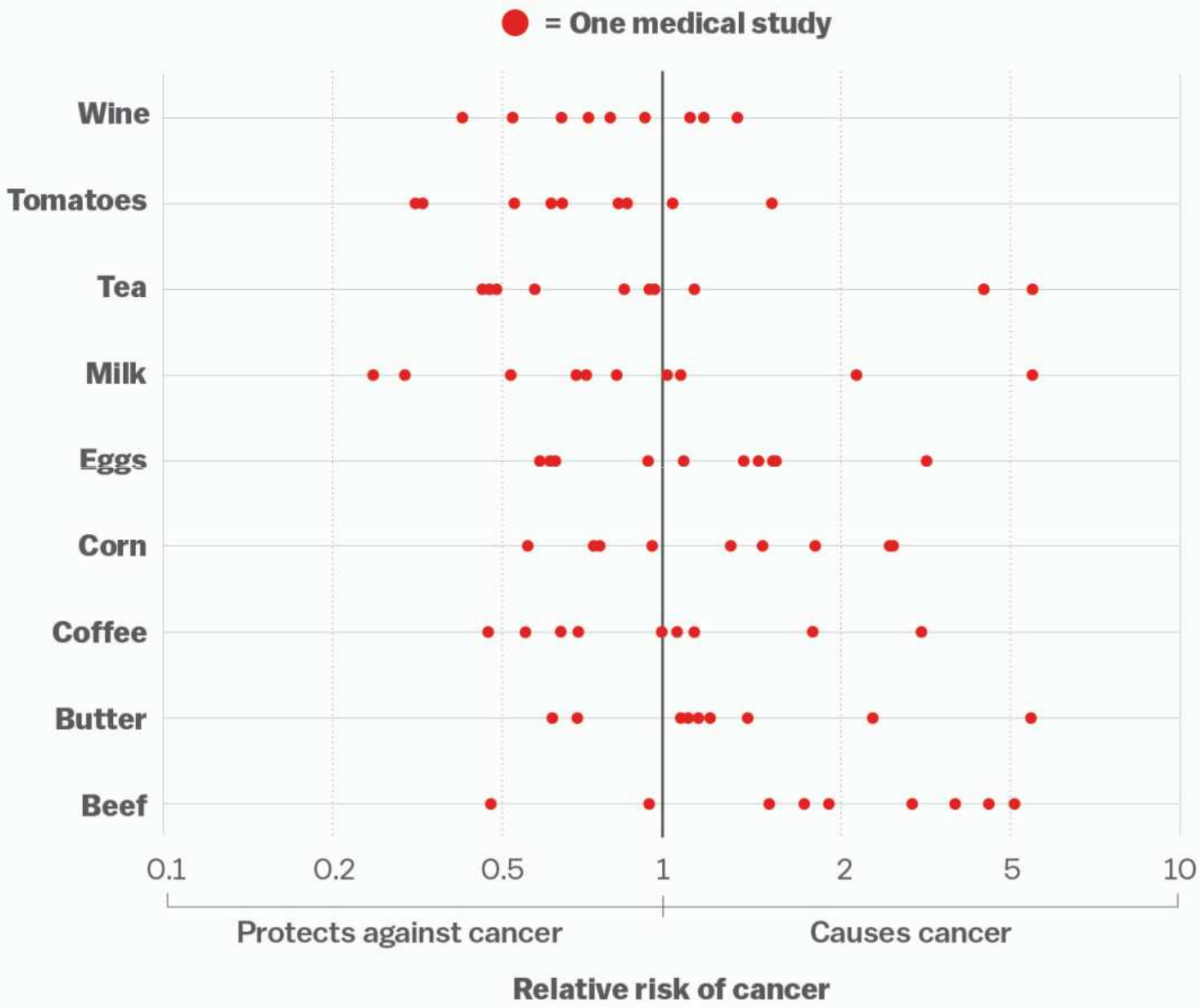
NEUROCIENCIA Y APRENDIZAJE

@german_sierra

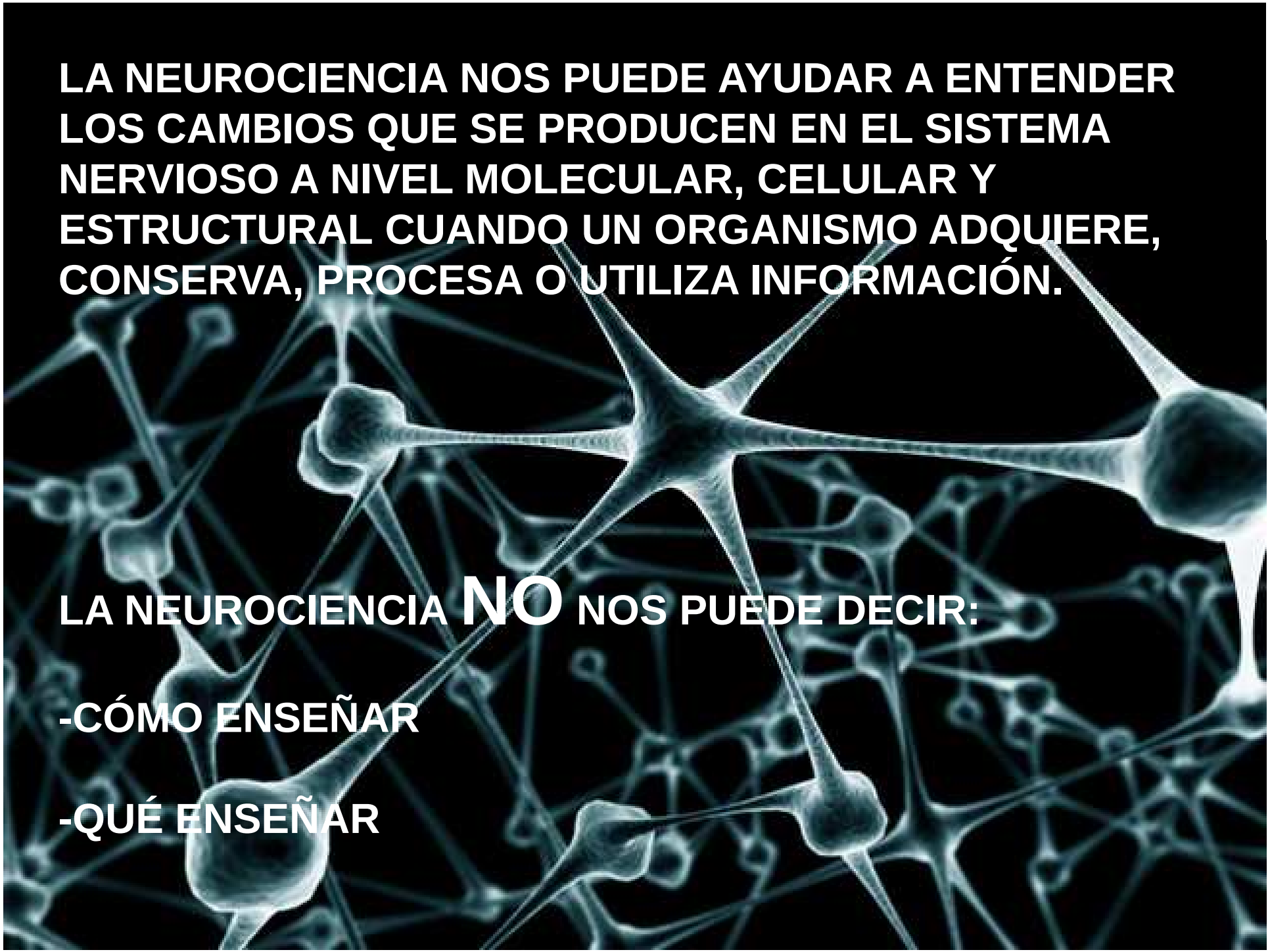
esperando a los bárbaros

Everything we eat both causes and prevents cancer



SOURCE: Schoenfeld and Ioannidis, *American Journal of Clinical Nutrition*

Vox



LA NEUROCIENCIA NOS PUEDE AYUDAR A ENTENDER LOS CAMBIOS QUE SE PRODUCEN EN EL SISTEMA NERVIOSO A NIVEL MOLECULAR, CELULAR Y ESTRUCTURAL CUANDO UN ORGANISMO ADQUIERE, CONSERVA, PROCESA O UTILIZA INFORMACIÓN.

LA NEUROCIENCIA NO NOS PUEDE DECIR:

-CÓMO ENSEÑAR

-QUÉ ENSEÑAR

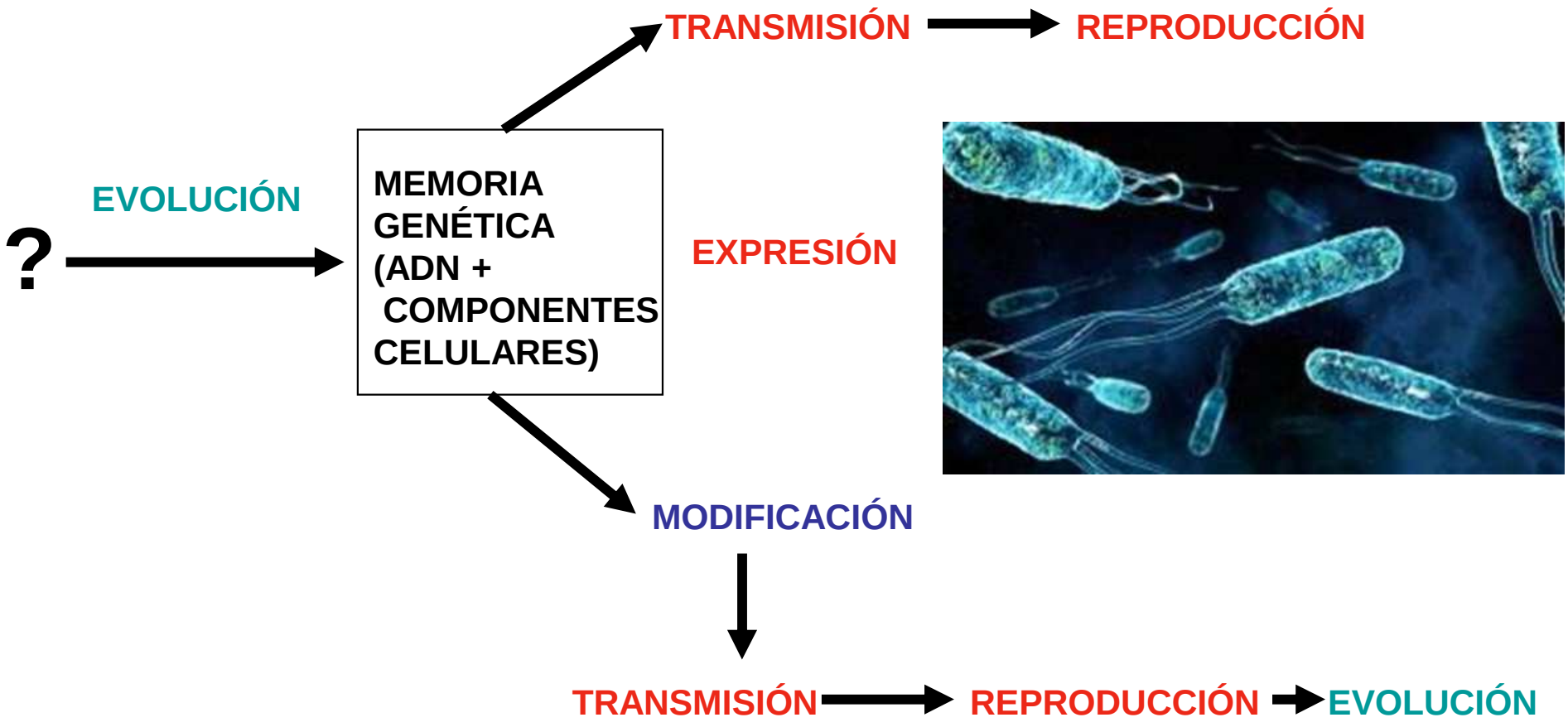
¿para qué sirve un cerebro?

-CONTROL Y COORDINACIÓN DE LA FISIOLOGÍA DEL ORGANISMO

-PERCEPCIÓN, MOVIMIENTO Y COORDINACIÓN SENSORIOMOTORA

RUTAS DE LA BIOINFORMACIÓN

1. SERES UNICELULARES



2. SERES PLURICELULARES

EVOLUCIÓN REPRODUCCIÓN → **MEMORIA GENÉTICA (ADN + COMP. CEL.)** → **EXPRESIÓN, TRANSMISIÓN** → **ORGANISMO (MEMORIA DE LA ESPECIE)**

DESARROLLO
amplificación de la capacidad de memoria

CÉLULAS MADRE

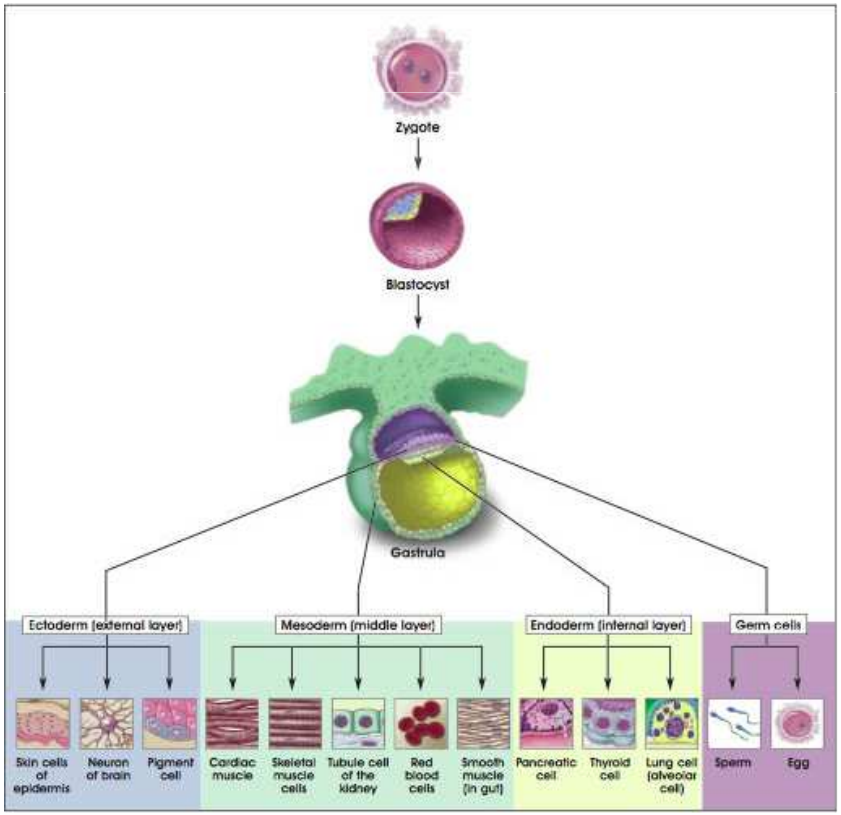
↓

DIFERENCIACIÓN

↓

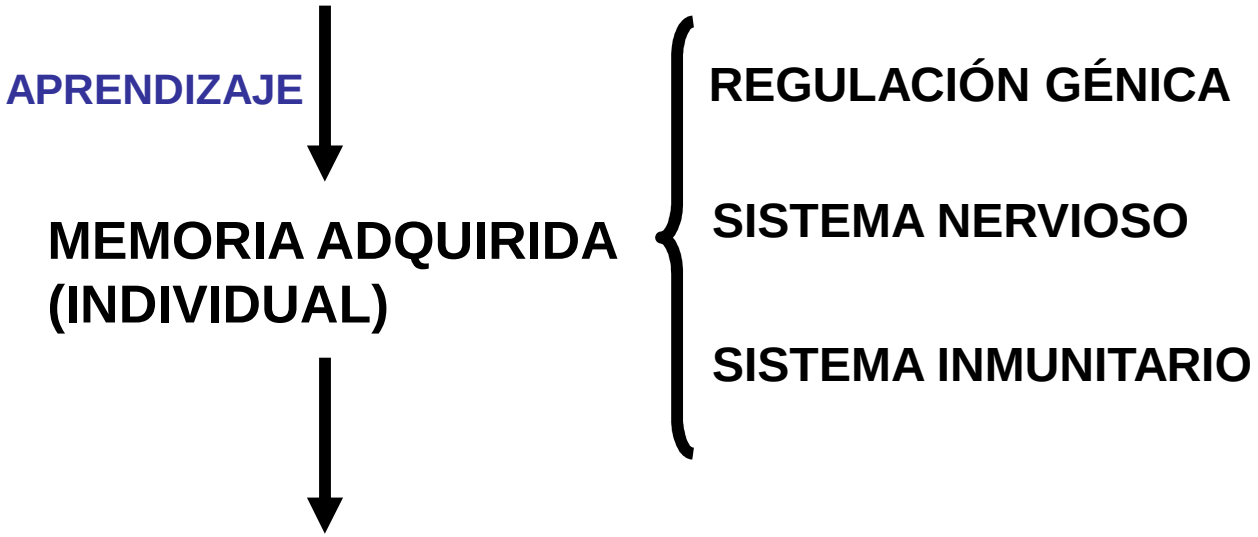
DESARROLLO

el desarrollo es más que diferenciación, ya que las células diferenciadas forman TEJIDOS, no se diferencian aisladamente



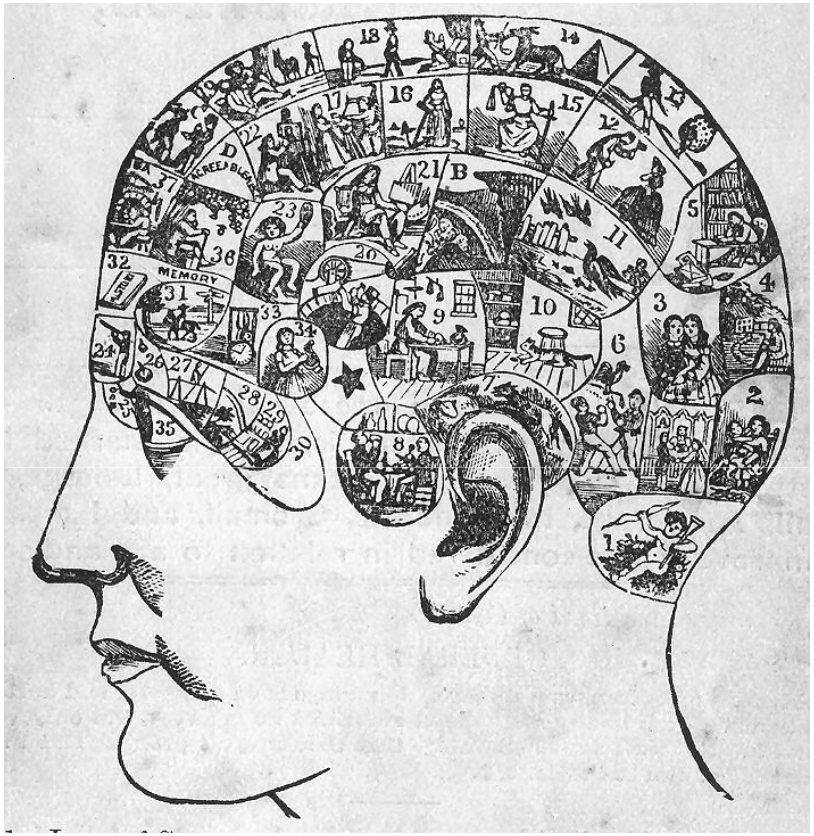
CARACTERÍSTICAS INFORMATIVAS DE LOS ORGANISMOS PLURICELULARES

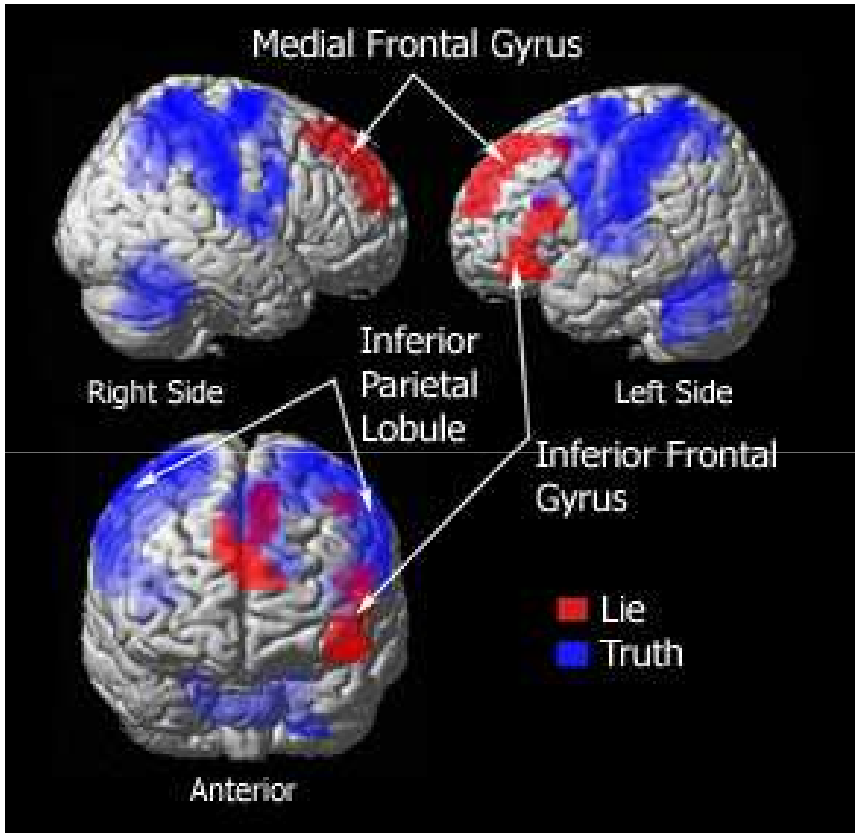
PLASTICIDAD: CAPACIDAD DE MODIFICARSE DE ACUERDO A INFORMACIÓN EXTERNA



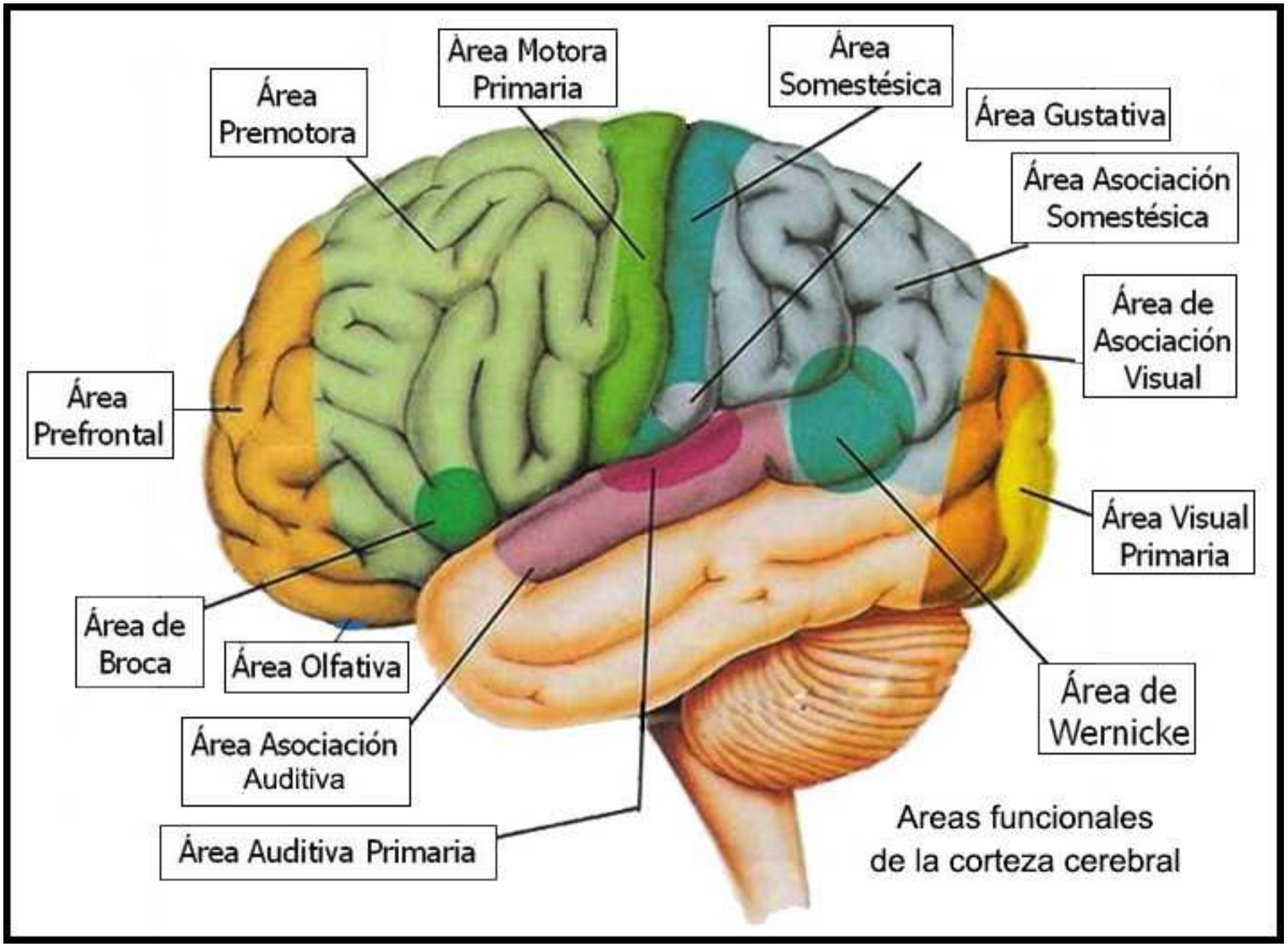

lightly carbonated
neuro
SONIC
non carbonated
neuro
SLEEP
lightly carbonated
neuro
BLISS
non carbonated
neuro
TRIM
A leaner you in every bottle
35
NO

El reduccionismo cerebral:





1883 **2007**



Areas funcionales de la corteza cerebral

EL CEREBRO NO APRENDE, EL ORGANISMO APRENDE:

El cerebro NO ES un sistema de almacenamiento de memoria, o un procesador. Es una parte de un organismo complejo cuyo objetivo es la supervivencia.

LAS FUNCIONES COGNITIVAS “SUPERIORES” SON UN ARTIFICIO:

La “inteligencia” no es una consecuencia de la actividad del cerebro. Es el uso socio-cultural que le damos a la actividad del cerebro.

LA CAPACIDAD DE APRENDIZAJE DEL SER HUMANO ESTÁ A LA VEZ LIMITADA Y AMPLIFICADA POR SUS CARÁCTERÍSTICAS BIOLÓGICAS:

-no podemos aprender cualquier cosa, pero podemos hacer que muchísimas cosas se transformen en algo que podemos aprender.

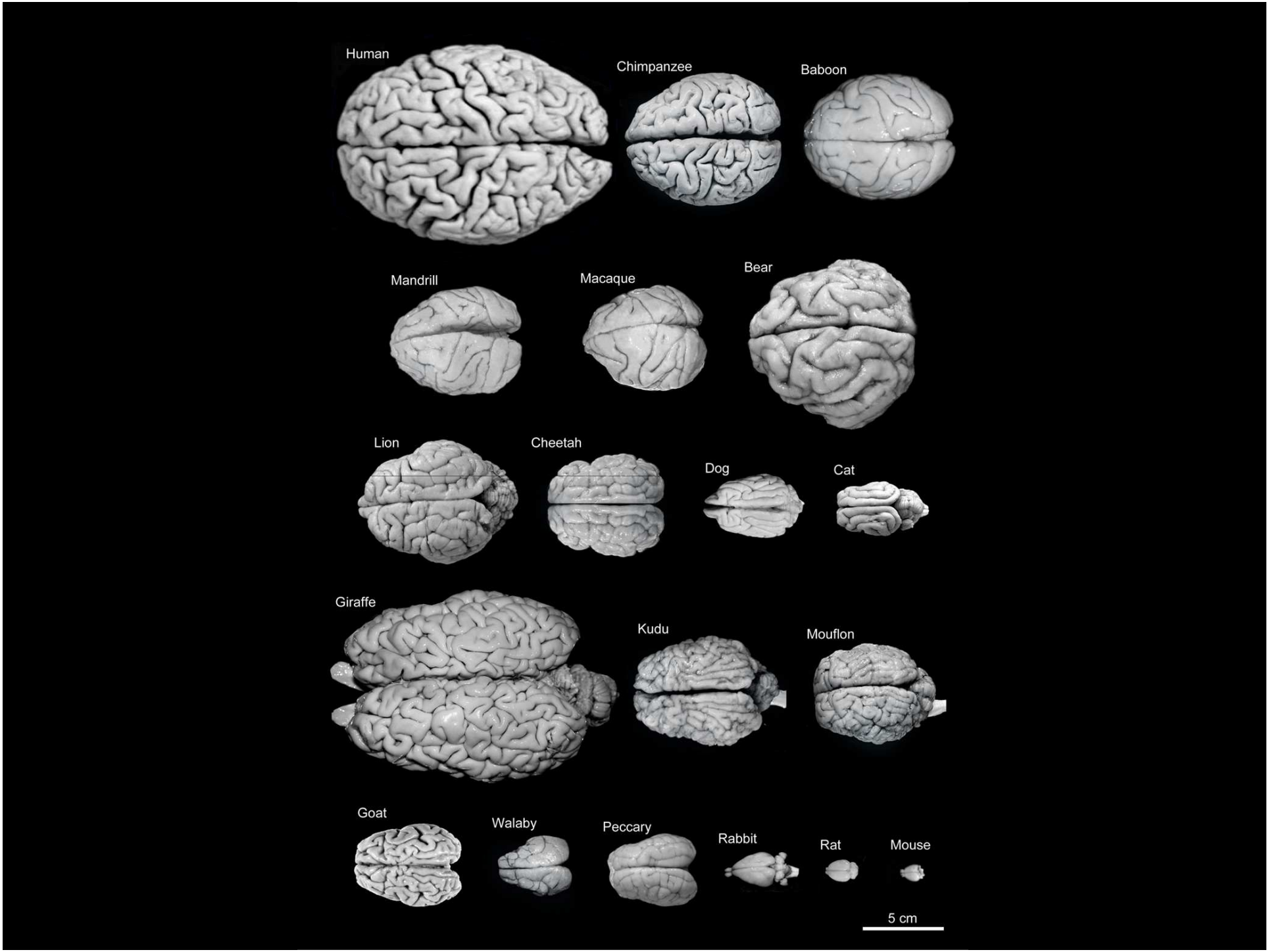
“Disponemos, entre otras capacidades, de tres que son esenciales para entender como nos consideramos hoy a nosotros mismos: el lenguaje hablado, la escritura y la música. Estas capacidades no son producto de la selección natural ni el resultado de la ingeniería genética o la mejora cibernética del cerebro: han sido adquiridas “modelando” el cerebro mediante reciclaje neuronal.”

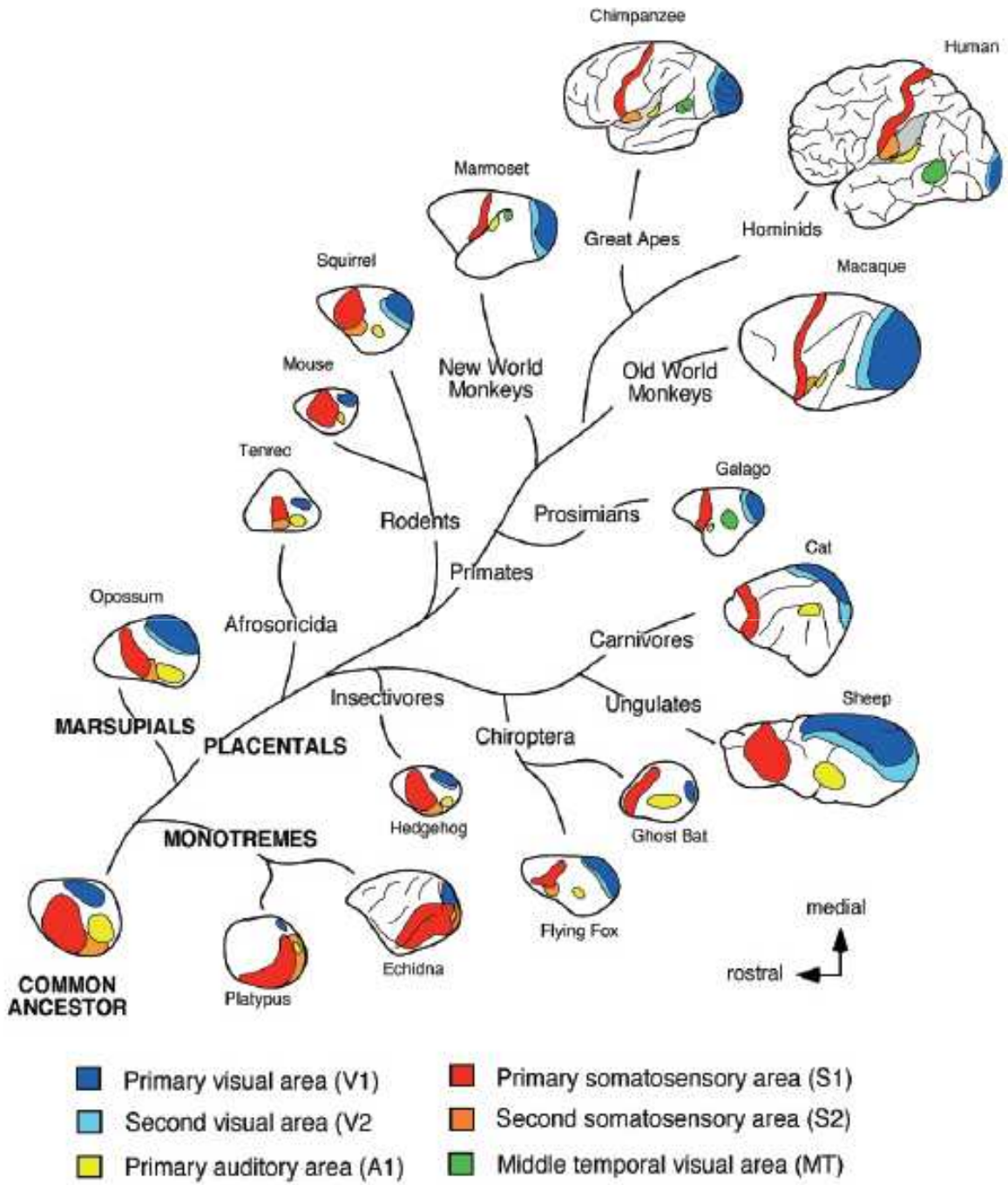
“Nosotros no hemos modelado el cerebro directamente. Ha sido una propiedad evolutiva emergente en nuestra conducta y cultura, que dio forma a la escritura para adaptarse a nuestro sistema visual, al habla y a la música a nuestro sistema auditivo…”

Mark Changizi

LAS FUNCIONES COGNITIVAS SUPERIORES EMERGEN COMO CONSECUENCIA DE INTERACCIONES ENTRE LOS INDIVIDUOS

PRIMERA LEY DE LA PEDAGOGÍA:


Human
Chimpanzee
Baboon
Mandrill
Macaque
Bear
Lion
Cheetah
Dog
Cat
Giraffe
Kudu
Mouflon
Goat
Walaby
Peccary
Rabbit
Rat
Mouse
5 cm


Chimpanzee
Human
Marmoset
Great Apes
Hominids
Squirrel
Macaque
Mouse
New World Monkeys
Old World Monkeys
Tenrec
Galago
Rodents
Prosimians
Primates
Cat
Opossum
Afrosoricida
Carnivores
Insectivores
Ungulates
Sheep
MARSUPIALS
PLACENTALS
Chiroptera
Hedgehog
Ghost Bat
MONOTREMES
Flying Fox
medial
rostral
COMMON ANCESTOR
Platypus
Echidna
Primary visual area (V1)
Second visual area (V2
Primary auditory area (A1)
Primary somatosensory area (S1)
Second somatosensory area (S2)
Middle temporal visual area (MT)

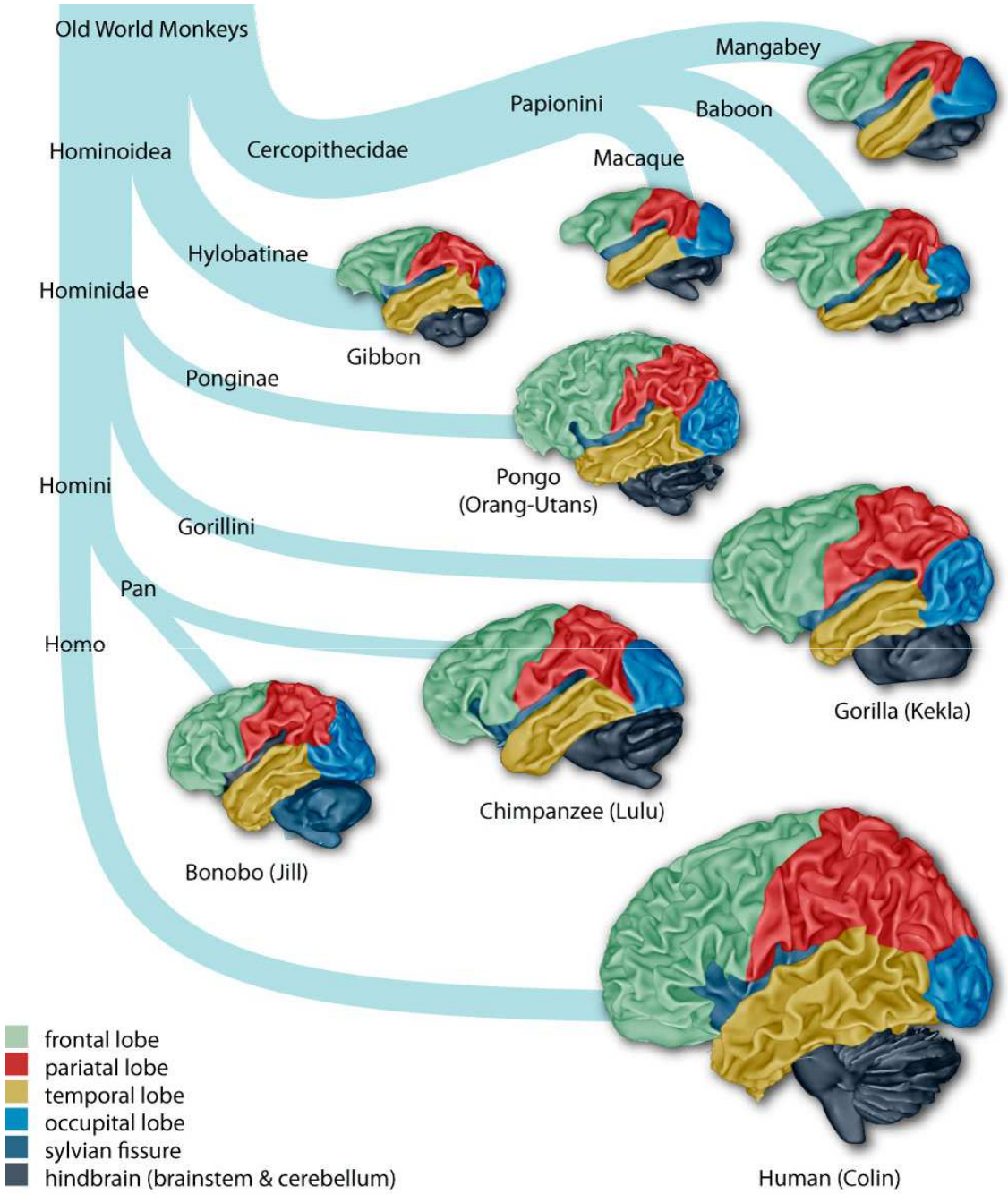
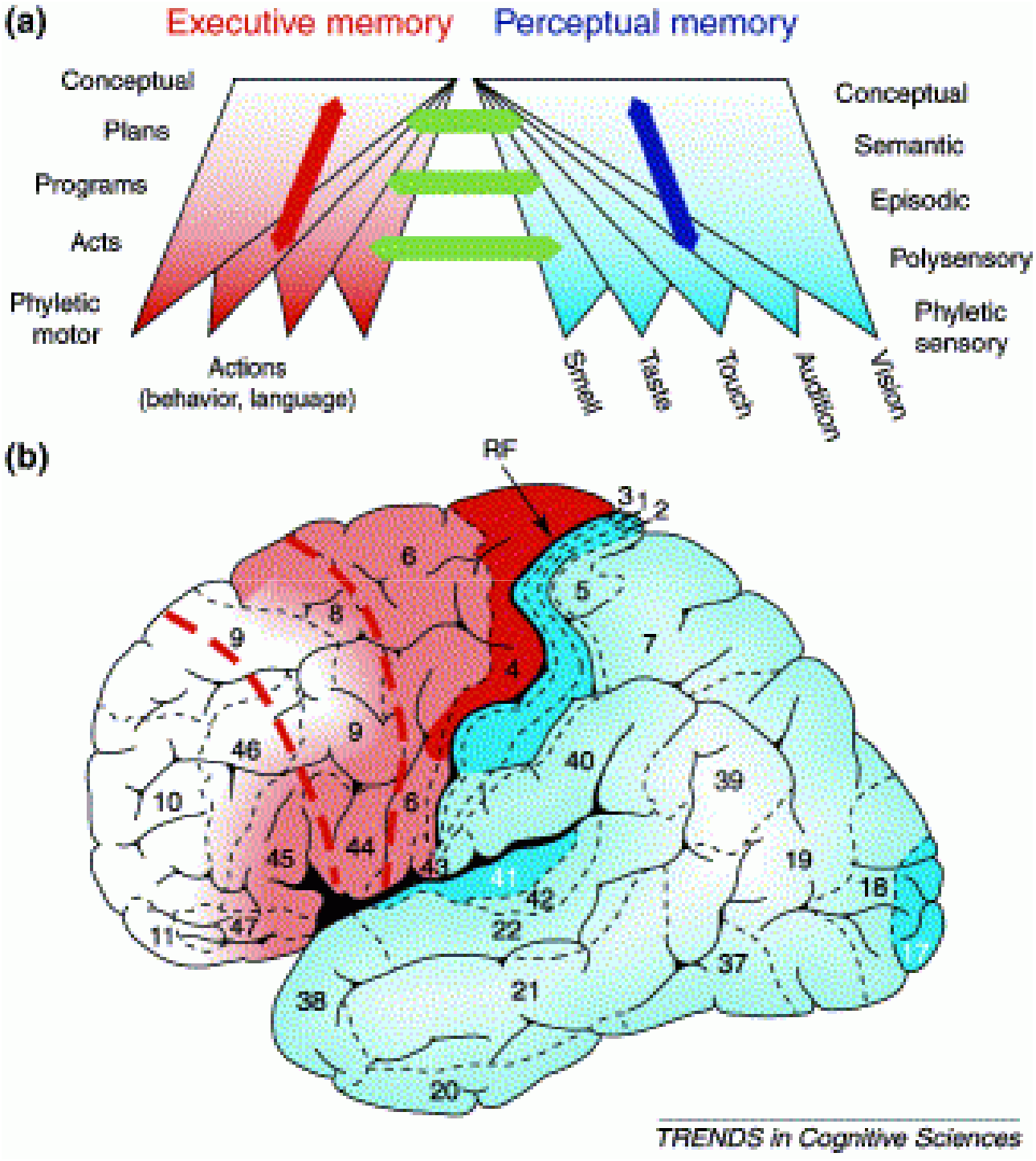
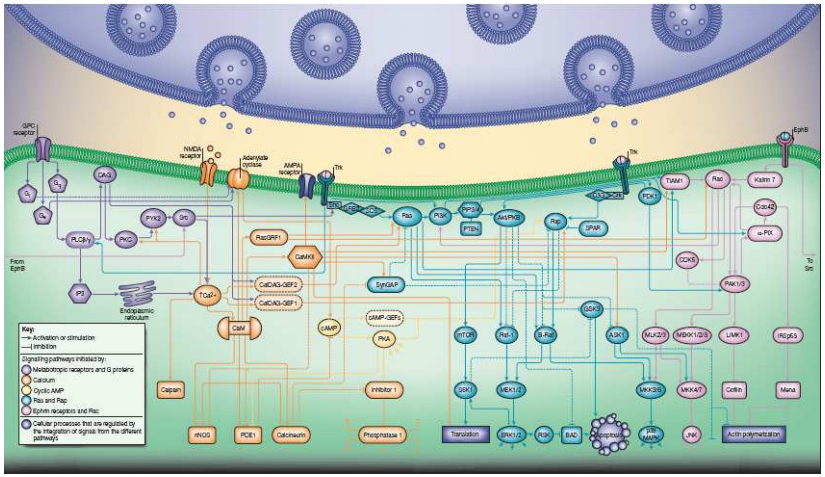
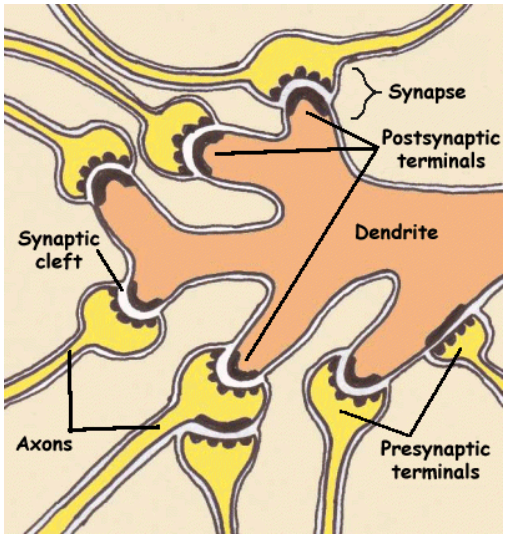


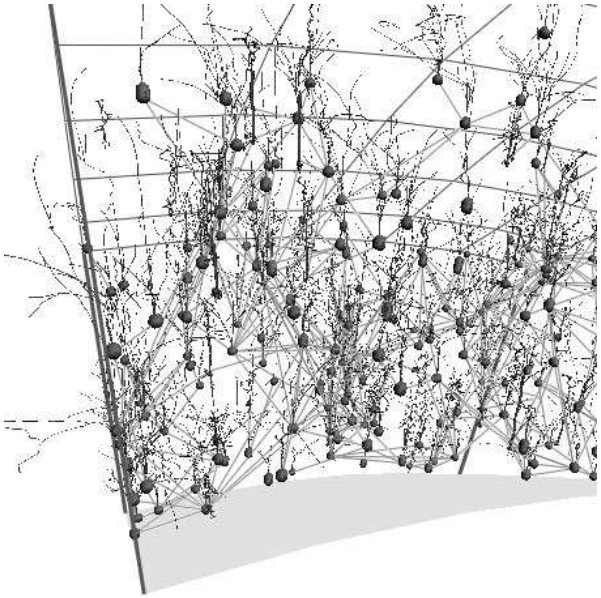
Fig. HE: Visualization of evolution of brains in primates based on the inner surface. The lobes, the sylvian fissure and the hindbrain (brainstem and cerebellum) are colorized for better orientation.

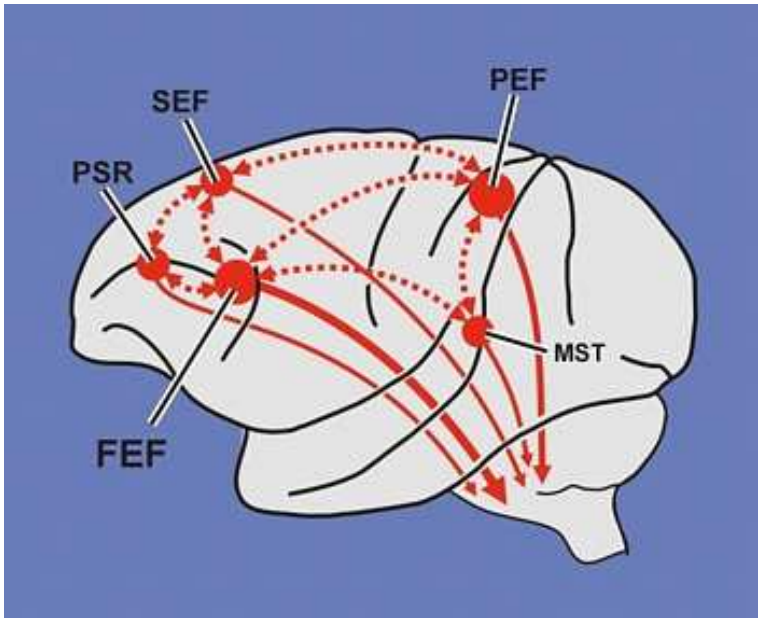

(a)
Executive memory
Perceptual memory
Conceptual
Plans
Programs
Acts
Phyletic motor
Actions (behavior, language)
Conceptual
Semantic
Episodic
Polysensory
Phyletic sensory
Smell
Taste
Touch
Audition
Vision
(b)
RF
3
1
2
6
8
5
9
7
4
9
46
40
39
10
6
45
44
43
41
42
19
18
47
11
22
37
21
38
20
TRENDS in Cognitive Sciences


¡PLASTICIDAD!

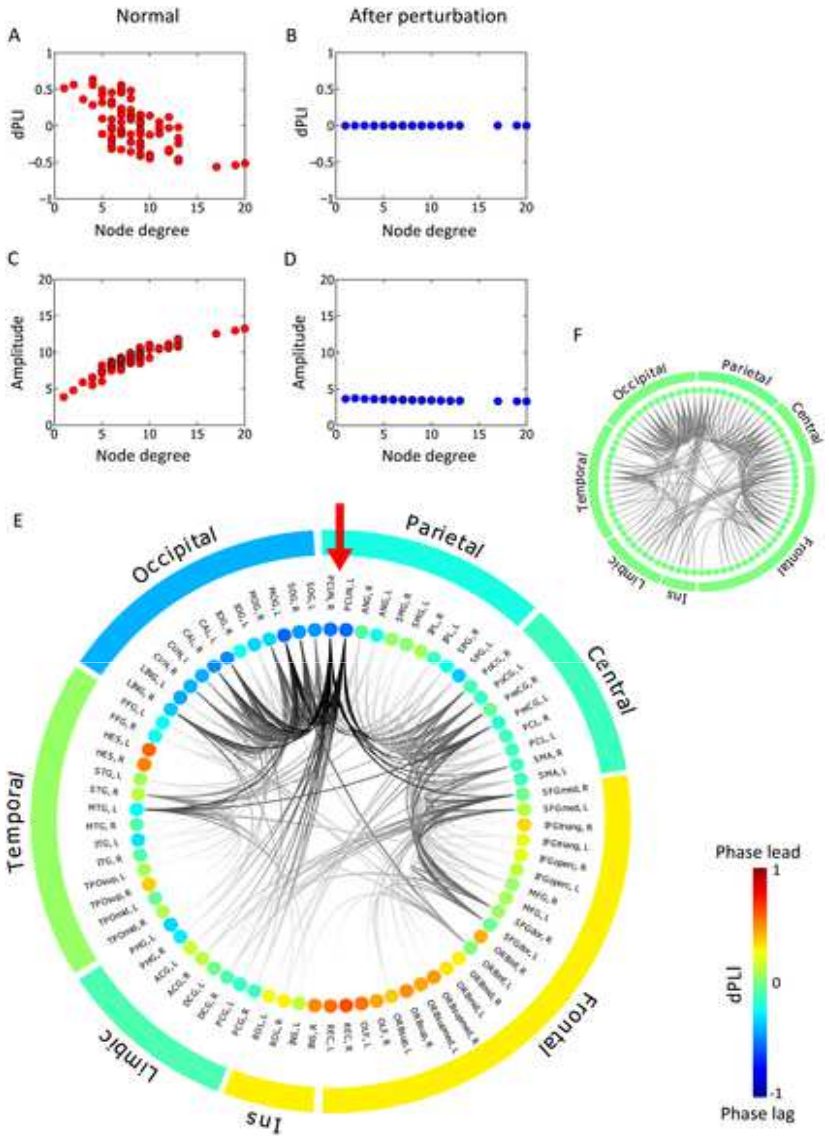



Synapse
Postsynaptic terminals
Dendrite
Synaptic cleft
Axons
Presynaptic terminals

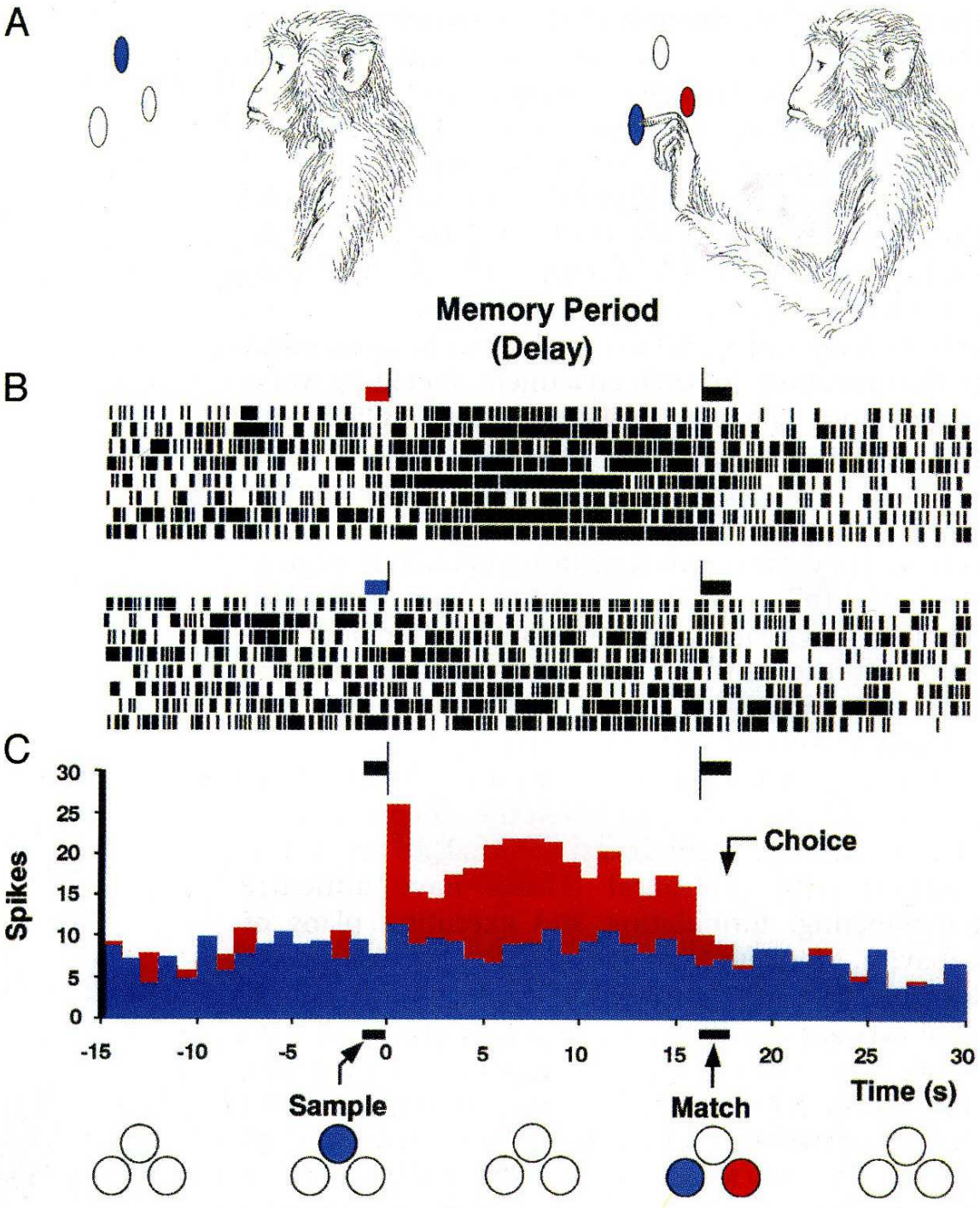


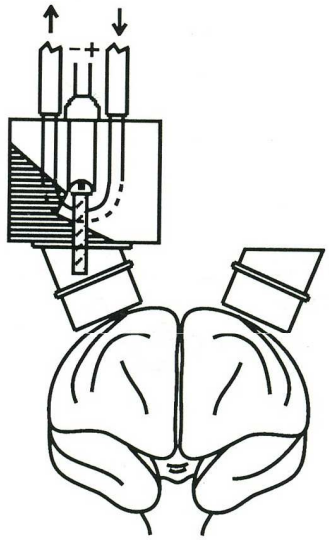

SEF
PEF
PSR
MST
FEF

- **Fig 4. Relationships of node degree,**
- **amplitude and dPLI in human neuroanatomical networks**.



Moon JY, Lee U, Blain-Moraes S, Mashour GA (2015) General Relationship of Global Topology, Local Dynamics, and Directionality in Large-Scale Brain Networks. PLoS Comput Biol 11(4): e1004225. doi:10.1371/journal.pcbi.1004225
http://127.0.0.1:8081/ploscompbiol/article?id=info:doi/10.1371/journal.pcbi.1004225


A
Memory Period
(Delay)
B
C
Spikes
30
25
20
15
10
5
0
-15
-10
-5
0
5
10
15
20
25
30
Choice
Sample
Match
Time (s)



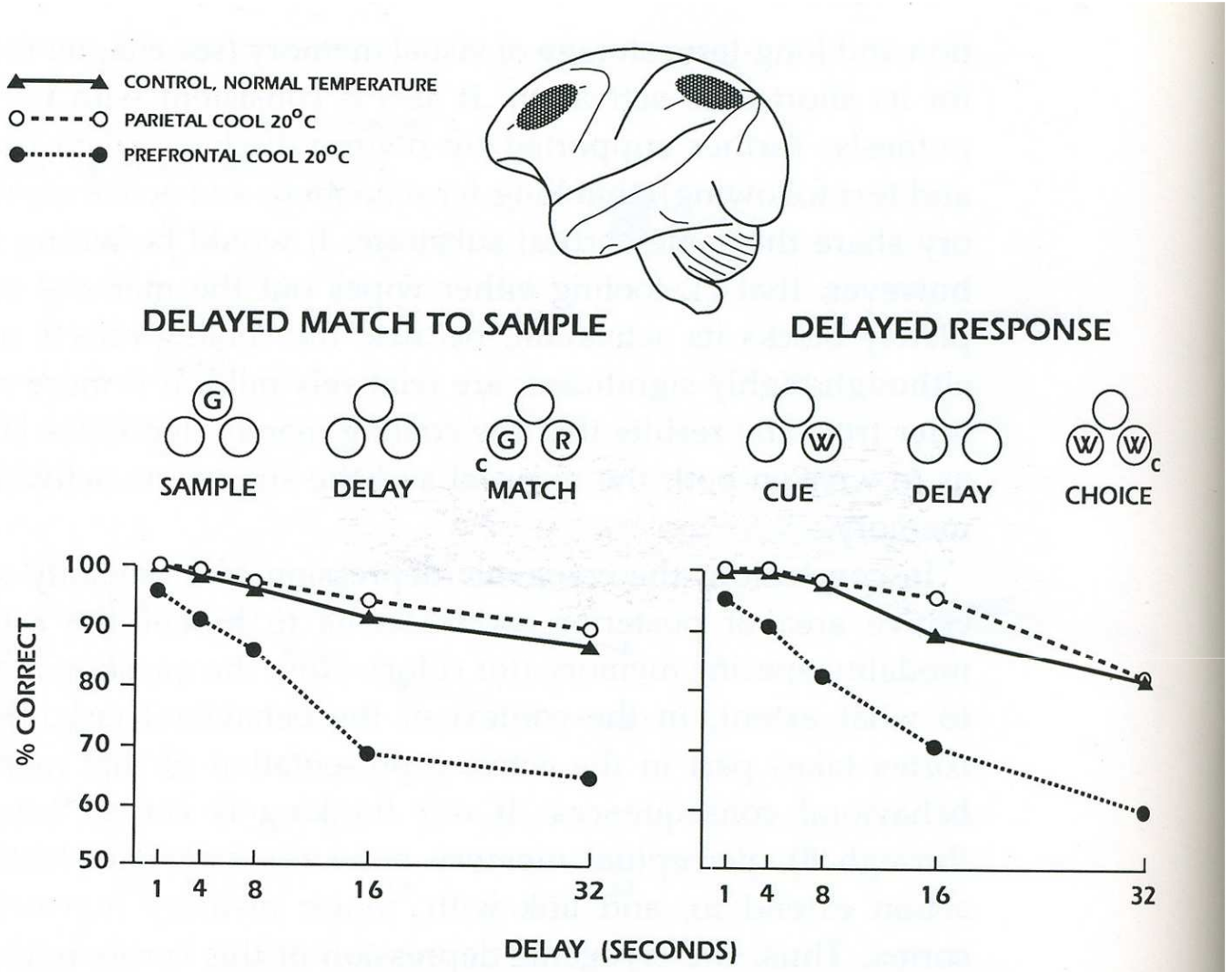
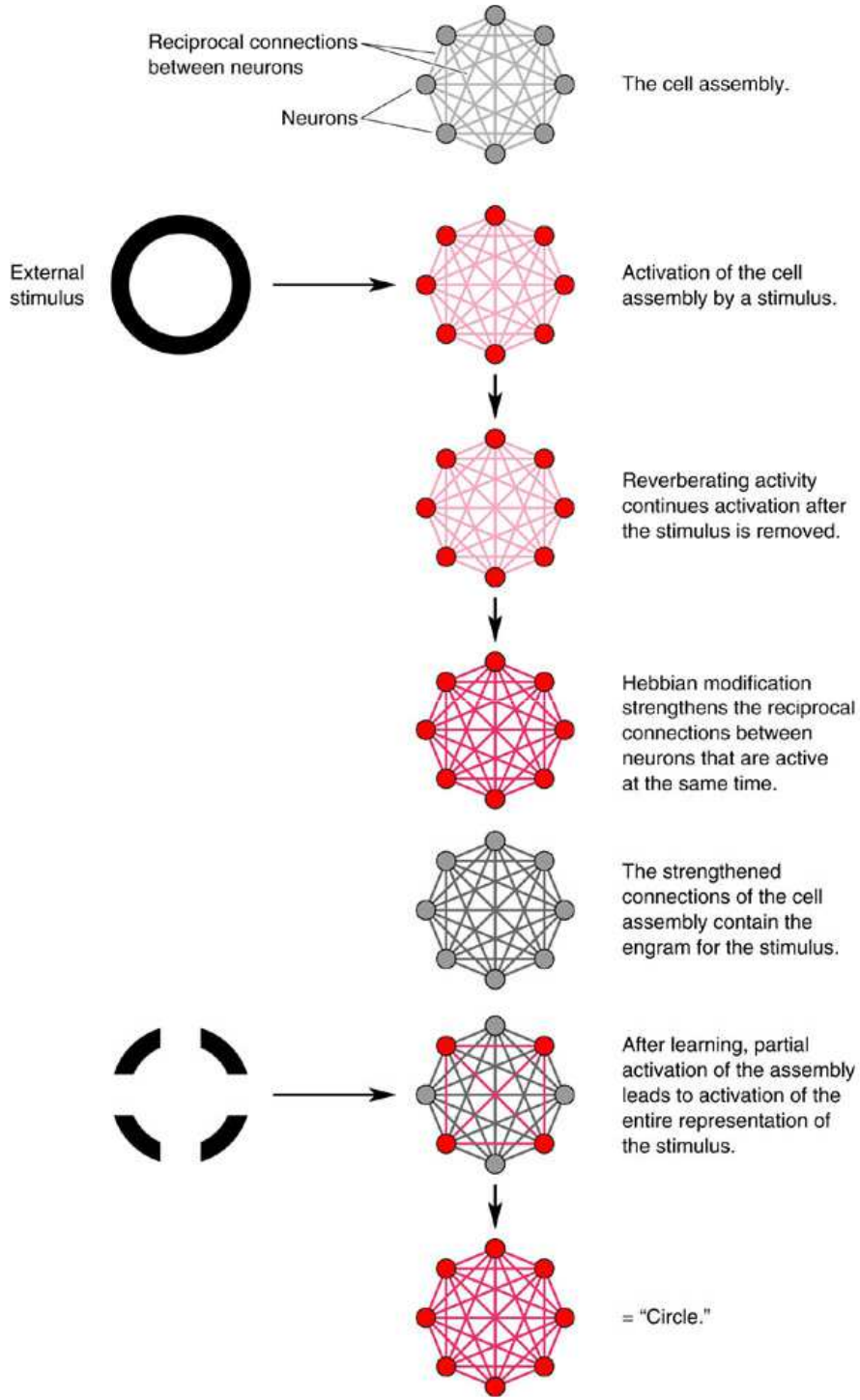
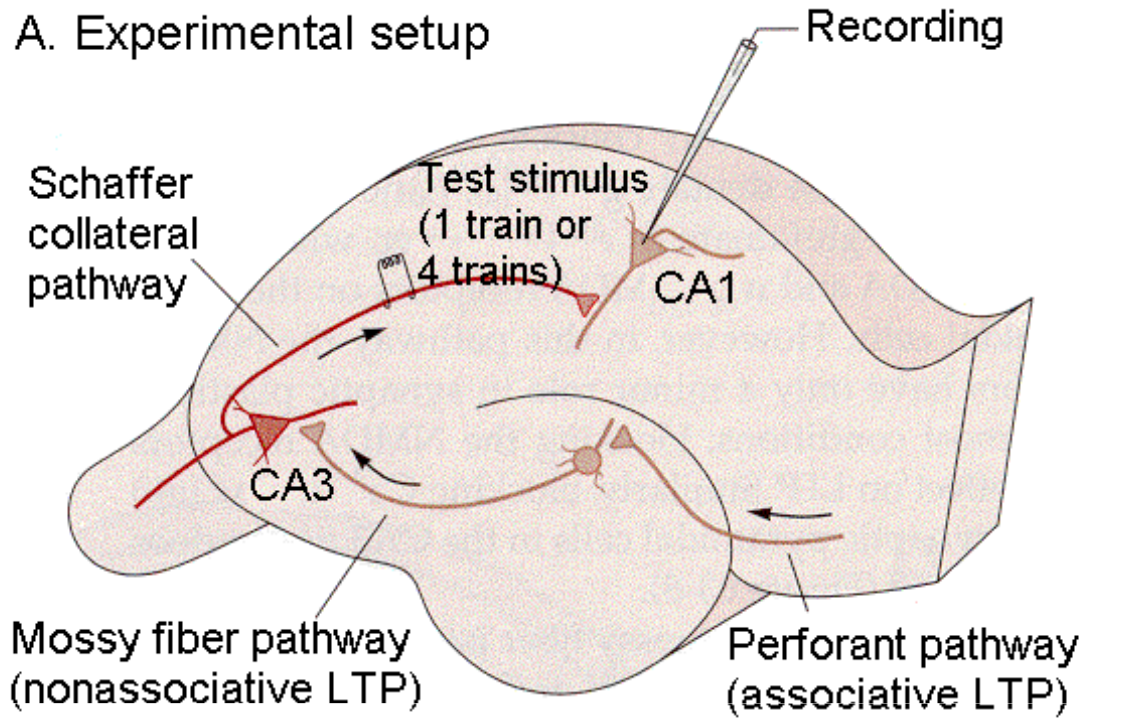
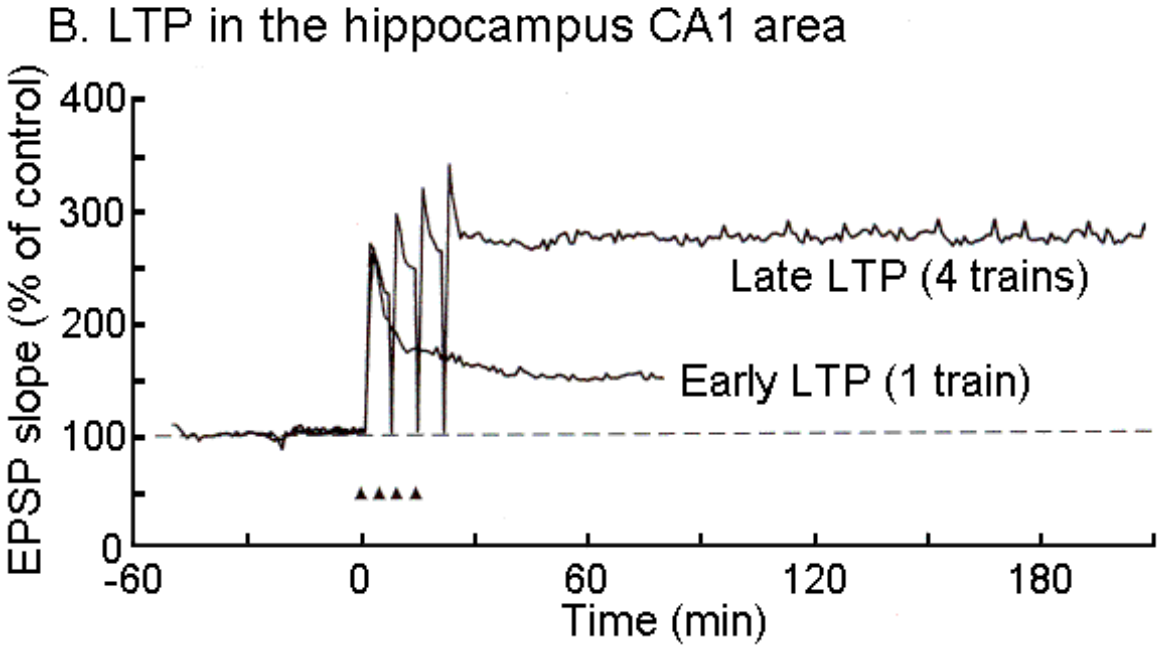
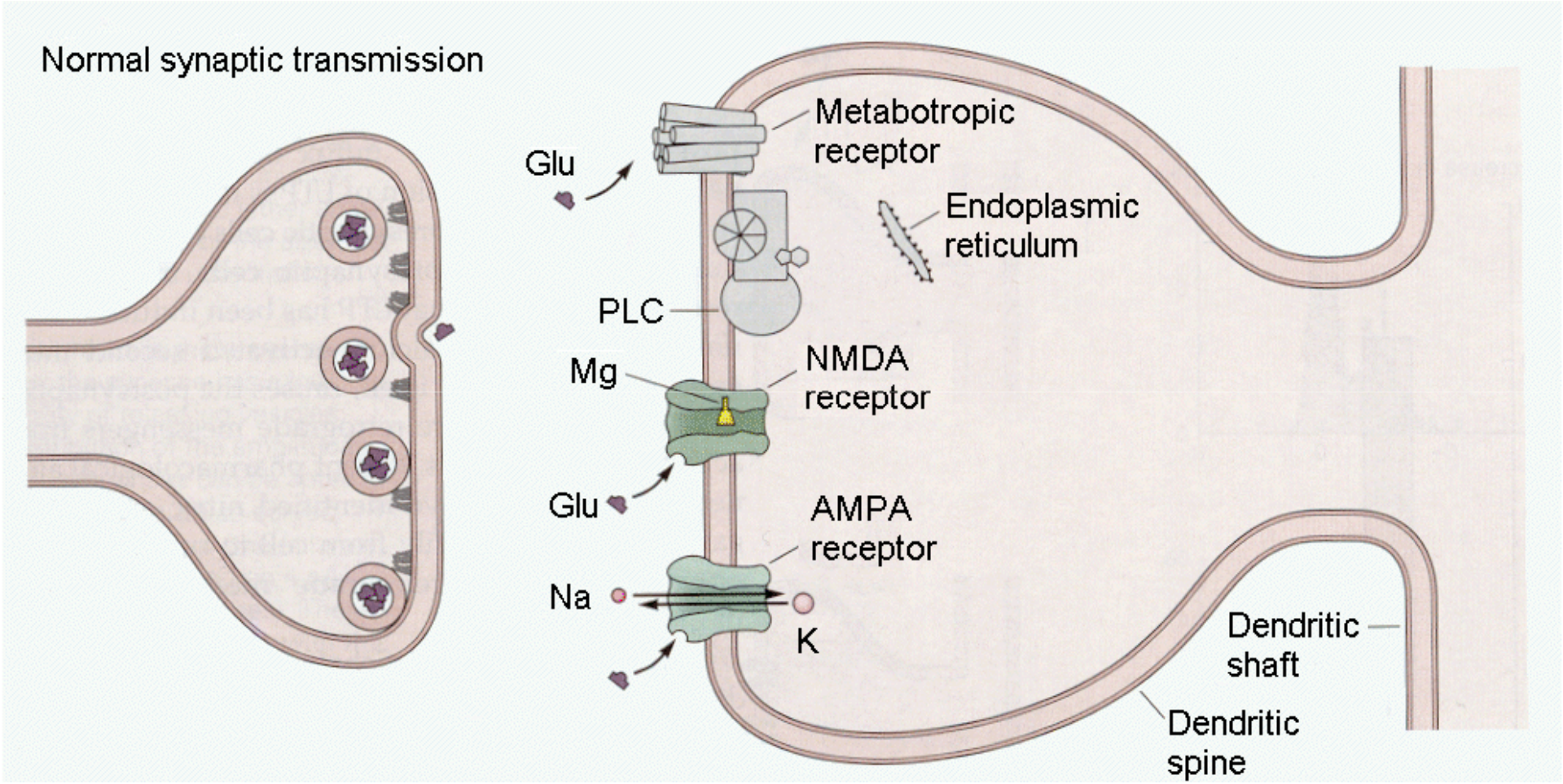


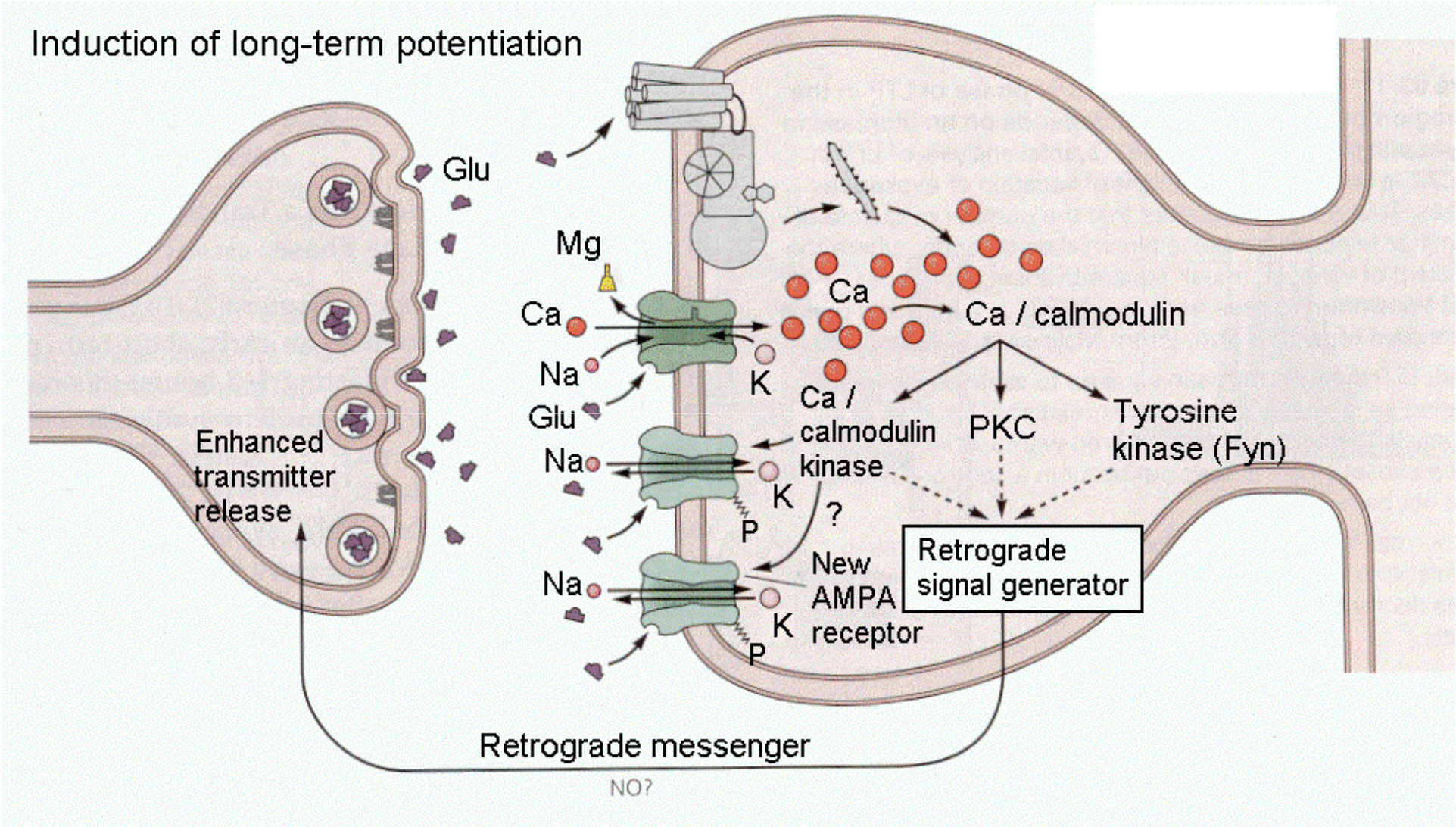
Figure 9.3 Effects of cooling bilaterally portions of dorsolateral prefrontal cortex or posterior parietal cortex (*shaded area* above) on performance of two delay tasks. C, correct response; G, green; R, red; W, white.

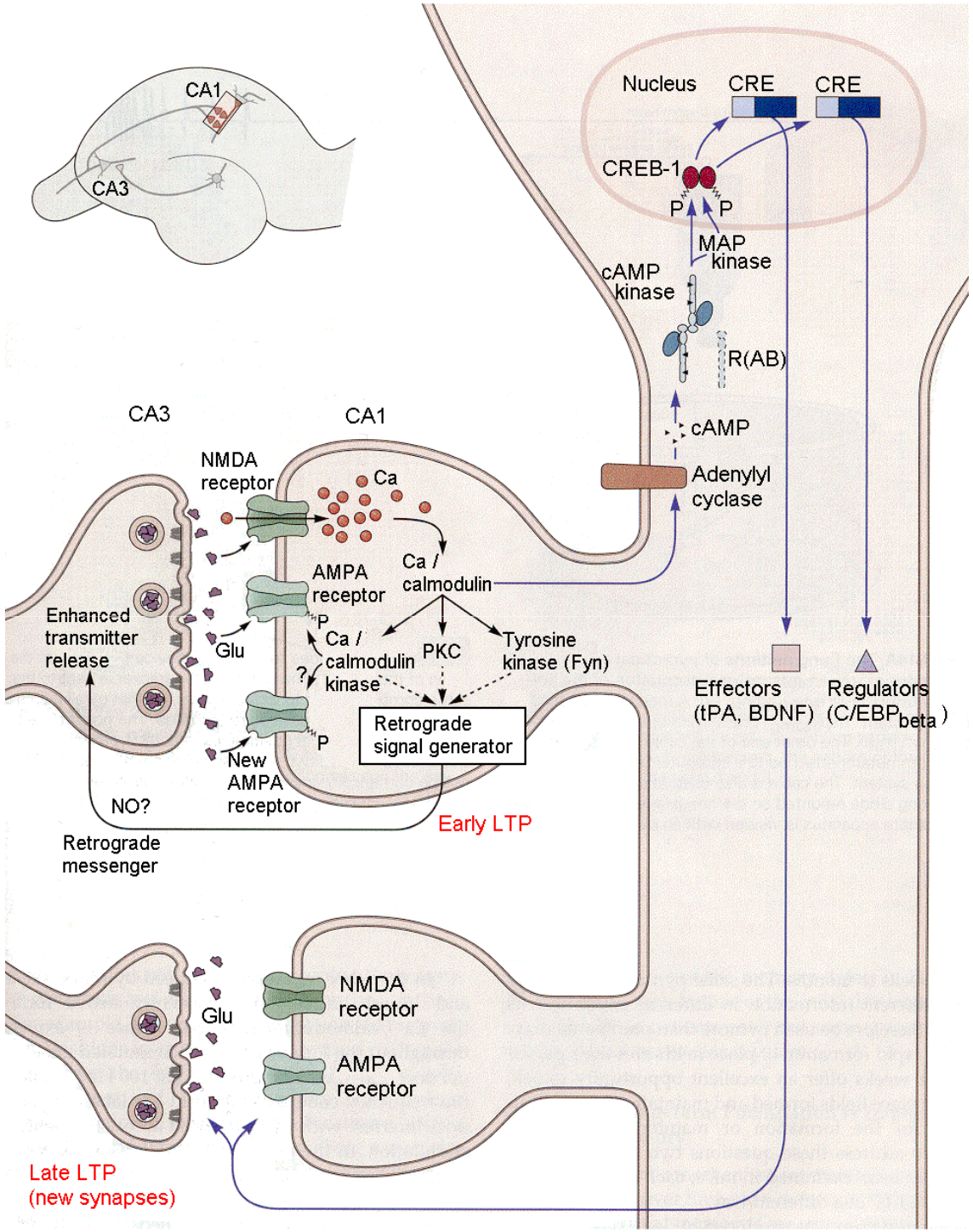

Reciprocal connections between neurons
Neurons
The cell assembly.
External stimulus
Activation of the cell assembly by a stimulus.
Reverberating activity continues activation after the stimulus is removed.
Hebbian modification strengthens the reciprocal connections between neurons that are active at the same time.
The strengthened connections of the cell assembly contain the engram for the stimulus.
After learning, partial activation of the assembly leads to activation of the entire representation of the stimulus.
= "Circle."

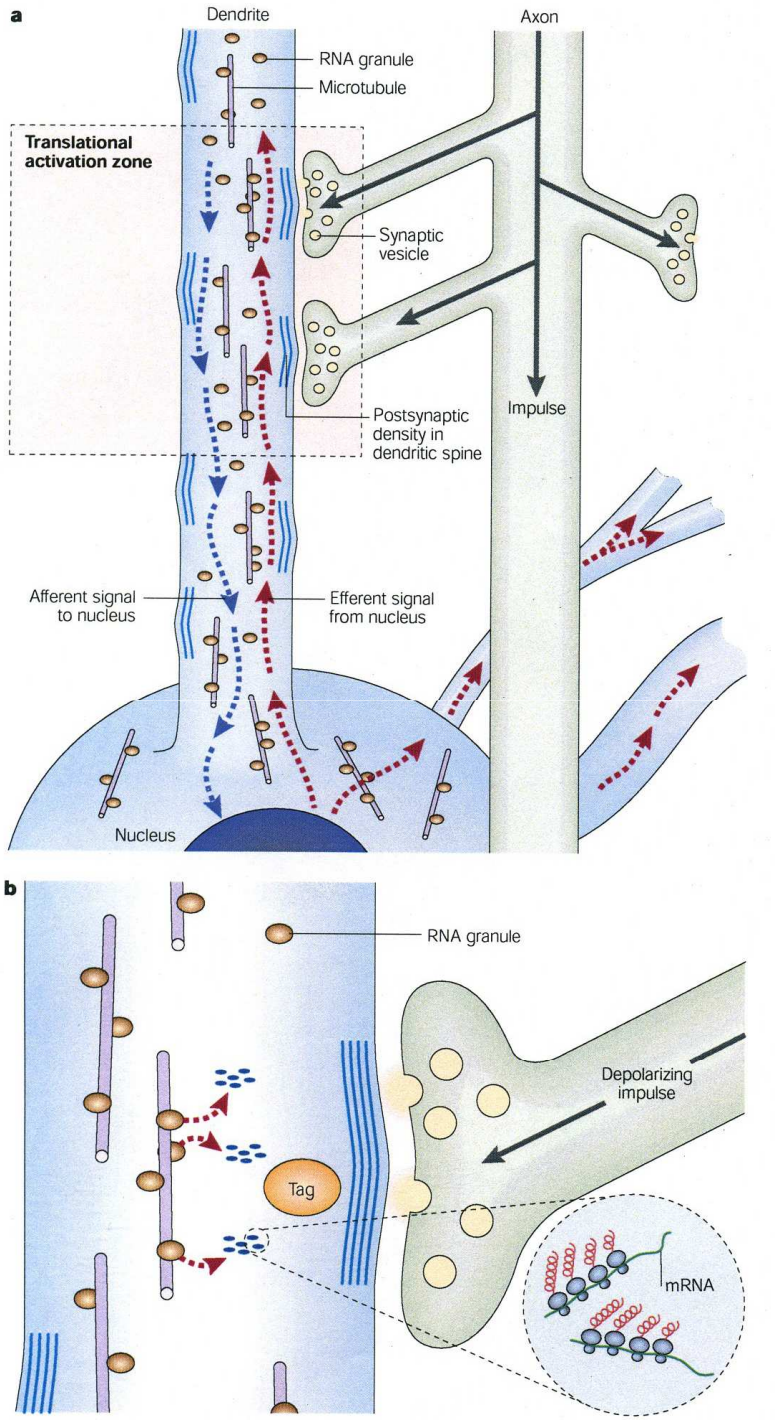

A. Experimental setup
Recording
Schaffer
collateral
pathway
Test stimulus
(1 train or
4 trains)
CA1
CA3
Mossy fiber pathway
(nonassociative LTP)
Perforant pathway
(associative LTP)

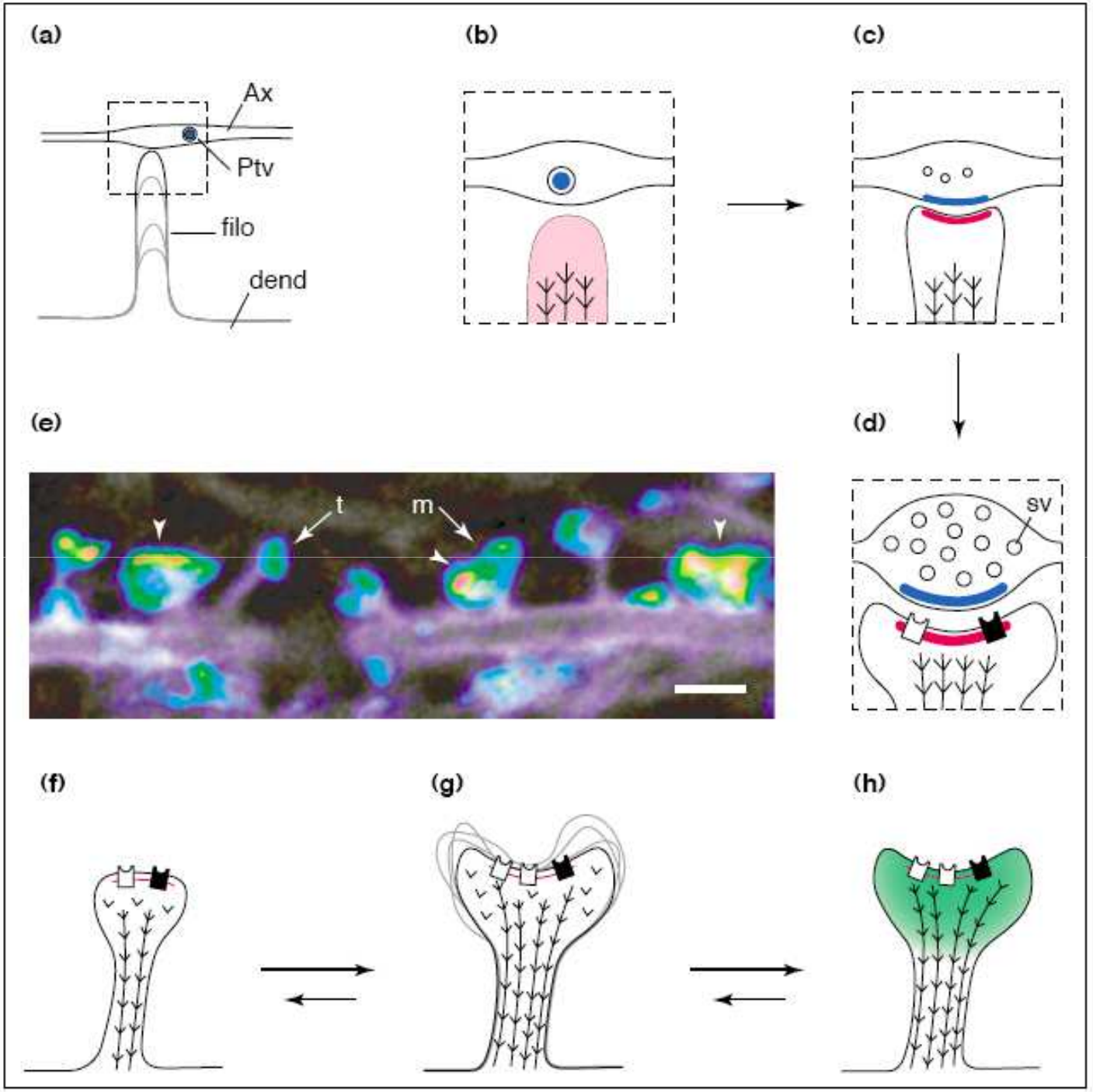

B. LTP in the hippocampus CA1 area
EPSP slope (% of control)
400
300
200
100
0
-60
0
60
120
180
Time (min)
Late LTP (4 trains)
Early LTP (1 train)


Normal synaptic transmission
Glu
Metabotropic receptor
Endoplasmic reticulum
PLC
Mg
NMDA receptor
Glu
AMPA receptor
Na
K
Dendritic shaft
Dendritic spine


Induction of long-term potentiation
Glu
Mg
Ca
Na
Glu
Na
Na
K
K
K
P
P
Ca
Ca / calmodulin
Ca / calmodulin kinase
?
PKC
Tyrosine kinase (Fyn)
Retrograde signal generator
New AMPA receptor
Enhanced transmitter release
Retrograde messenger
NO?


CA1
CA3
Nucleus
CRE
CRE
CREB-1
P
P
MAP kinase
cAMP kinase
R(AB)
cAMP
Adenylyl cyclase
CA3
CA1
NMDA receptor
Ca
AMPA receptor
Ca / calmodulin
P
Enhanced transmitter release
Glu
Ca / calmodulin kinase
?
PKC
Tyrosine kinase (Fyn)
Retrograde signal generator
P
New AMPA receptor
NO?
Retrograde messenger
Early LTP
Effectors (tPA, BDNF)
Regulators (C/EBP beta)
Glu
NMDA receptor
AMPA receptor
Late LTP (new synapses)


a
Dendrite
Axon
RNA granule
Microtubule
Translational activation zone
Synaptic vesicle
Impulse
Postsynaptic density in dendritic spine
Afferent signal to nucleus
Efferent signal from nucleus
Nucleus
b
RNA granule
Depolarizing impulse
Tag
mRNA


(a)
Ax
Ptv
filo
dend
(b)
(c)
(d)
sv
(e)
t
m
(f)
(g)
(h)

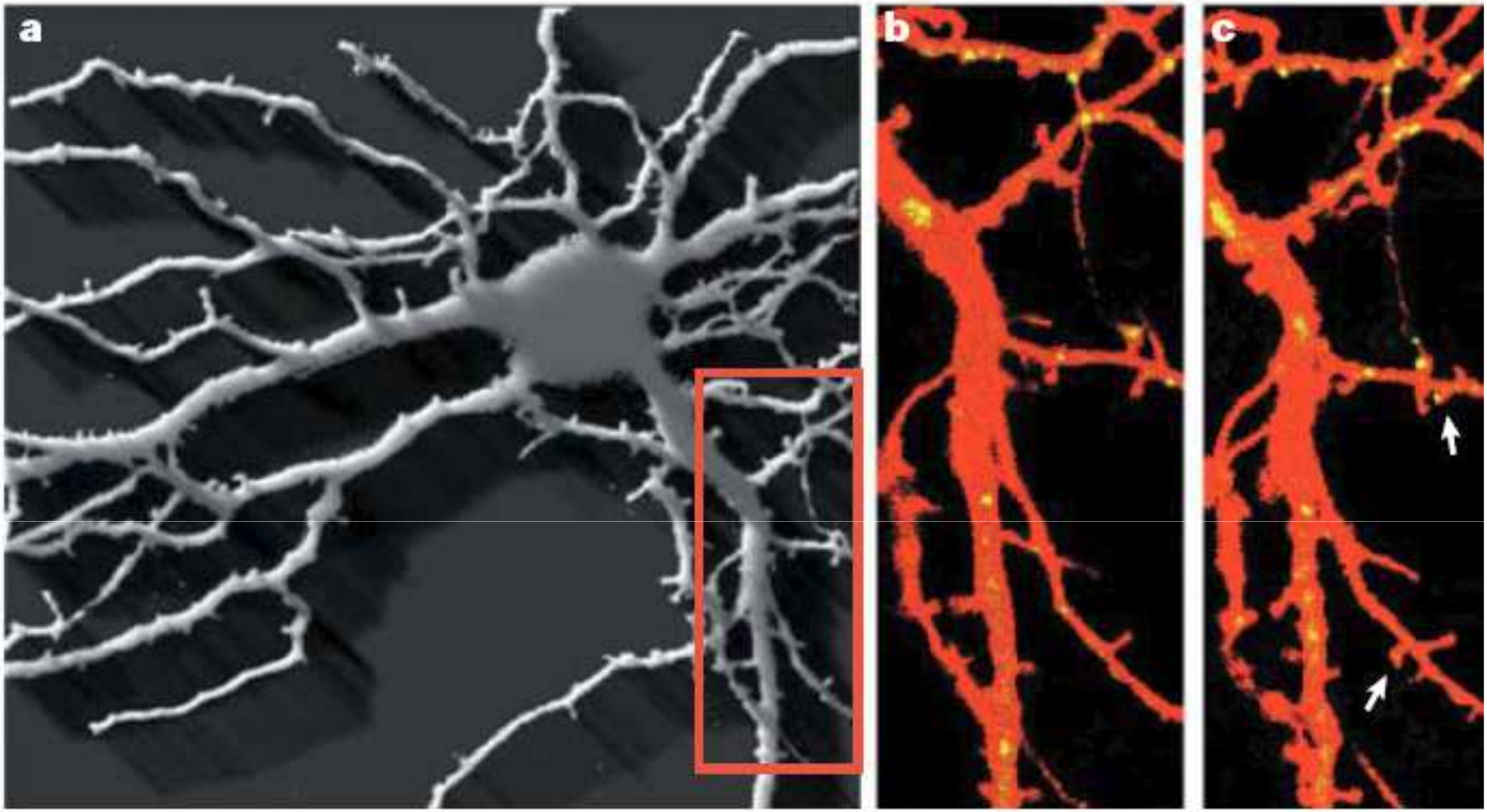
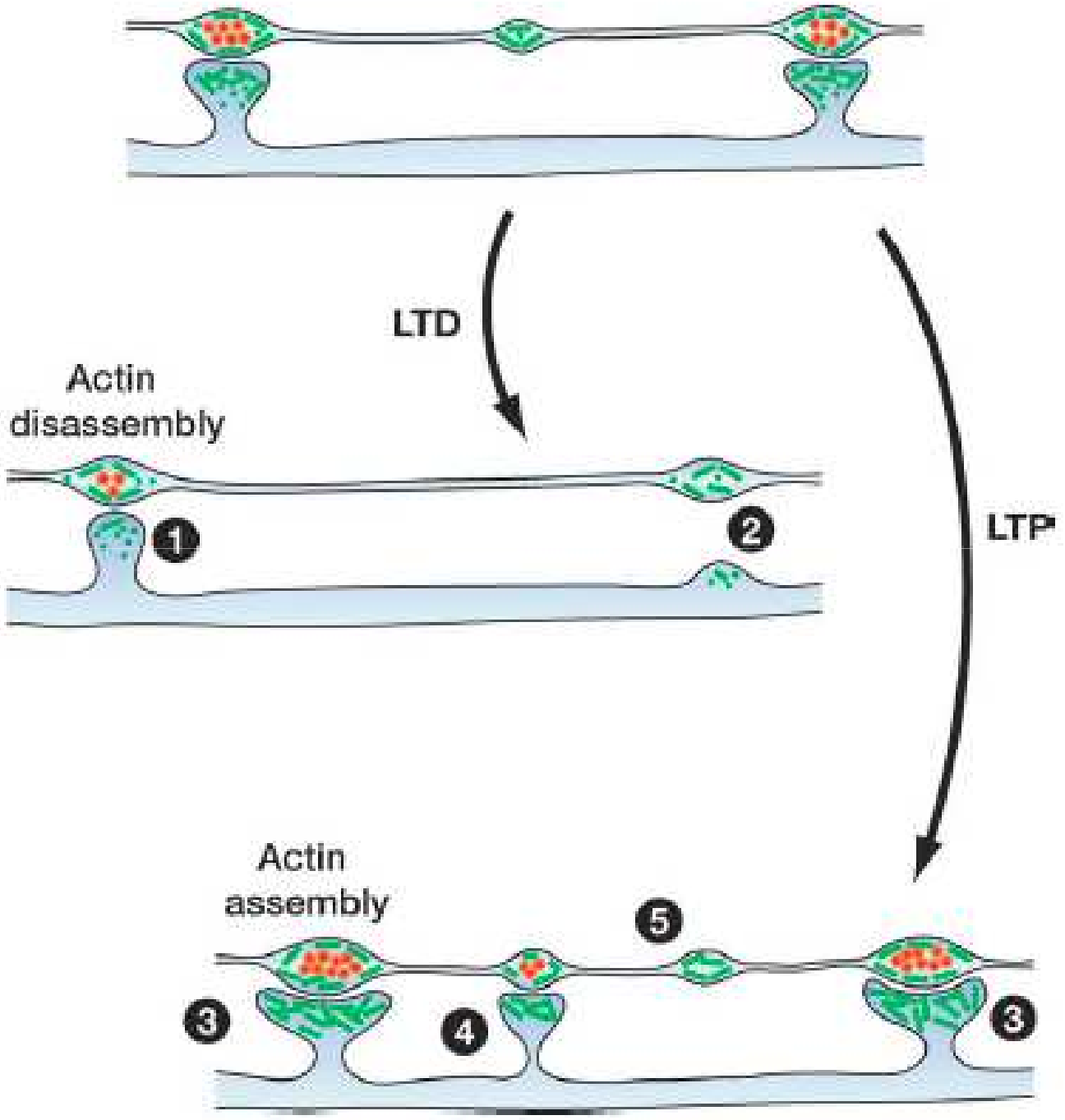
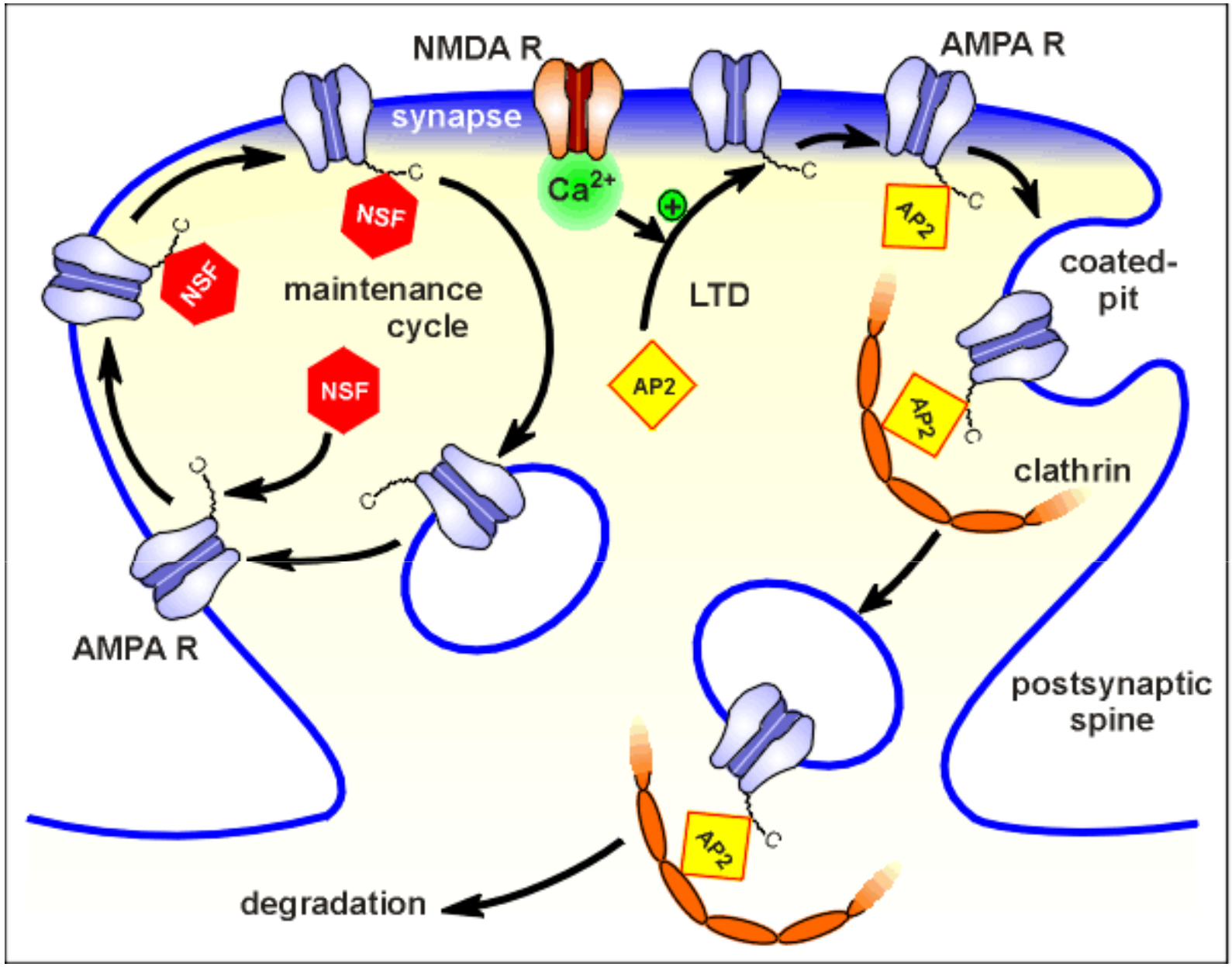


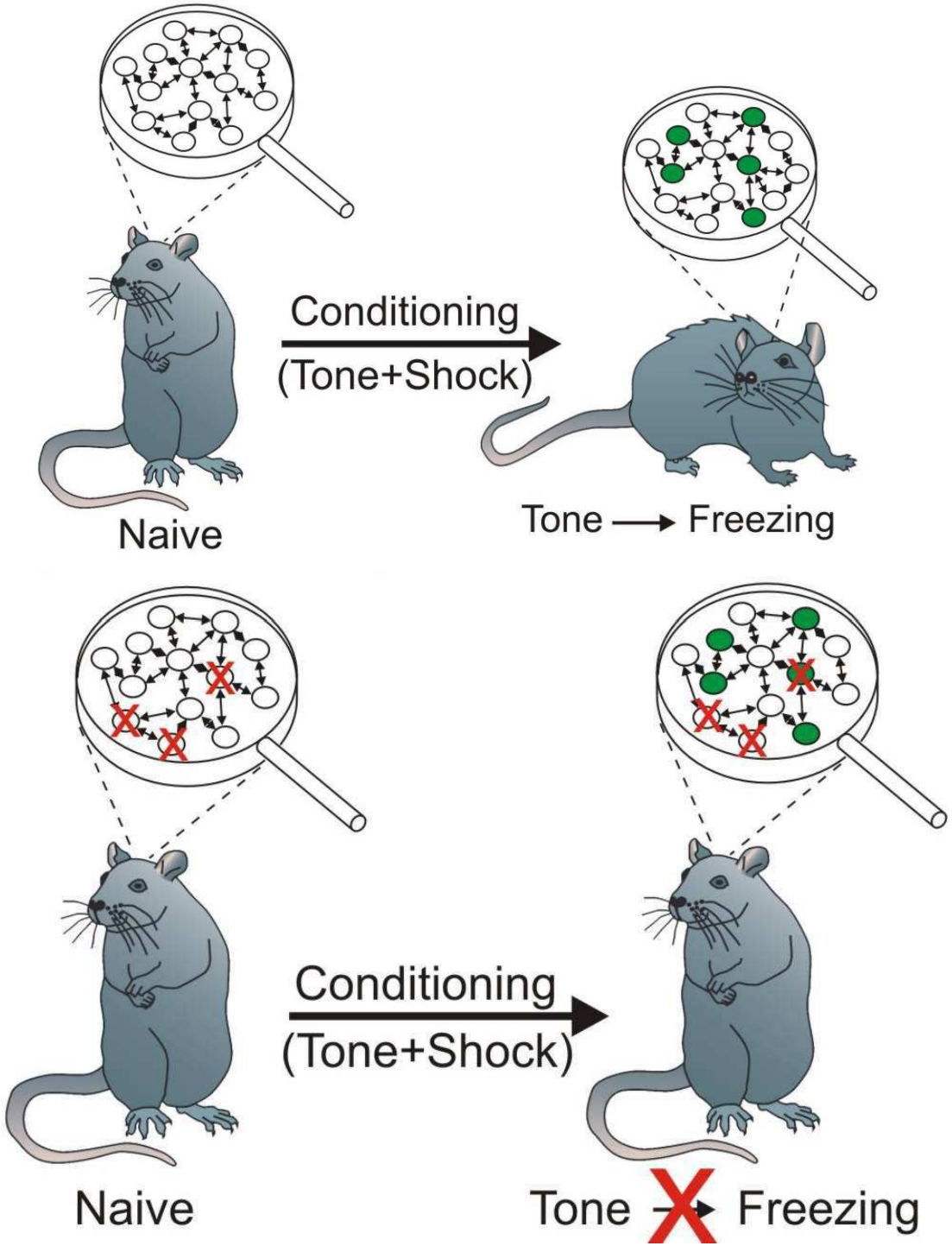
Figure 2 | **Changes in dendritic spines in cultured hippocampal neurons after conditioning stimulation. a** | A confocal microscopic three-dimensional reconstruction of a neuron that was transfected with red florescent protein to allow visualization of its morphology. **b**,**c** | The frame shown in **a** is enlarged to show a dendrite and green puncta of green fluorescent protein-tagged glutamate receptor 1 (GluR1–GFP) before (**b**) and 2 h after (**c**) the culture was exposed to a 10 min conditioning stimulation. Arrows in **c** point to two new dendritic spines that contain GluR1 puncta.

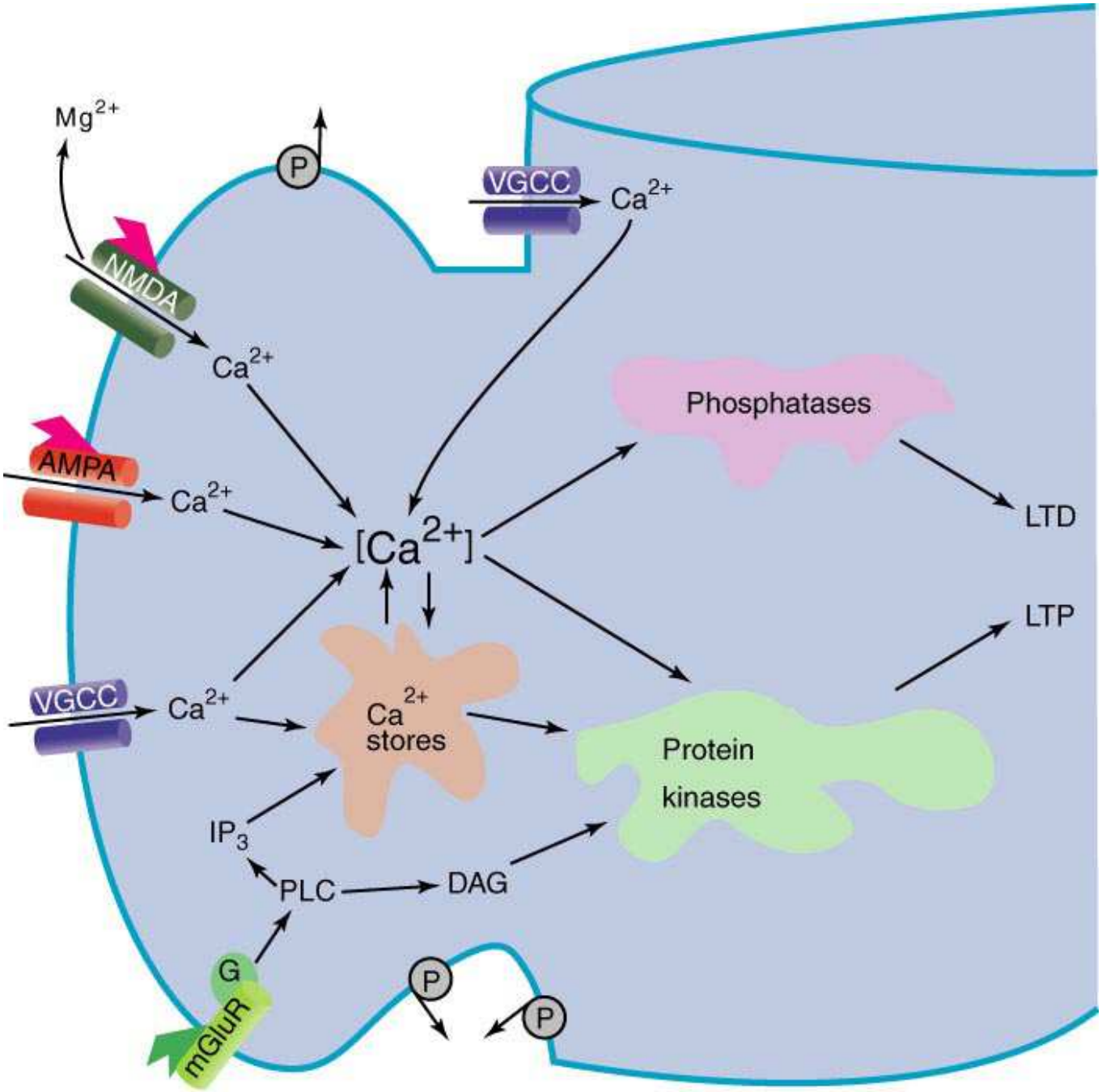

LTD
Actin
disassembly
1
2
LTP
Actin
assembly
5
3
4
3

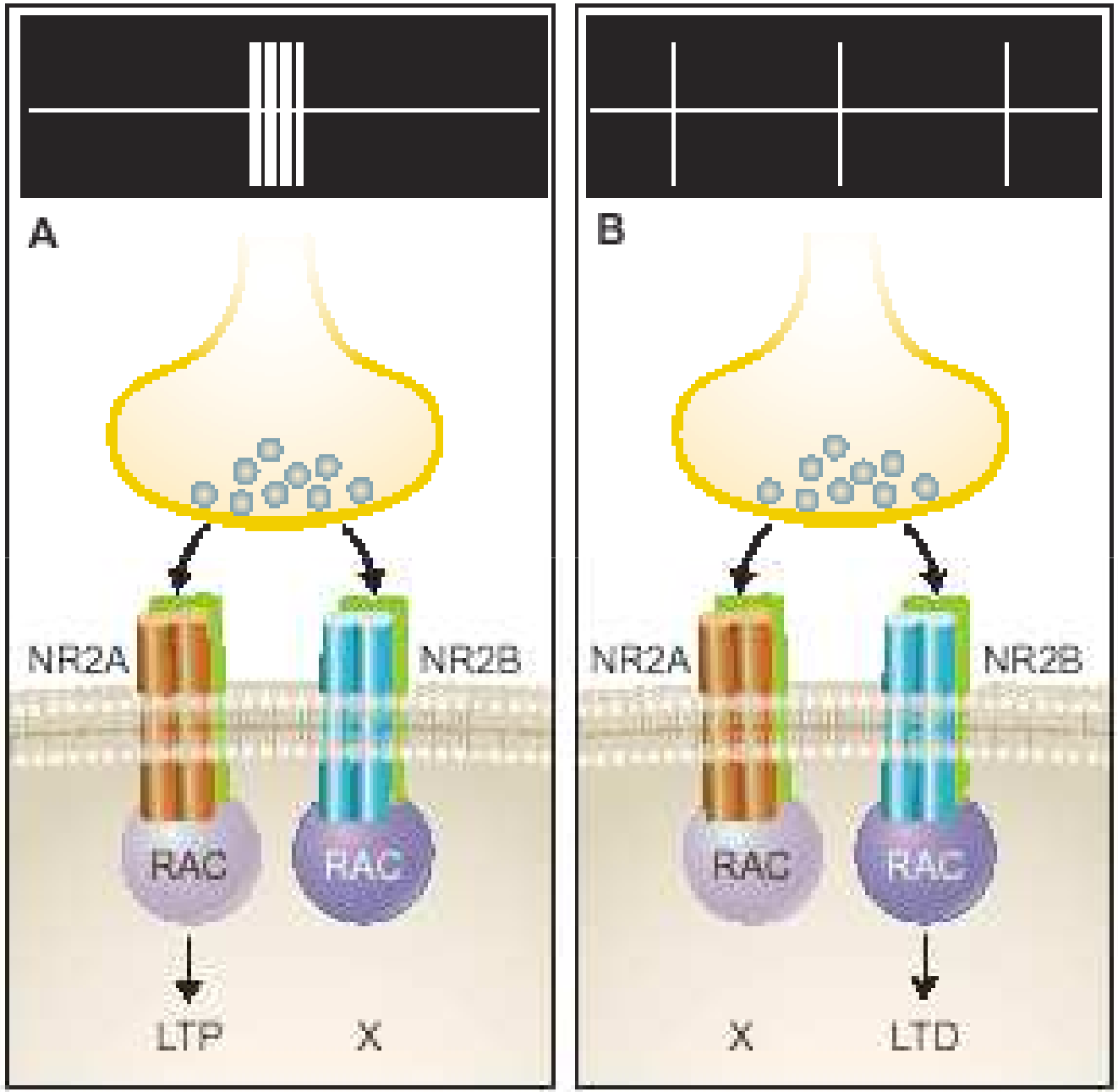


AP2:PROTEÍNA ADAPTADORA

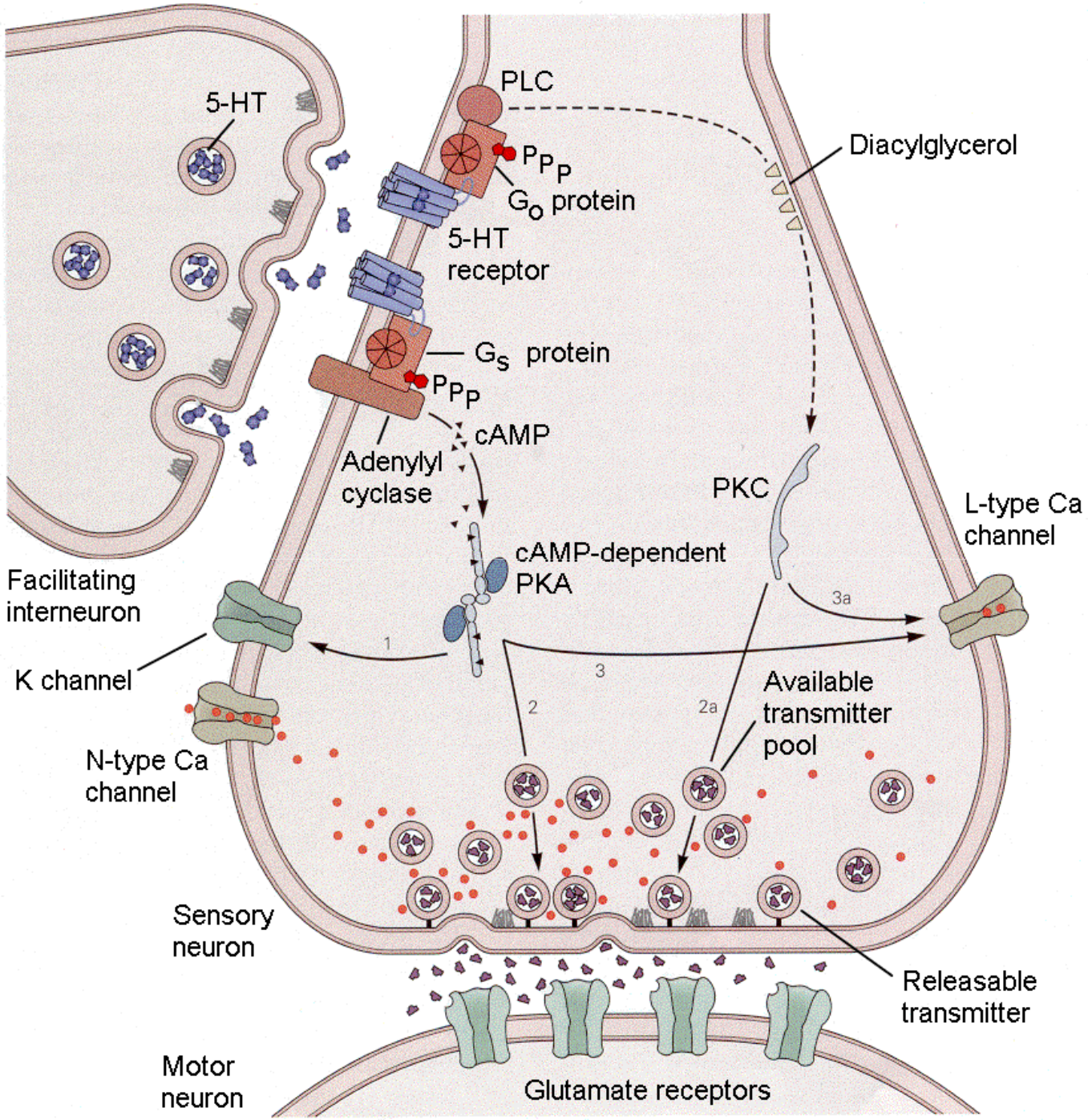
NSF:ATPASA TRANSPORTADORA

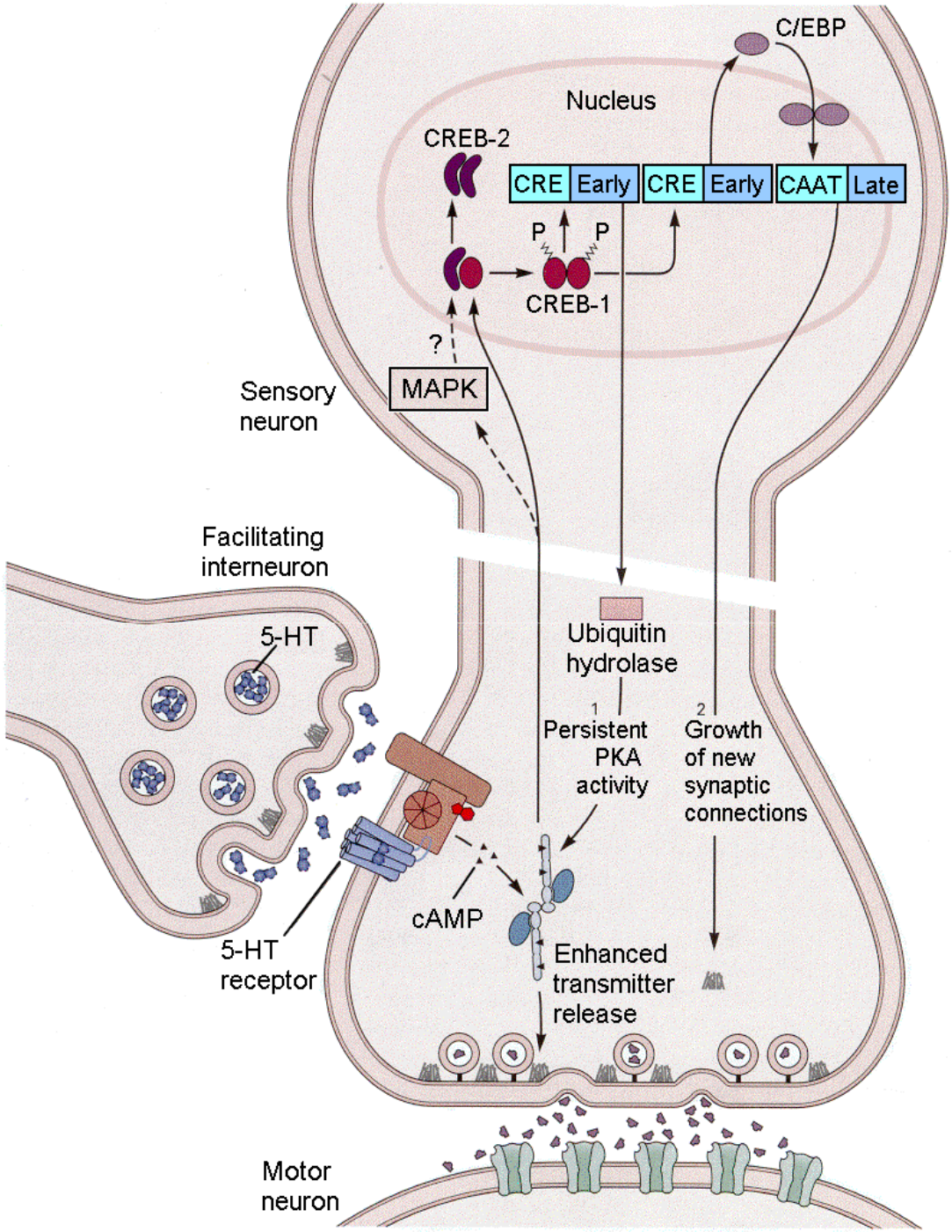

Conditioning
(Tone+Shock)
Naive
Tone → Freezing
Conditioning
(Tone+Shock)
Naive
Tone → Freezing





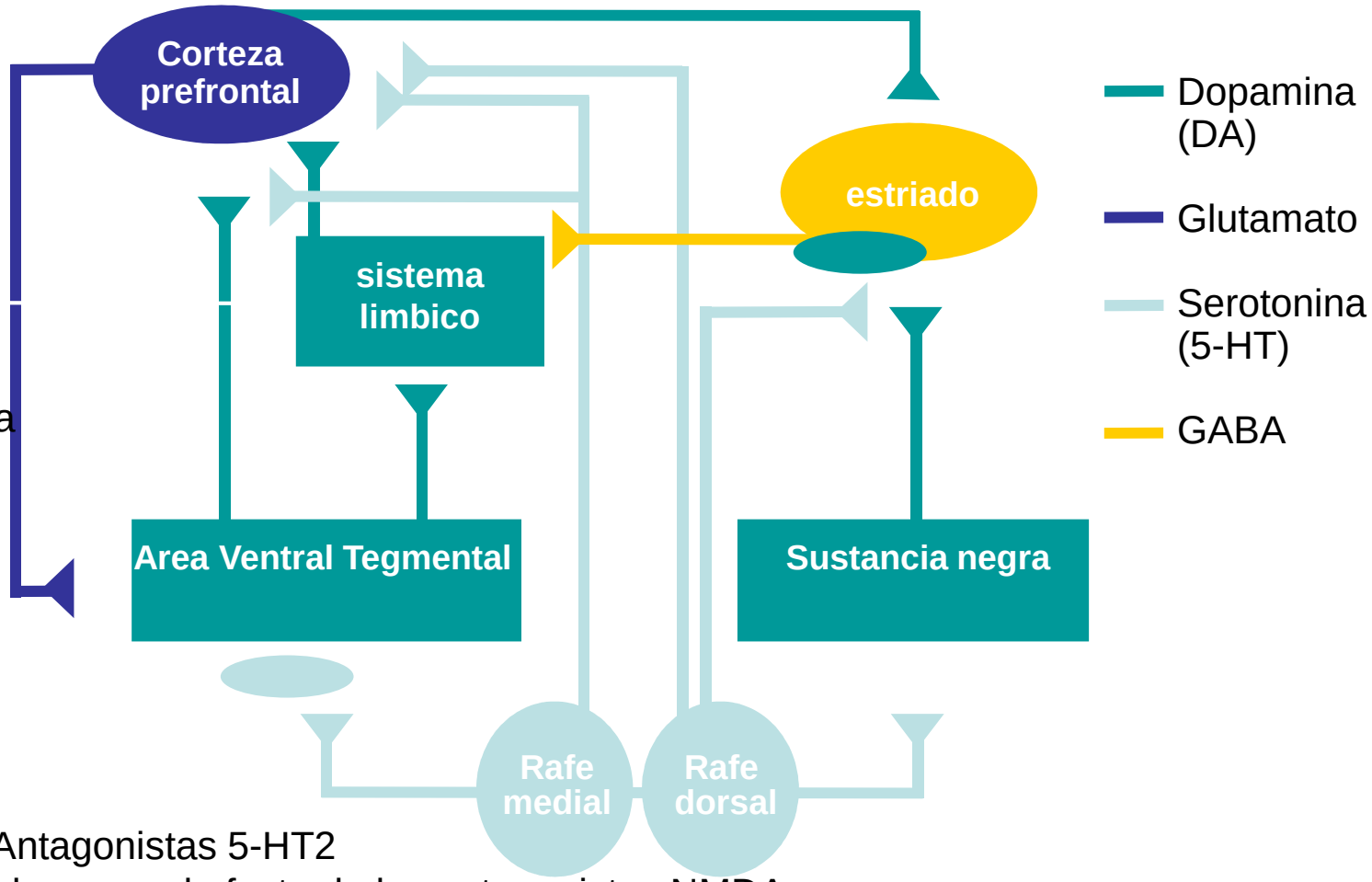
Secret liaisons. Distinct NMDA receptor subtypes direct changes in synaptic strength induced by different patterns of neural activity. Stimulation of nerve fibers projecting to hippocampal pyramidal cells leads to the release of the neurotransmitter glutamate from presynaptic terminals. Glutamate binds to all glutamate receptor subtypes on the postsynaptic membrane, including NMDA receptors (the only type of glutamate receptor depicted). (**A**) High-frequency stimulation leads to the induction of LTP mediated by NMDA receptors containing the NR2A subunit. (**B**) In contrast, low-frequency stimulation leads to LTD mediated by NR2B-containing NMDA receptors. The composition and signaling properties of the receptor-associated protein complex (RAC) may be different for the two NMDA receptor subtypes. NR1 subunits (green) are obligatory members of NMDA receptors.


5-HT
PLC
Diacylglycerol
P P P
G_o protein
5-HT receptor
G_s protein
P P P
cAMP
Adenylyl cyclase
PKC
L-type Ca channel
cAMP-dependent PKA
Facilitating interneuron
3a
1
3
2
2a
K channel
Available transmitter pool
N-type Ca channel
Sensory neuron
Releasable transmitter
Motor neuron
Glutamate receptors


C/EBP
Nucleus
CREB-2
CRE
Early
CRE
Early
CAAT
Late
P
P
CREB-1
?
MAPK
Sensory neuron
Facilitating interneuron
5-HT
Ubiquitin hydrolase
1
Persistent PKA activity
2
Growth of new synaptic connections
cAMP
5-HT receptor
Enhanced transmitter release
Motor neuron

Antagonistas NMDA elevan los Niveles de serotonina en corteza prefrontal

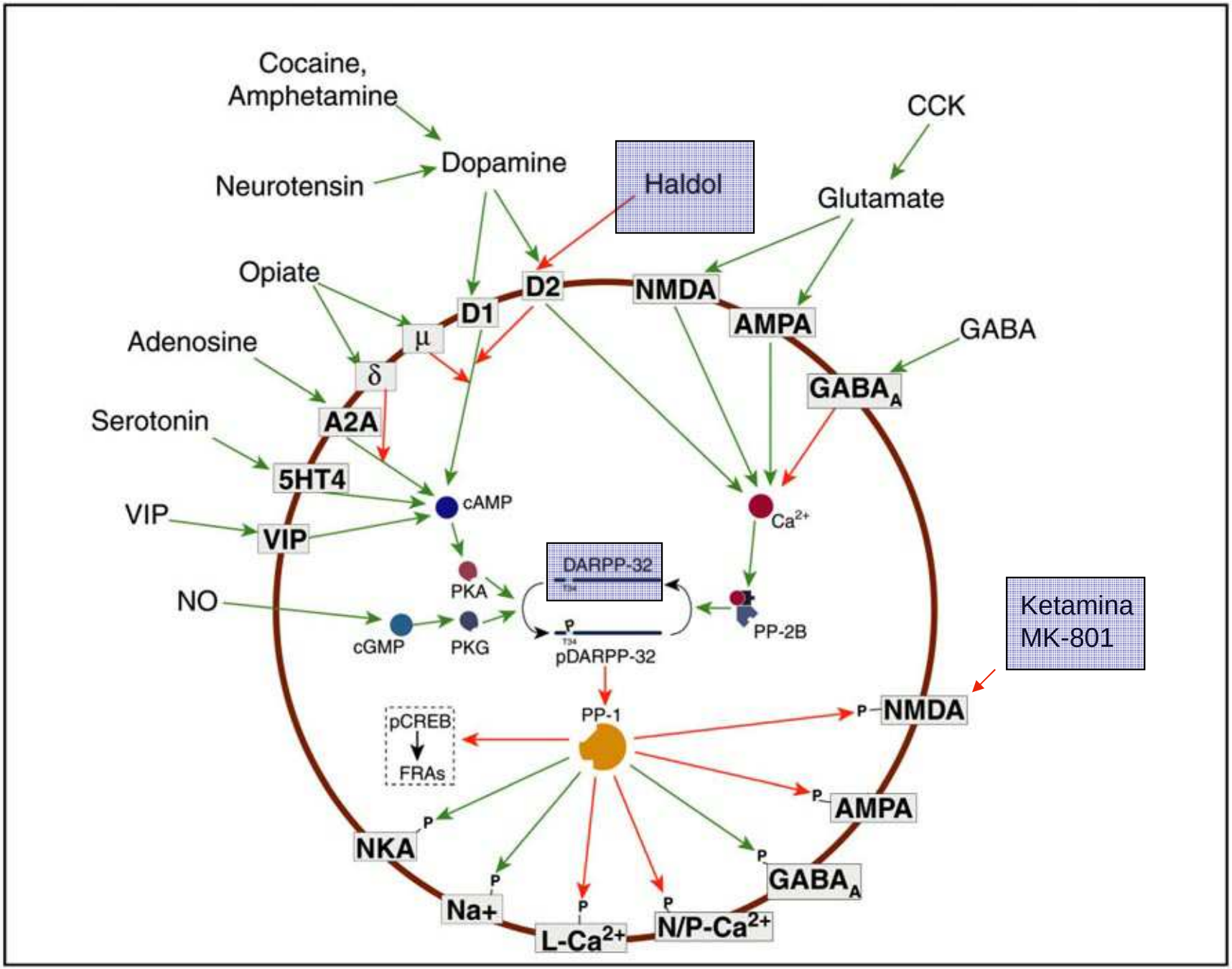
Antagonistas 5-HT2A mejoran la función Dopaminérgica en la corteza prerontal

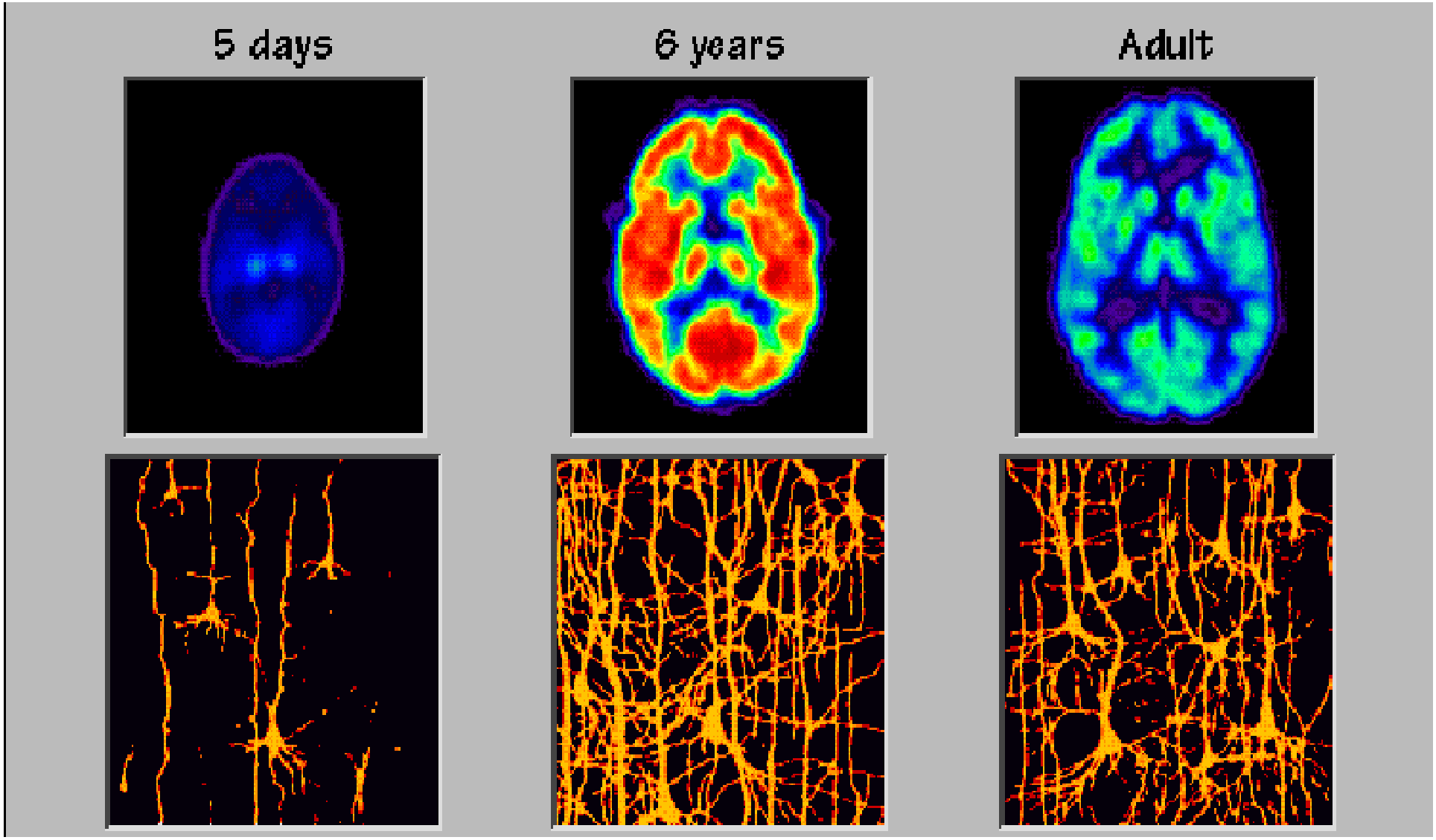


Los antagonistas NMDA aumentan la transmisión dopaminérgica

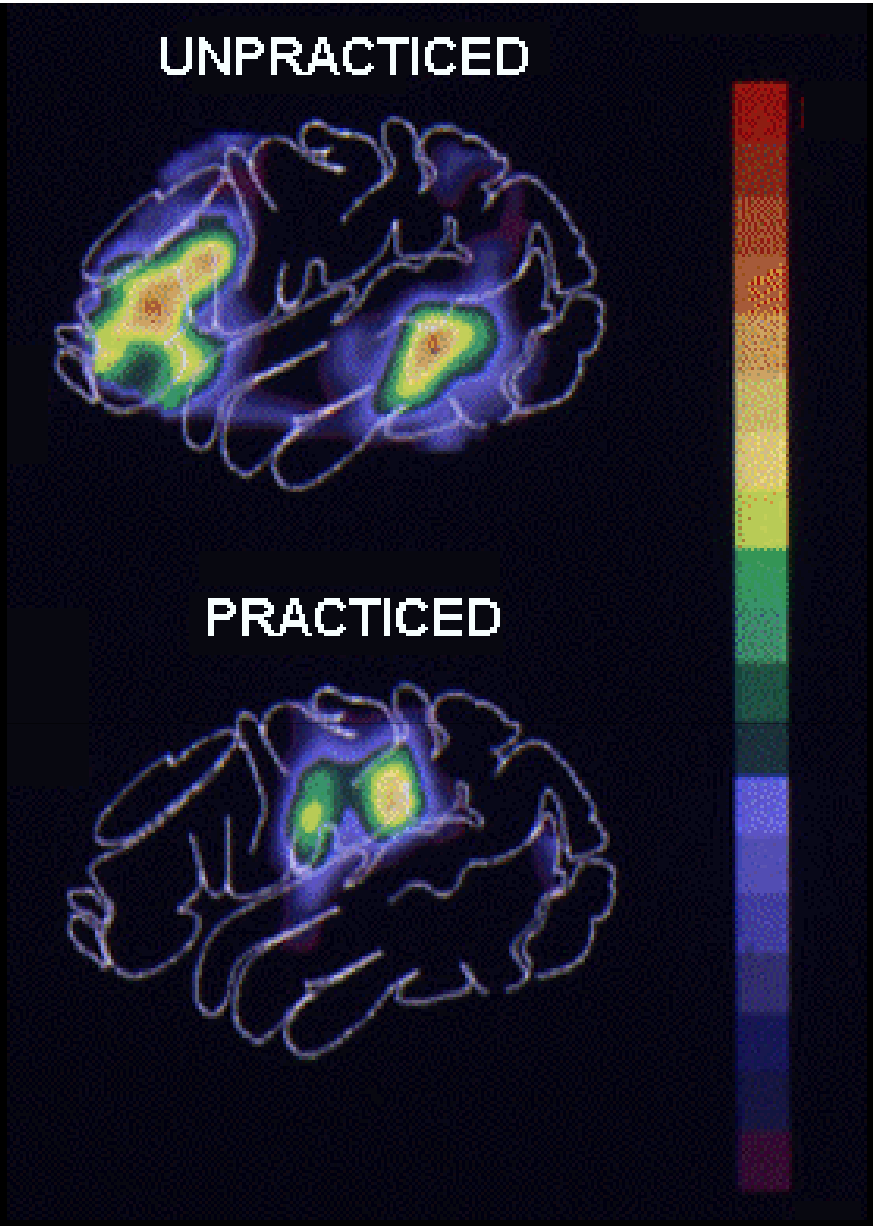
Los antagonistas NMDA aumentan la transmisión dopaminérgica

Antagonistas 5-HT2 bloquean el efecto de los antagonistas NMDA

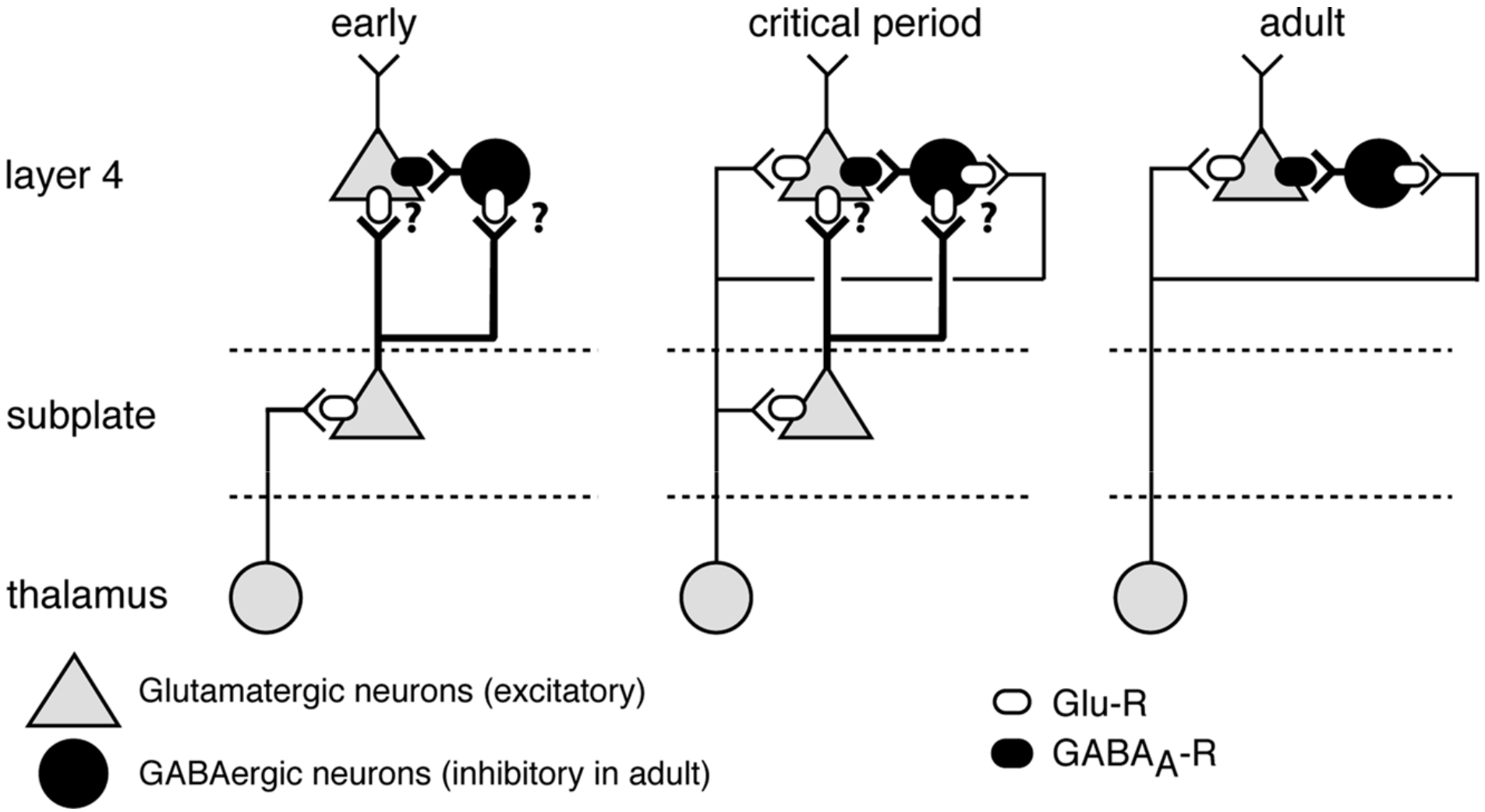




El cerebro se modifica continuamente, a todas las edades…



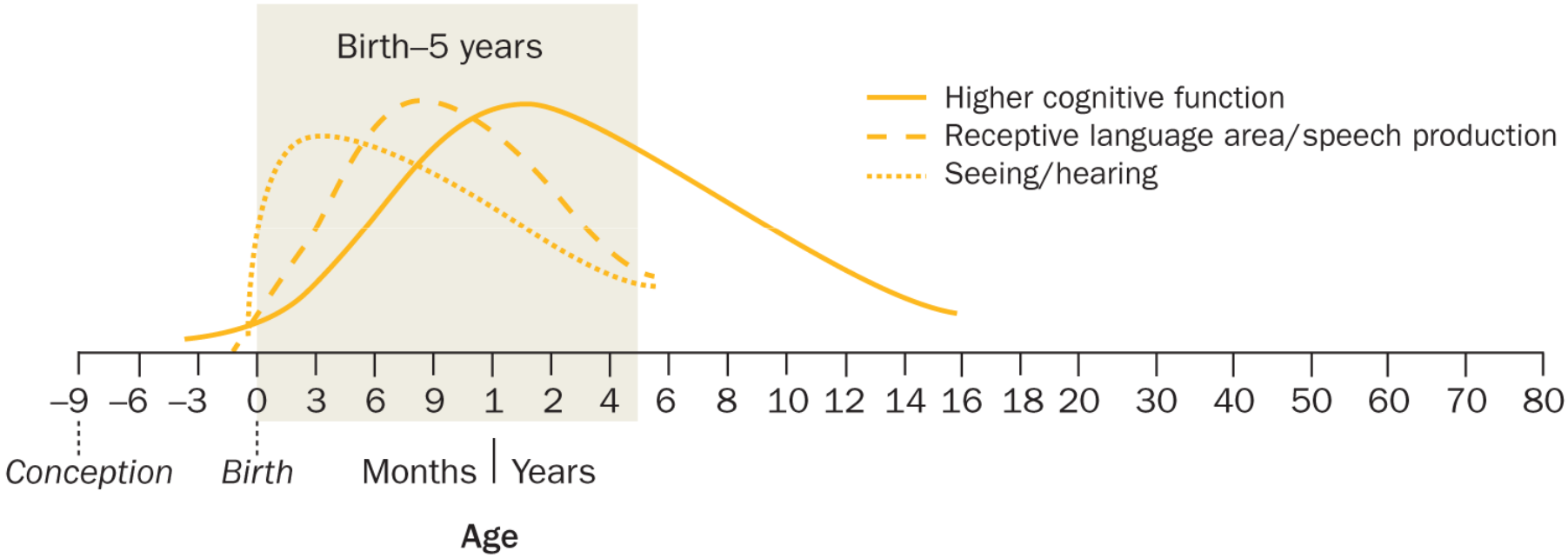
…y como consecuencias de todas las actividades

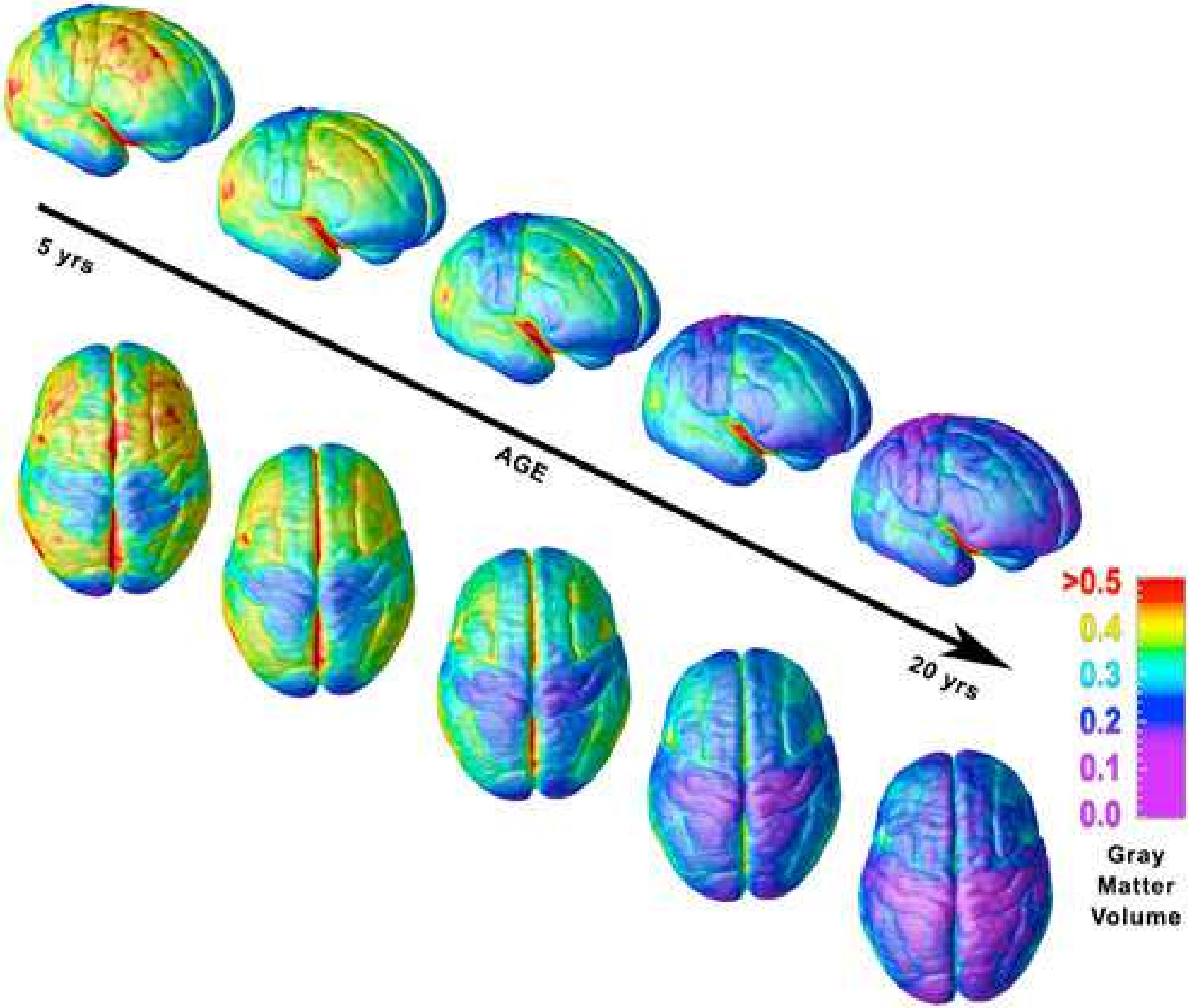

early
critical period
adult
layer 4
subplate
thalamus
?
?
?
?
Glutamatergic neurons (excitatory)
GABAergic neurons (inhibitory in adult)
Glu-R
GABA$_A$-R

“El modo en que usamos nuestro cerebro, cambia nuestro cerebro”

Cathy Davidson

Synapse formation in the brain




5 yrs
AGE
20 yrs
>0.5
0.4
0.3
0.2
0.1
0.0
Gray
Matter
Volume

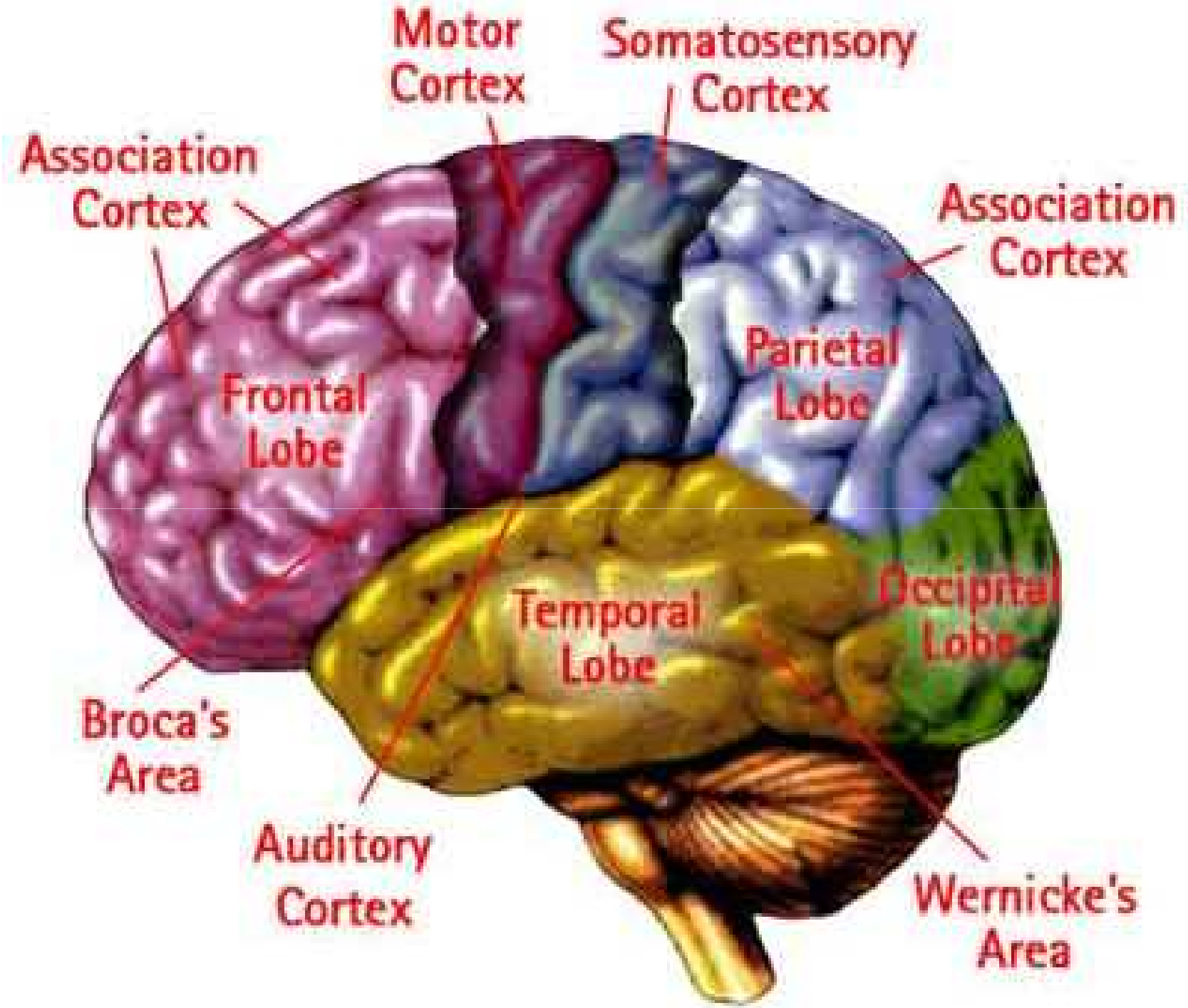
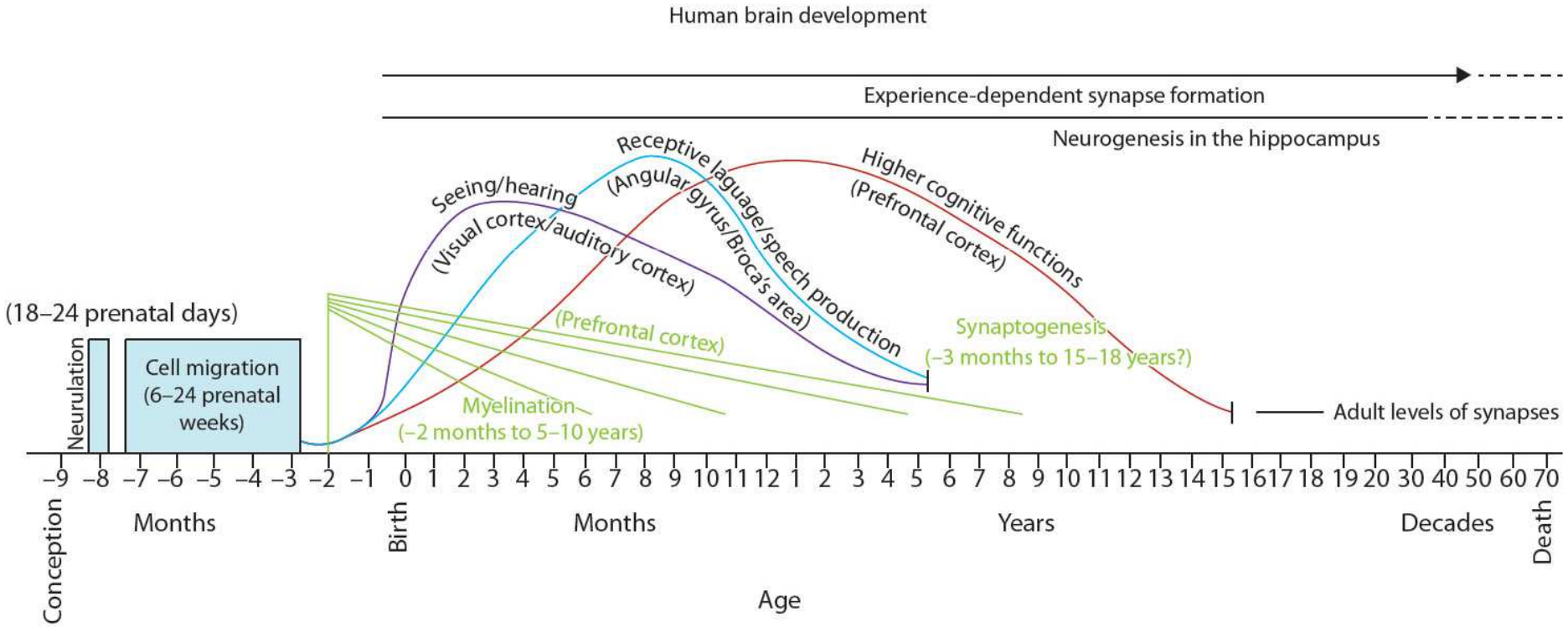

Motor Cortex
Somatosensory Cortex
Association Cortex
Association Cortex
Frontal Lobe
Parietal Lobe
Temporal Lobe
Occipital Lobe
Broca's Area
Auditory Cortex
Wernicke's Area

FIGURE 1 Visual representation of human brain development according to age (Thompson, R. A. & Nelson, C. A., 2001)



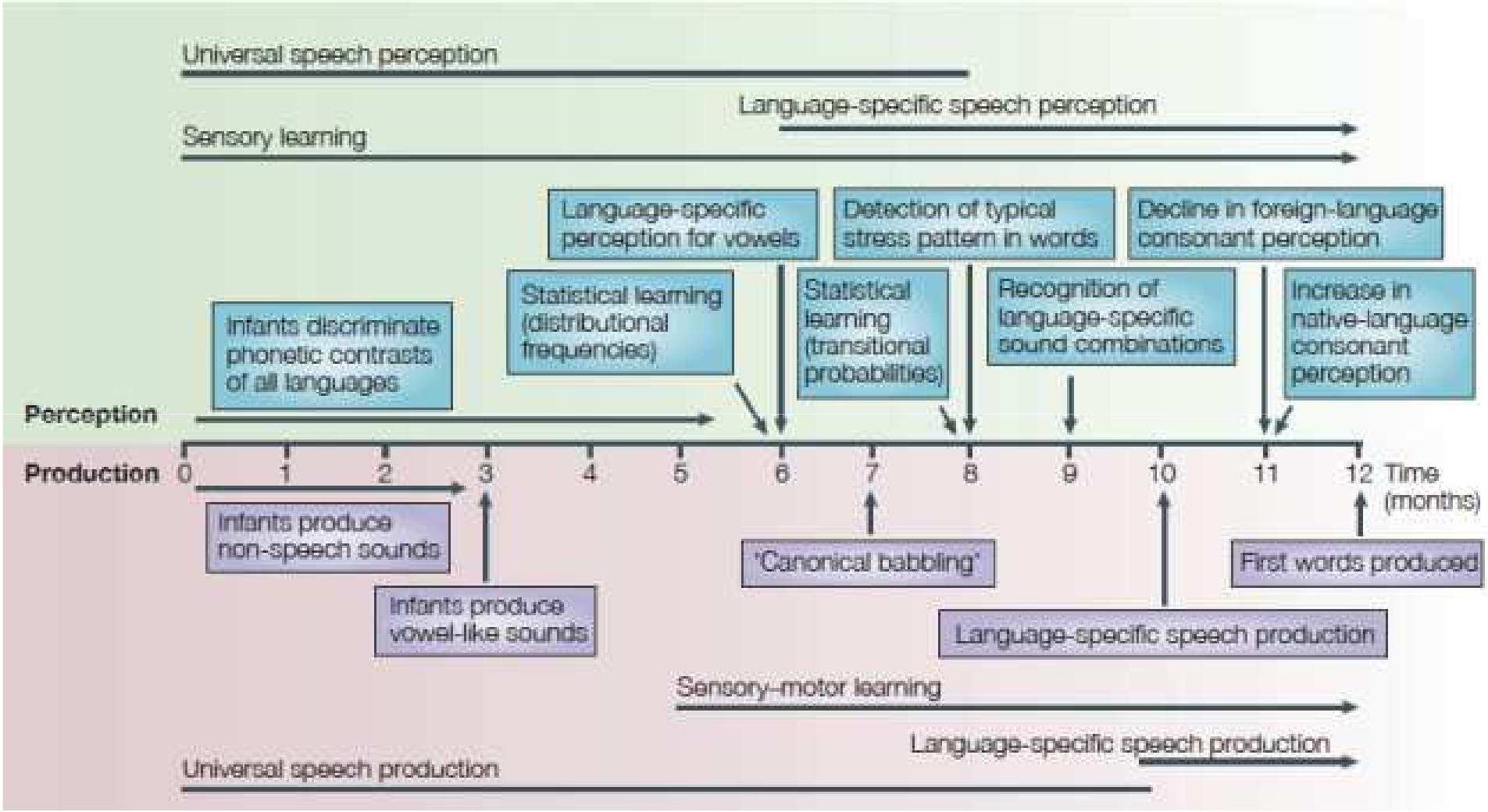

Universal speech perception
Language-specific speech perception
Sensory learning
Language-specific perception for vowels
Detection of typical stress pattern in words
Decline in foreign-language consonant perception
Statistical learning (distributional frequencies)
Statistical learning (transitional probabilities)
Recognition of language-specific sound combinations
Increase in native-language consonant perception
Infants discriminate phonetic contrasts of all languages
Perception
Production
0 1 2 3 4 5 6 7 8 9 10 11 12 Time (months)
Infants produce non-speech sounds
Infants produce vowel-like sounds
'Canonical babbling'
First words produced
Language-specific speech production
Sensory-motor learning
Language-specific speech production
Universal speech production

Figure AB-16: Limbic System

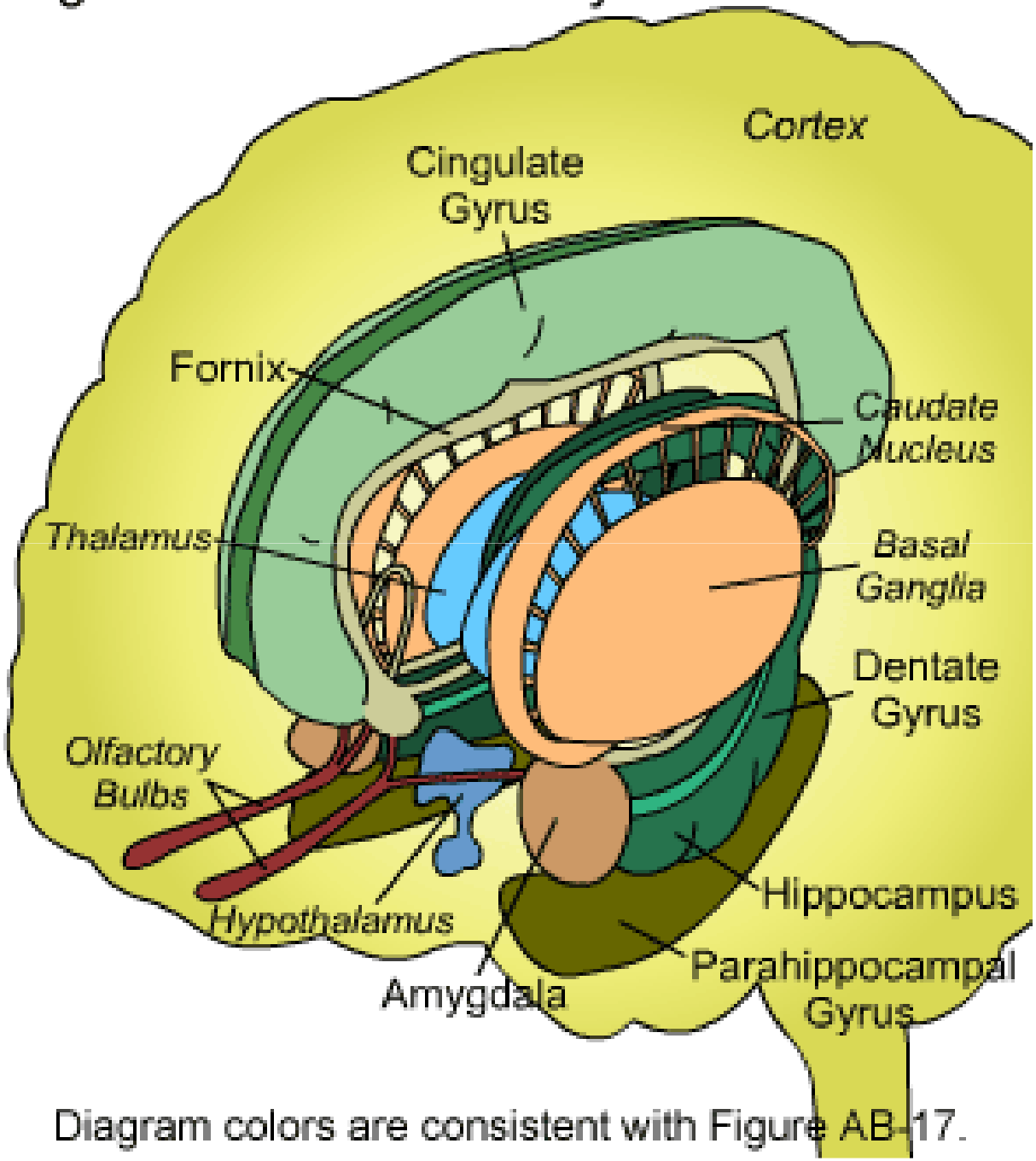
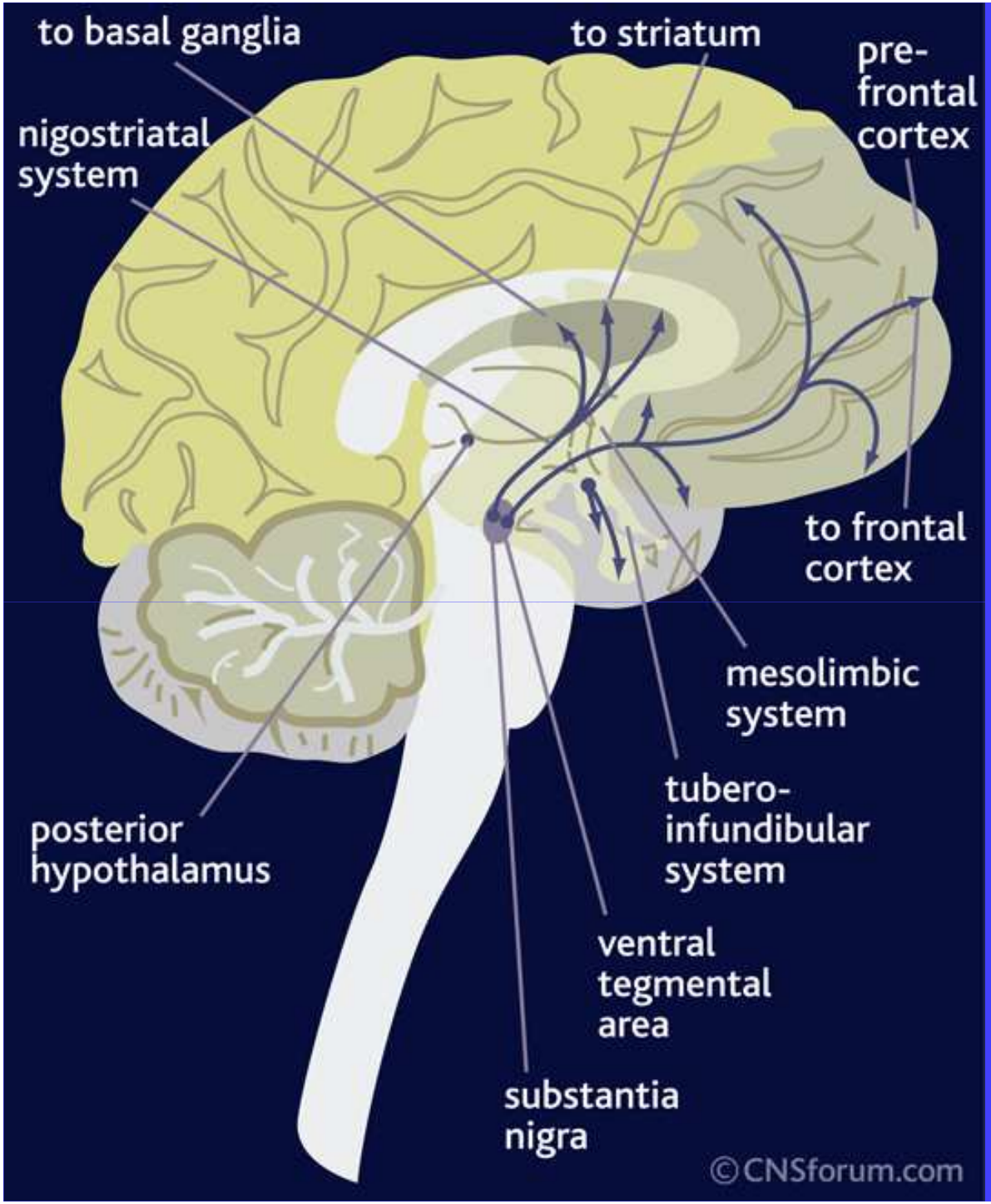
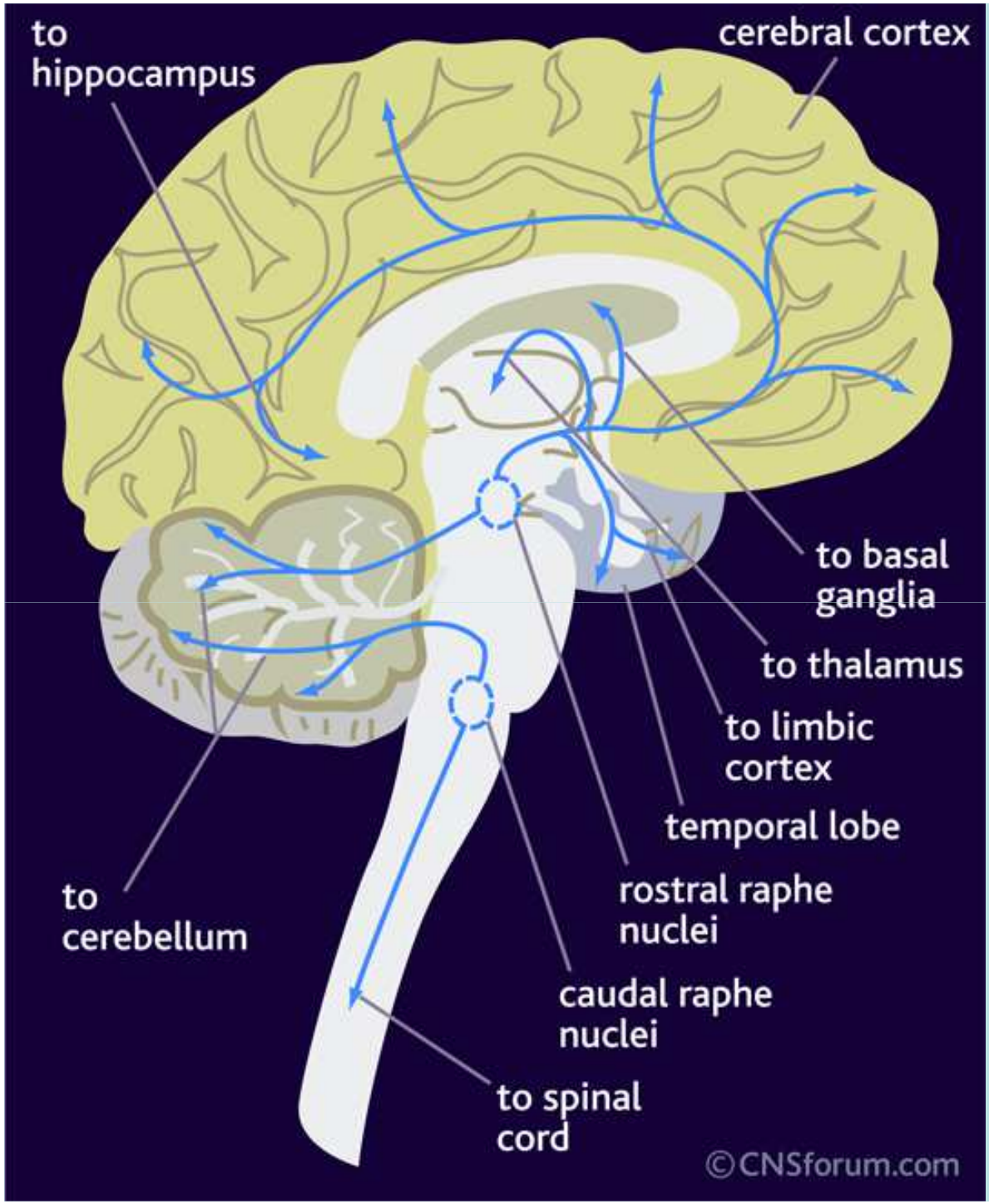


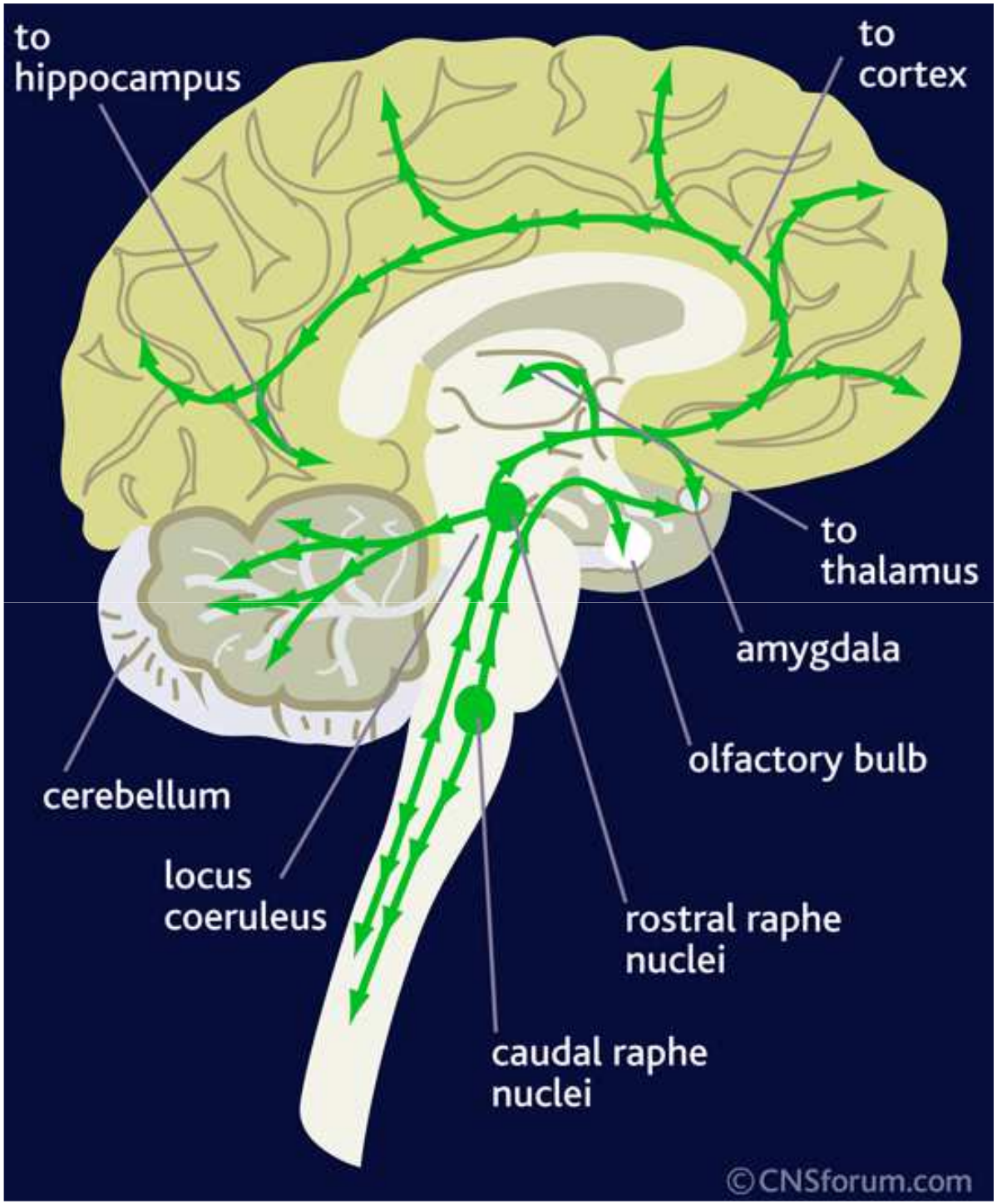
Diagram colors are consistent with Figure AB-17.



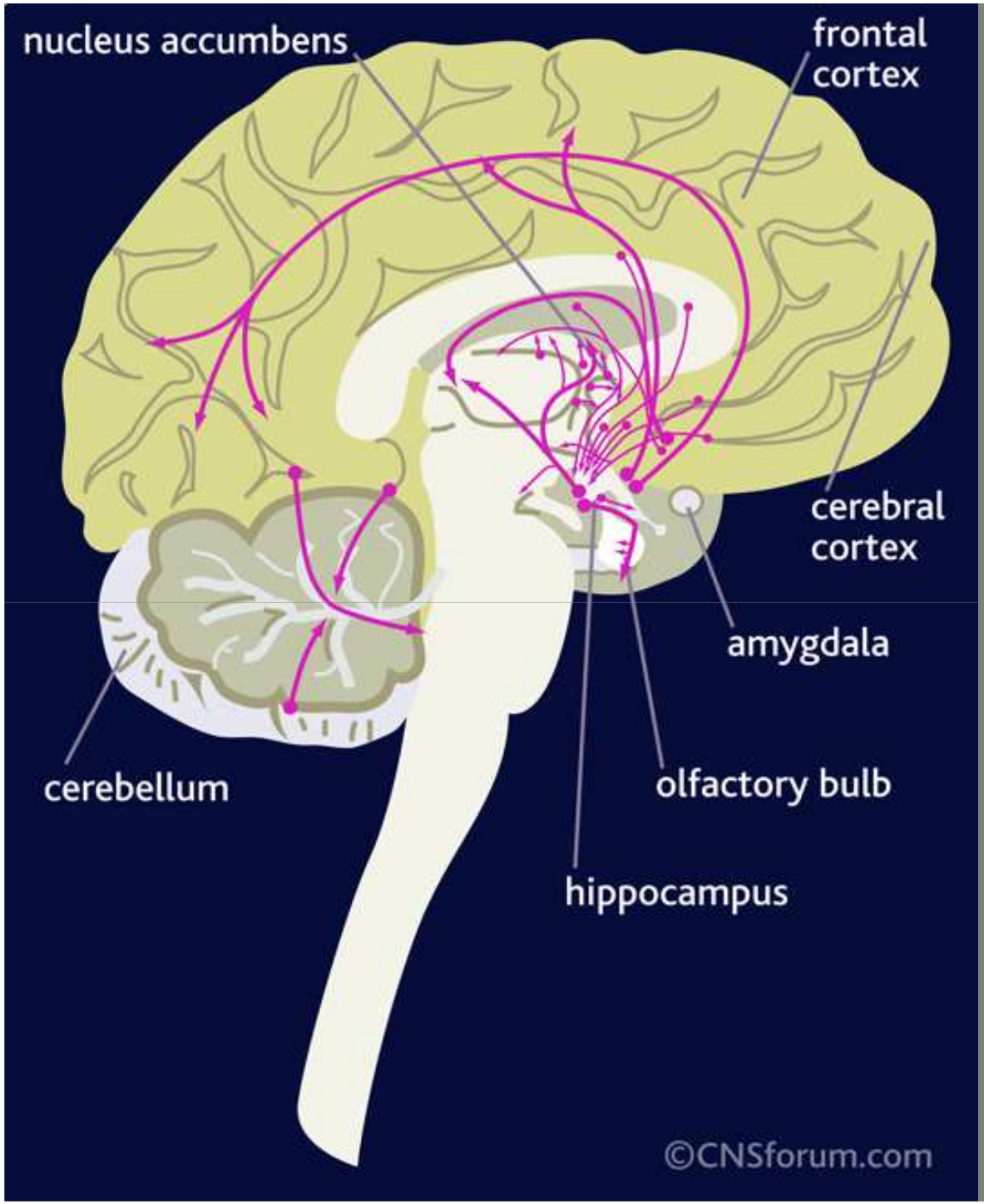
VÍAS DOPAMINÉRGICAS



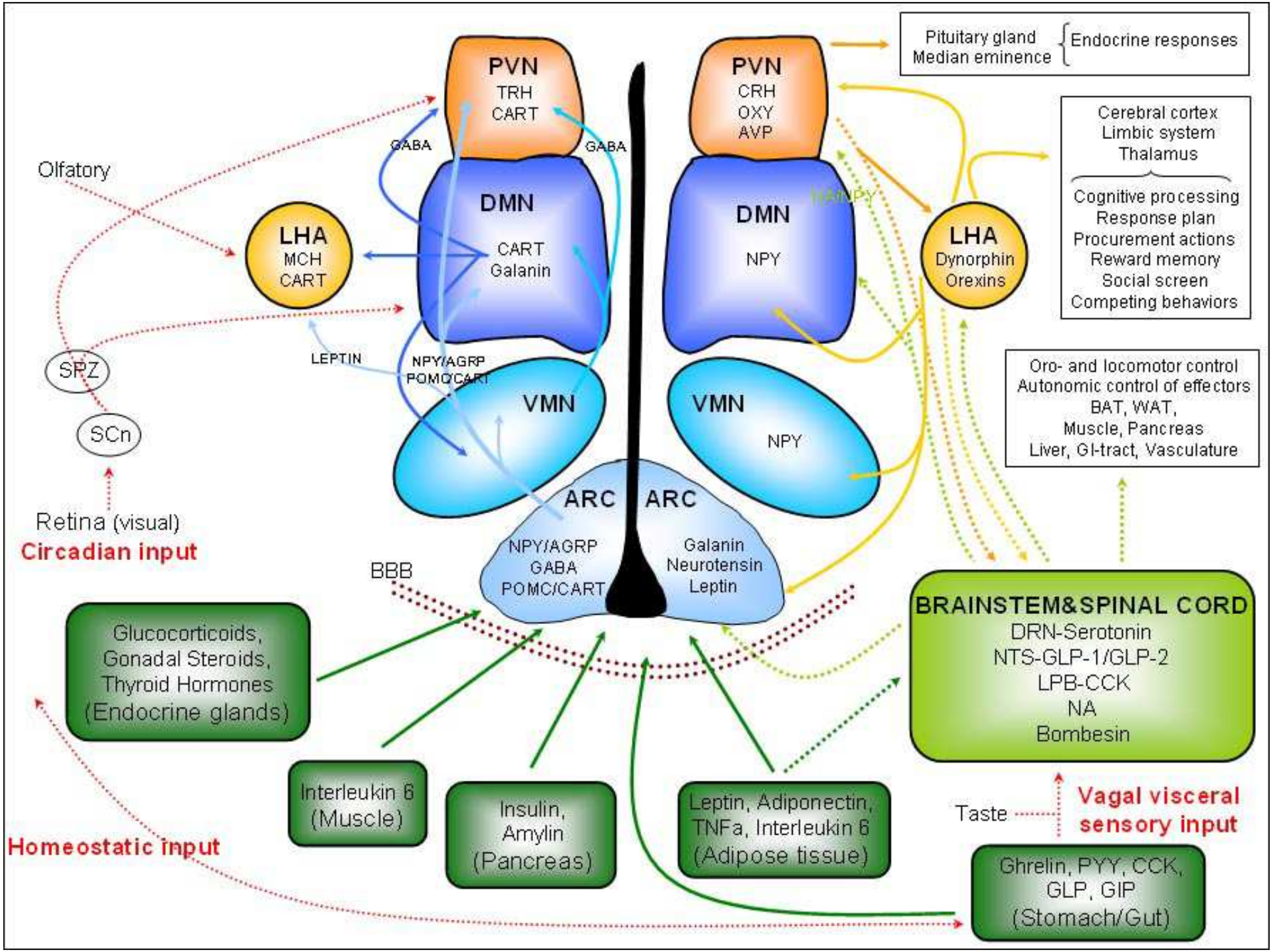
VIAS SEROTONINÉRGICAS



VÍAS NORADRENÉRGICAS

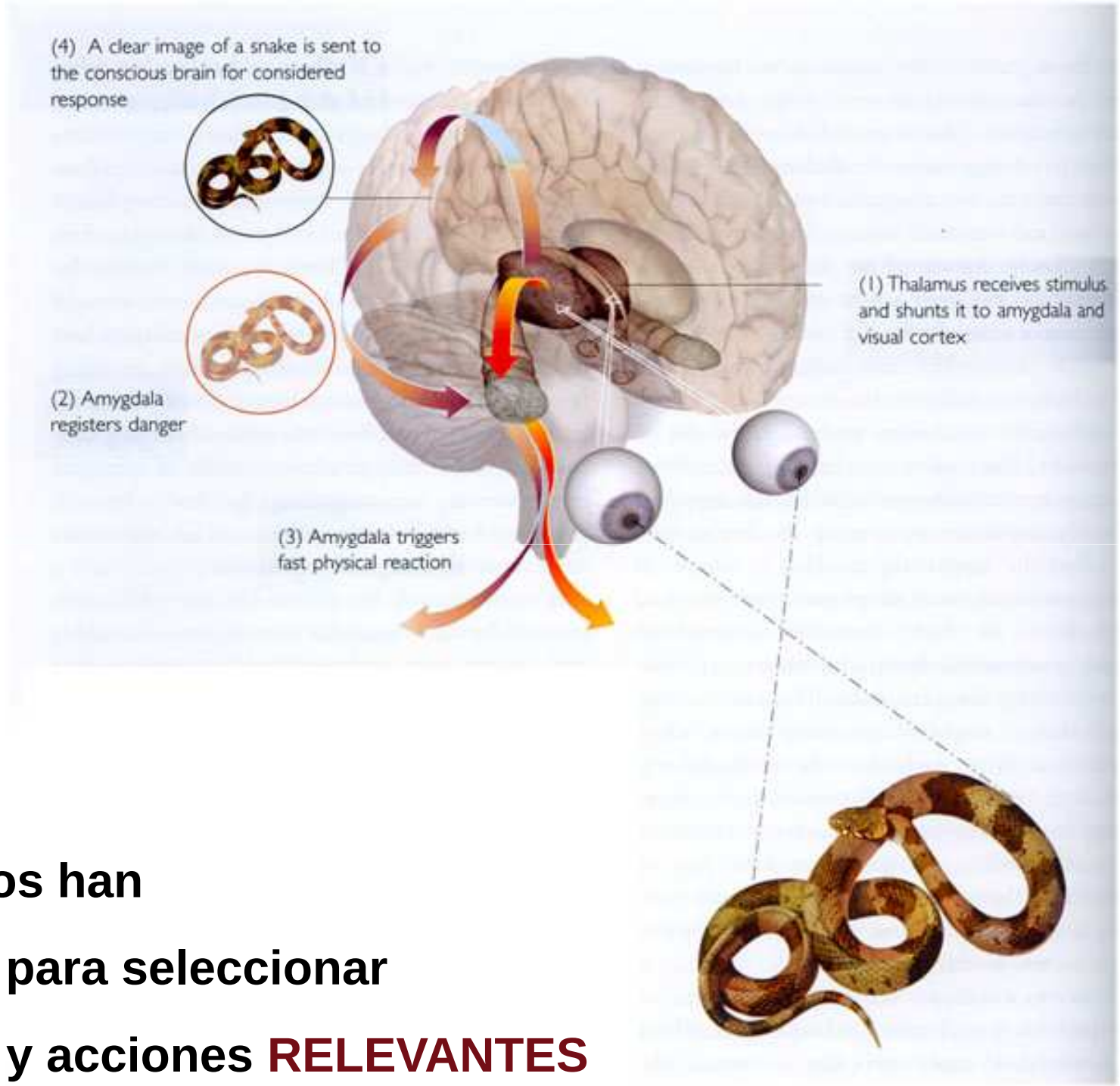


VÍAS GABAÉRGICAS


Pituitary gland
Median eminence
Endocrine responses
PVN
TRH
CART
PVN
CRH
OXY
AVP
GABA
GABA
Olfatory
DMN
CART
Galanin
DMN
NPY
NAtNPY
LHA
MCH
CART
LHA
Dynorphin
Orexins
Cerebral cortex
Limbic system
Thalamus
Cognitive processing
Response plan
Procurement actions
Reward memory
Social screen
Competing behaviors
LEPTIN
NPY/AGRP
POMC/CART
SPZ
SCn
VMN
VMN
NPY
Oro- and locomotor control
Autonomic control of effectors
BAT, WAT,
Muscle, Pancreas
Liver, GI-tract, Vasculature
ARC
ARC
NPY/AGRP
GABA
POMC/CART
Galanin
Neurotensin
Leptin
Retina (visual)
Circadian input
BBB
BRAINSTEM&SPINAL CORD
DRN-Serotonin
NTS-GLP-1/GLP-2
LPB-CCK
NA
Bombesin
Glucocorticoids,
Gonadal Steroids,
Thyroid Hormones
(Endocrine glands)
Interleukin 6
(Muscle)
Insulin,
Amylin
(Pancreas)
Leptin, Adiponectin,
TNFa, Interleukin 6
(Adipose tissue)
Taste
Vagal visceral
sensory input
Homeostatic input
Ghrelin, PYY, CCK,
GLP, GIP
(Stomach/Gut)

EL CEREBRO NO APRENDE, EL ORGANISMO APRENDE:

El cerebro NO ES un sistema de almacenamiento de memoria, o un procesador. Es una parte de un organismo complejo cuyo objetivo es la supervivencia.



Los seres vivos han evolucionado para seleccionar percepciones y acciones RELEVANTES

“El arte de la física consiste en decidir qué ignorar”

Brian Greene

“Piensan que la inteligencia consiste en reconocer lo relevante (detectar patrones); en un mundo complejo, la inteligencia consiste en ignorar las cosas que son irrelevantes (evitar falsos patrones)”

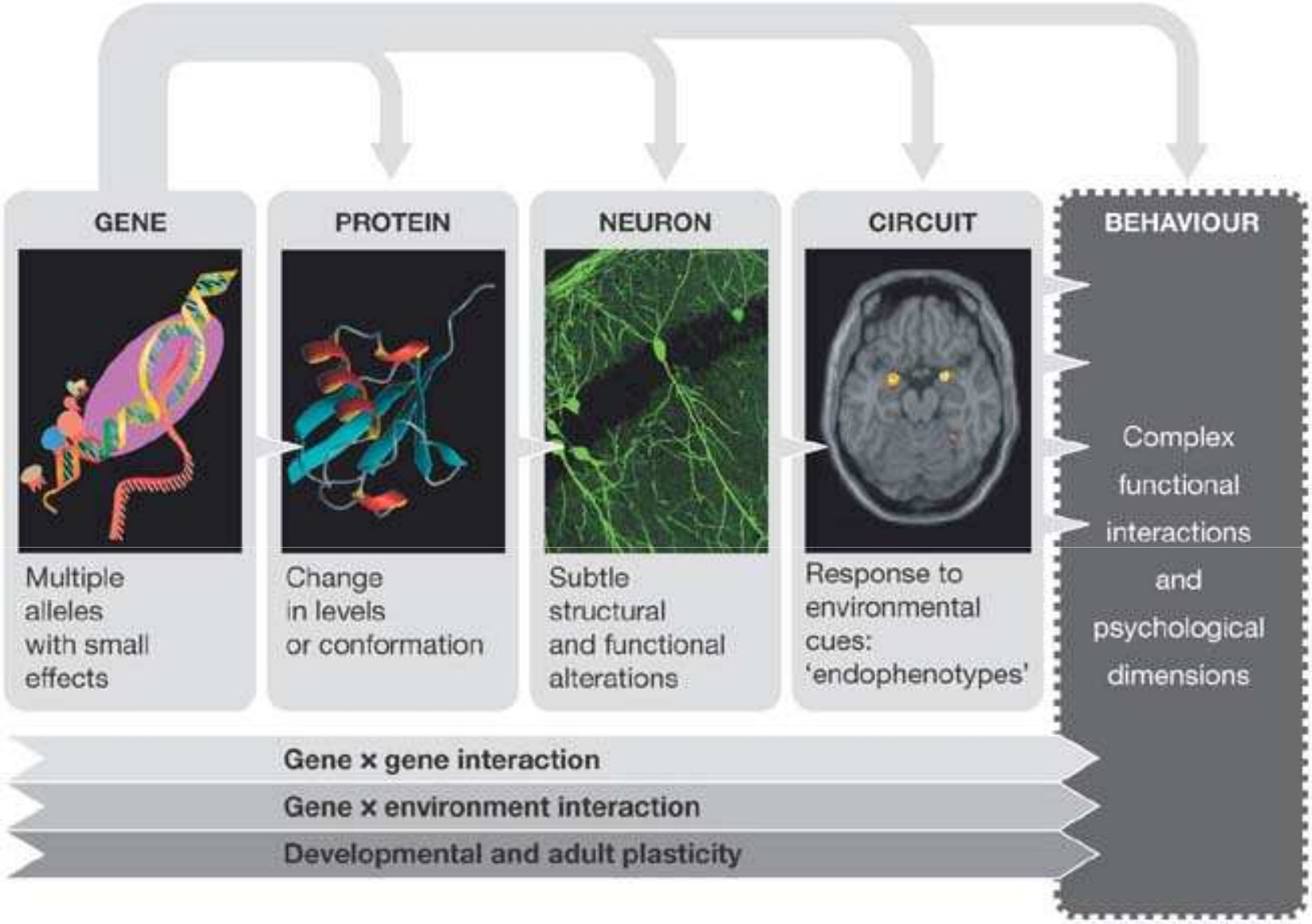
Nassim N. Taleb


CAUTION
THIS SIGN HAS
SHARP EDGES
DO NOT TOUCH THE EDGES OF THIS SIGN
ALSO, THE BRIDGE IS OUT AHEAD

LA ATENCIÓN ES SELECTIVA

“...a menudo llegamos a un callejón sin salida cuando discutimos cosas importantes, no porque en el otro lado estén equivocados, sino porque ambos lados tienen razón en lo que ven, pero ninguno puede ver lo que ve el otro.”

Cathy Davidson



La respuesta a cambios en el medio es a menudo individual, pero…

“O, resumiendo, es el problema del uso de un conocimiento que nadie posee en su totalidad”

Freidrich Hayek

El conocimiento no es algo que se adquiere individualmente, es el producto emergente de nuestras interacciones

CADA VEZ APRENDEMOS ACCEDIENDO DE FORMA MÁS PERSONAL A LOS CONTENIDOS, AL MISMO TIEMPO QUE PODEMOS COMUNICARNOS MEJOR

LA NECESIDAD CONSTANTE DE DESAPRENDER:

“Se requiere desaprendizaje cuando el mundo o tus circunstancias personales han cambiado tan completamente que tus viejos hábitos te mantienen anclado en el pasado. No puedes sencillamente decidir cambiar. Necesitas romper un patrón, liberarte de los viejos modos antes de poder adoptar los nuevos”

Cathy Davidson

“Las instituciones intentan preservar el problema para el que son la solución”

Clay Shirky

LA NECESIDAD CONSTANTE DE DESAPRENDER:

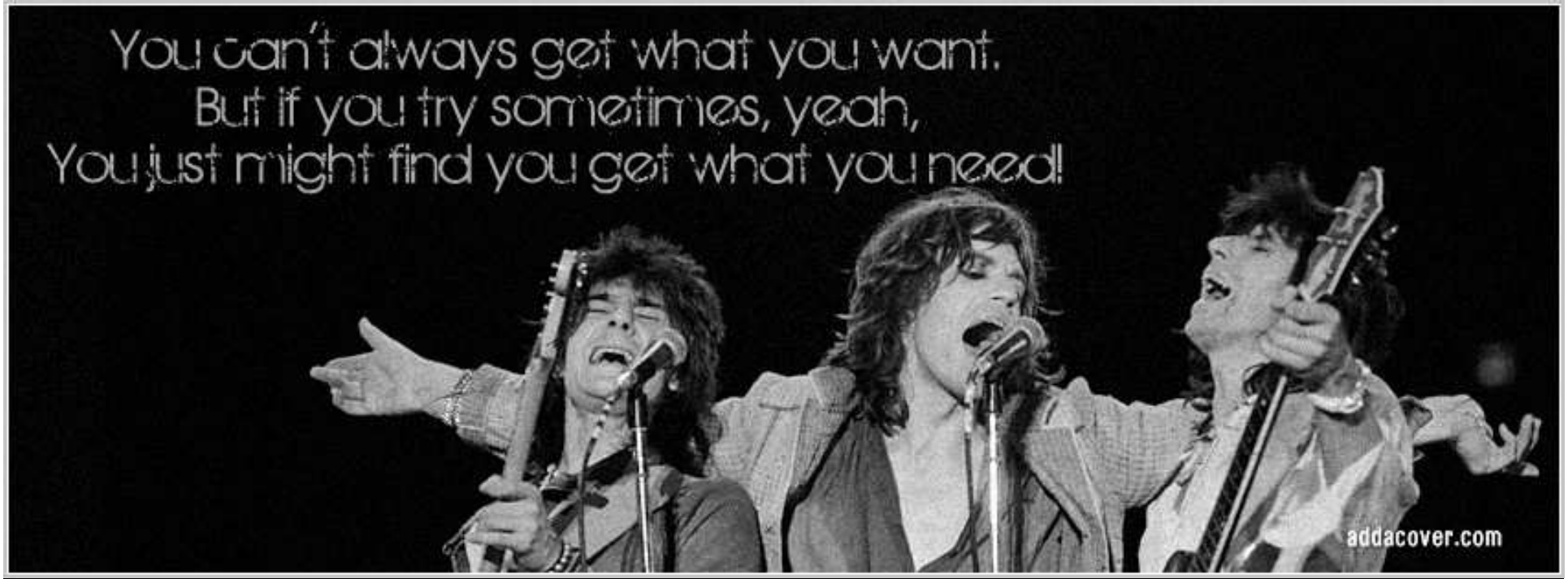
“El proceso de desaprendizaje para volver a aprender demanda un nuevo concepto de conocimiento, no como un objeto, sino como un proceso; no como un sustantivo, sino como un verbo; no como una calificación en un examen, sino como un continuo. Requiere actualizar el navegador mental. Y significa, siempre, apoyarse en otros para recibir ayuda en un proceso que es casi imposible llevar a cabo por uno mismo”

Cathy Davidson

inestabilidad contextual/medioambiental

FACILITAR EL APRENDIZAJE CONSISTE EN ENCONTRAR NICHOS DE ESTABILIDAD MEDIOAMBIENTAL

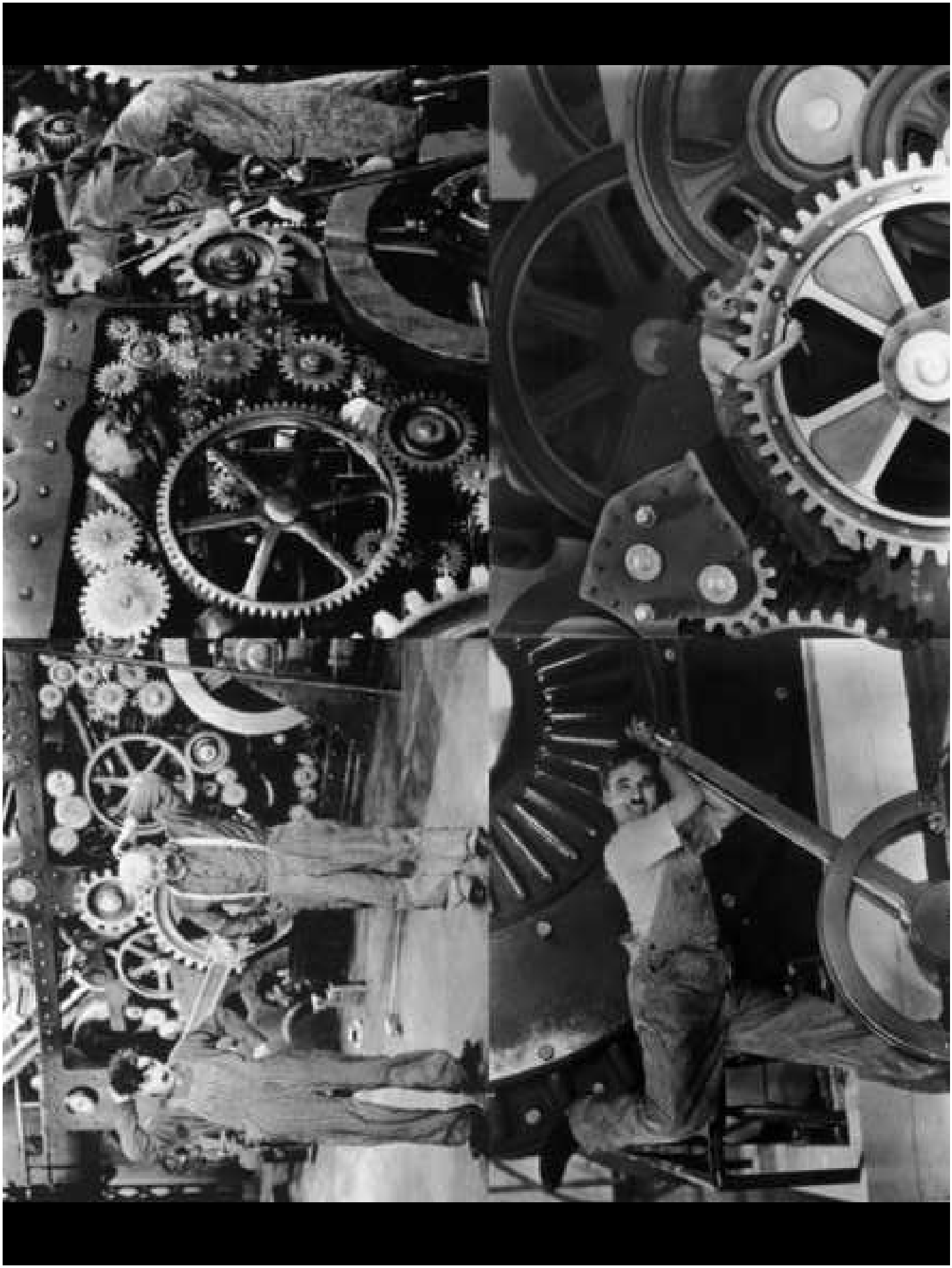
ENSEÑAR HOY YA NO ES APORTAR INFORMACIÓN, SINO CONTEXTUALIZAR

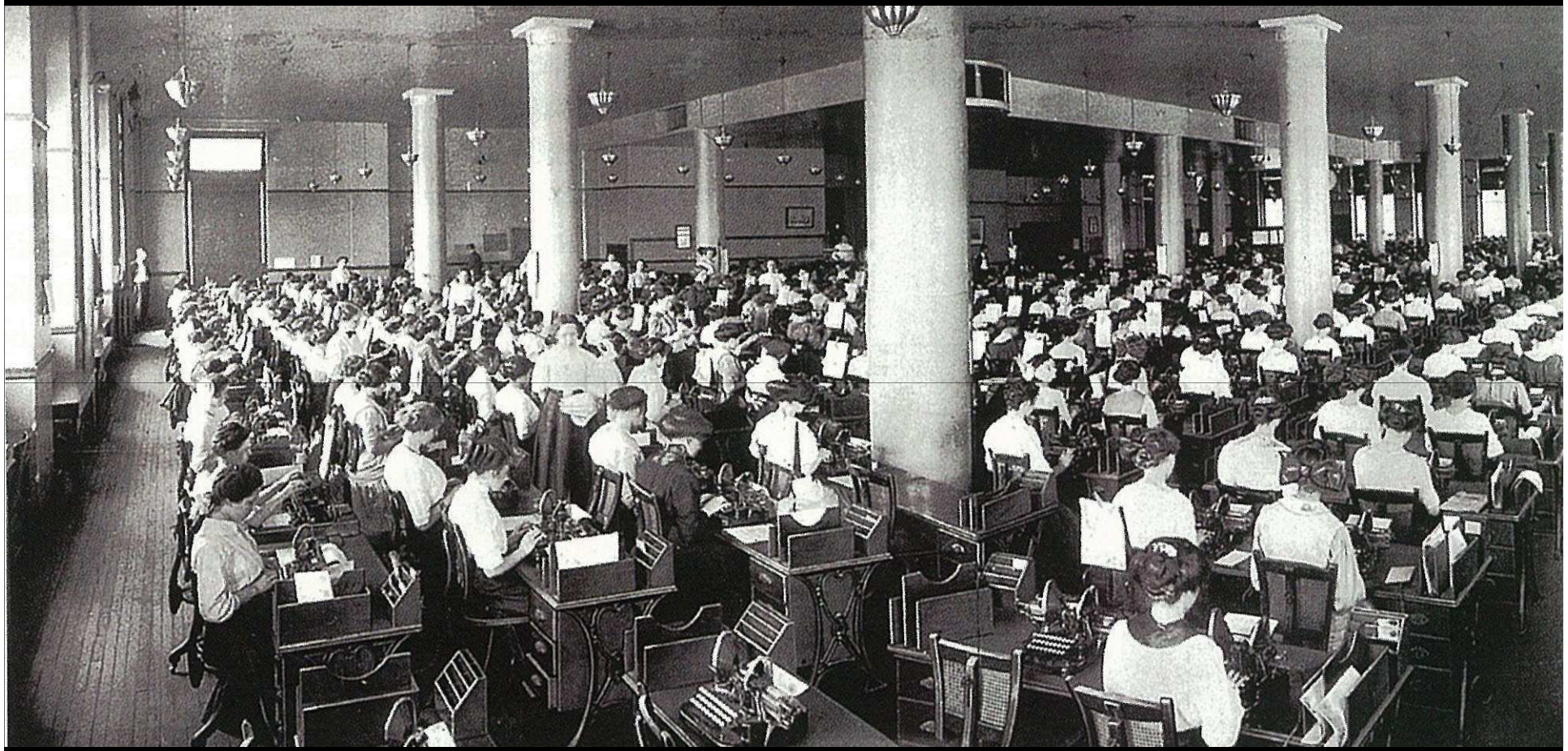

You can't always get what you want.
But if you try sometimes, yeah,
You just might find you get what you need!
addacover.com

"The Victorians were great engineers. They engineered a [schooling] system that was so robust that it's still with us today, continuously producing identical people for a machine that no longer exists."

— Sugata Mitra

el contexto socio-laboral






COMPUTING
DIVISION
COMPUTING
SECTION


03
05

A modo de reflexión final:

1. **Aprendemos aquello que reconocemos como importante en un contexto determinado.**

2. **Los contextos sociales tradicionales de motivación al aprendizaje (“cultura”, “prestigio social”, “laboral…”) ya no funcionan —o sólo funcionan para una élite.**

3. **No es posible evitar la influencia de INESTABLES contextos coercitivos, imitativos, etc…**

4. **Si deseamos enseñar algo, deberemos identificar nuevos contextos META-ESTABLES, dondequiera que sea y cualesquiera que sean, en los que el conocimiento a adquirir sea reconocido como relevante.**