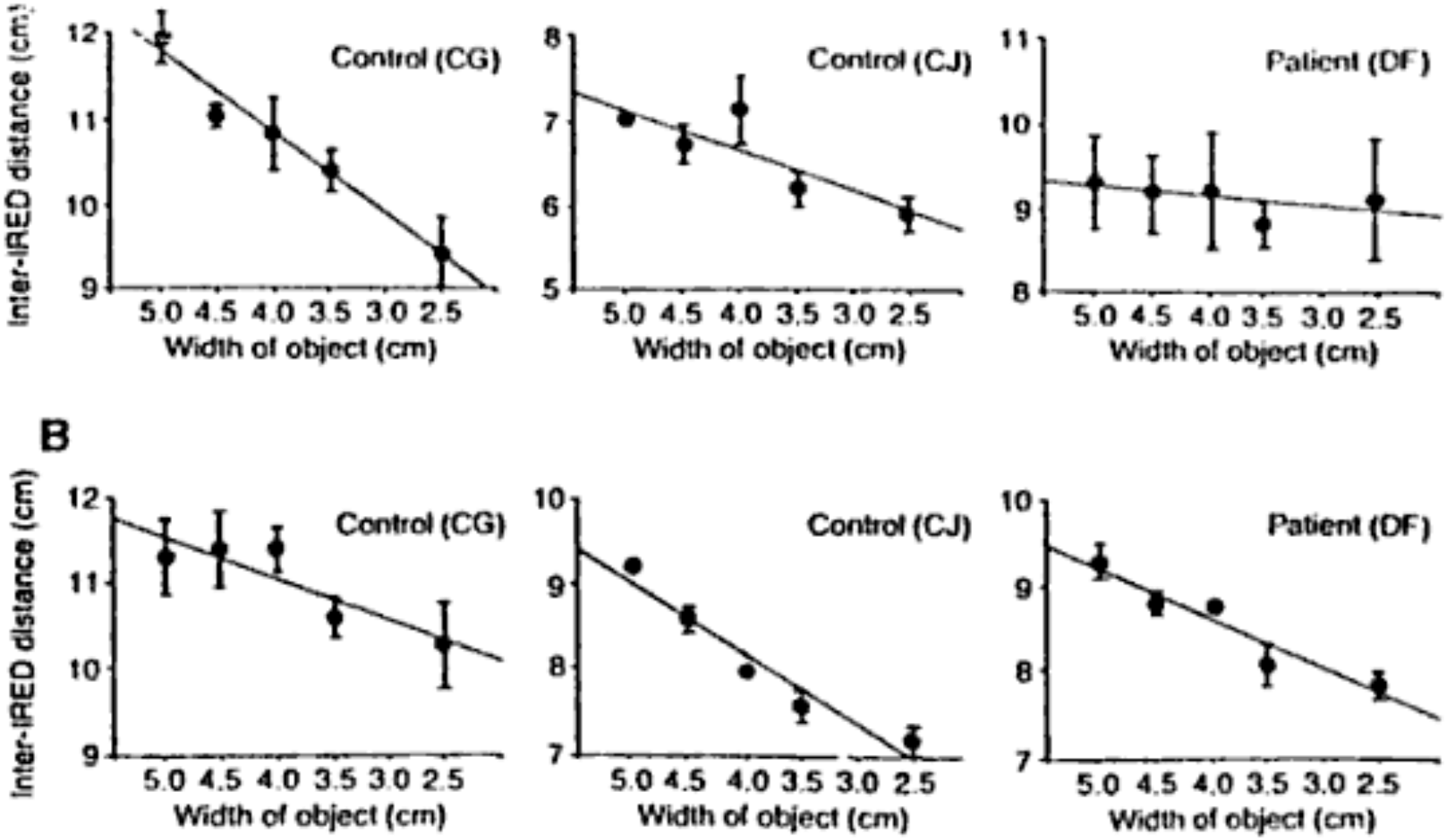
Impaired



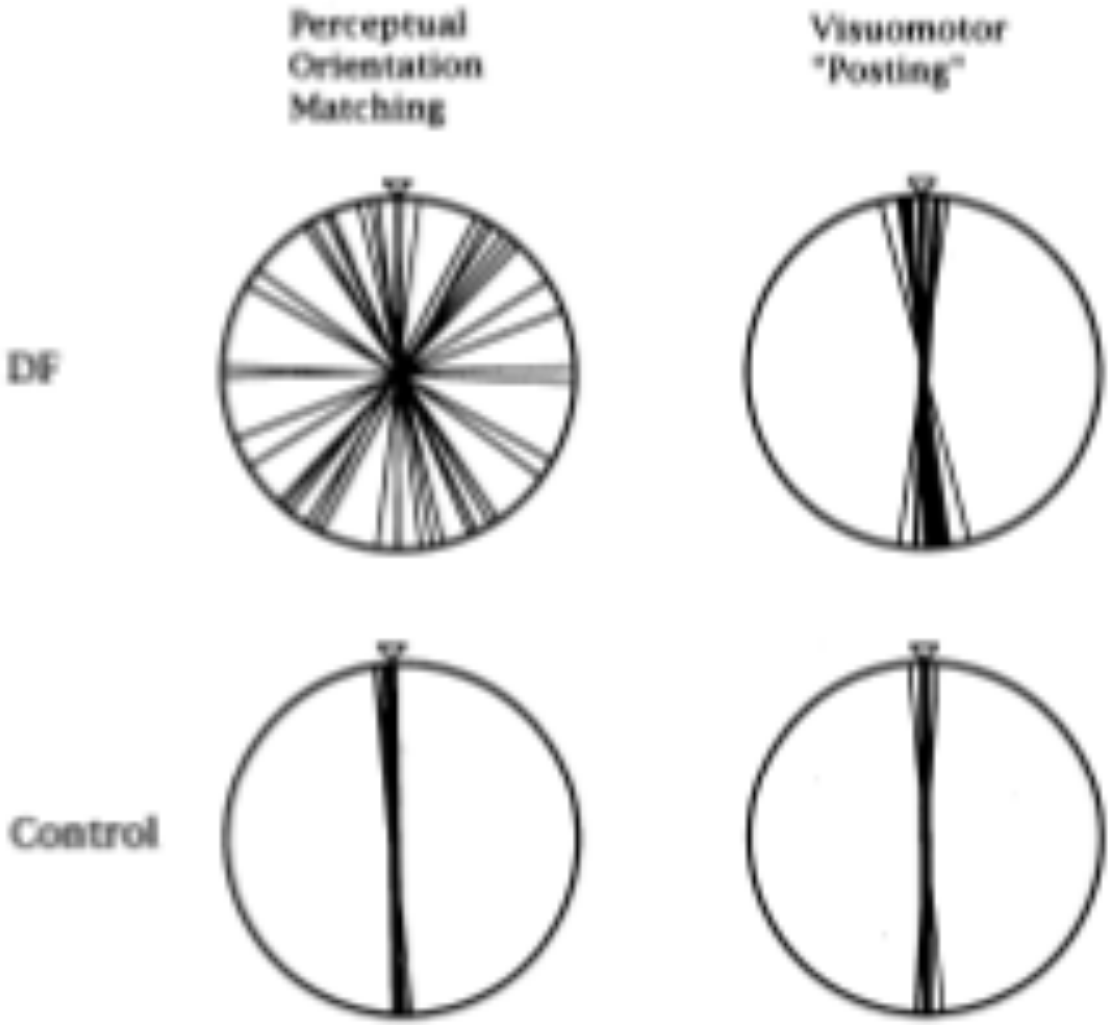
Patient DF

Top Panel: Demonstrate

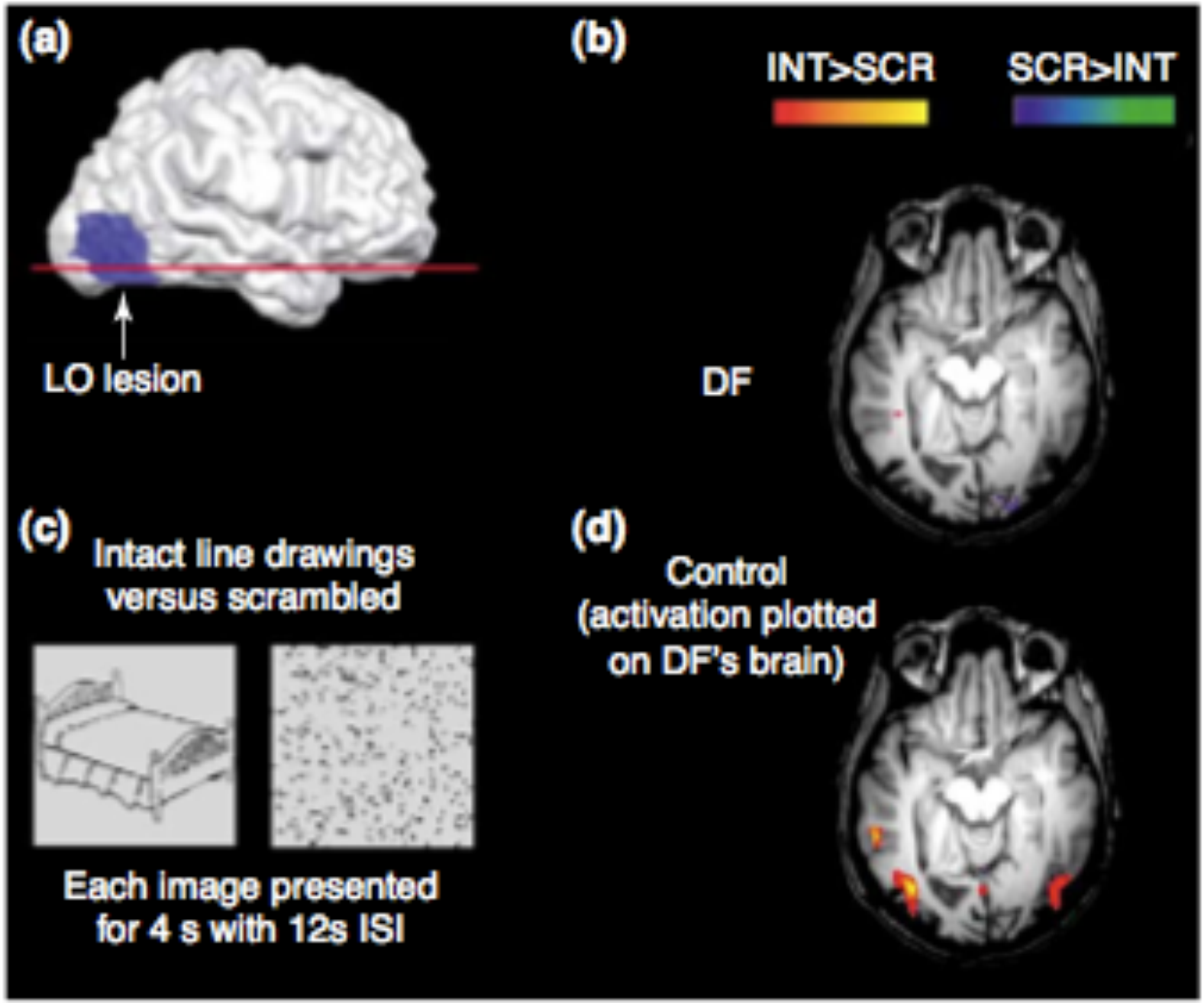
Bottom Panel: Grab



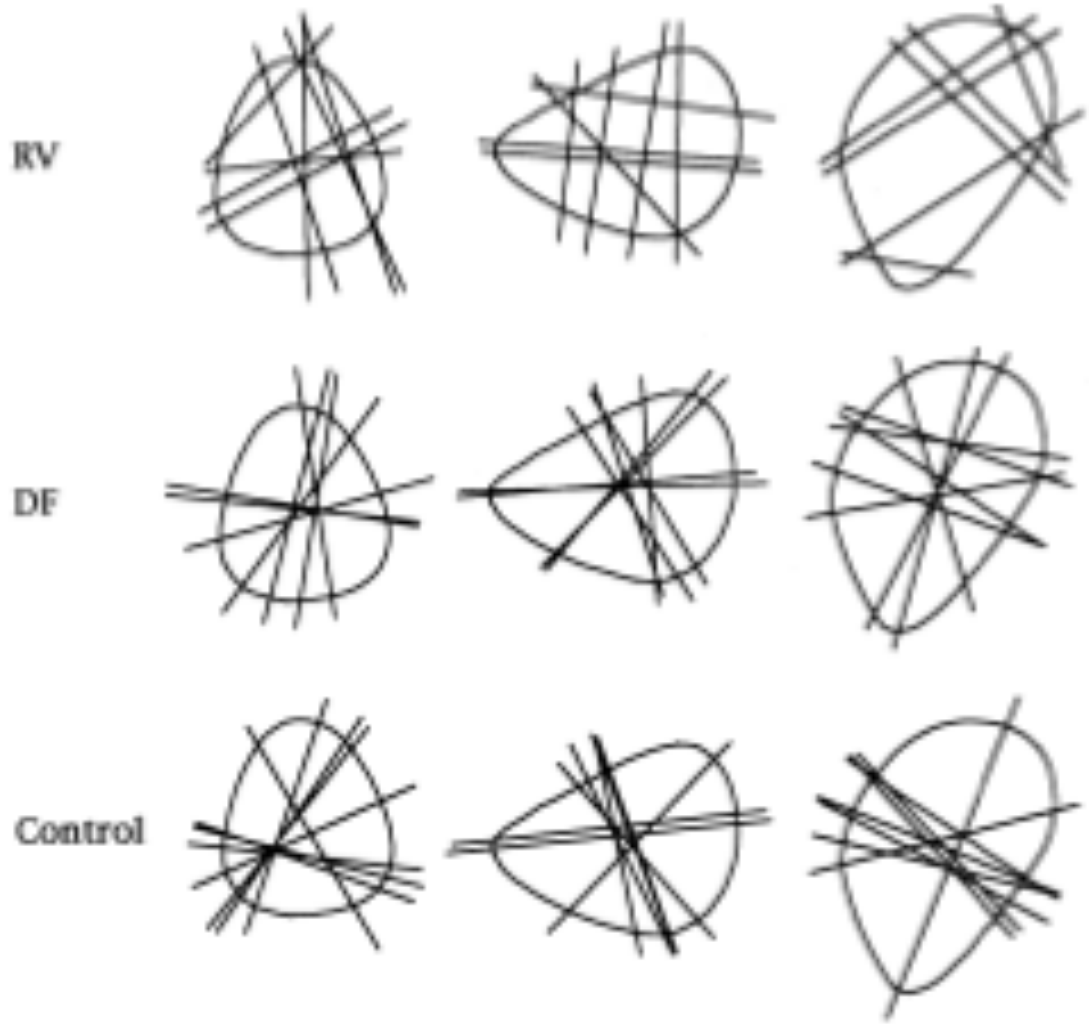
Patient DF



The Mail Slot

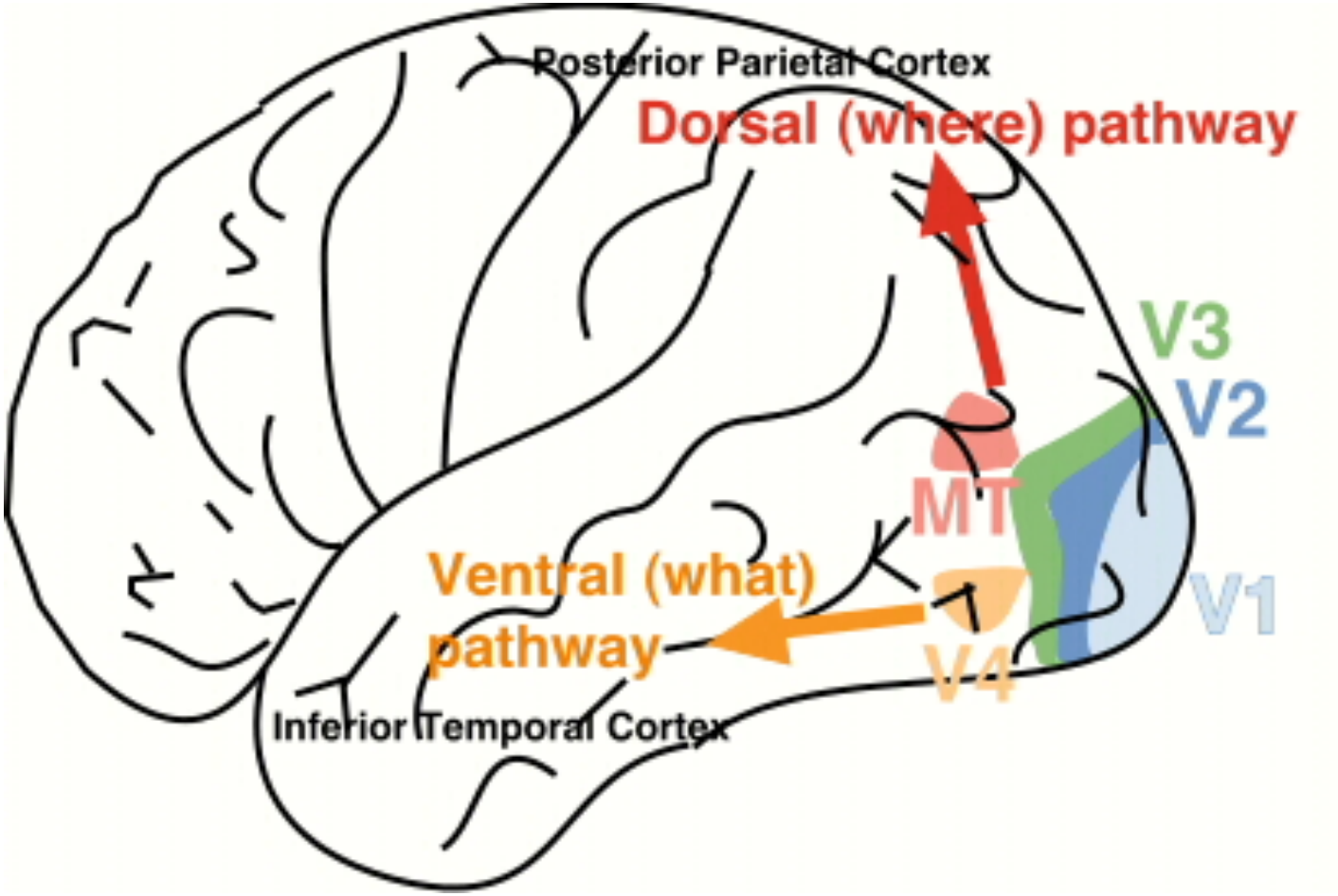

(a)
LO lesion
(b)
INT>SCR
SCR>INT
DF
(c)
Intact line drawings versus scrambled
Each image presented for 4 s with 12s ISI
(d)
Control (activation plotted on DF's brain)

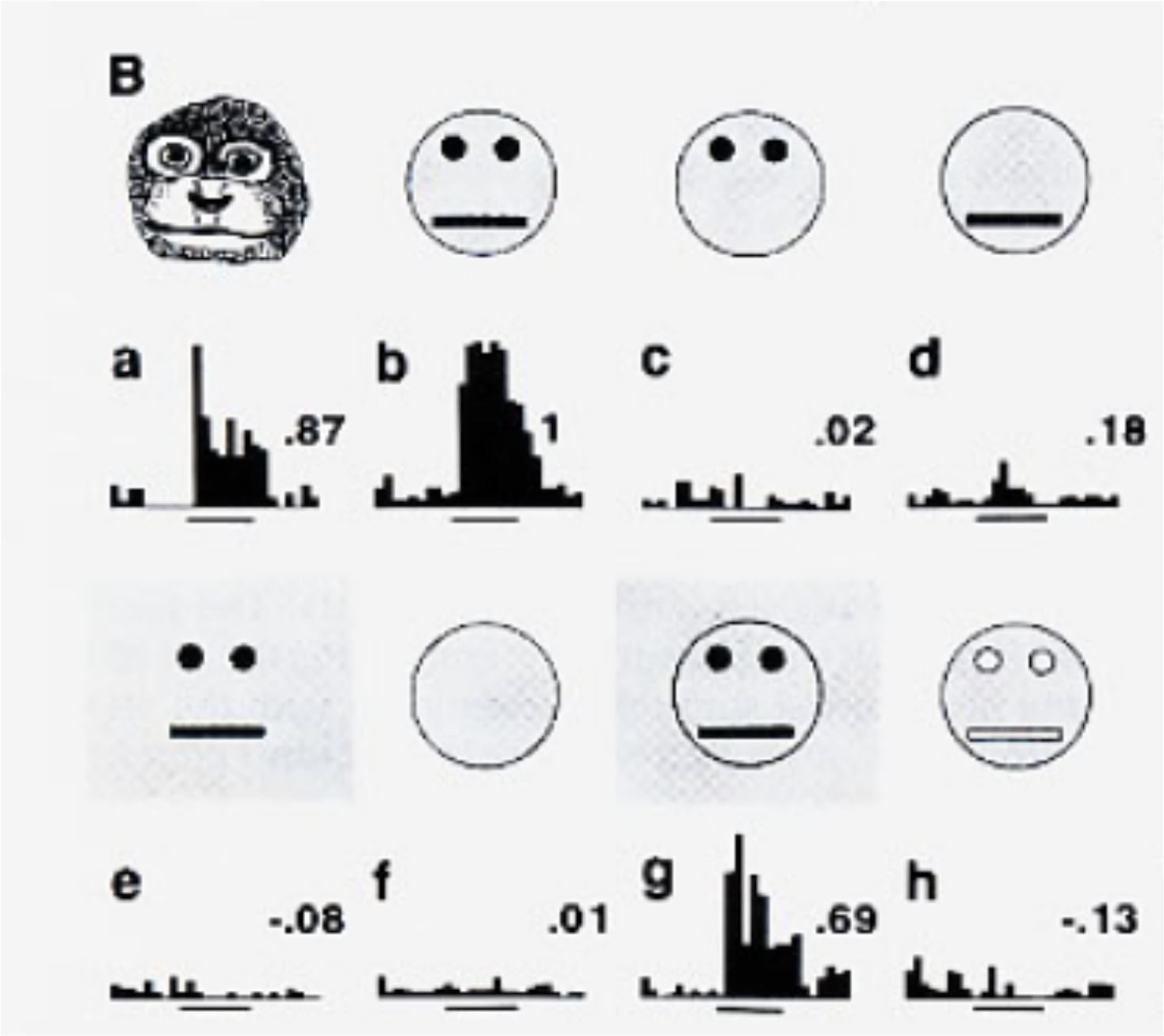
Patient RV and DF

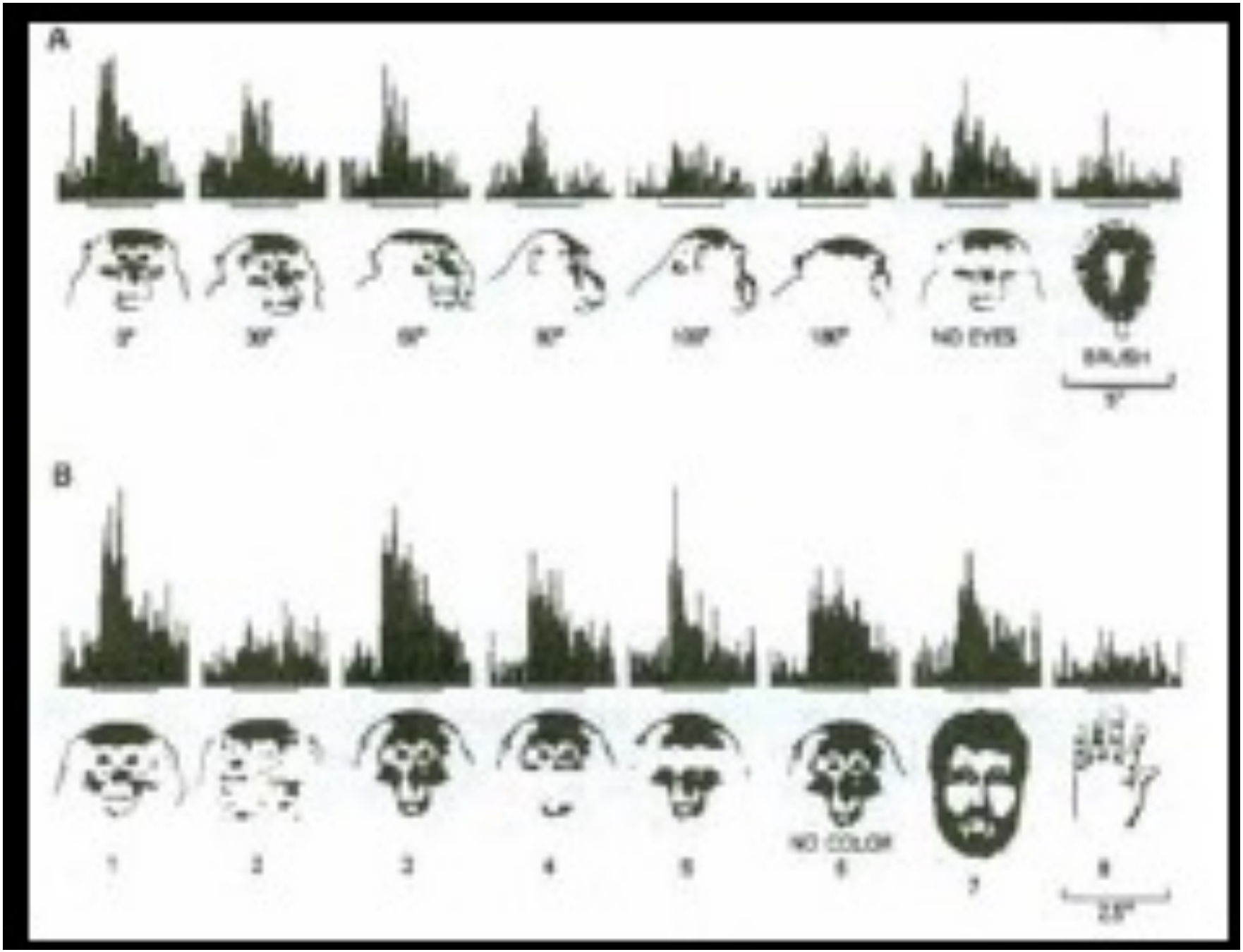


"Grasp Lines"

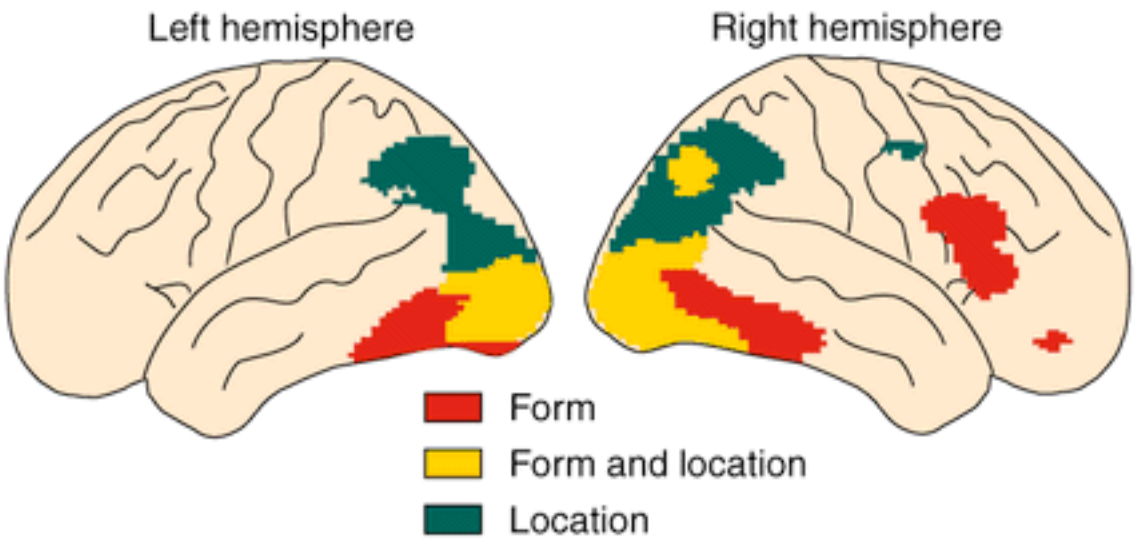
The Ventral Visual Stream


Posterior Parietal Cortex
Dorsal (where) pathway
V3
V2
MT
V1
Ventral (what)
pathway
V4
Inferior Temporal Cortex

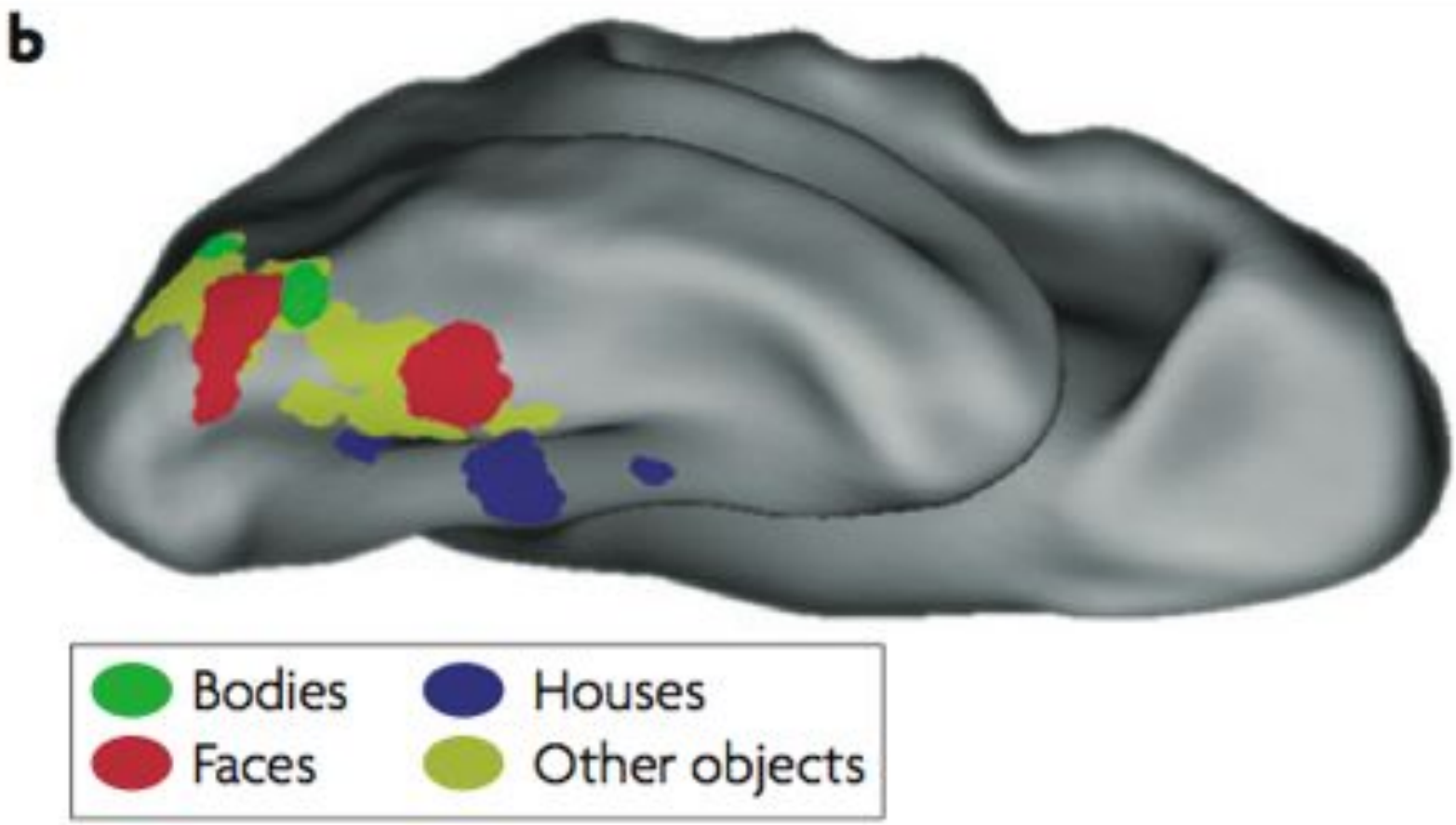

B
a
.87
b
1
c
.02
d
.18
e
-.08
f
.01
g
.69
h
-.13

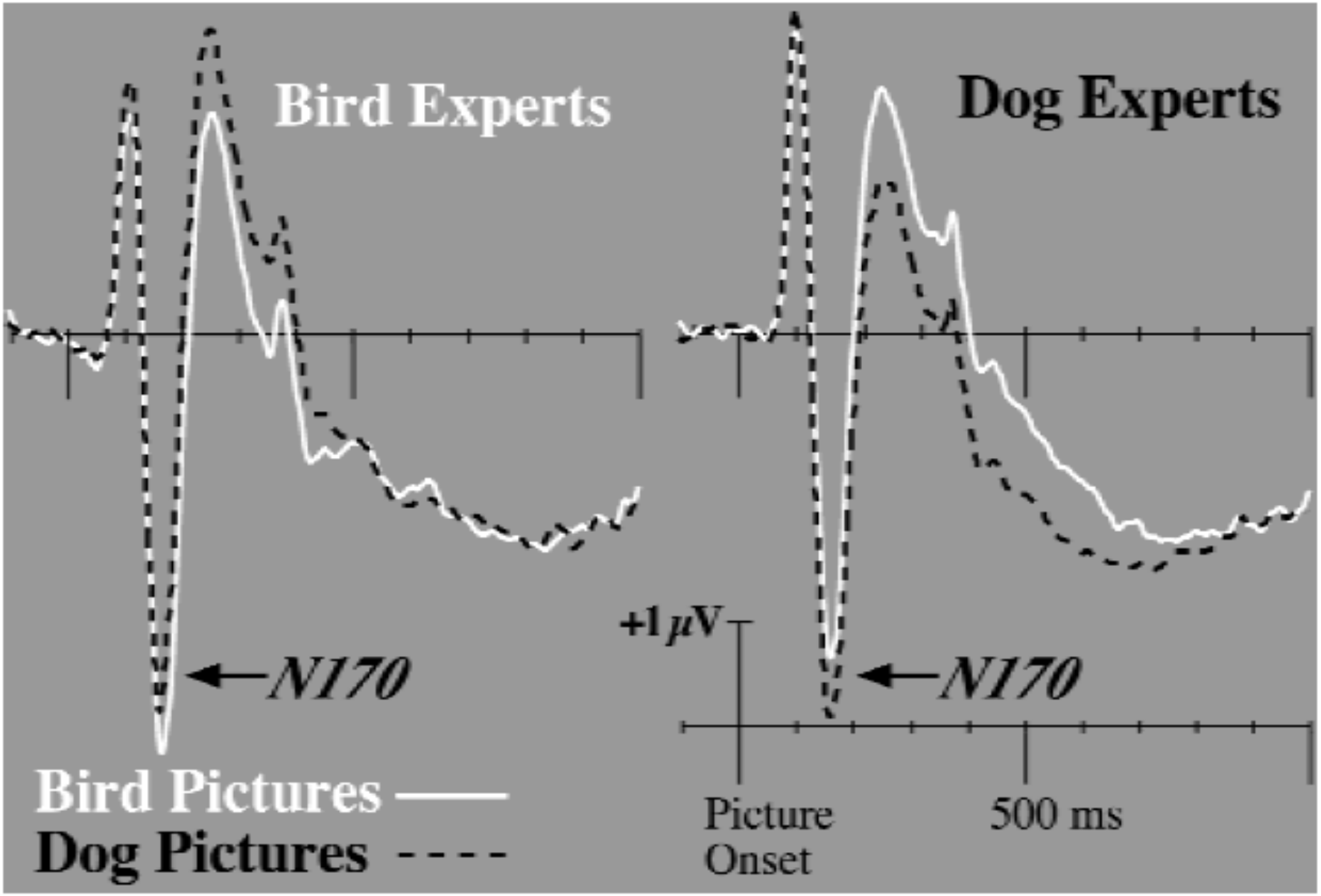

A
NO EYES
B
NO COLOR

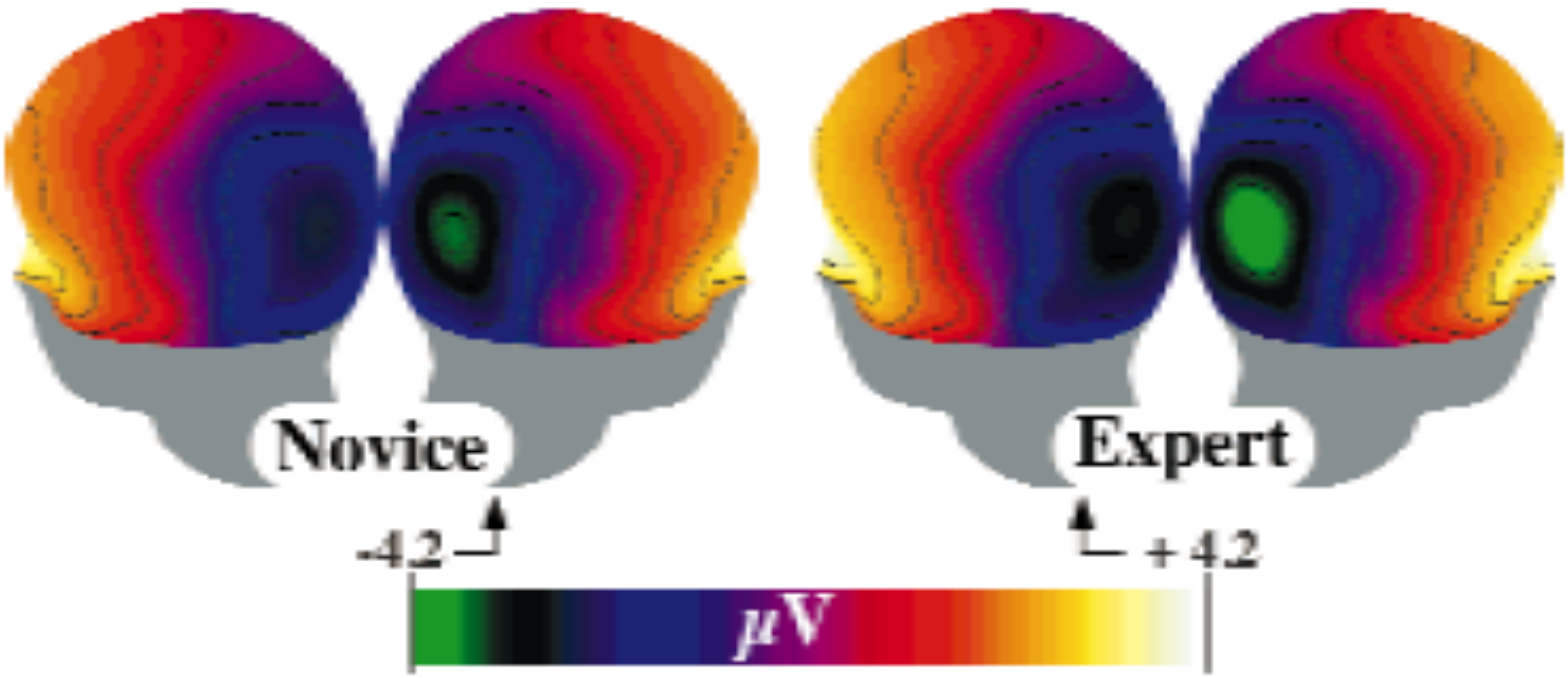
▶ Responses to Objects and Location



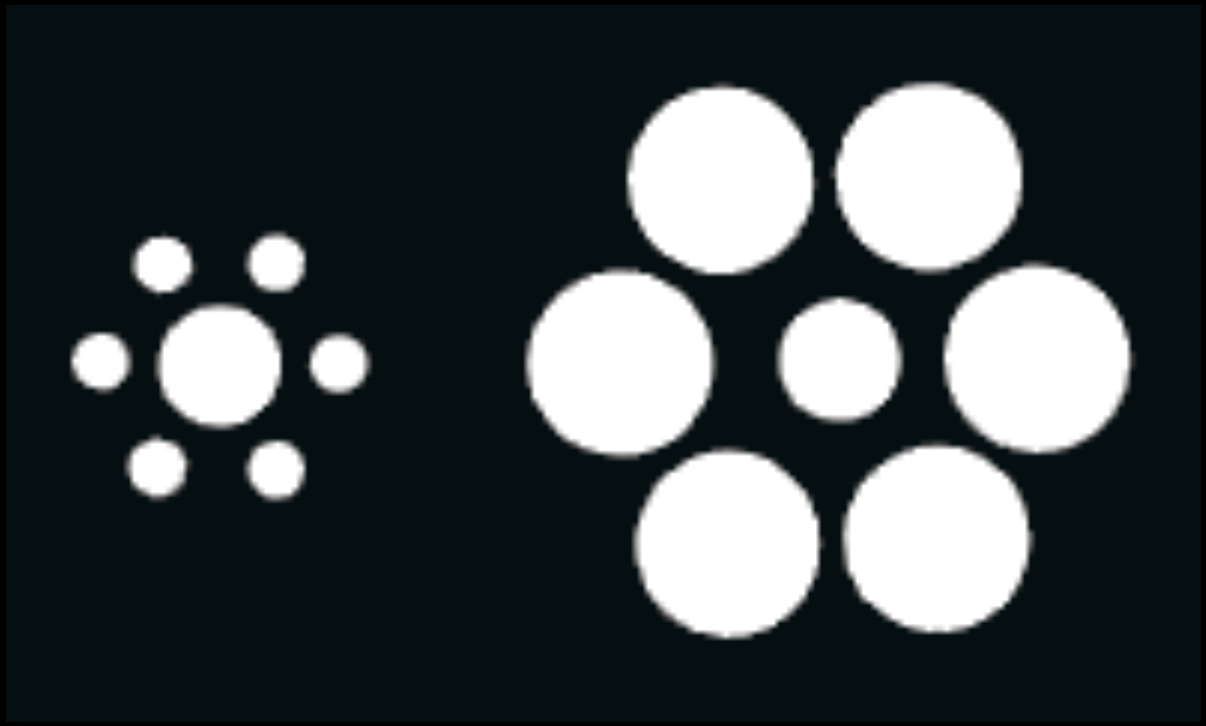
Source: Adapted from Haxby, J.V., Horwitz, B., Underleider, L.G., Maisog, J.M., Pietrini, P., and Grady, C.L. *Journal of Neuroscience,* 1994, *14*, 6336–6353.


b
Bodies
Faces
Houses
Other objects


Bird Experts
Dog Experts
N170
N170
+1 μV
Bird Pictures
Dog Pictures
Picture Onset
500 ms


Novice
Expert
-42
+42
μV

The Ventral Stream in Trouble



"What" Pathway

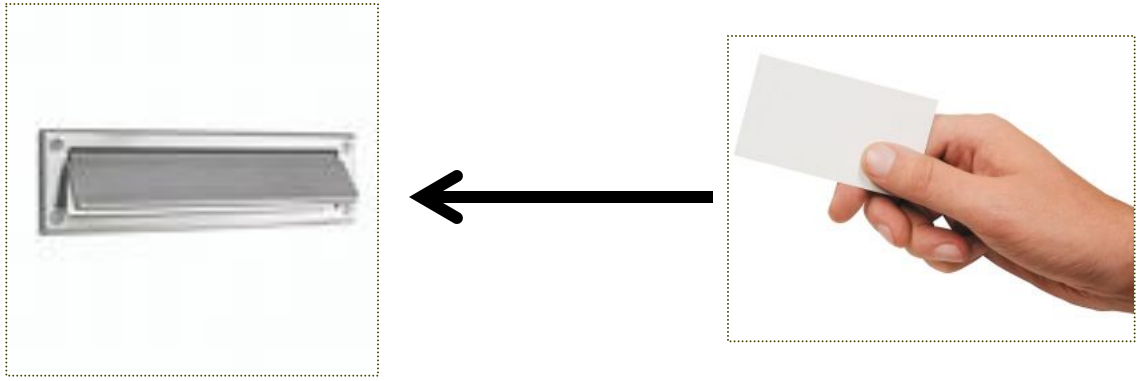
Visual Agnosia

Representation	Deficit
Form/Shape	Apperceptive Agnosia
Objects	Associative Agnosia
Faces	Prospopagnosia

Apperceptive Agnosia

Patient DF

Exp 2 - Orientation and Action Task



Task: Put card into mail slot

Associative Agnosia

Overt/Covert Awareness

flip open

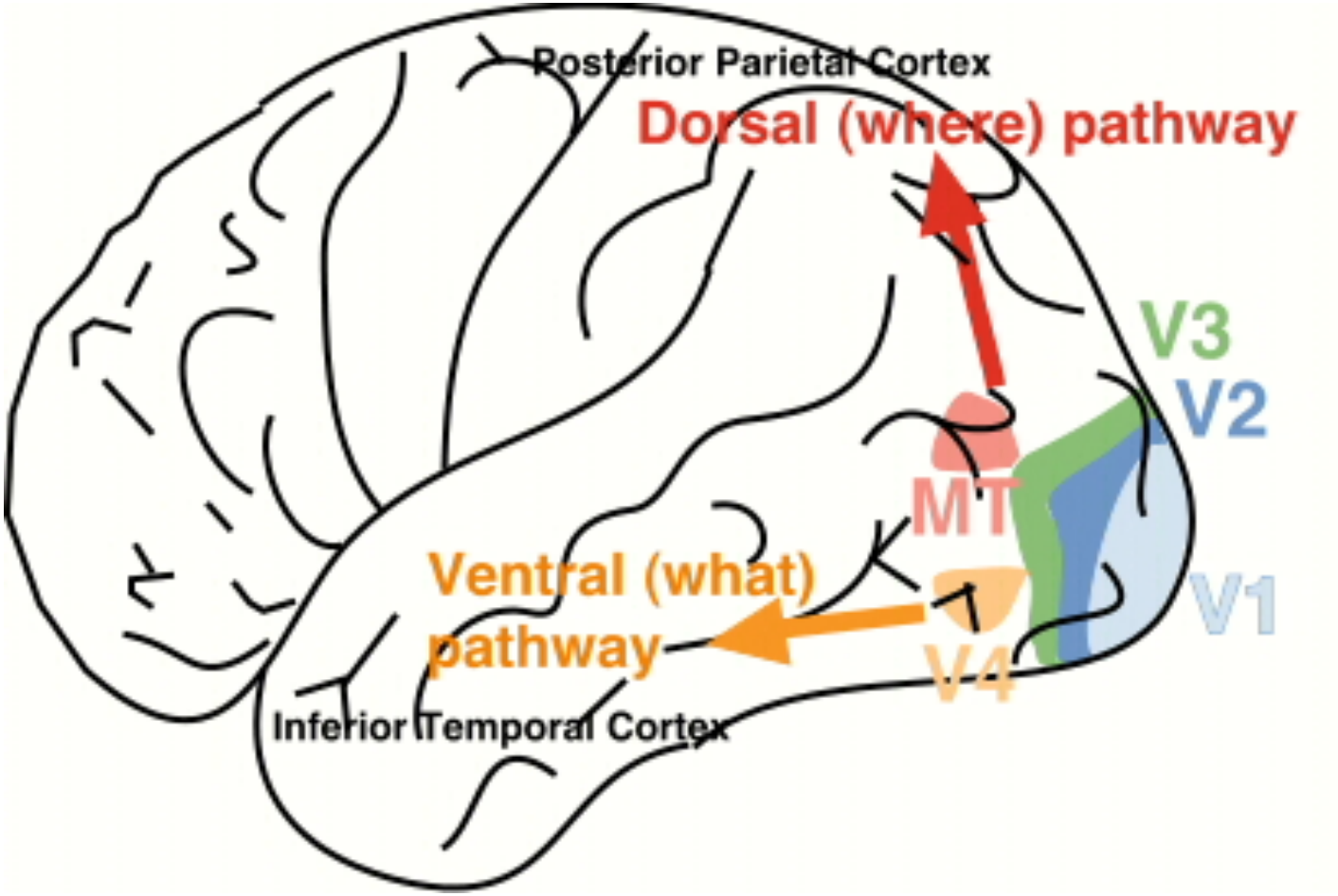
buttons

Some device?

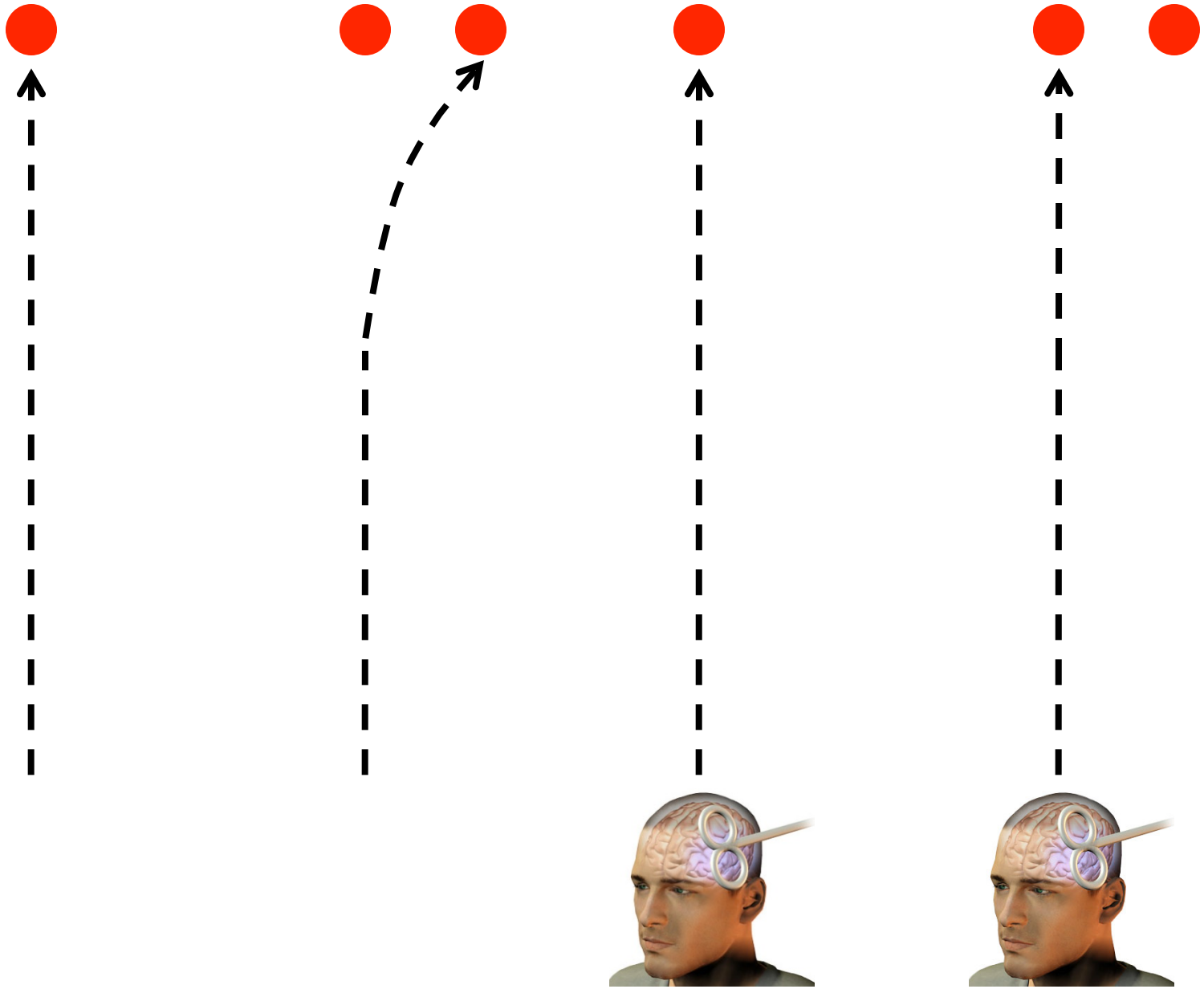
Prospopagnosia

What is it like?

The Dorsal Visual Stream

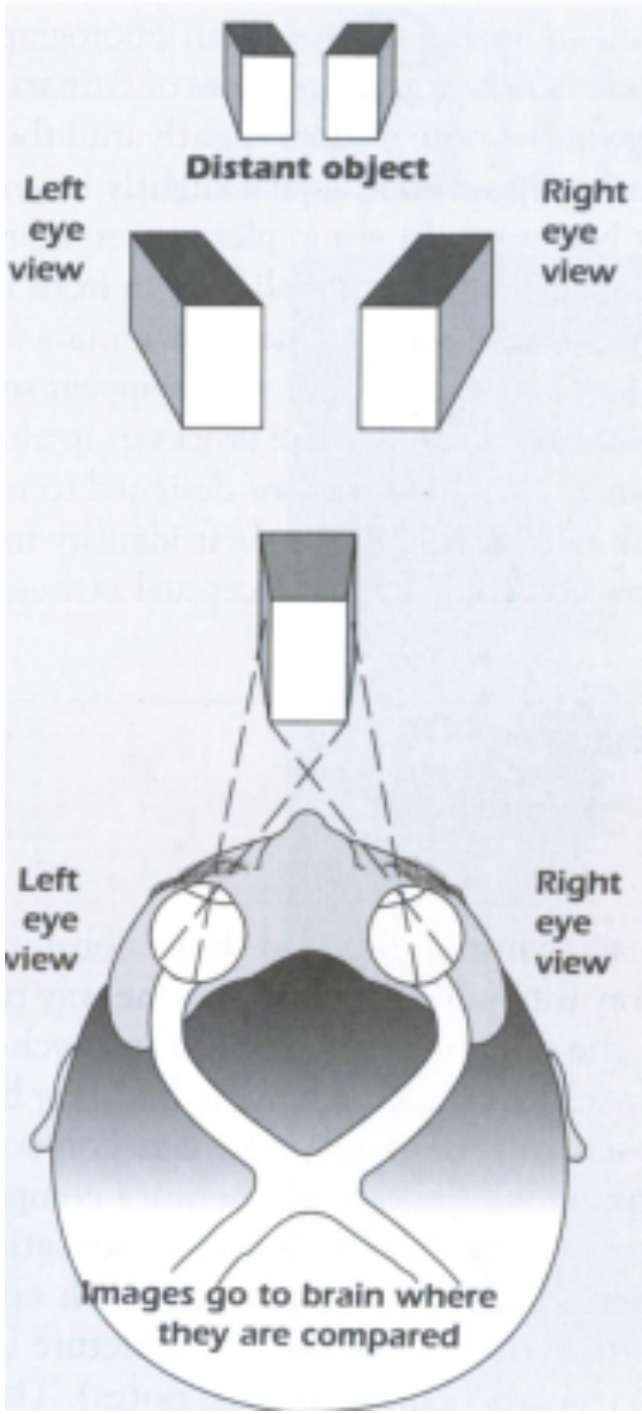

Posterior Parietal Cortex
Dorsal (where) pathway
V3
V2
MT
V1
Ventral (what)
pathway
V4
Inferior Temporal Cortex

Goodale, Pelisson, & Prablanc (1986)

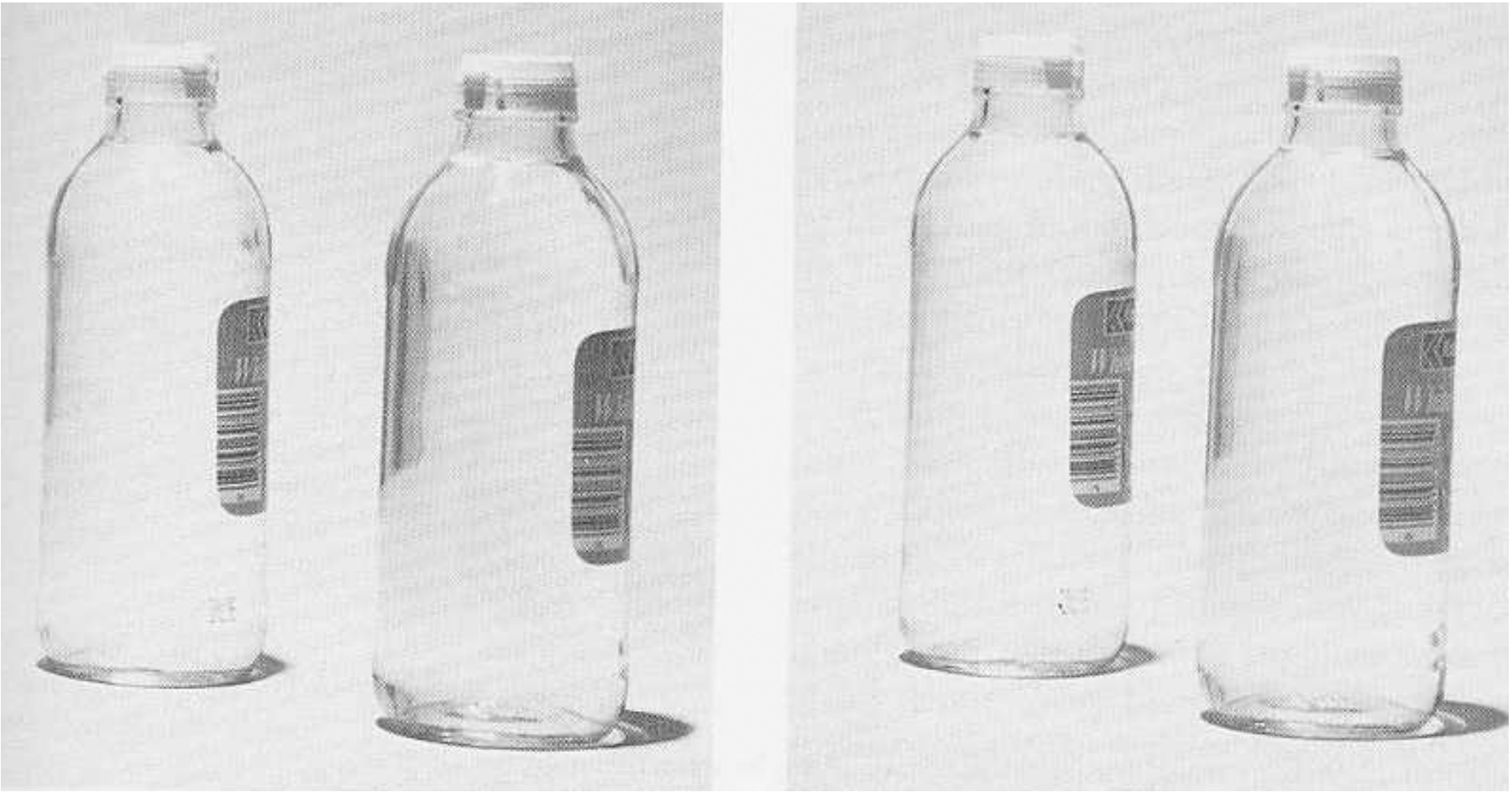


Determining Object Location

Disparity

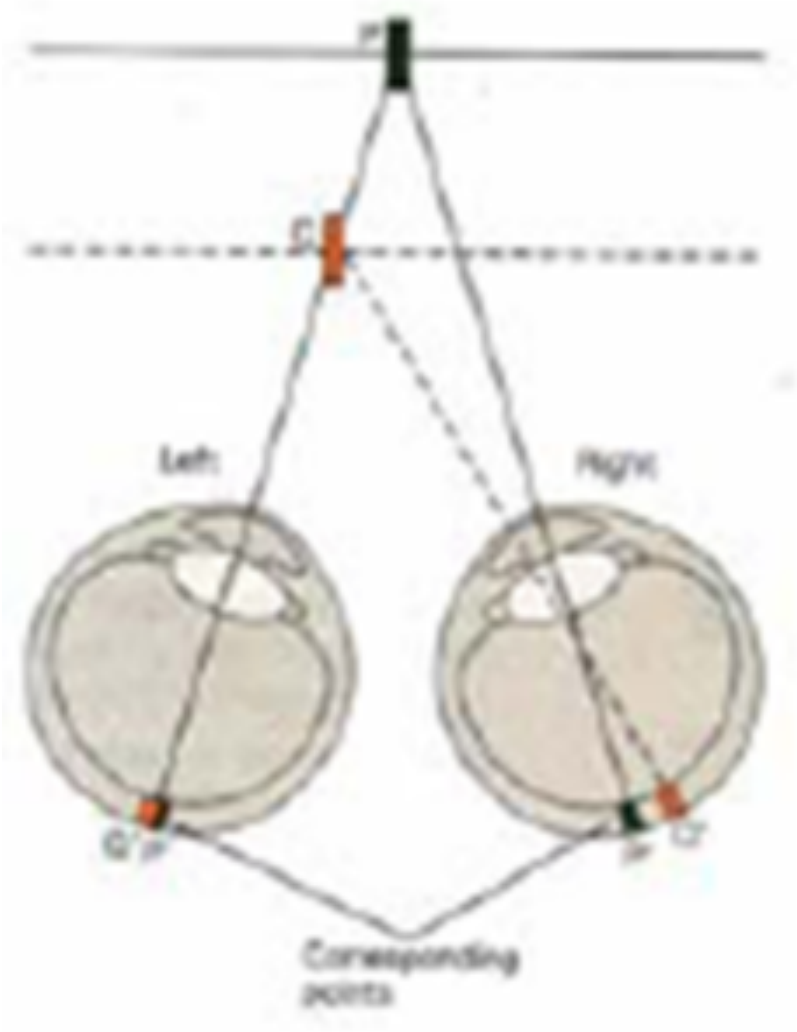

Distant object
Left eye view
Right eye view
Left eye view
Right eye view
Images go to brain where they are compared

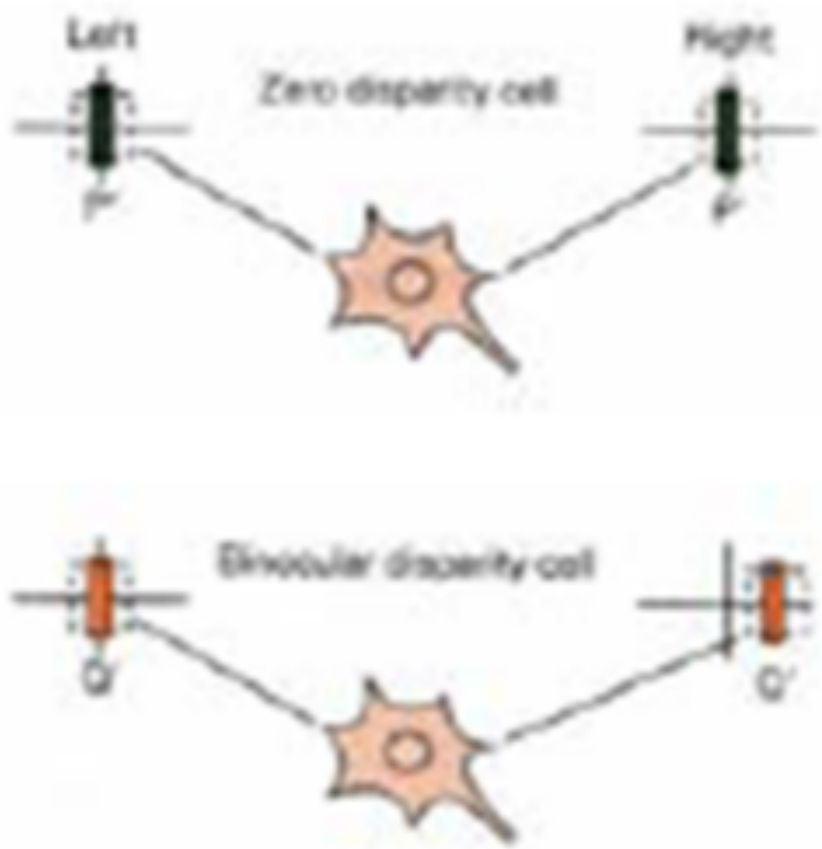
Disparity



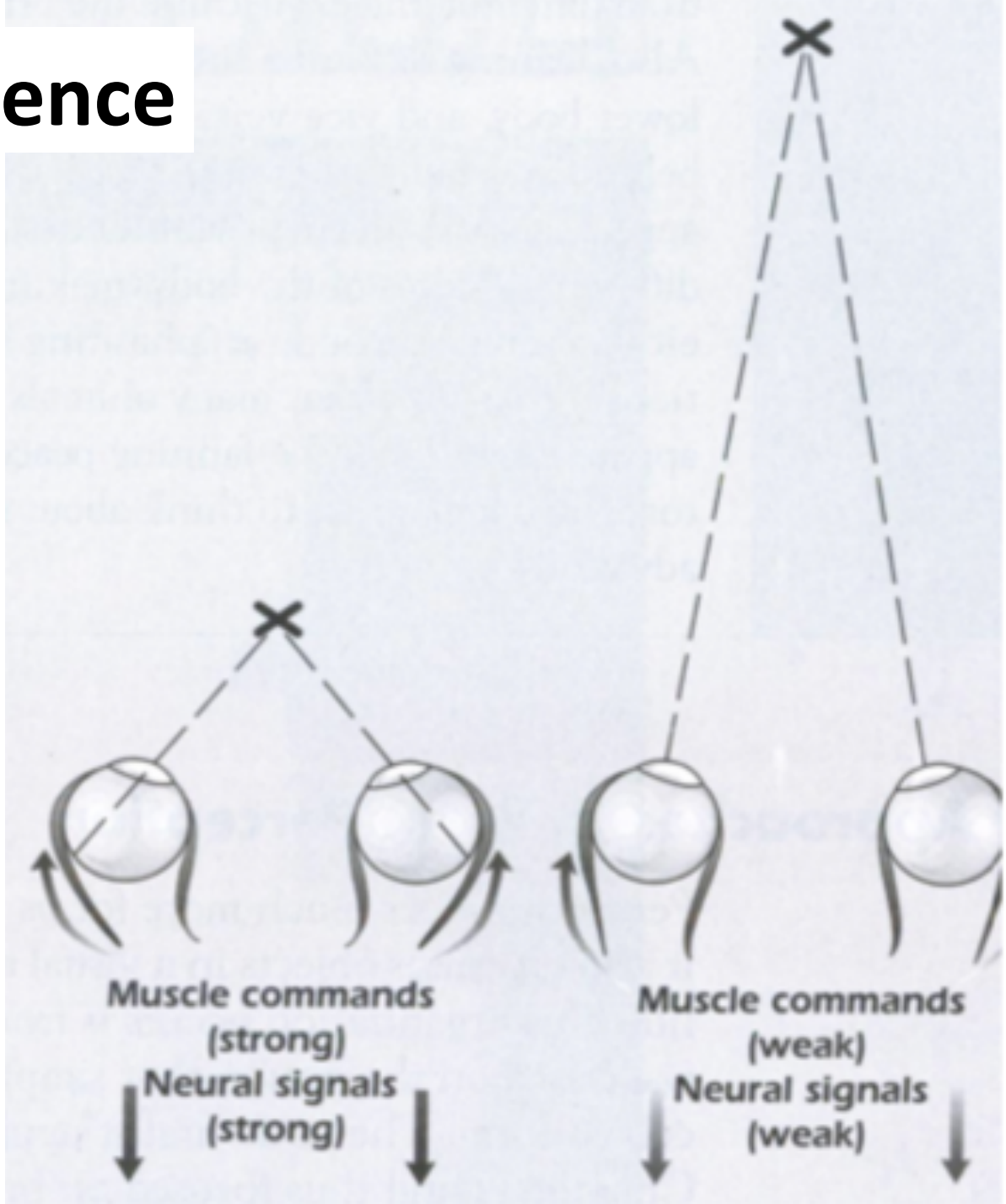
Left Eye **Right Eye**

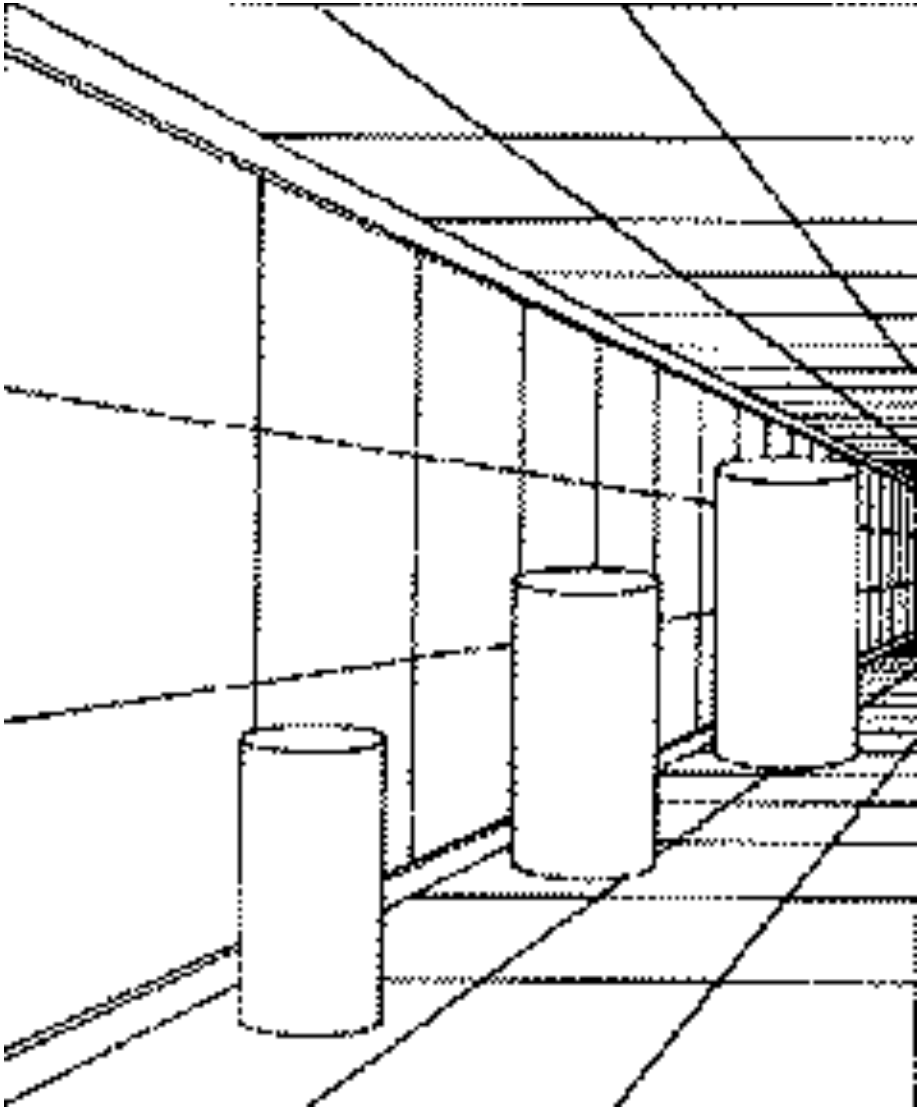
Disparity


Left
Right
Corresponding points

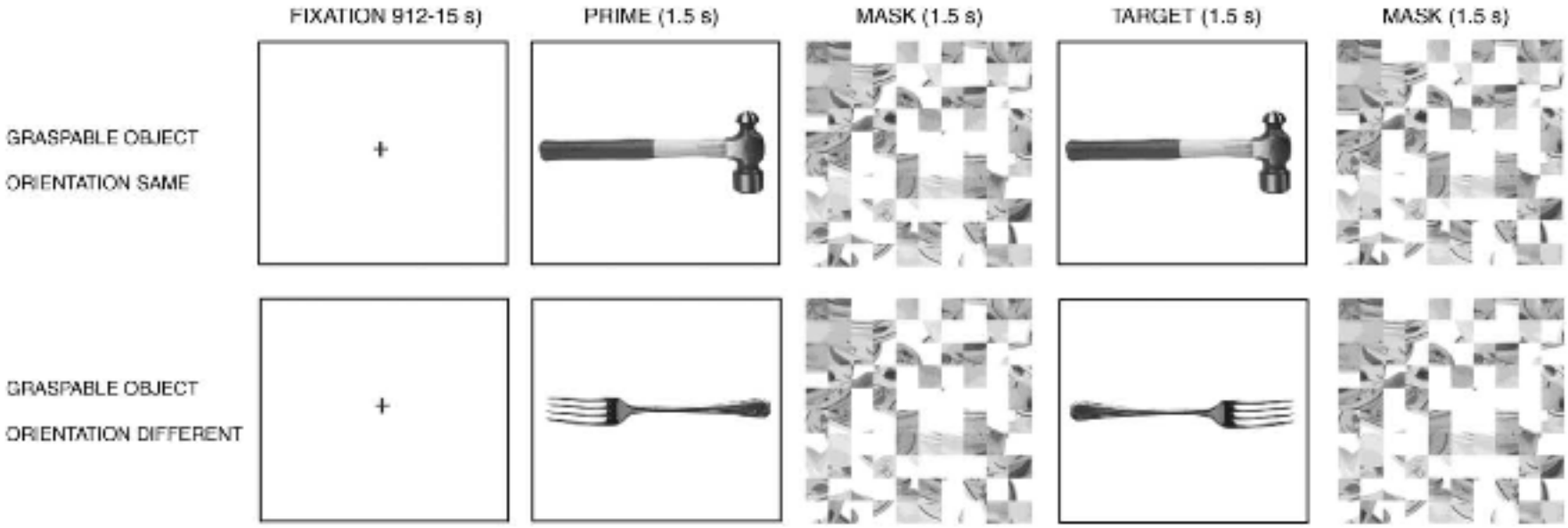

Left
Right
Zero disparity cell
Binocular disparity cell

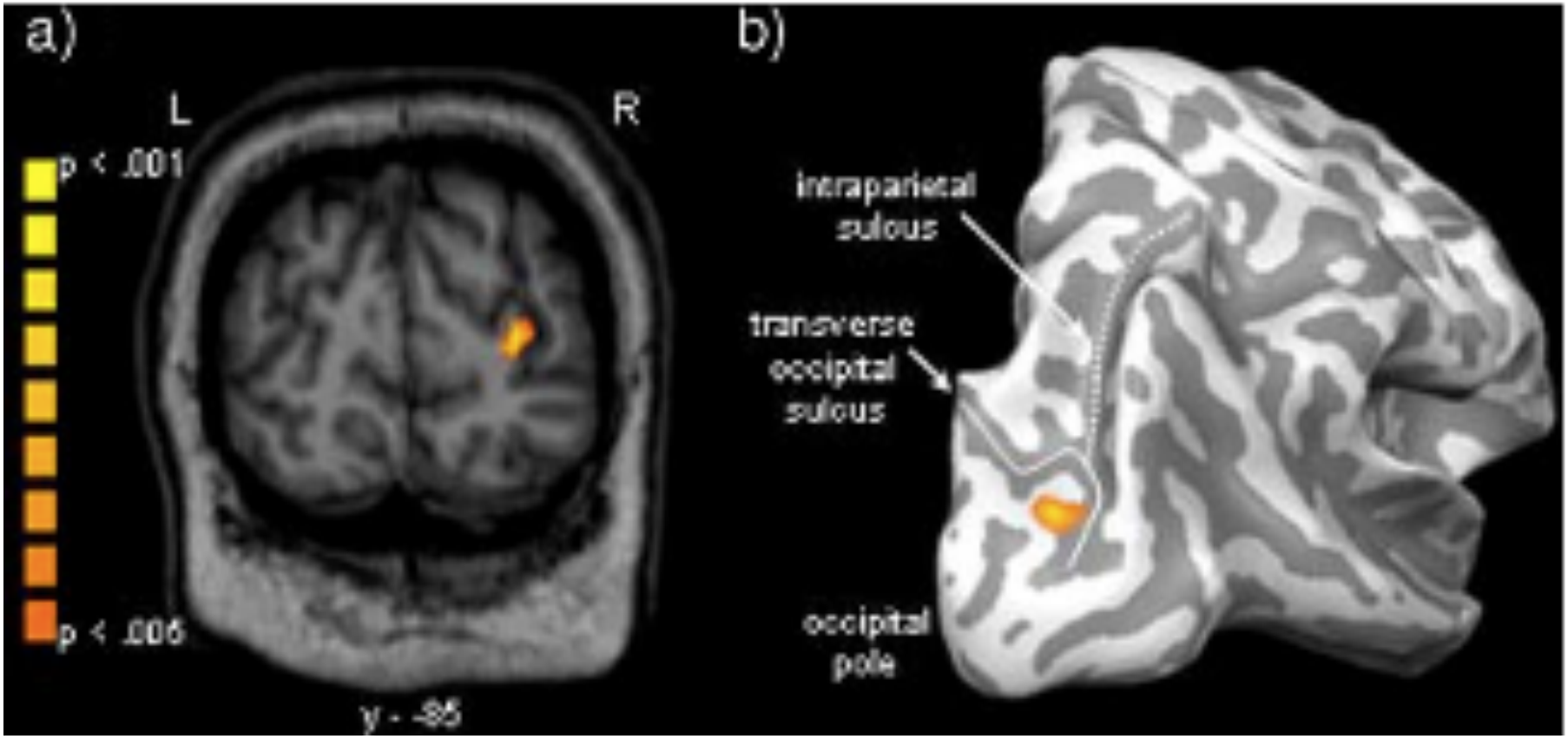
Convergence





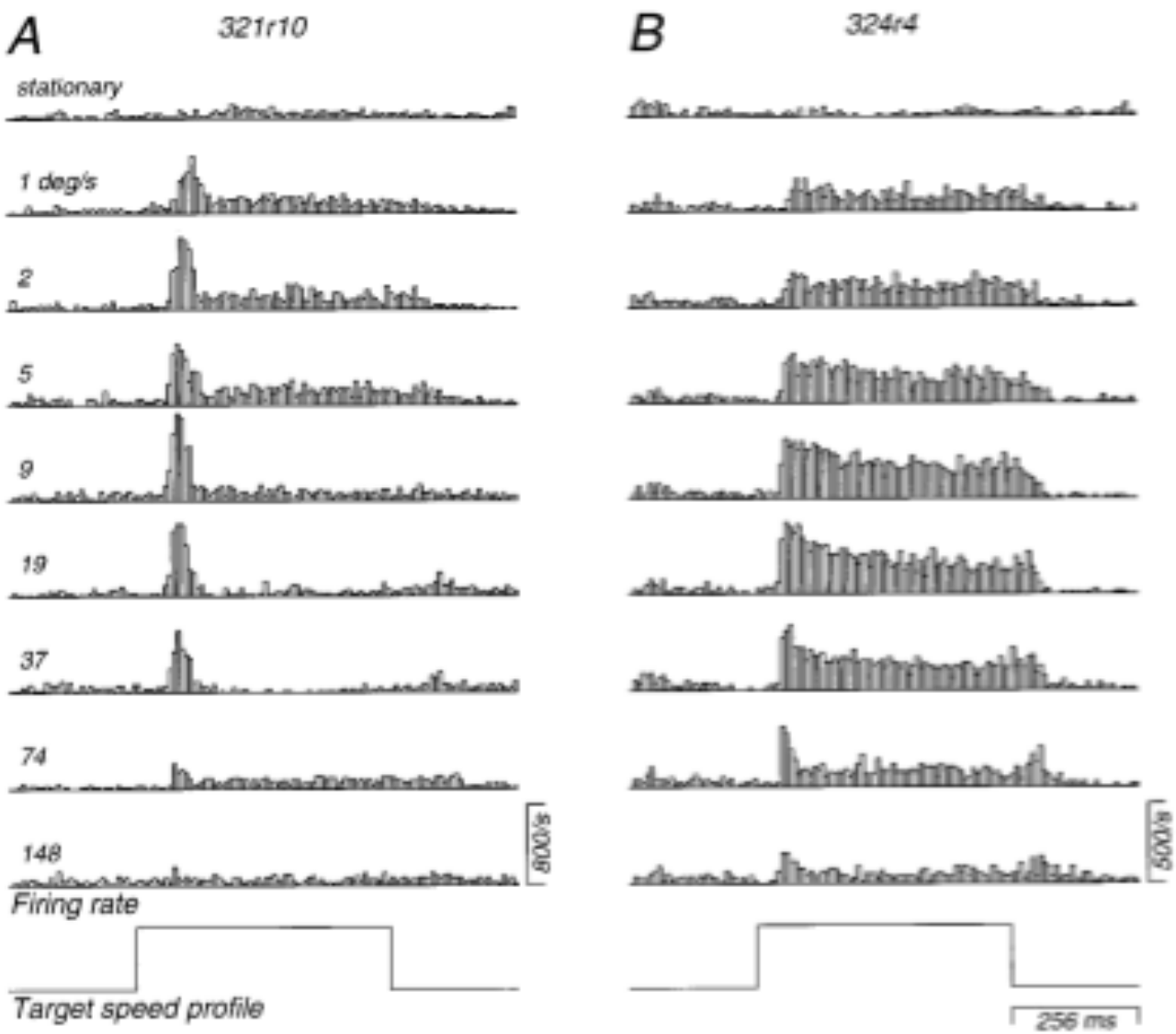
Object Orientation

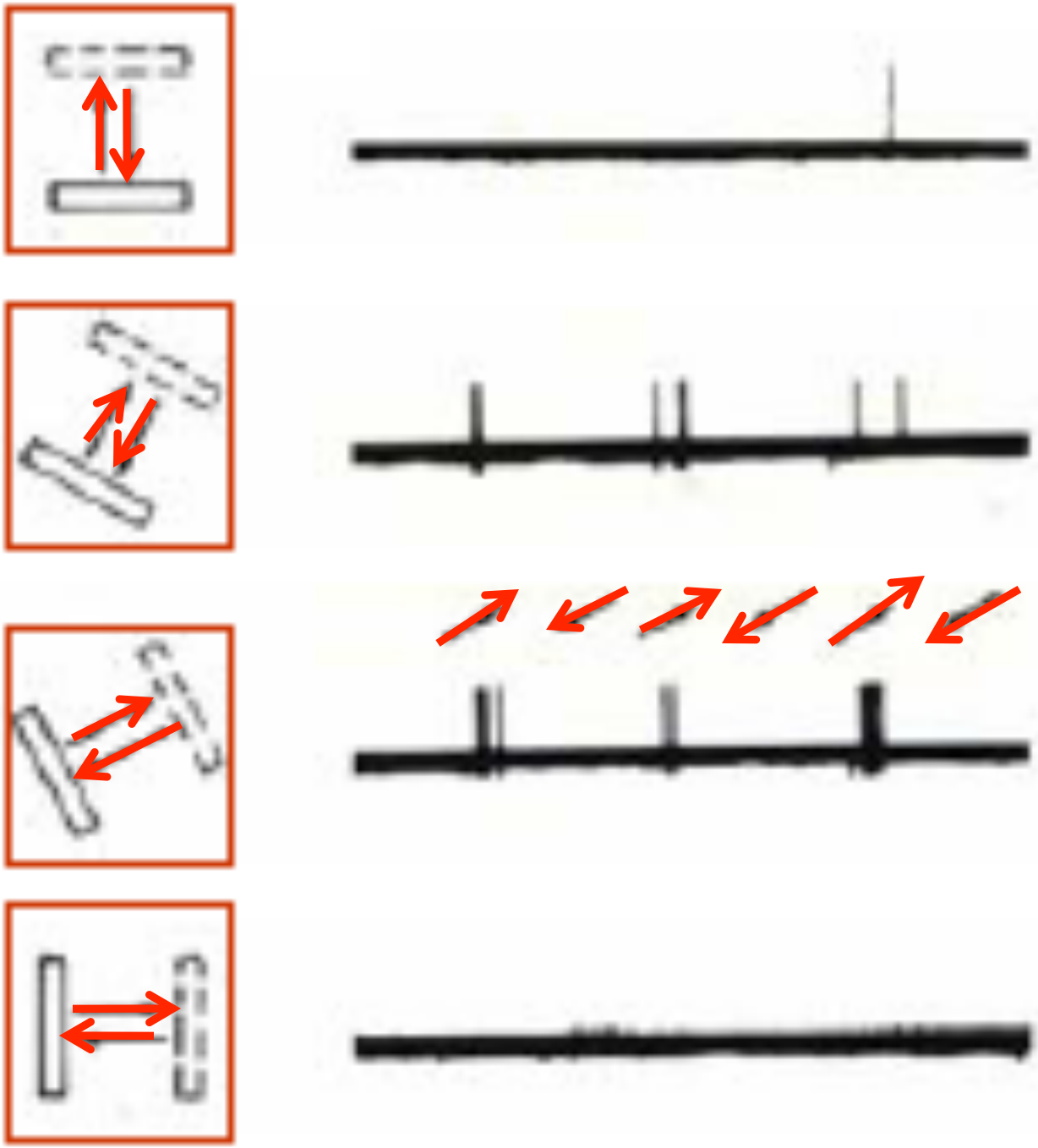

FIXATION 912-15 s)
PRIME (1.5 s)
MASK (1.5 s)
TARGET (1.5 s)
MASK (1.5 s)
GRASPABLE OBJECT
ORIENTATION SAME
GRASPABLE OBJECT
ORIENTATION DIFFERENT


a)
L
R
p < .001
p < .006
y = -85
b)
intraparietal sulcus
transverse occipital sulcus
occipital pole

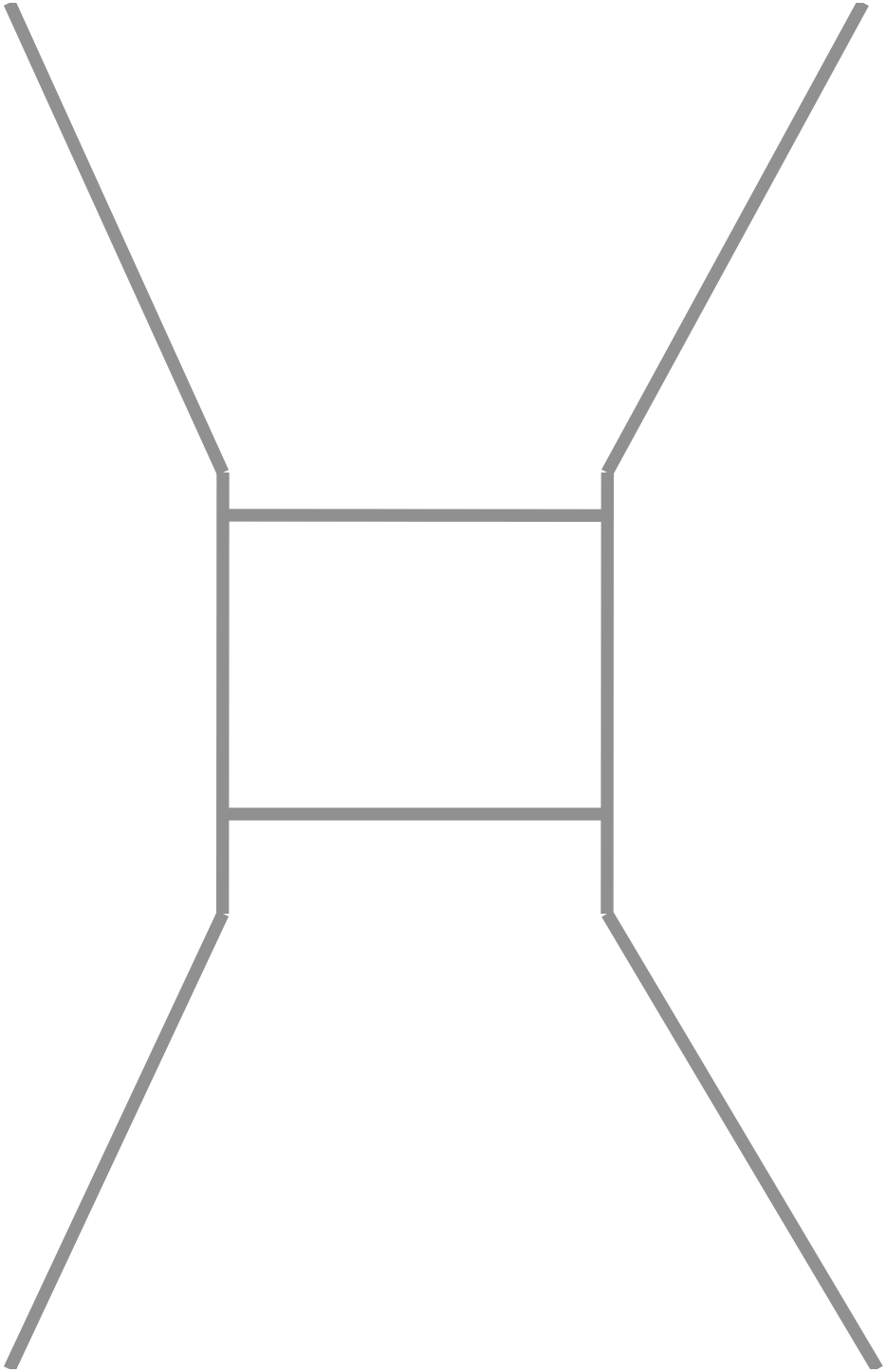
Motion Sensitive Neurons

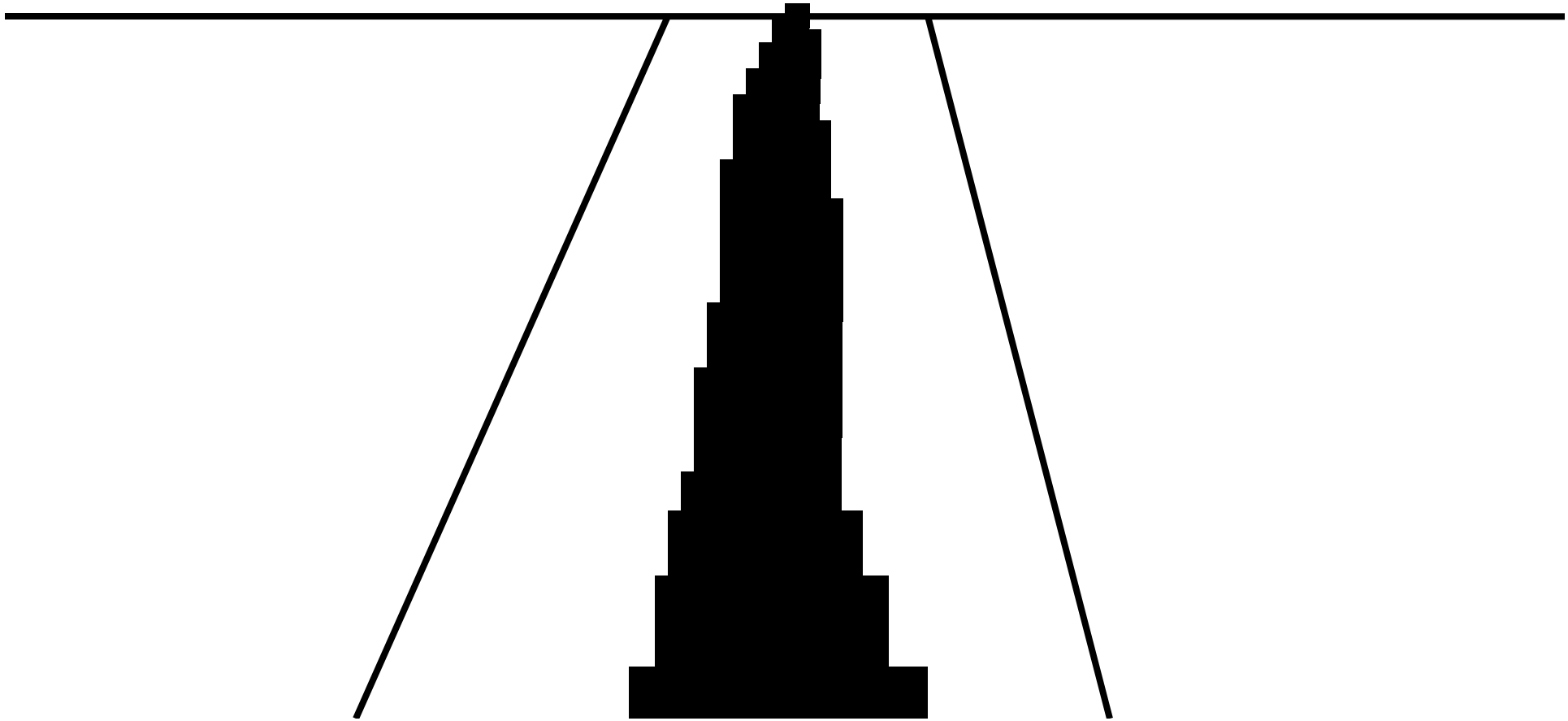
Area MT


A
321r10
B
324r4
stationary
1 deg/s
2
5
9
19
37
74
148
800/s
500/s
Firing rate
Target speed profile
256 ms



Learned Cues





RAPID COMMUNICATION

Representation of Manipulable Man-Made Objects in the Dorsal Stream

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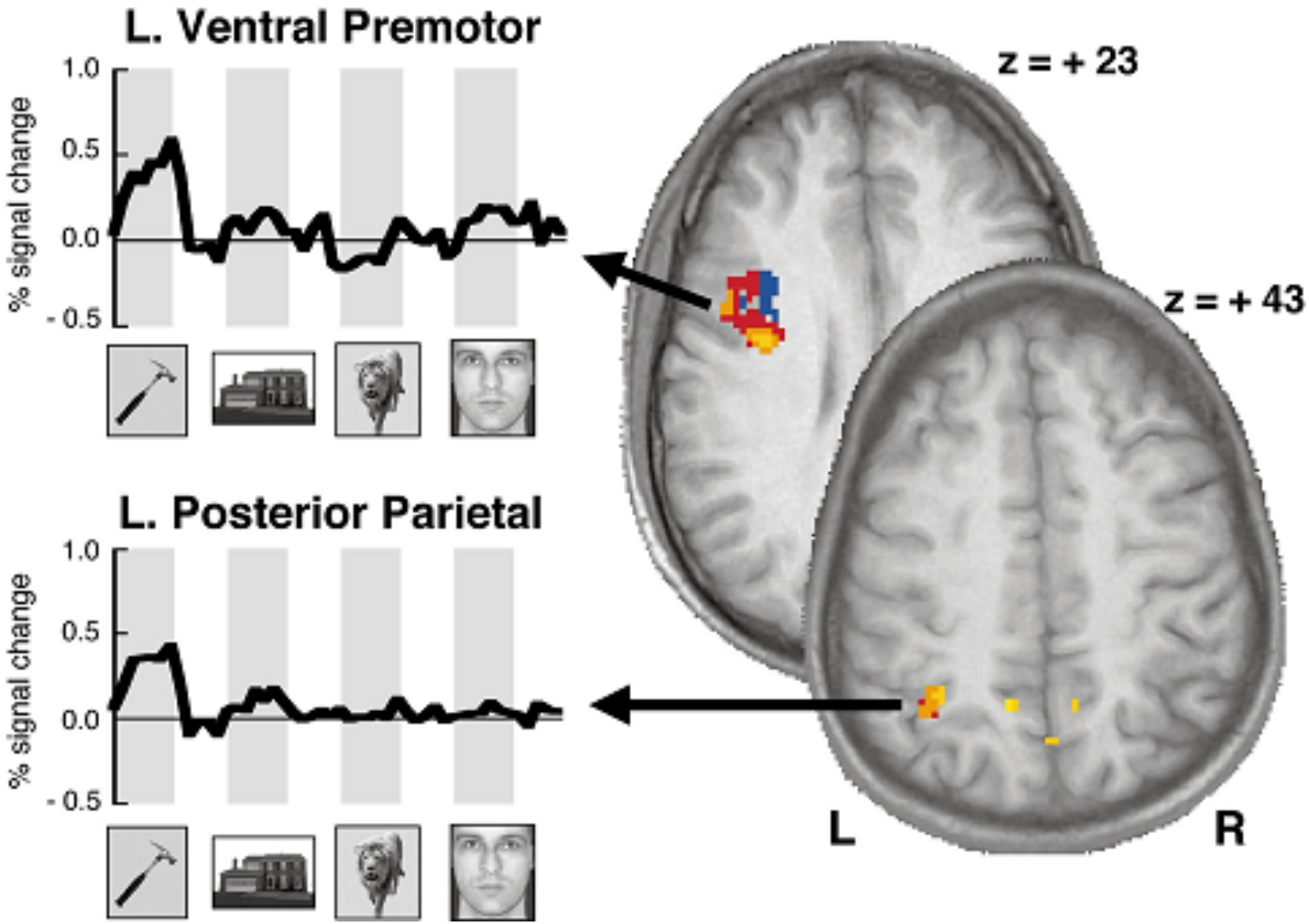
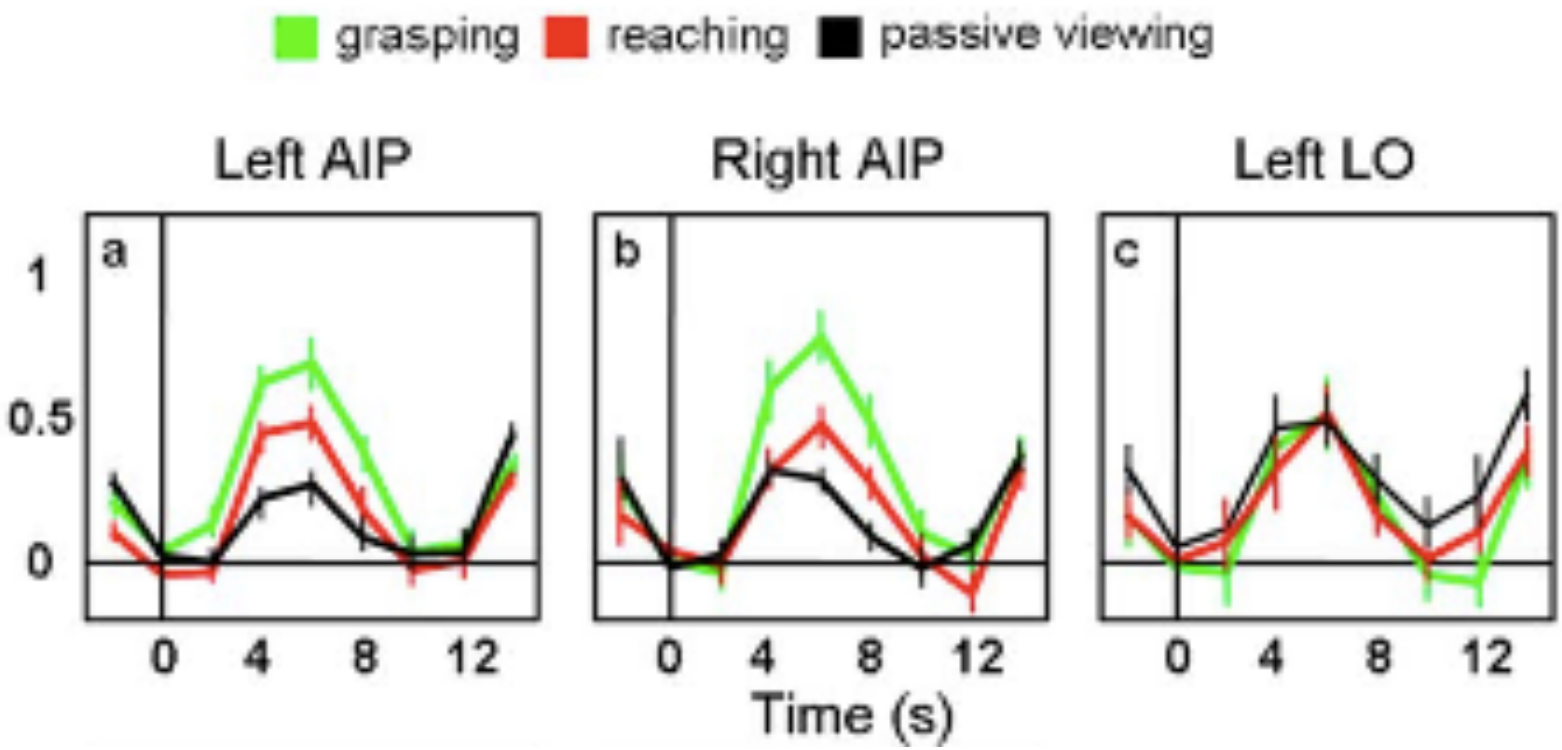
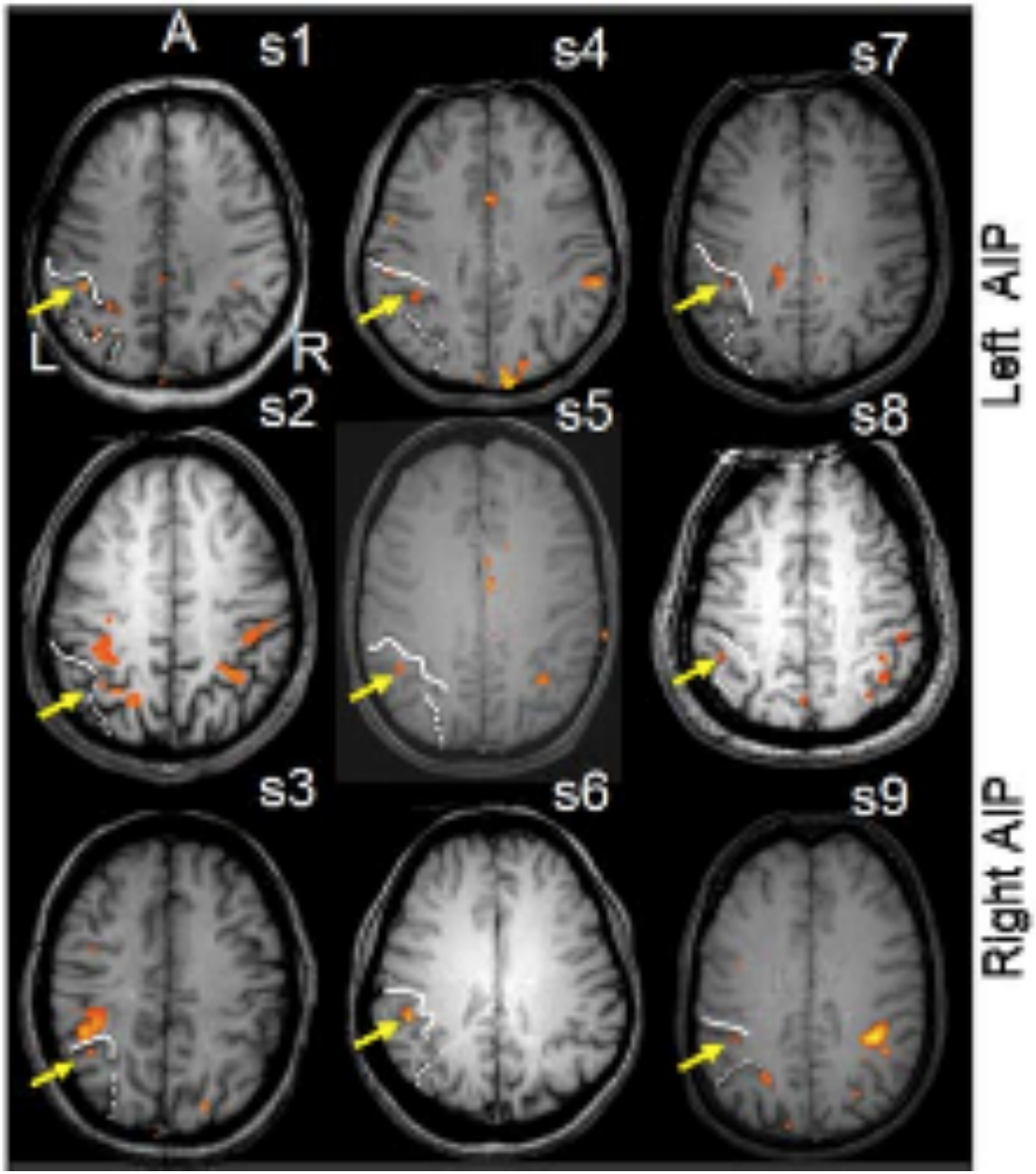
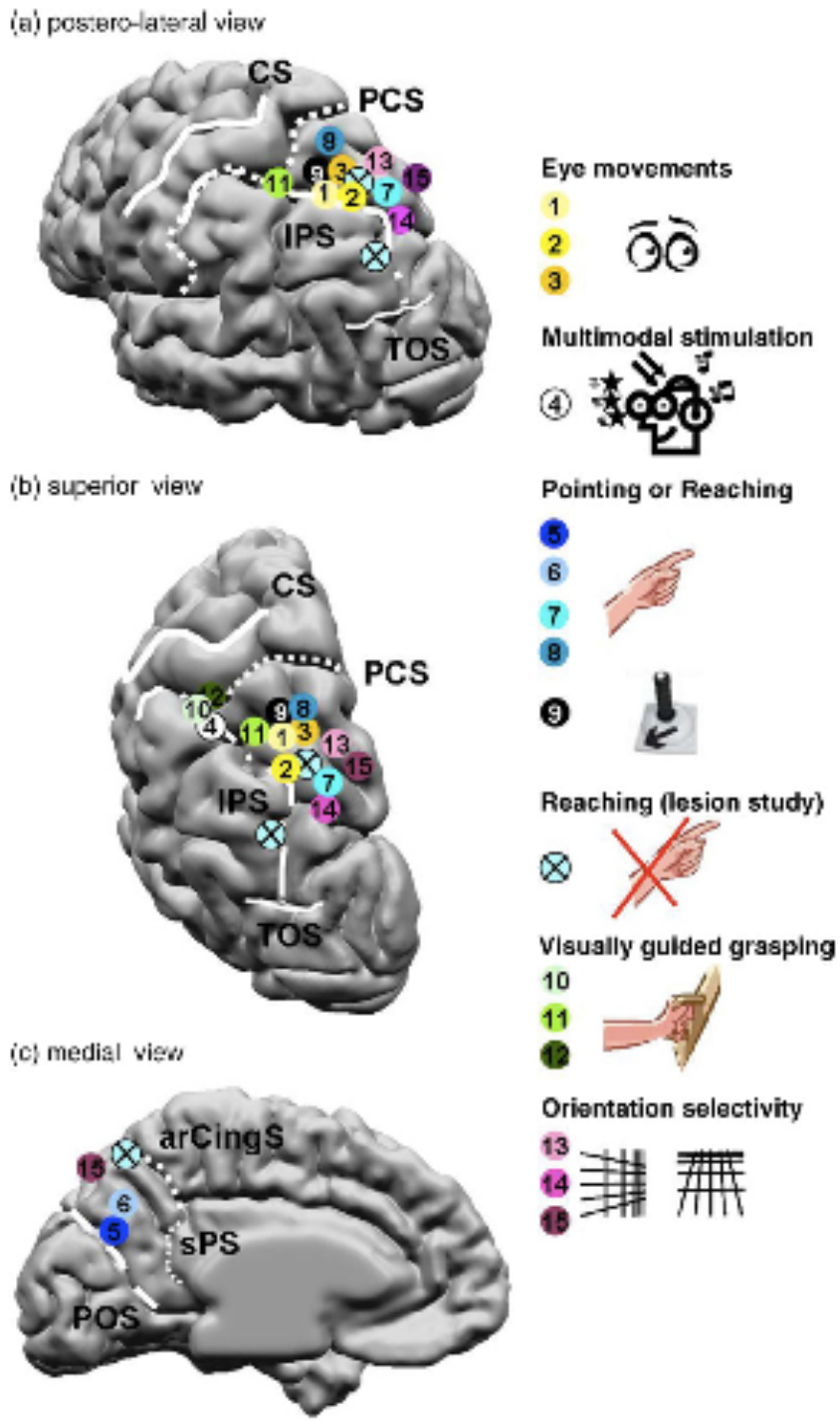
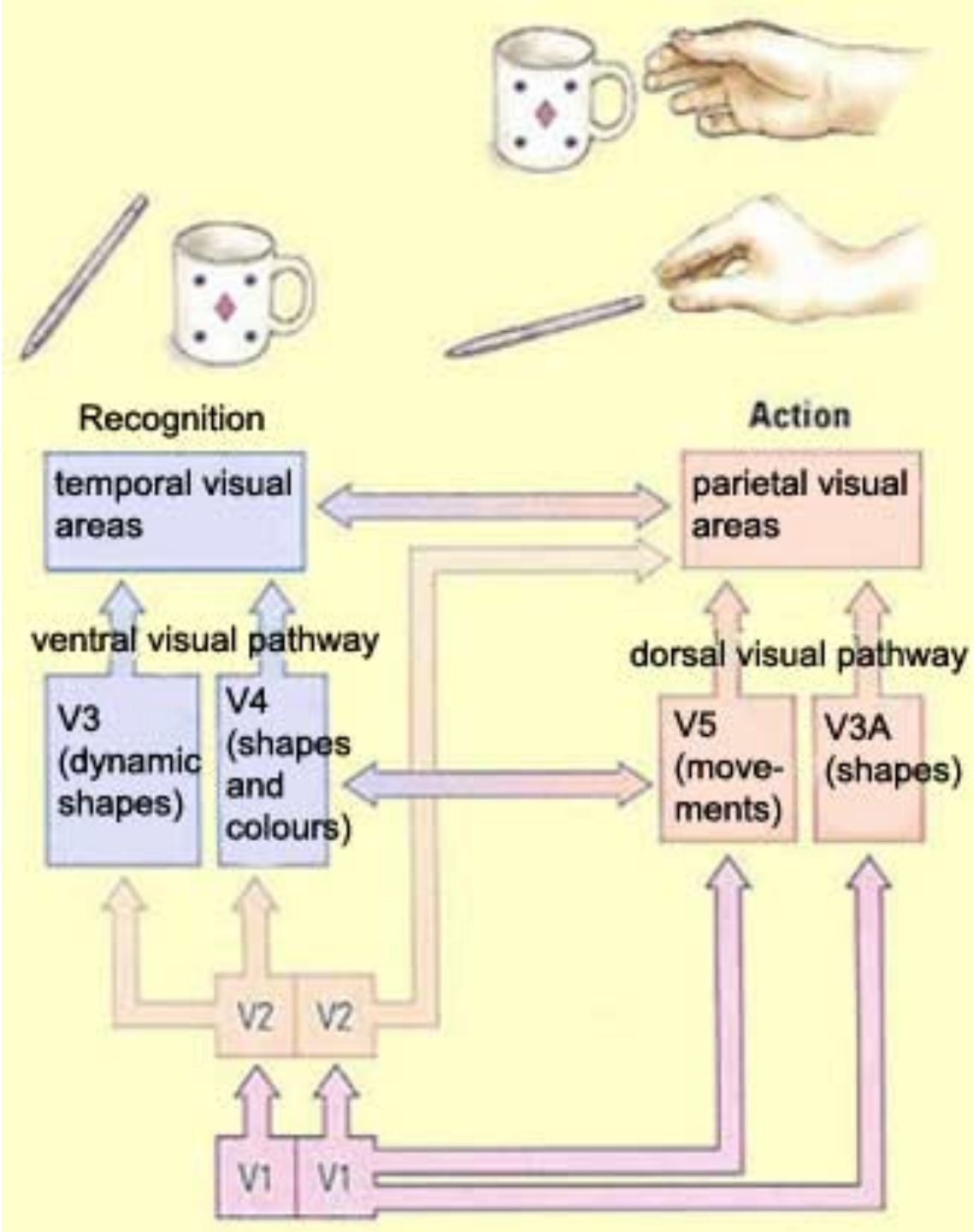

L. Ventral Premotor
% signal change
1.0
0.5
0.0
- 0.5
L. Posterior Parietal
% signal change
1.0
0.5
0.0
- 0.5
z = + 23
z = + 43
L
R

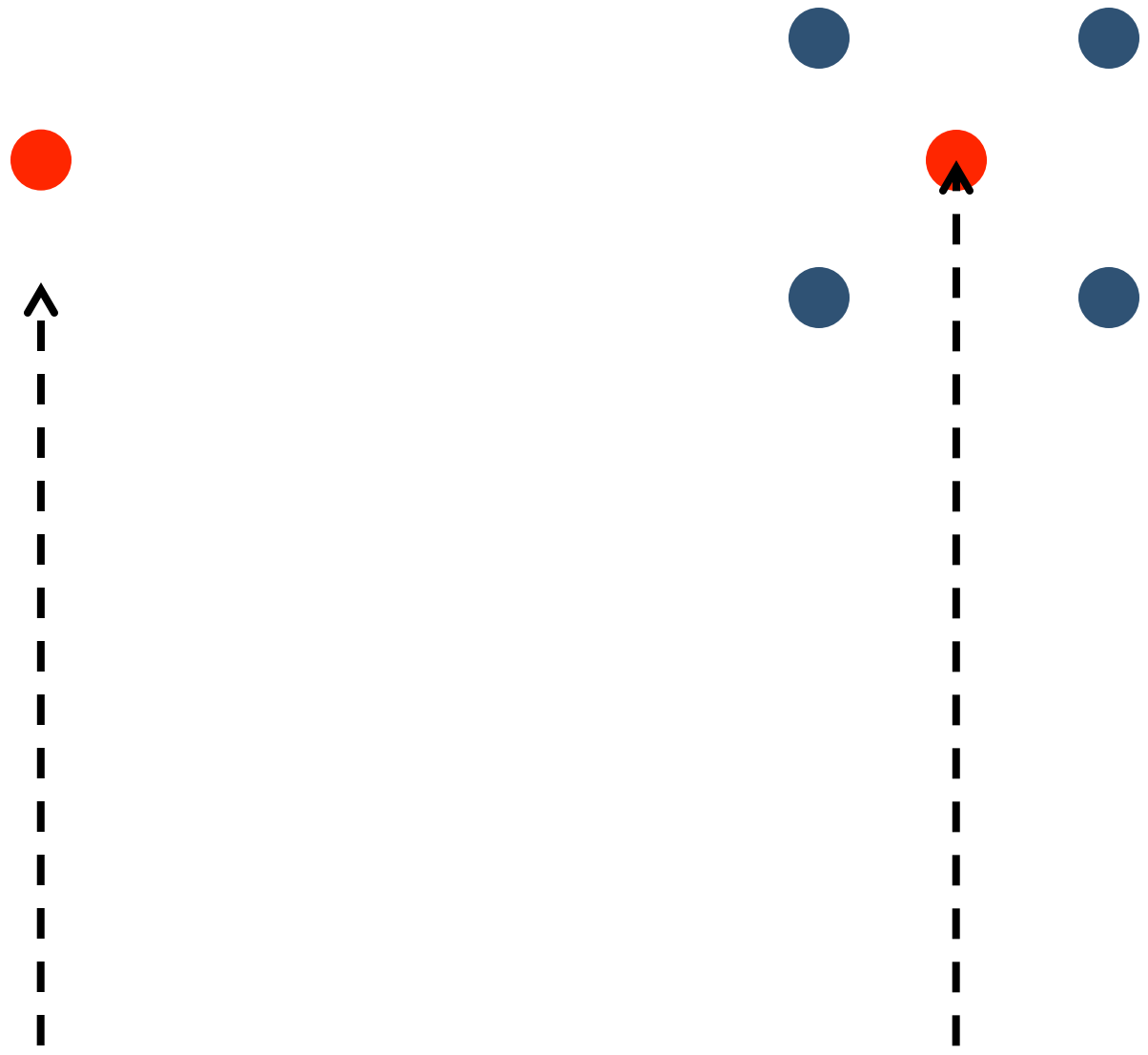

grasping
reaching
passive viewing
Left AIP
Right AIP
Left LO
a
b
c
1
0.5
0
0
4
8
12
Time (s)

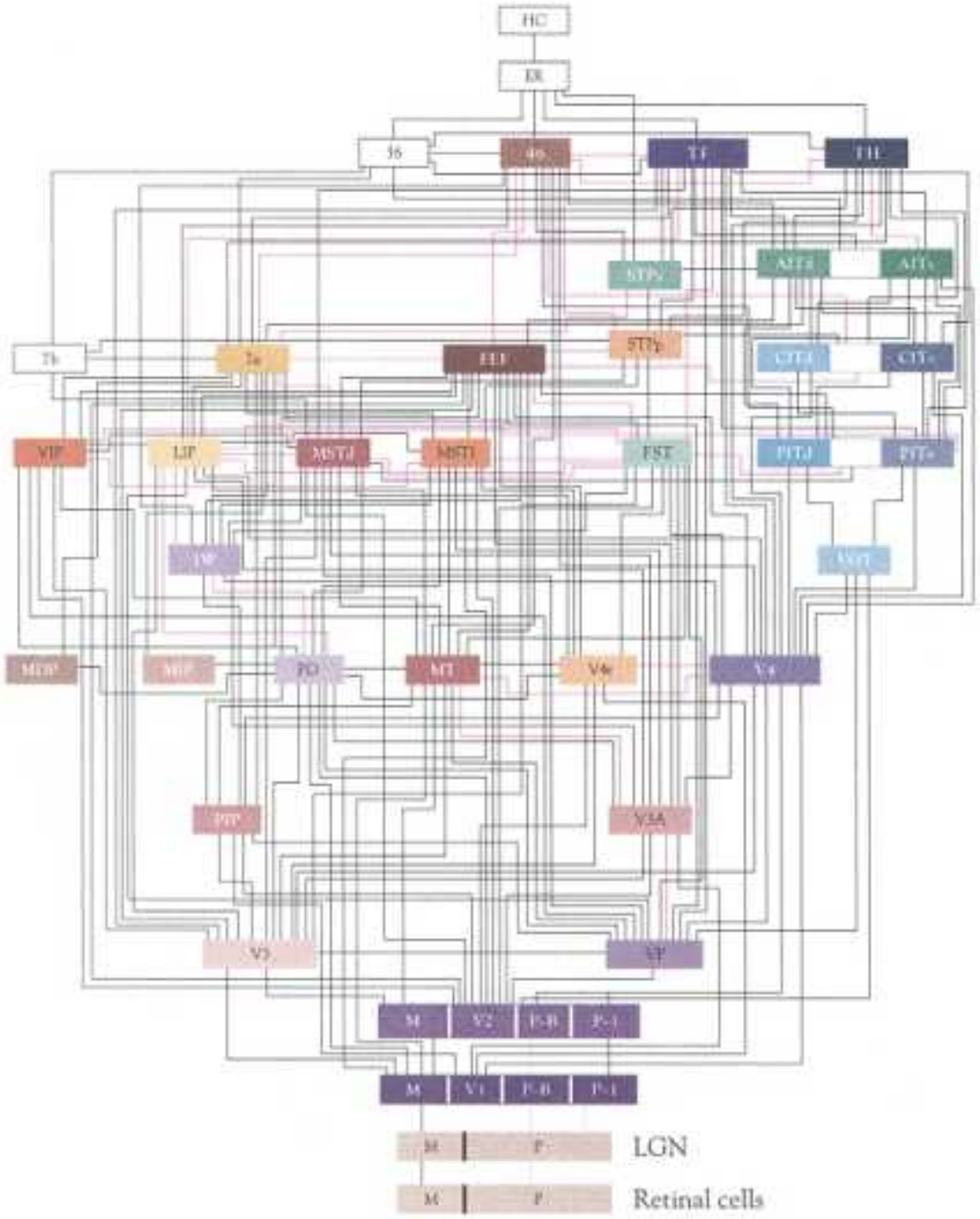

A
s1
s4
s7
L
R
s2
s5
s8
s3
s6
s9
Left AIP
Right AIP

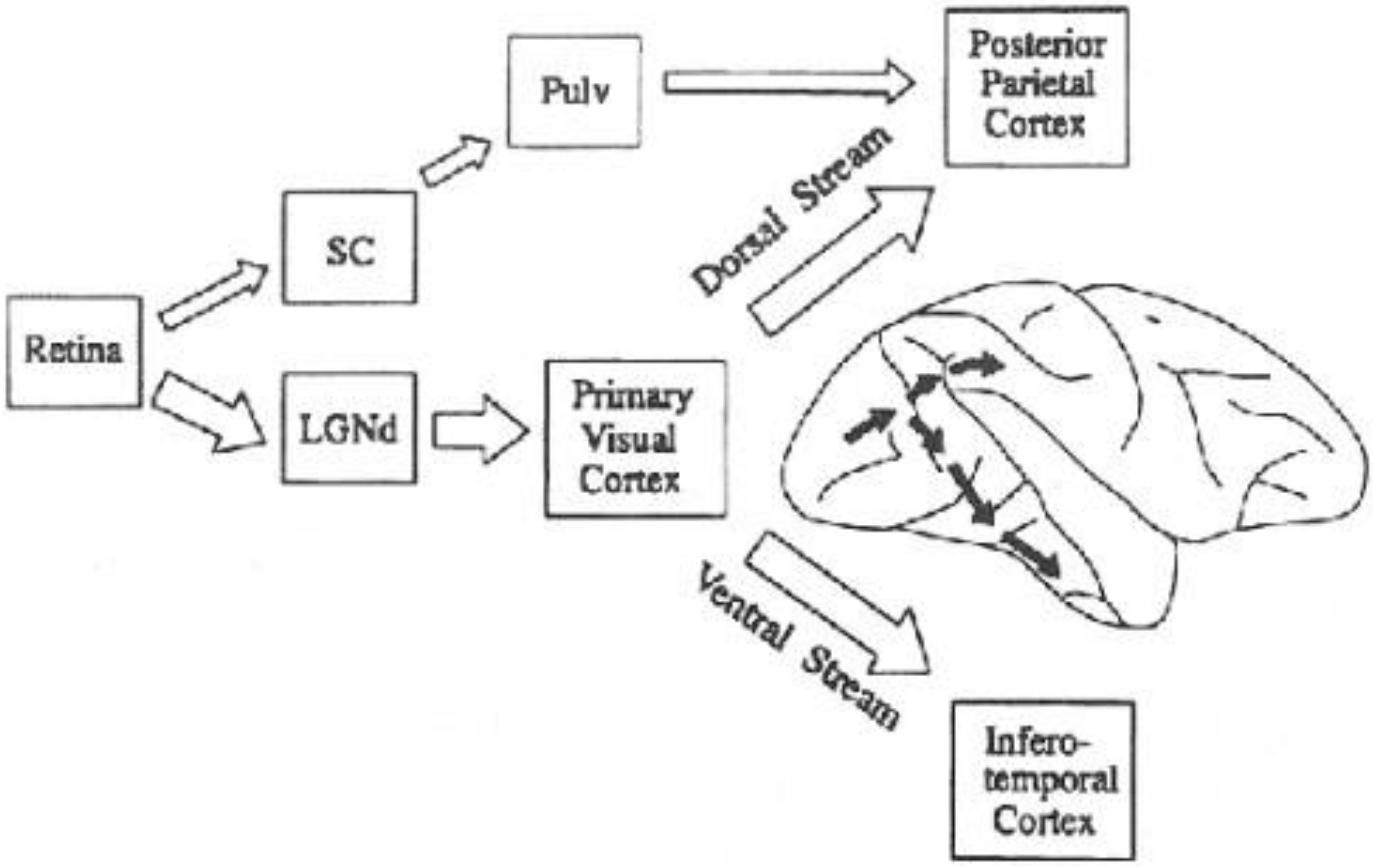

(a) postero-lateral view
CS
PCS
IPS
TOS
(b) superior view
CS
PCS
IPS
TOS
(c) medial view
arCingS
sPS
POS
Eye movements
1
2
3
Multimodal stimulation
4
Pointing or Reaching
5
6
7
8
9
Reaching (lesion study)
Visually guided grasping
10
11
12
Orientation selectivity
13
14
15

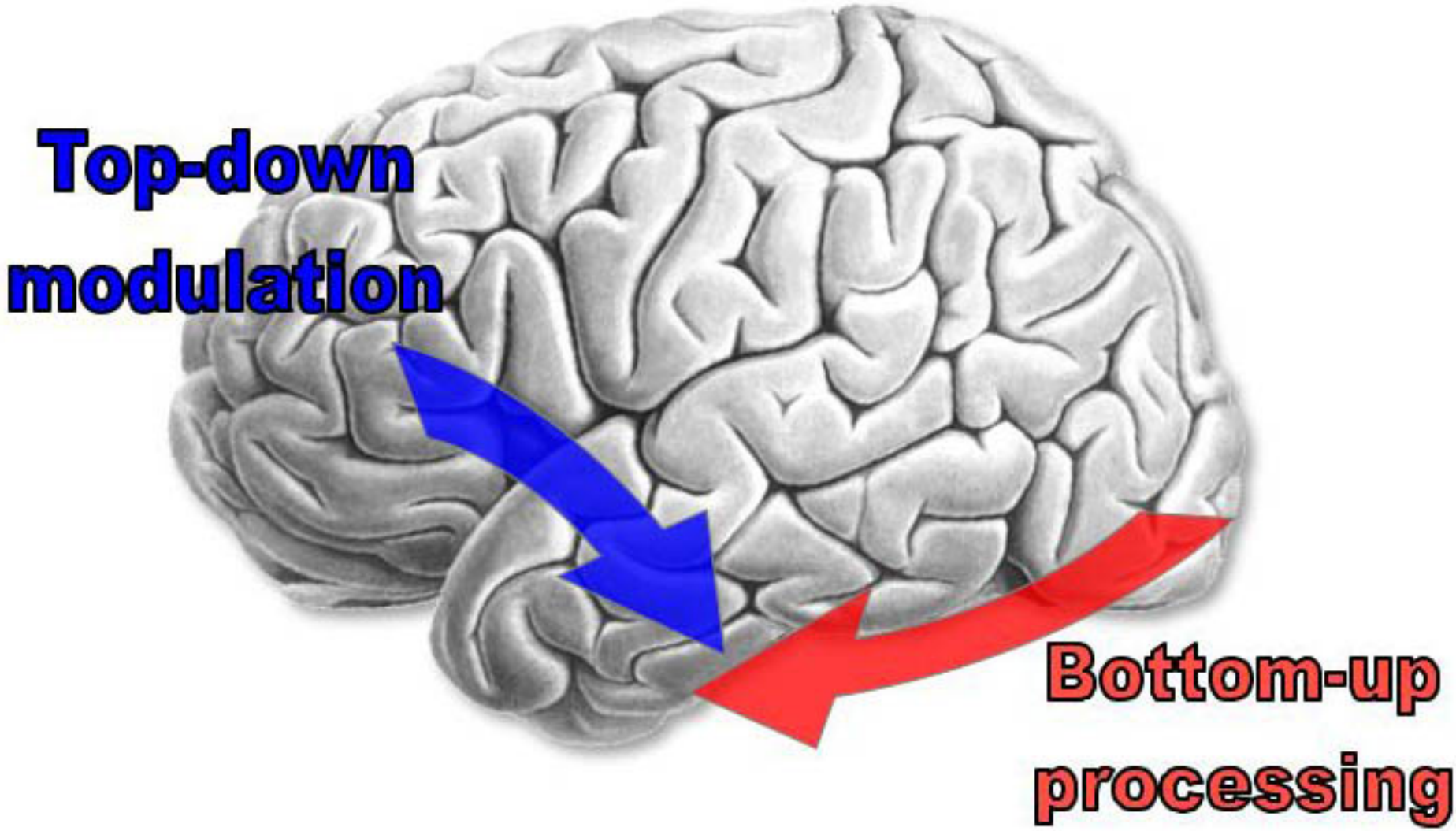
The Two Visual Streams Do Not Work in Isolation

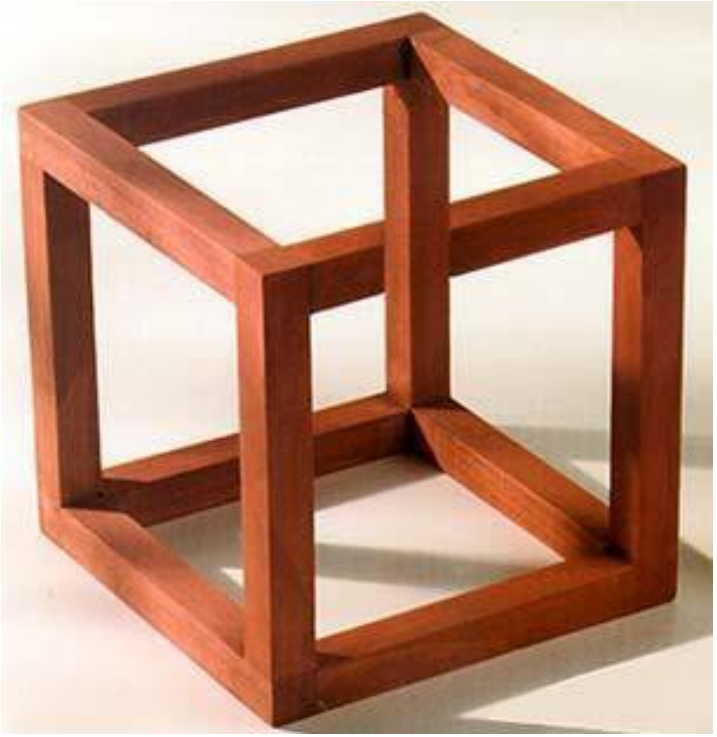

Recognition
Action
temporal visual areas
parietal visual areas
ventral visual pathway
dorsal visual pathway
V3 (dynamic shapes)
V4 (shapes and colours)
V5 (move-ments)
V3A (shapes)
V2
V2
V1
V1

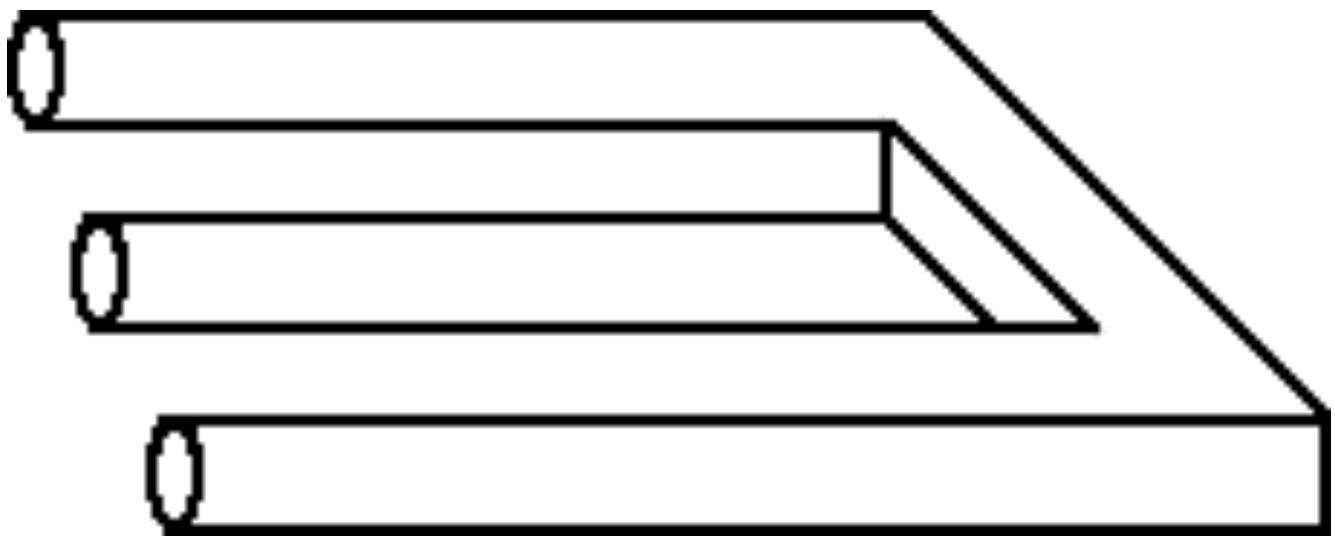


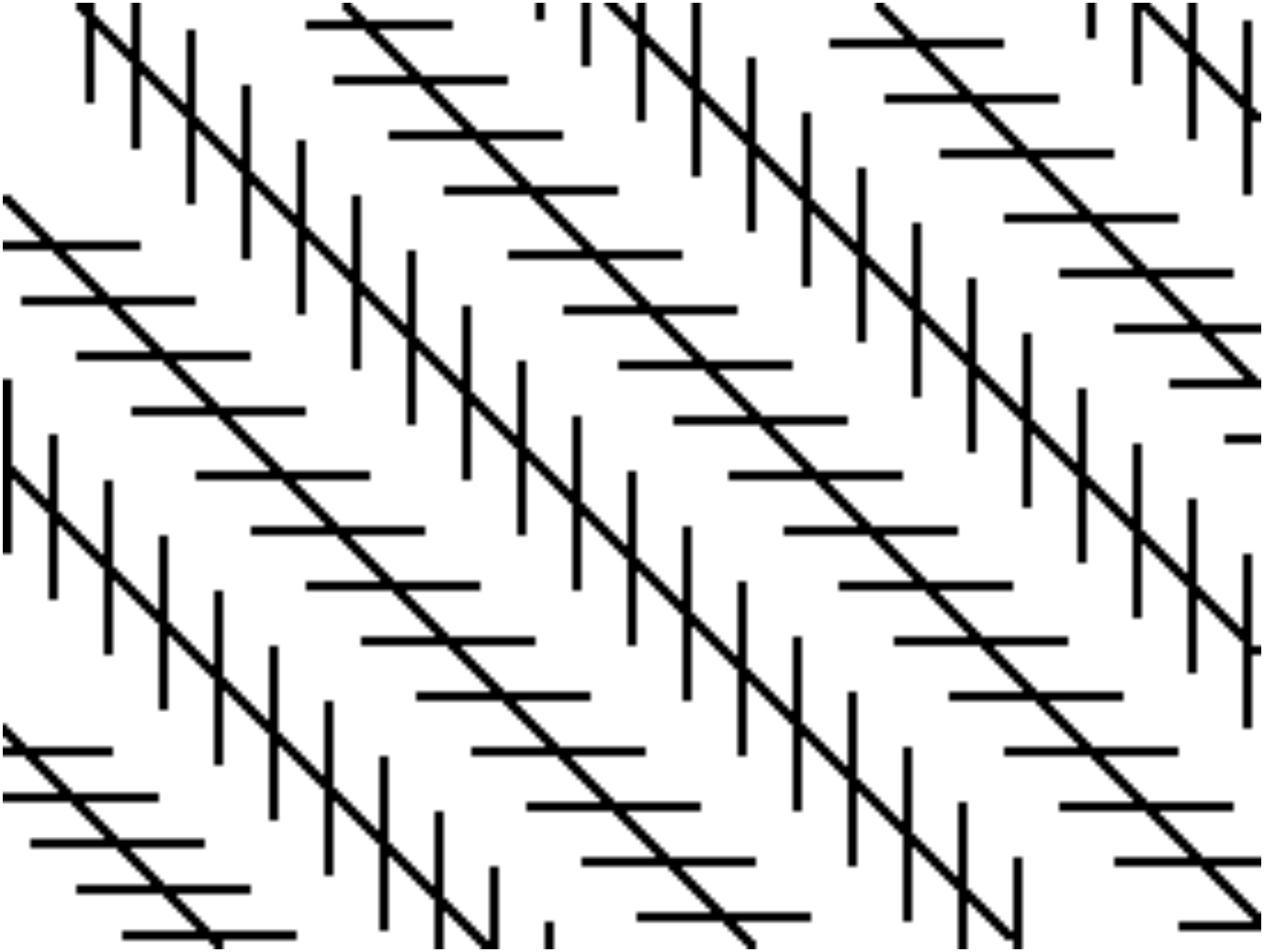

HC
ER
36
TF
TH
Th
VIP
LIP
MSTd
MSTl
FST
PITd
PITv
PO
MT
V4t
V4
VOT
V3
V3A
M
V2
P-B
P-I
M
V1
P-B
P-I
M
P
LGN
M
P
Retinal cells

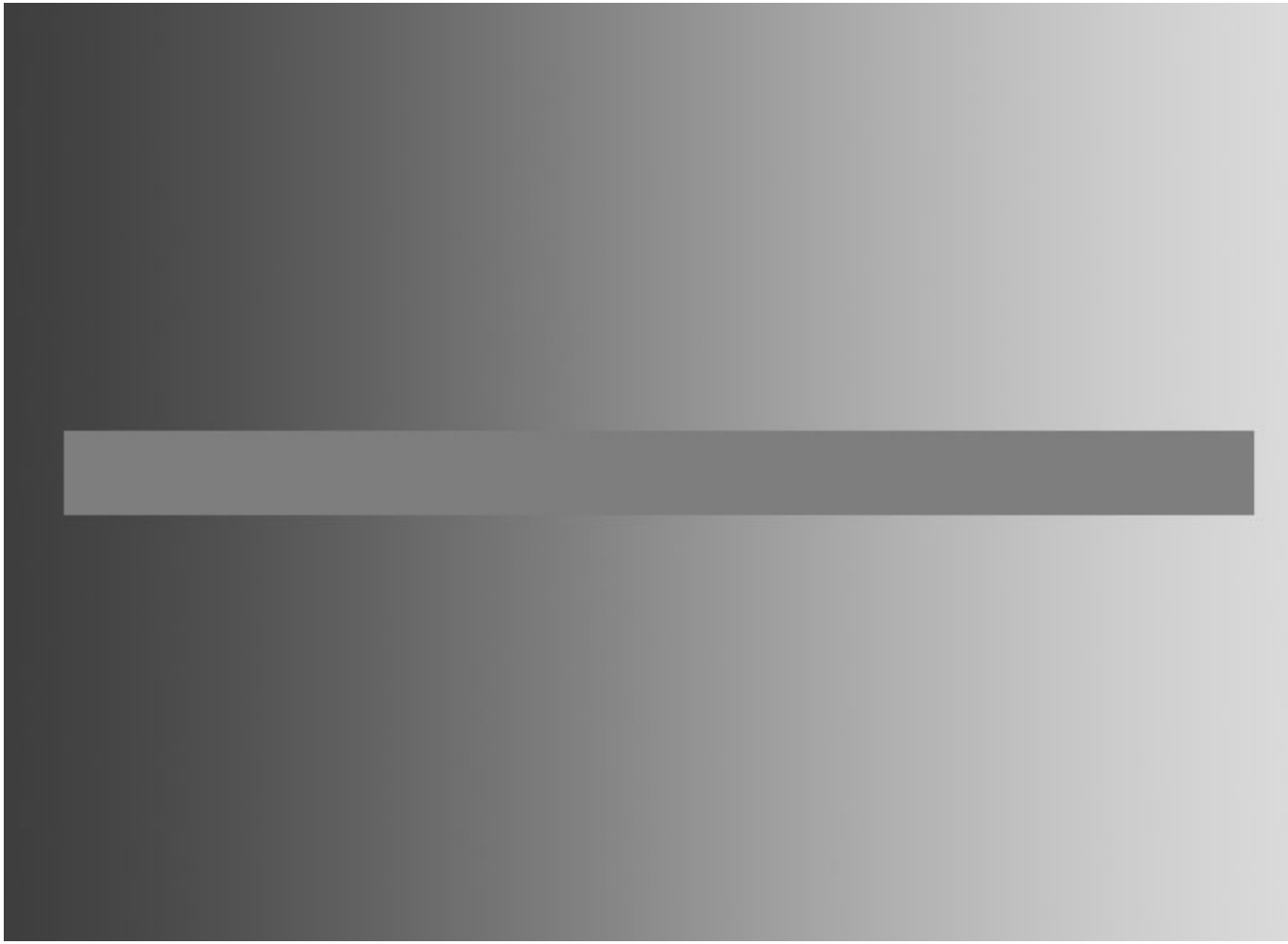

Retina
SC
Pulv
LGNd
Primary Visual Cortex
Posterior Parietal Cortex
Dorsal Stream
Ventral Stream
Infero-temporal Cortex

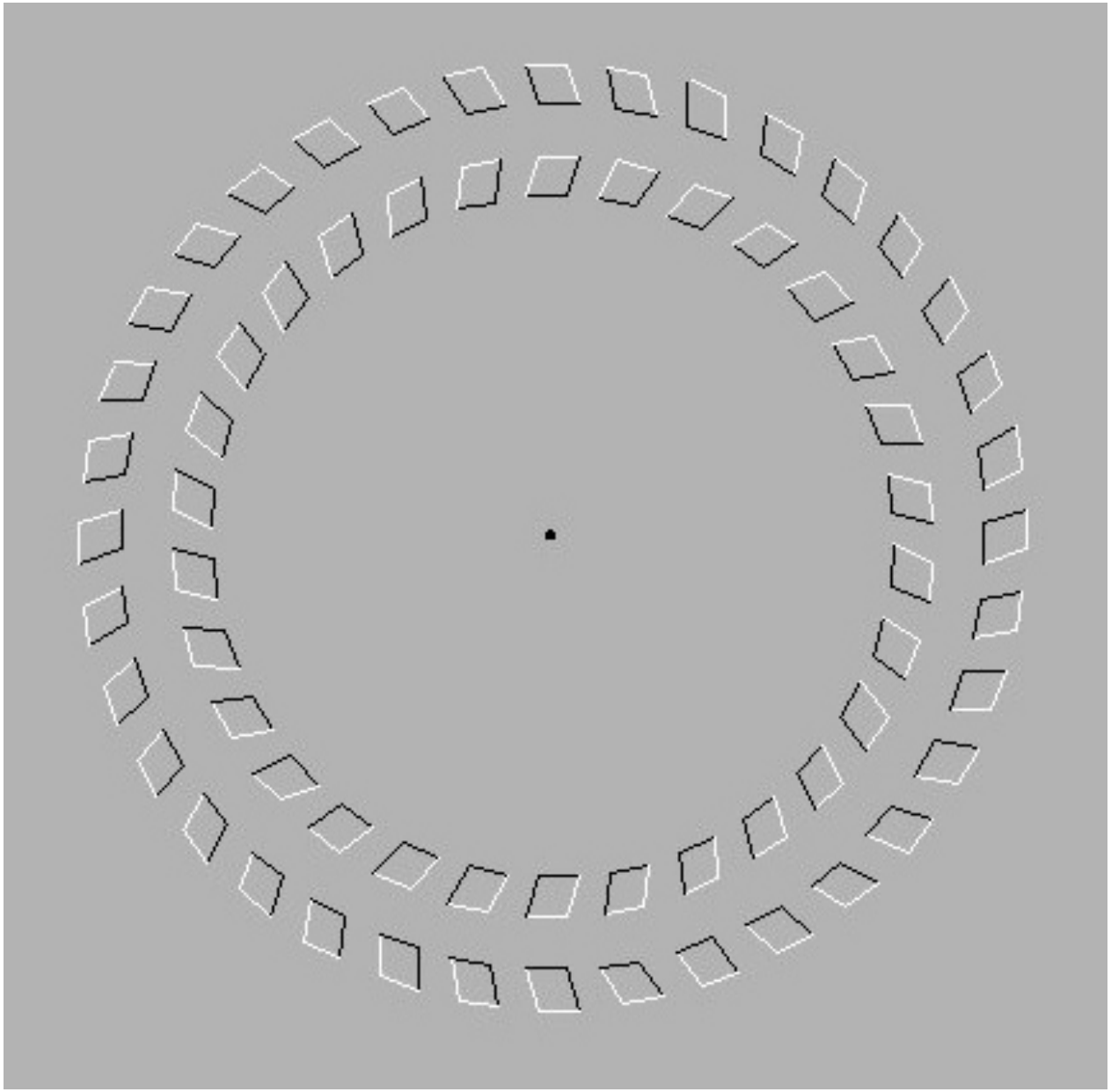

Top-down
modulation
Bottom-up
processing











The perception of an object:

Instantaneous and effortless

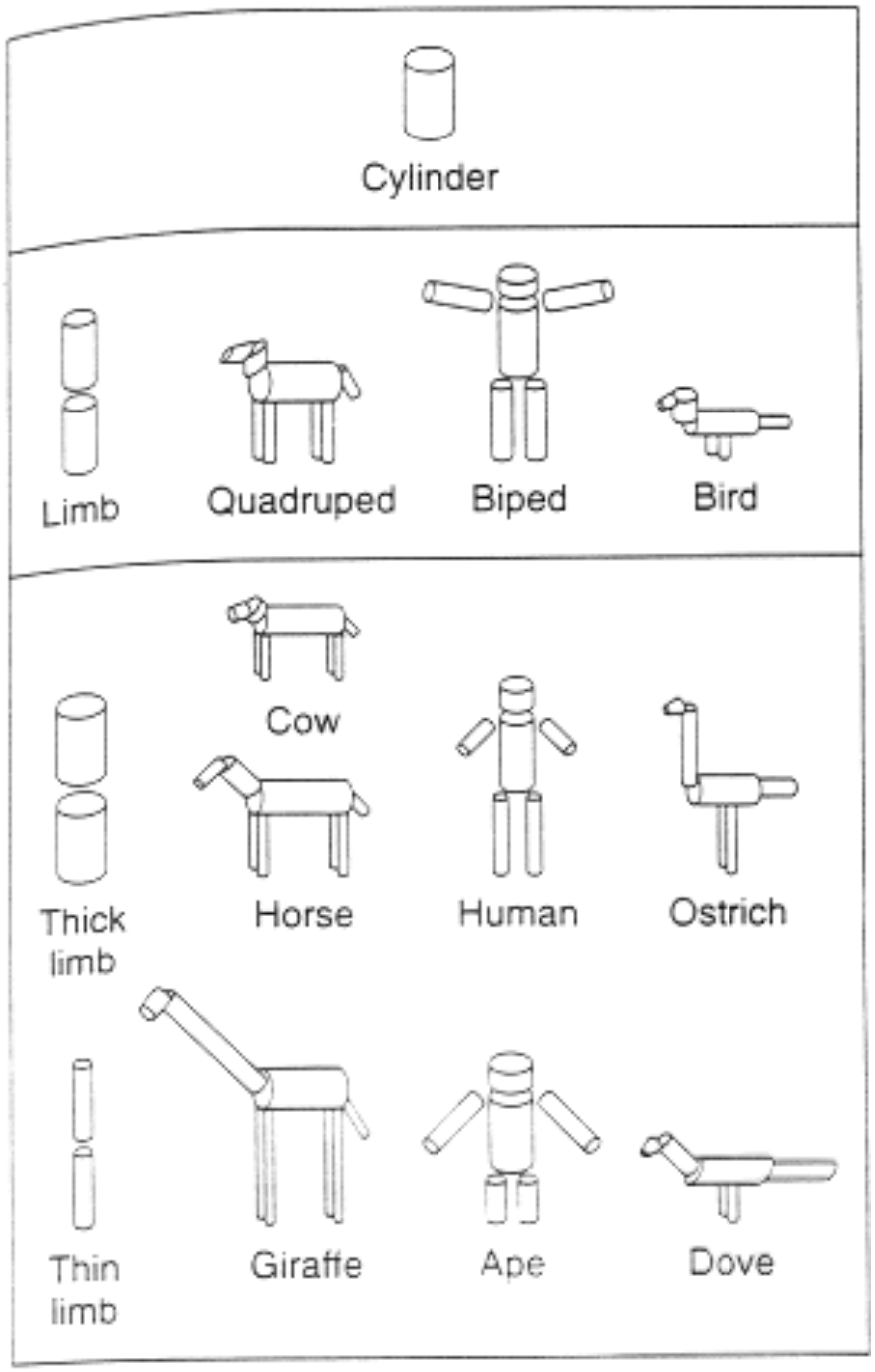
e.g. Thorpe, Fize and Marlot (1996); Grill-Spector and Kanwisher (2005)

Top-Down Processing

<u>Template Matching</u>

Top Down Processing

Geon Model



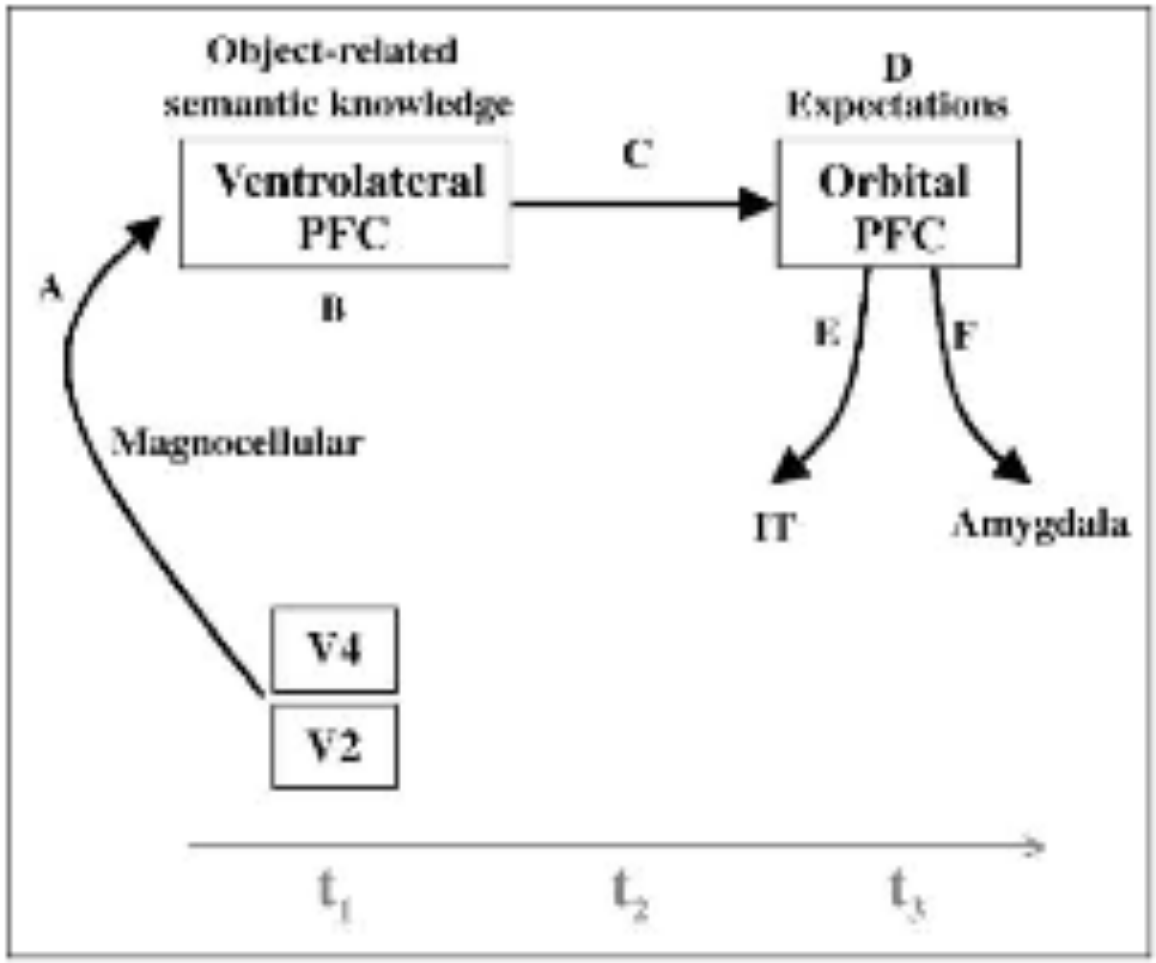
A Cortical Mechanism for Triggering Top-Down Facilitation in Visual Object Recognition

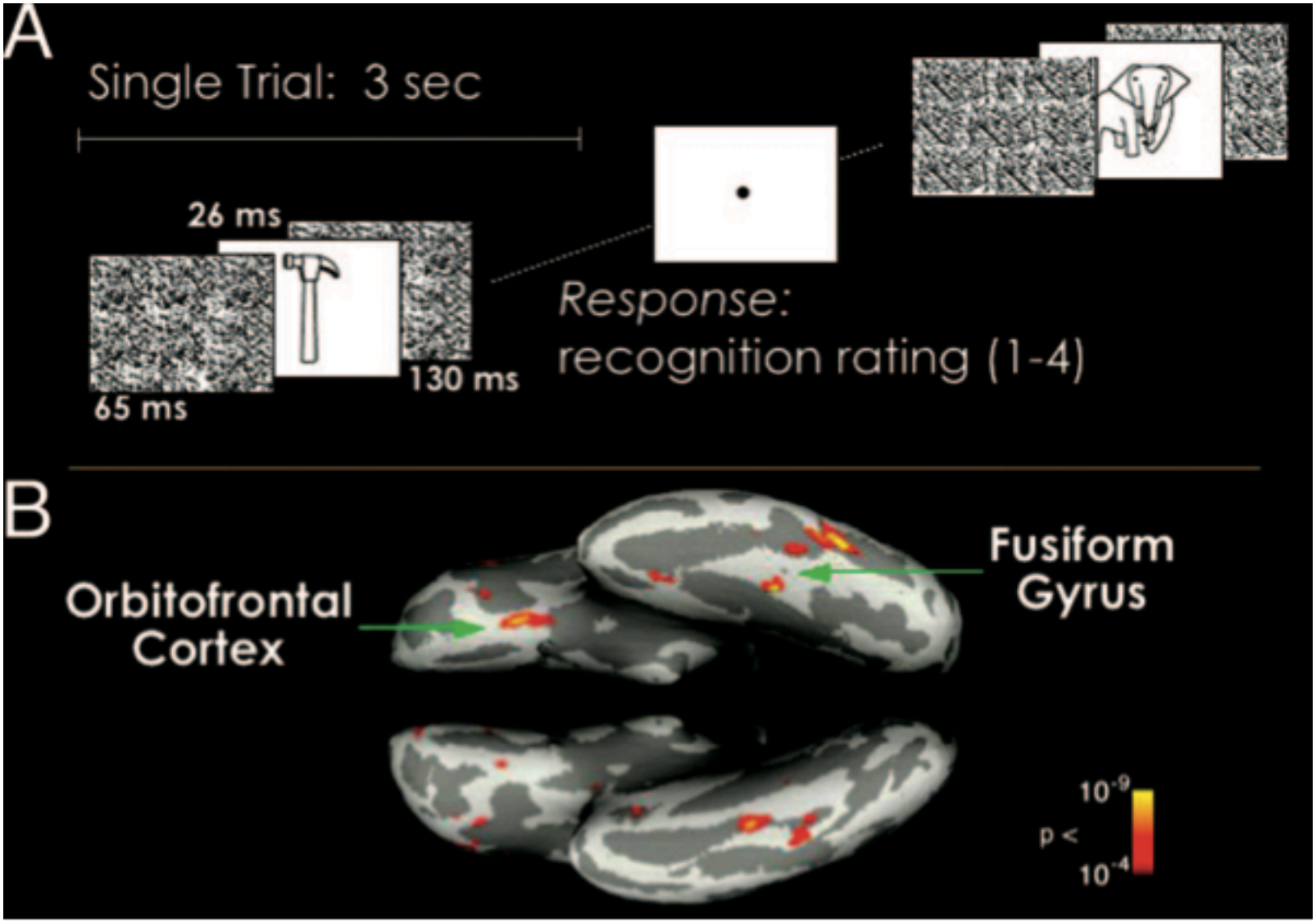
Moshe Bar

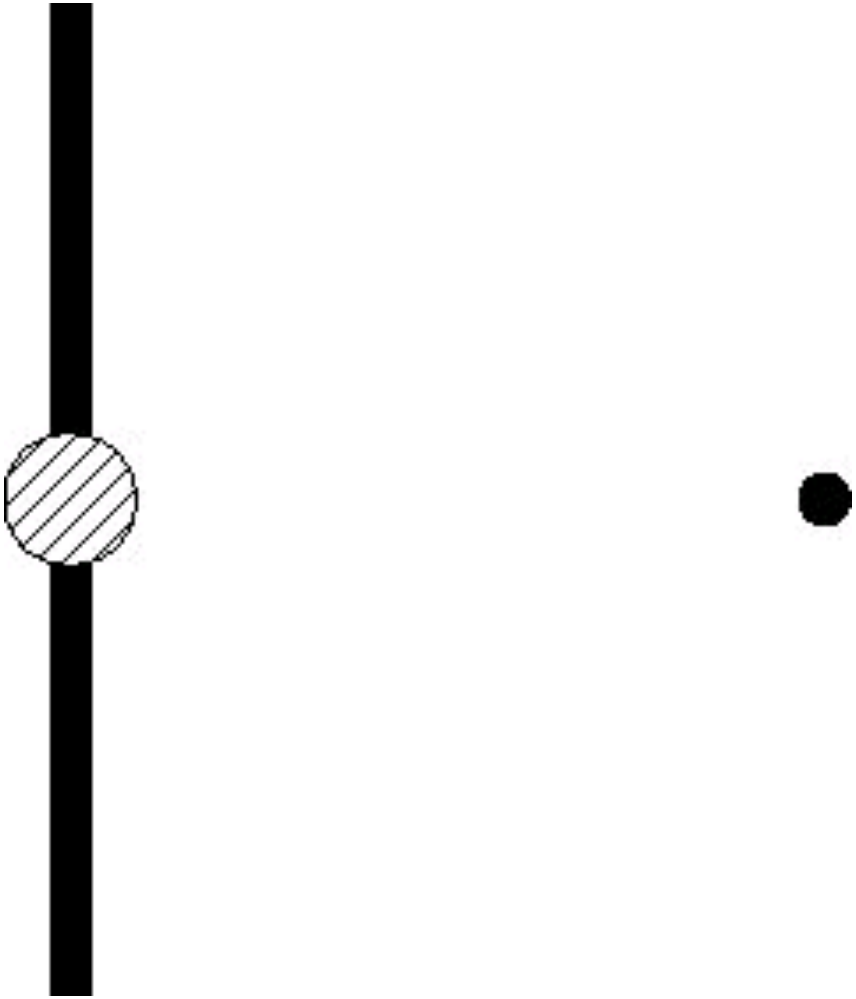
The Idea…

- A “blurred” image (low frequency information) is sent from early visual areas directly to PFC

- PFC generates an “expectation” which is sent back to temporal cortex

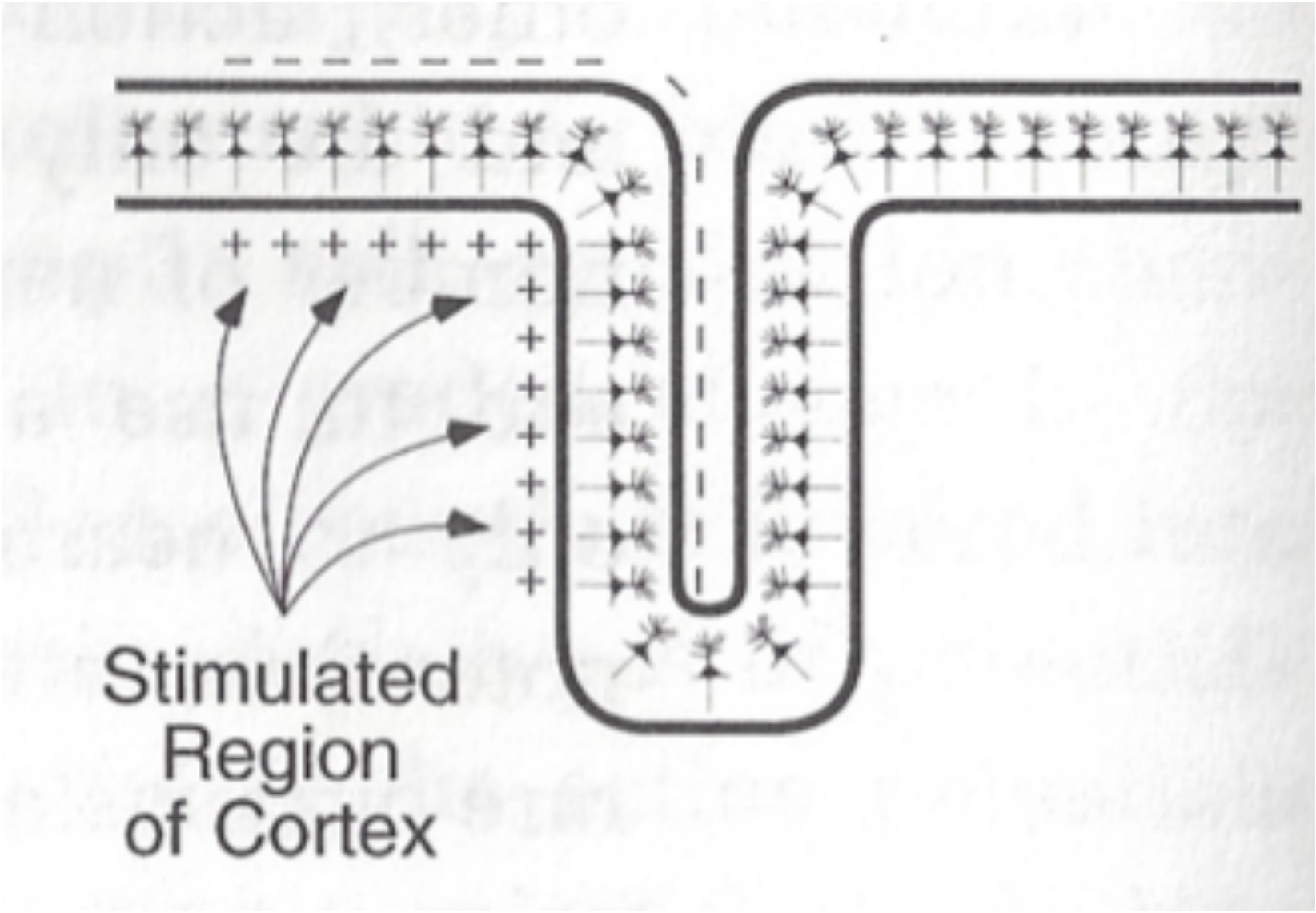


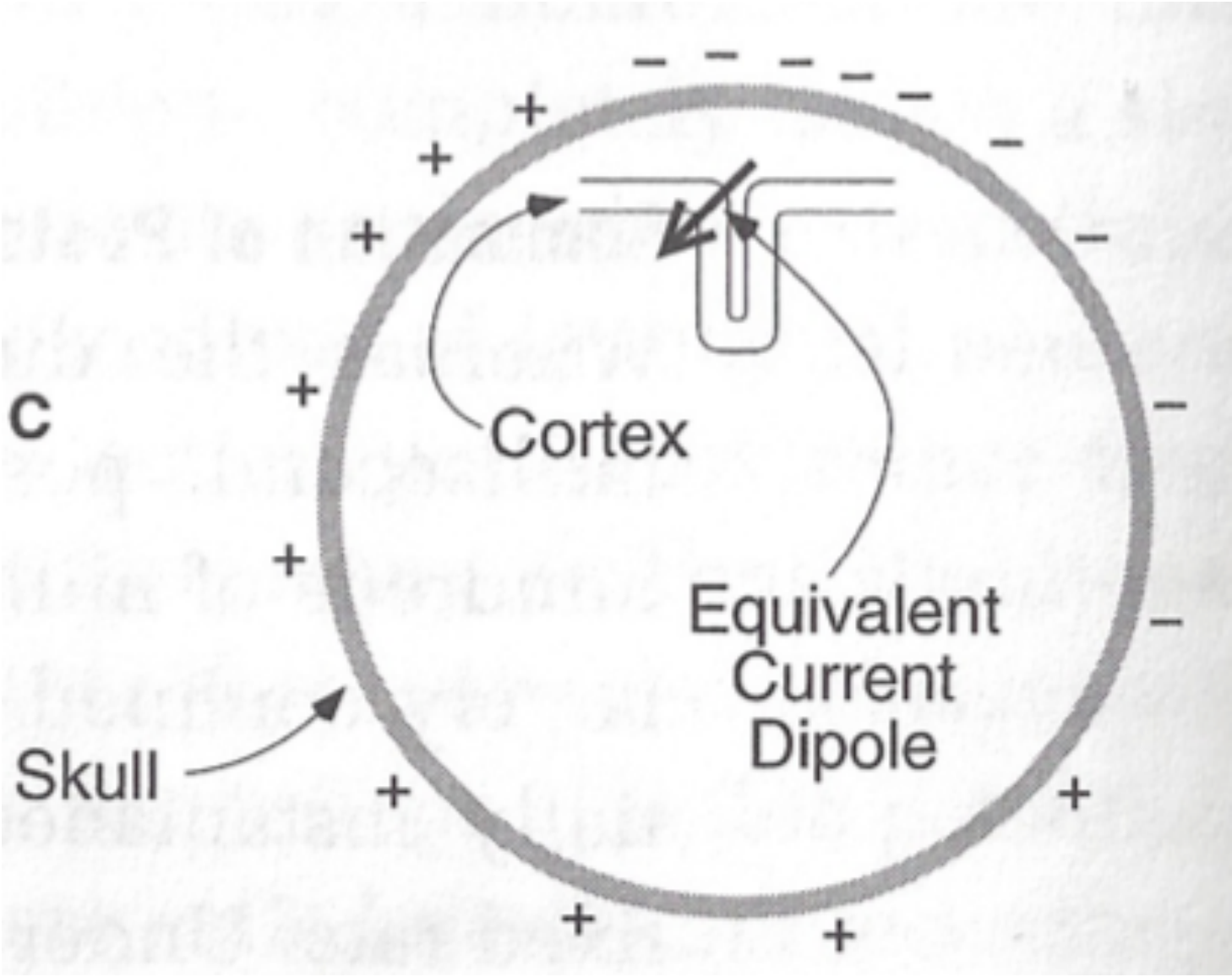

A
Single Trial: 3 sec
26 ms
65 ms
130 ms
Response:
recognition rating (1-4)
B
Orbitofrontal
Cortex
Fusiform
Gyrus
p <
10-9
10-4

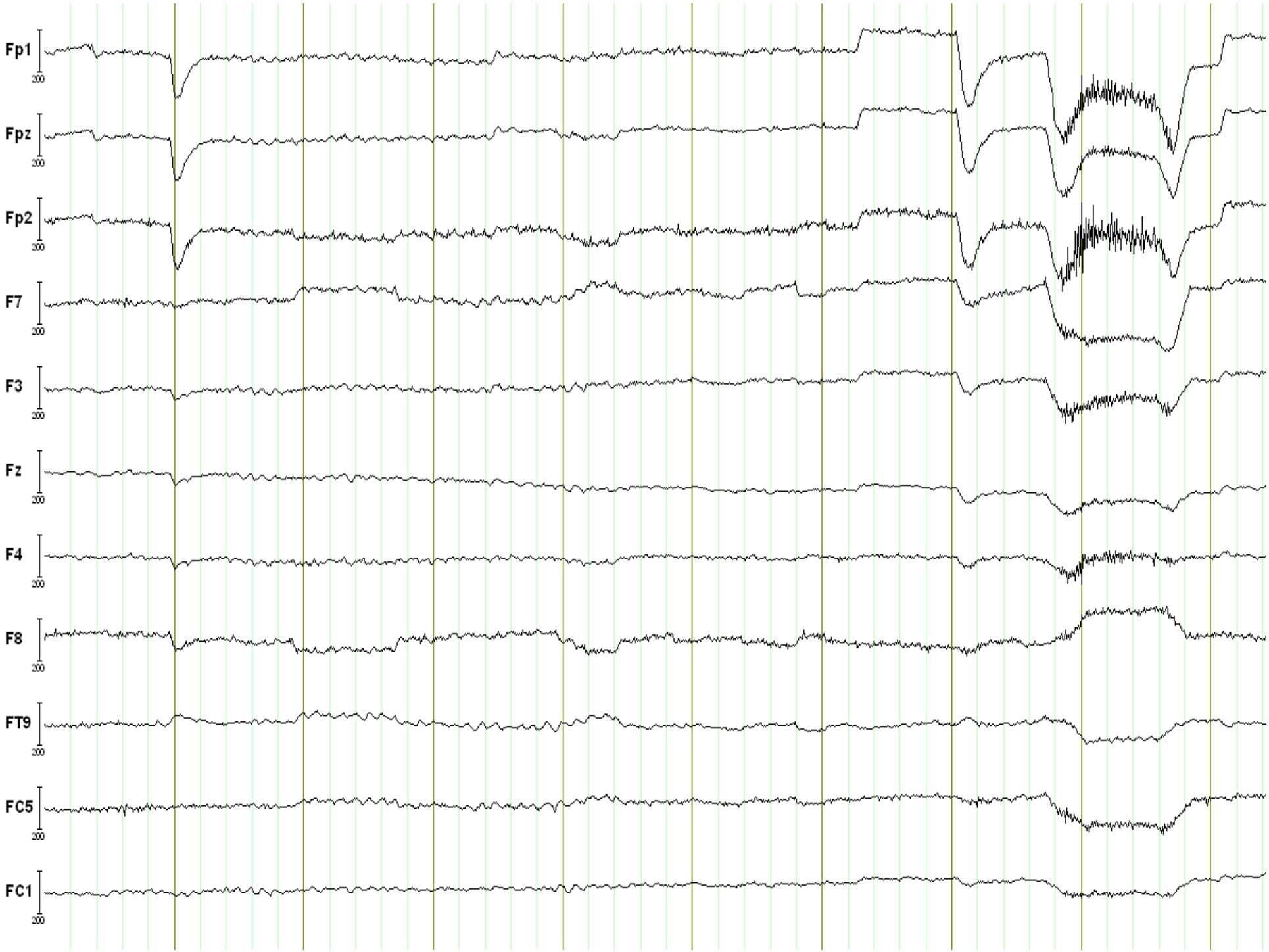


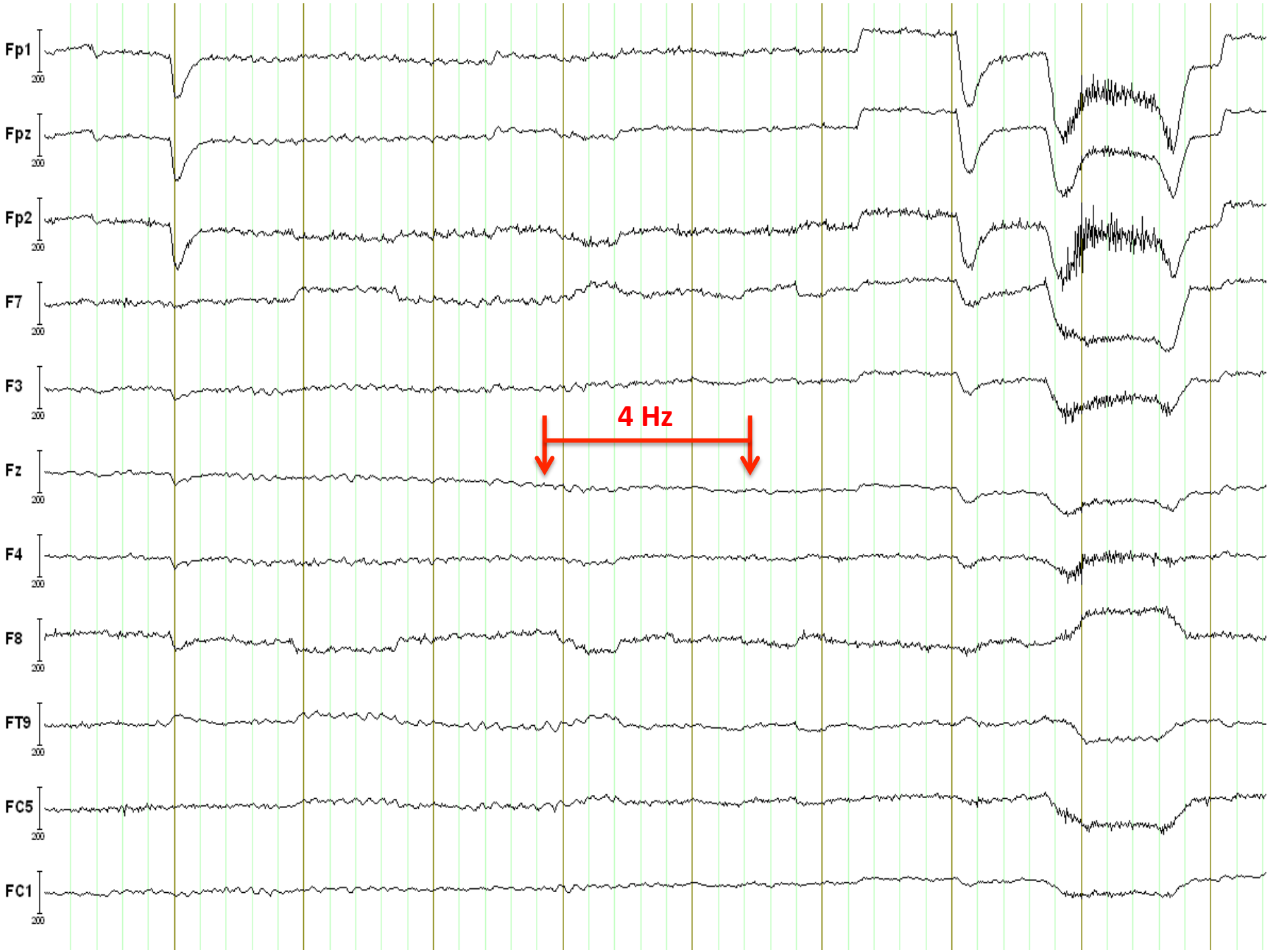
Electroencephalography


TOO SLOW


Stimulated
Region
of Cortex


C
Cortex
Equivalent
Current
Dipole
Skull


Fp1
200
Fpz
200
Fp2
200
F7
200
F3
200
Fz
200
F4
200
F8
200
FT9
200
FC5
200
FC1
200


Fp1
Fpz
Fp2
F7
F3
Fz
F4
F8
FT9
FC5
FC1
200
4 Hz