NEUROCIÊNCIAS E EDUCAÇÃO

V JORNADAS PEDAGÓGICAS DE VILA FRANCA DE XIRA

SETEMBRO 2017

ALFREDO PIMENTA EM 1928:

“a parte mais linda, mais forte e mais saudável da alma portuguesa reside nesses 75% de analfabetos”

Quadro 16: **Evolução da escolaridade obrigatória**

Ano	Tempo de escolaridade obrigatória	Legislação
1911	3 anos	DL de 29.3.1911
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Cedefop

CIÊNCIAS DA EDUCAÇÃO E NEUROCIÊNCIAS
CONSTRUIR UMA PONTE

MIND, BRAIN, AND EDUCATION

Bringing Research Into Educational Practice: Lessons Learned

2011

Katrin Hille[1]

LESSON 1: THE WORD "NEUROSCIENCE" ELICITS STRONG EMOTIONS: WATCH OUT!

LESSON 2: TRANSFER NEEDS A SPECIAL RESEARCH APPROACH: TRANSLATIONAL RESEARCH

LESSON 3: TRANSFER NEEDS A SPECIAL TYPE OF SCIENTIST: INTERDISCIPLINARY GENERALISTS WITH SERVICE COMMITMENTS

LESSON 4: NEUROSCIENCE SERVES AS A POSSIBLE FOUNDATION FOR LEARNING SCIENCES

AMBIENTE POBRE

AMBIENTE RICO

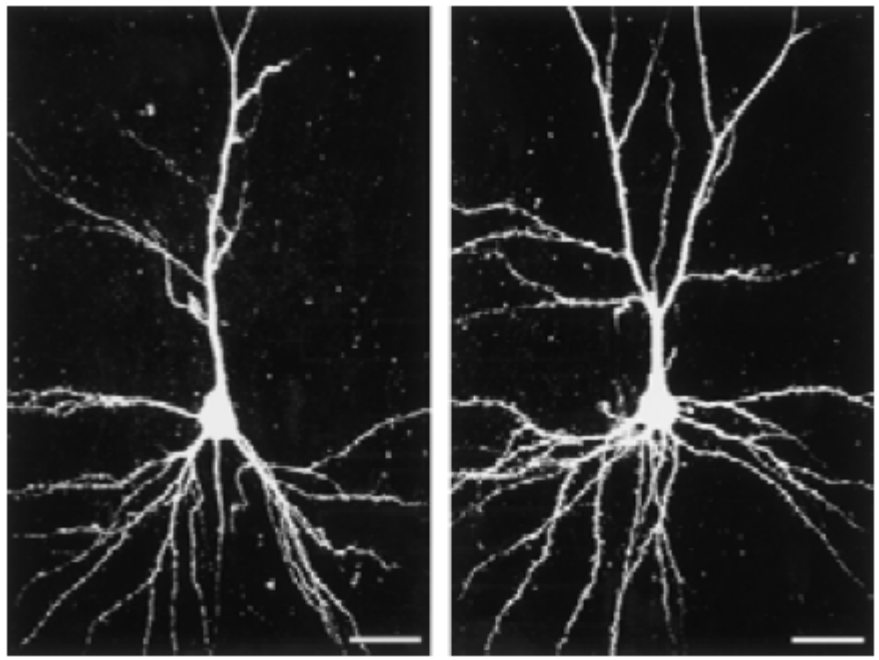


FIG. 1. Dendritic morphology of pyramidal neurons in layer III of the somatosensory cortex in a rat housed in standard (left) and enriched (right) environments, as viewed in confocal imaging after microinjection of Lucifer yellow into the neurons. Bar = 25 μm.

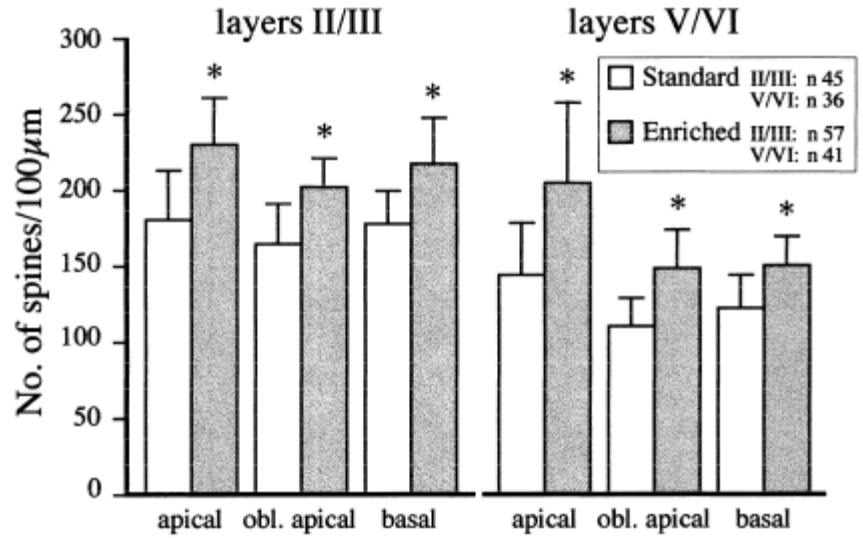
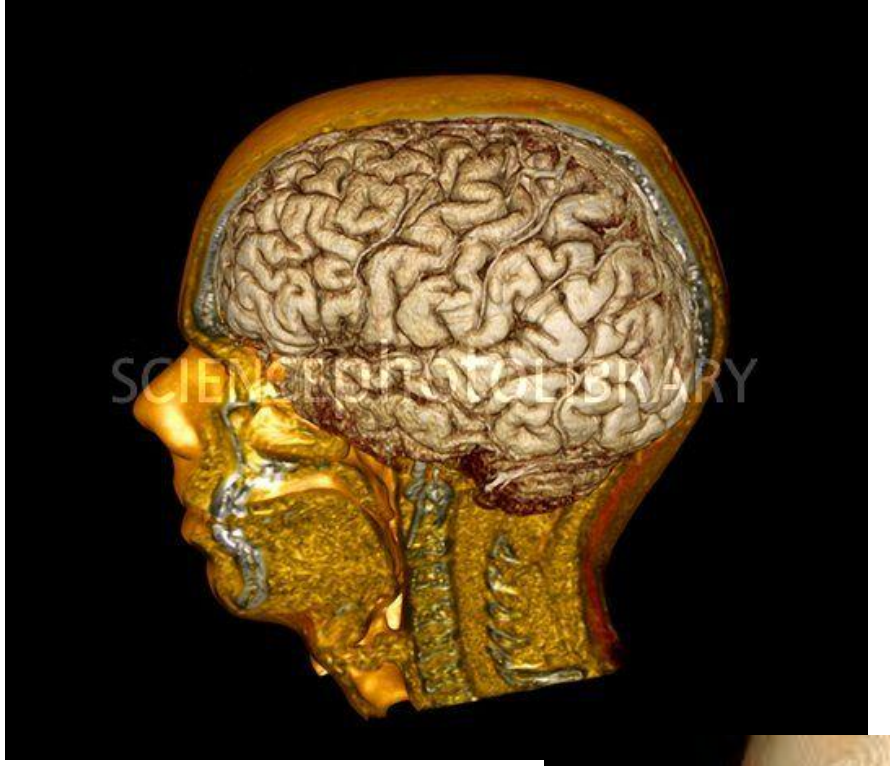
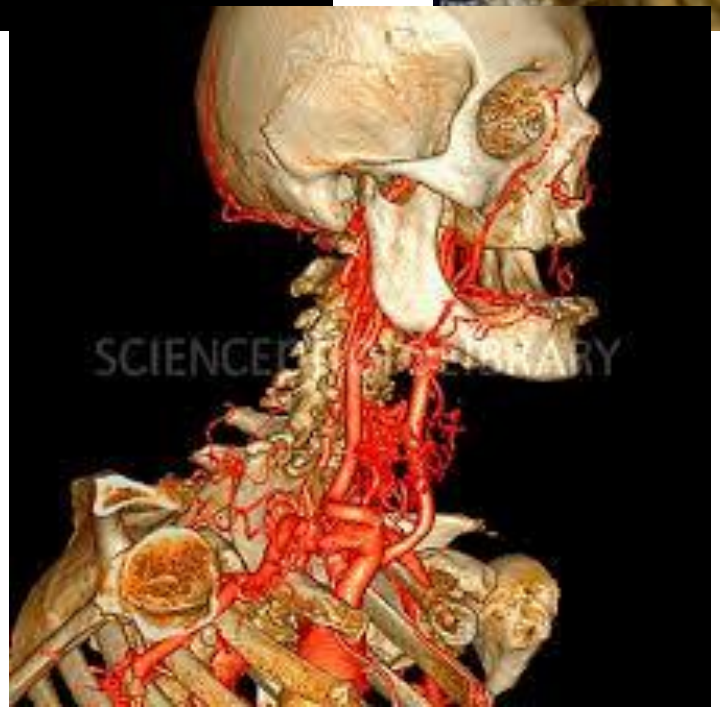
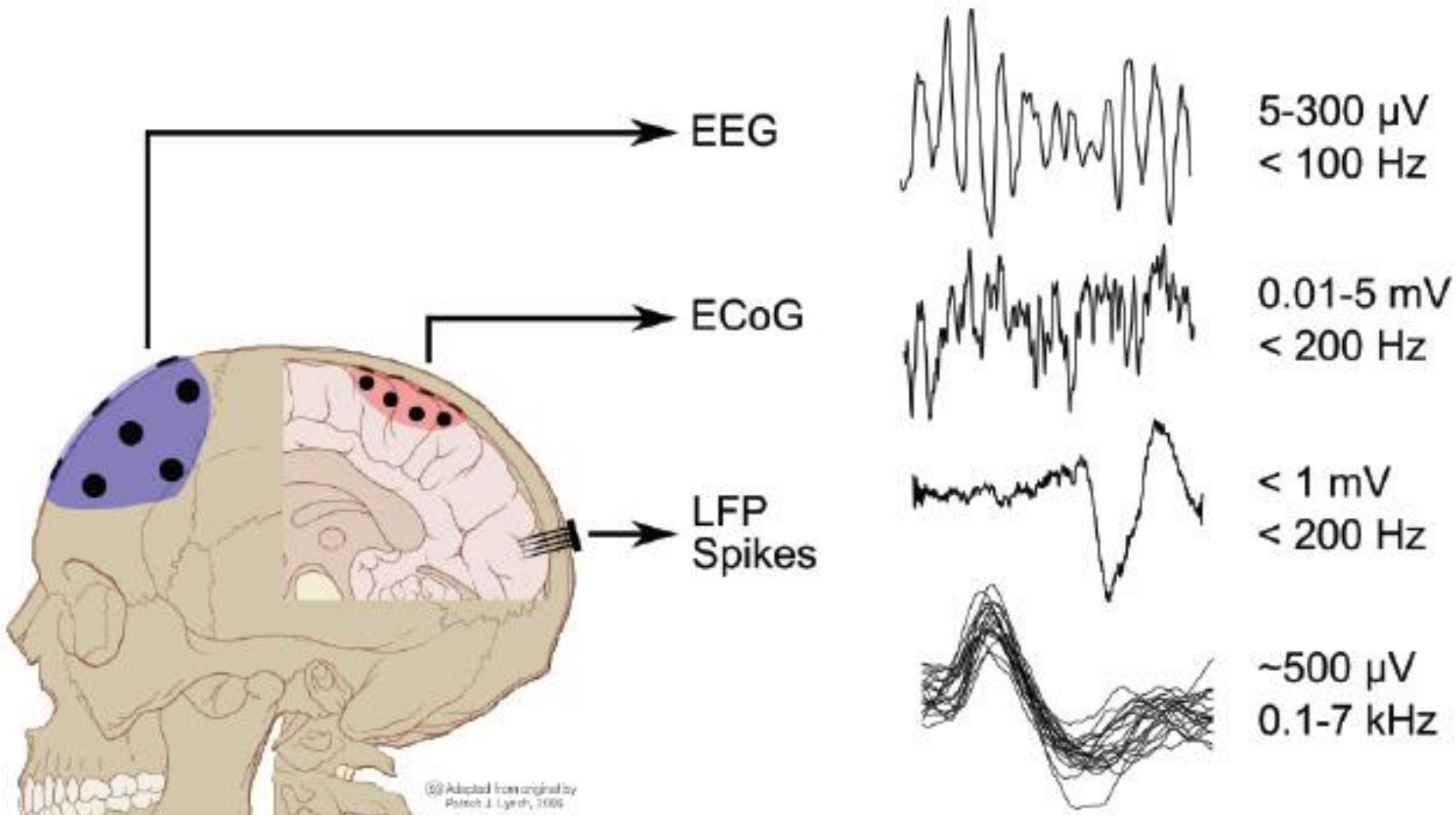
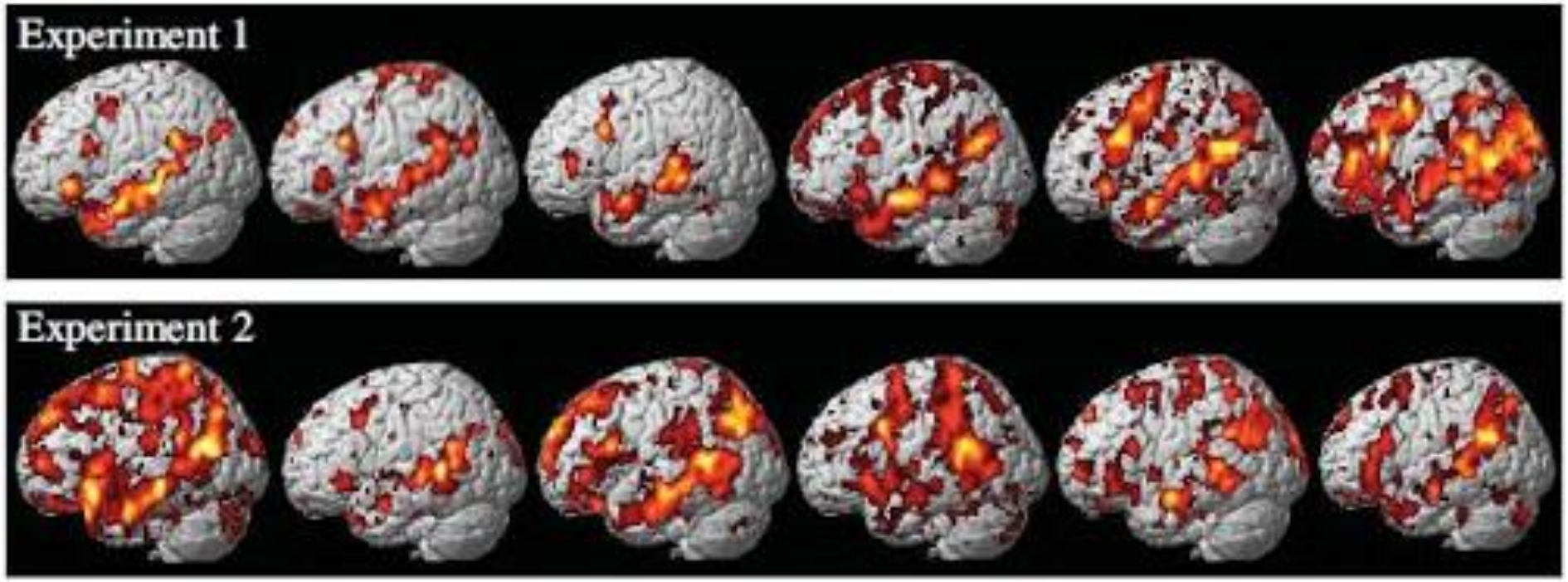


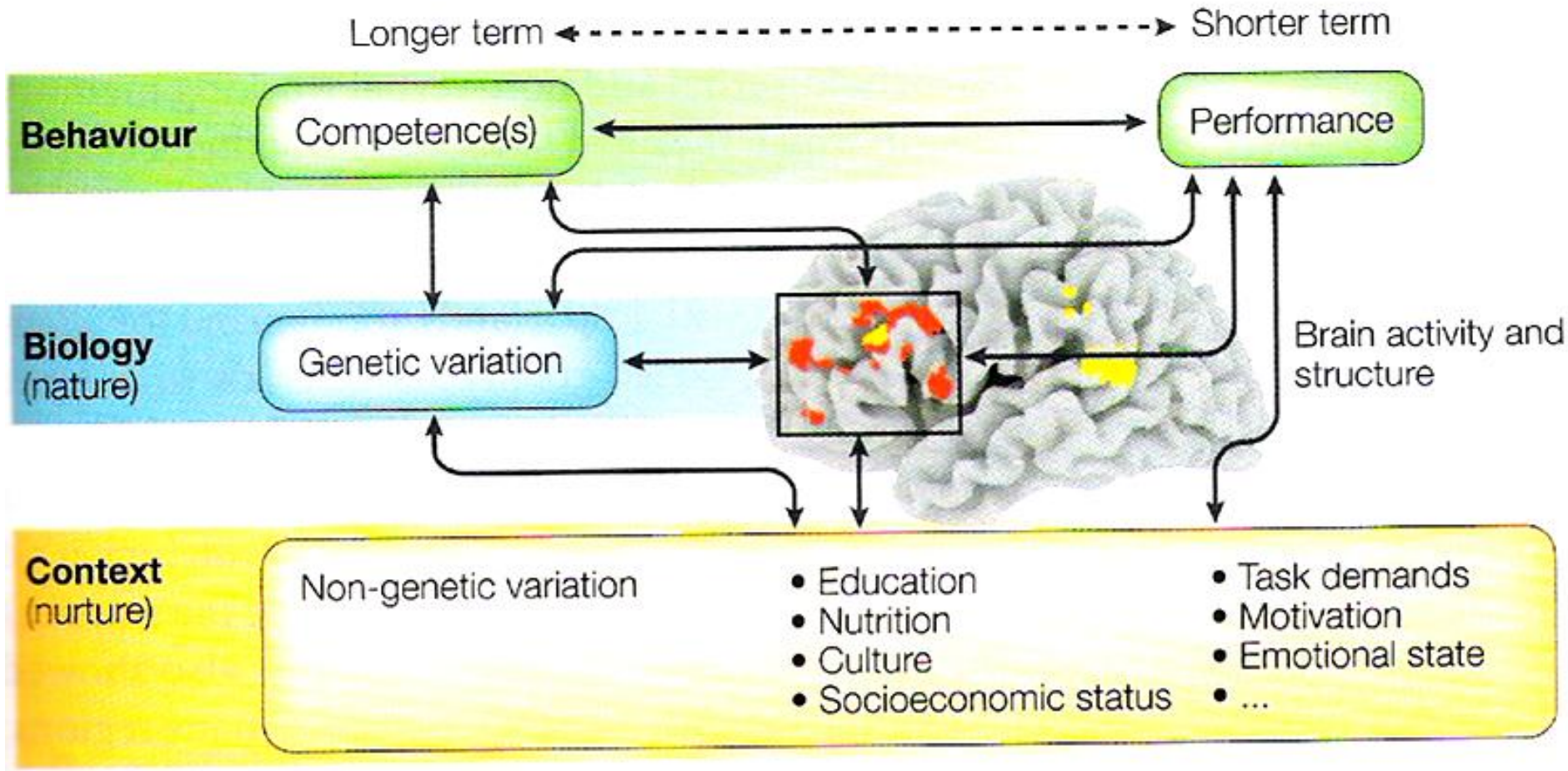
FIG. 2. Dendritic spine density presented as spines per 100-μm length of dendrite on apical, oblique (obl) apical, and basal dendrites of pyramidal neurons in a somatosensory cortex of adult intact rats housed in standard environment or transferred to an enriched environment for 3 weeks. Data are mean ± SD. $^{*}P < 0.05$ for differences between standard and enriched rats.

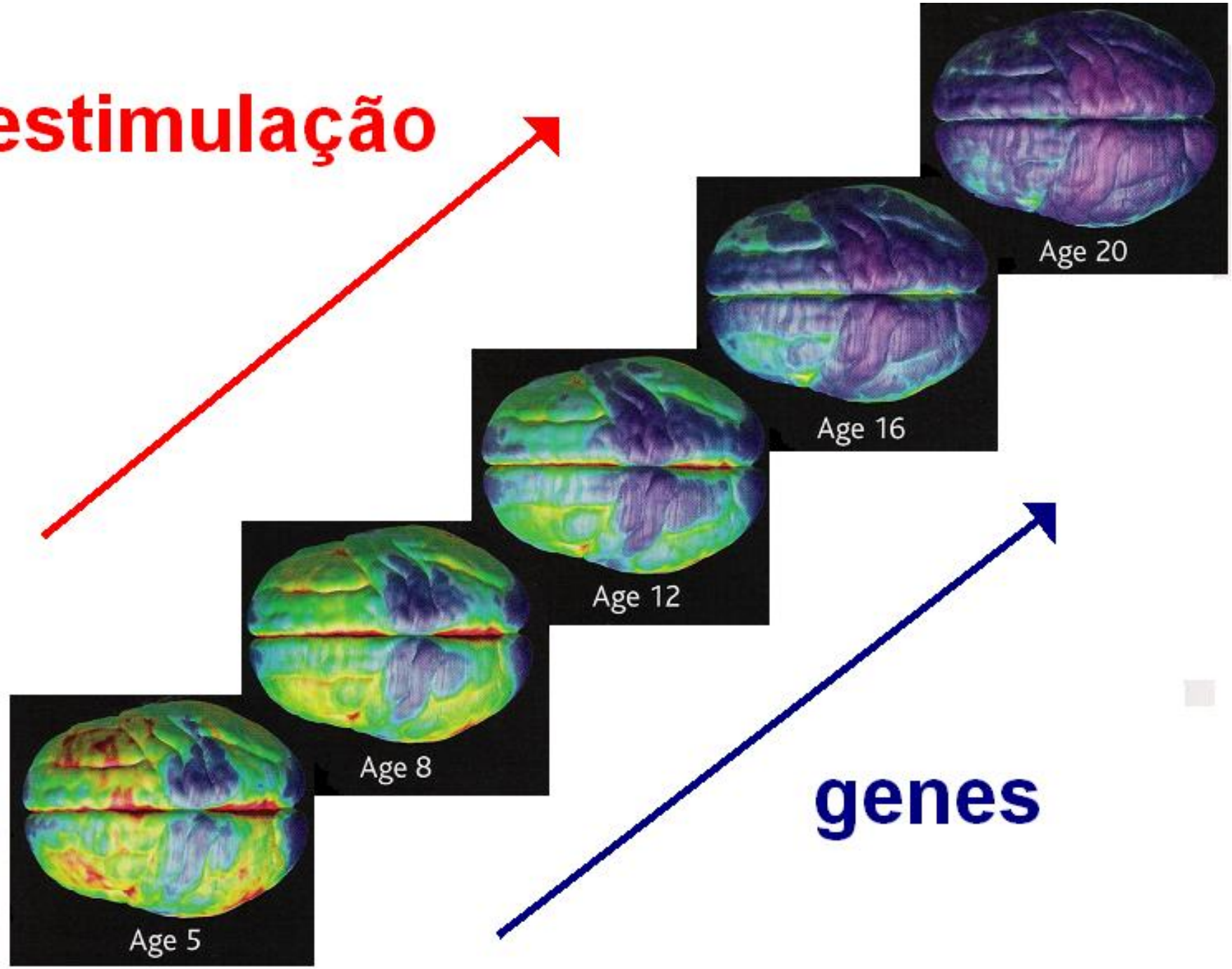


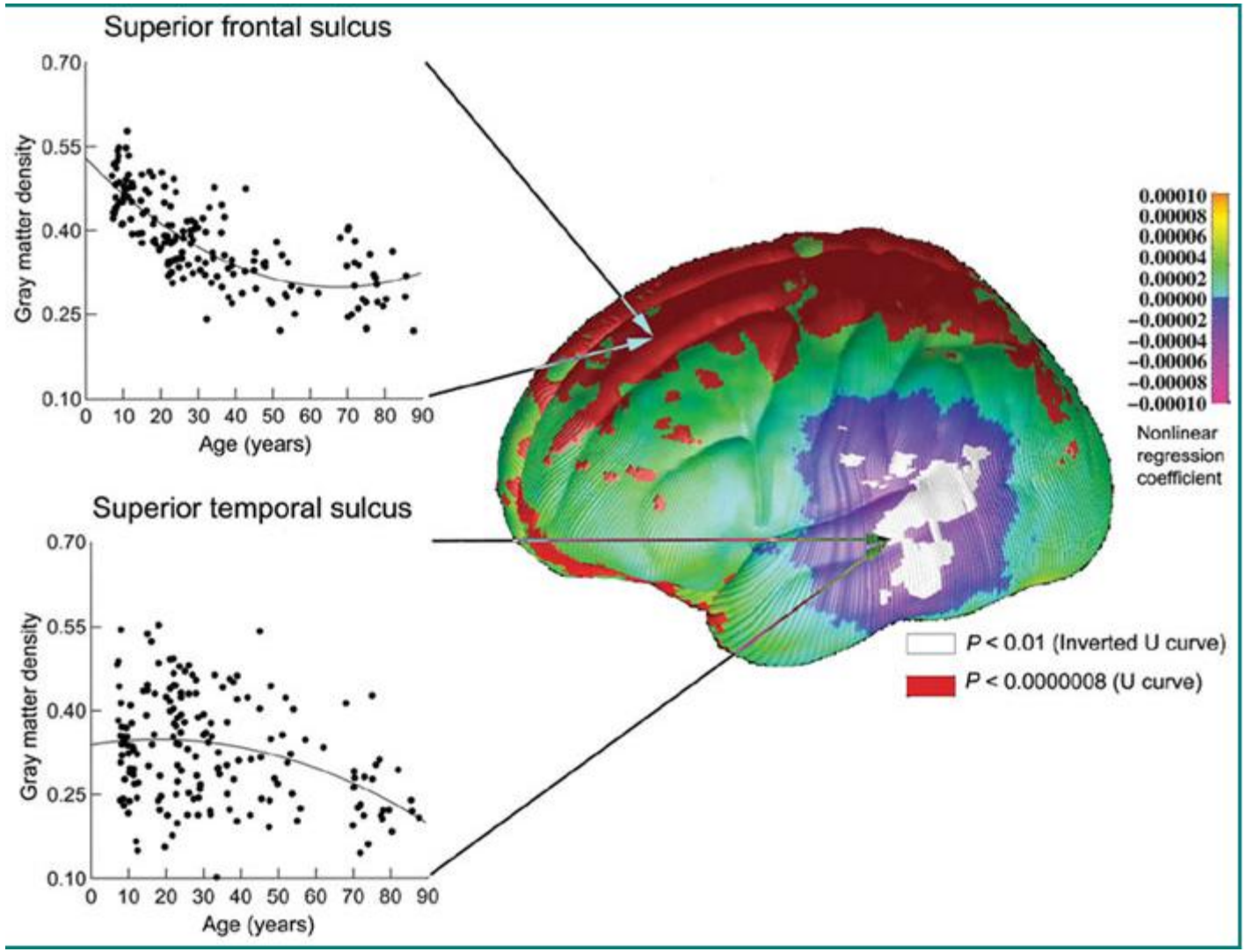



EEG
ECoG
LFP
Spikes
5-300 µV
< 100 Hz
0.01-5 mV
< 200 Hz
< 1 mV
< 200 Hz
~500 µV
0.1-7 kHz


Experiment 1
Experiment 2


Longer term
Shorter term
Behaviour
Competence(s)
Performance
Biology
(nature)
Genetic variation
Brain activity and
structure
Context
(nurture)
Non-genetic variation
• Education
• Nutrition
• Culture
• Socioeconomic status
• Task demands
• Motivation
• Emotional state
• ...

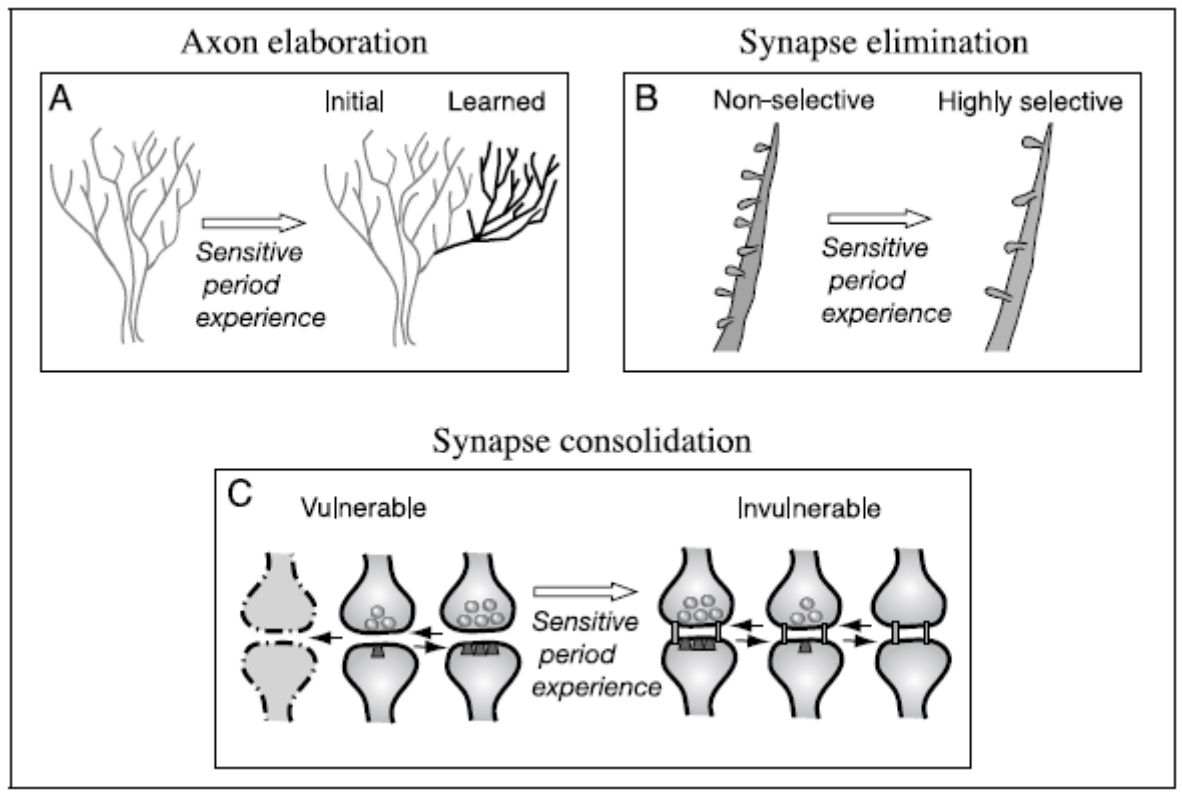

estimulação
Age 20
Age 16
Age 12
Age 8
Age 5
genes


Superior frontal sulcus
Gray matter density
0.70
0.55
0.40
0.25
0.10
0 10 20 30 40 50 60 70 80 90
Age (years)
Superior temporal sulcus
Gray matter density
0.70
0.55
0.40
0.25
0.10
0 10 20 30 40 50 60 70 80 90
Age (years)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
−0.00002
−0.00004
−0.00006
−0.00008
−0.00010
Nonlinear regression coefficient
P < 0.01 (Inverted U curve)
P < 0.0000008 (U curve)

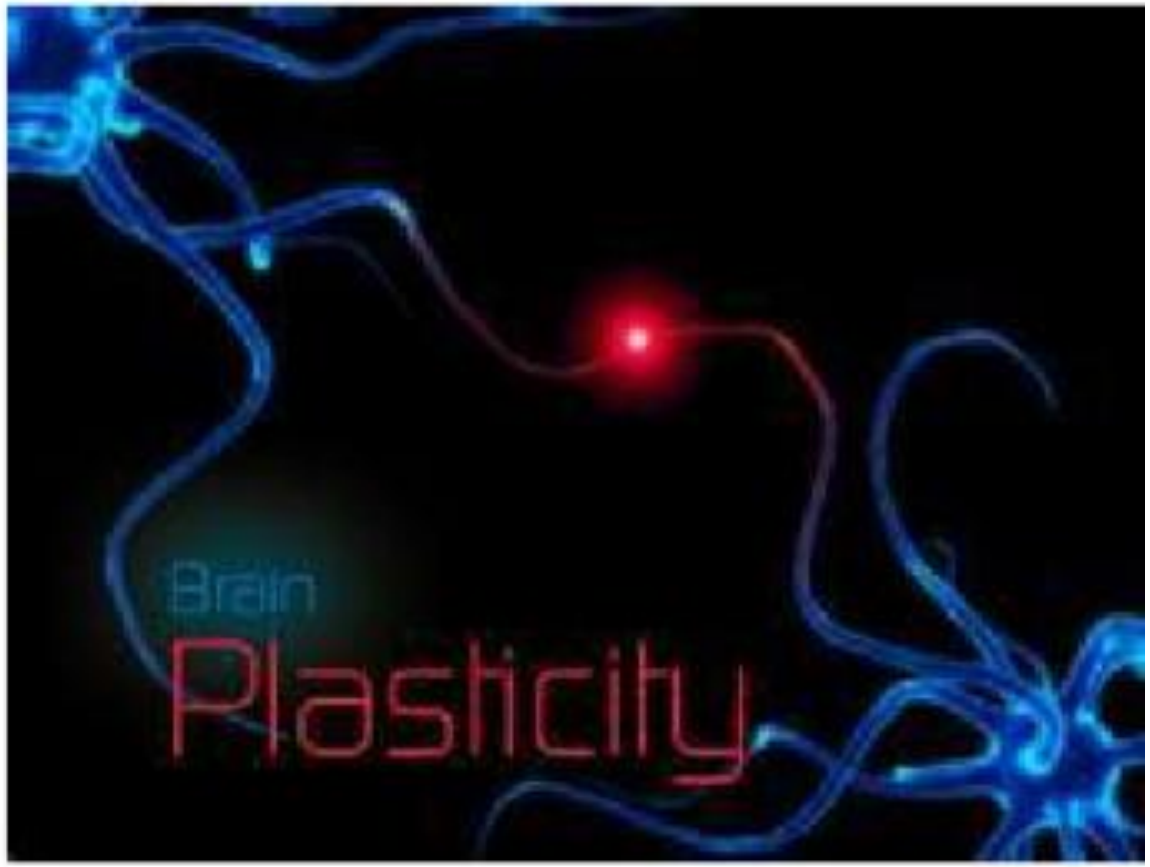
Sensitive Periods in the Development of the Brain and Behavior

Eric I. Knudsen

J Cognitive Neuroscience, 2004



- **Plasticity**: Refers to the brains ability to reorganise neural pathways throughout the lifespan as a result of experience.
- **Put simply: The brains ability to change with learning**.
- **There is a change in the internal structure of neurons, notably the synapses &**
- **increase in the number of synapses**

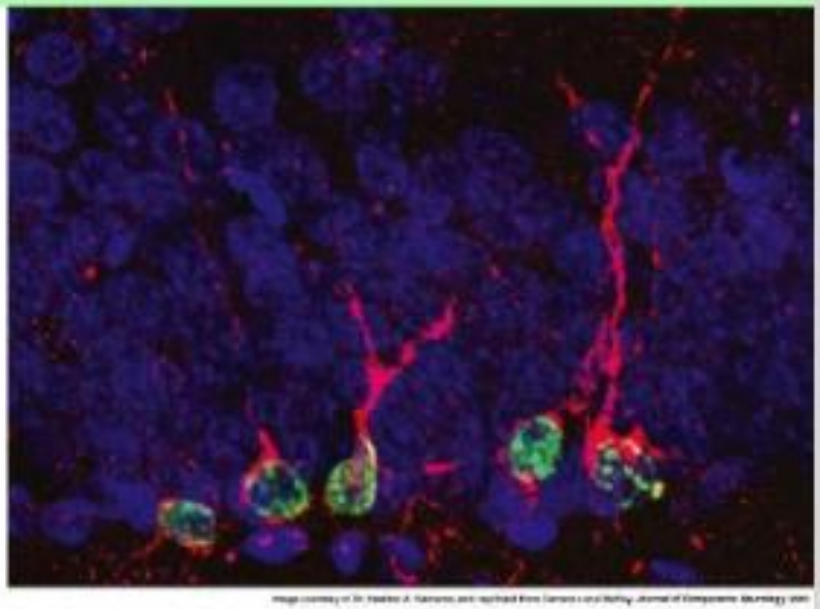


	Developmental Plasticity	Adaptive Plasticity
Definition	Changes in neural connections as a result of interactions with the environment (our experiences during childhood) as a consequence of developmental processes. e.g. development of visual cortex.	The brains ability to compensate for lost functionality due to brain damage as well as in response to interaction with the environment by reorganising its structure
Neuronal Changes	1. Synaptogenesis 2. Synaptic pruning 3. Neural migration 4. Myelination	1. Rerouting 2. Sprouting
Occurs in response to	It is predetermined & occurs in response to the initial processing of sensory information by the immature brain	Compensation for brain injury and in adjustment to new experiences
When it occurs	It occurs over the lifespan, but diminishes with age	Also occurs over the lifespan, but is more efficient and effective during infancy/ early childhood.

Developmental Plasticity

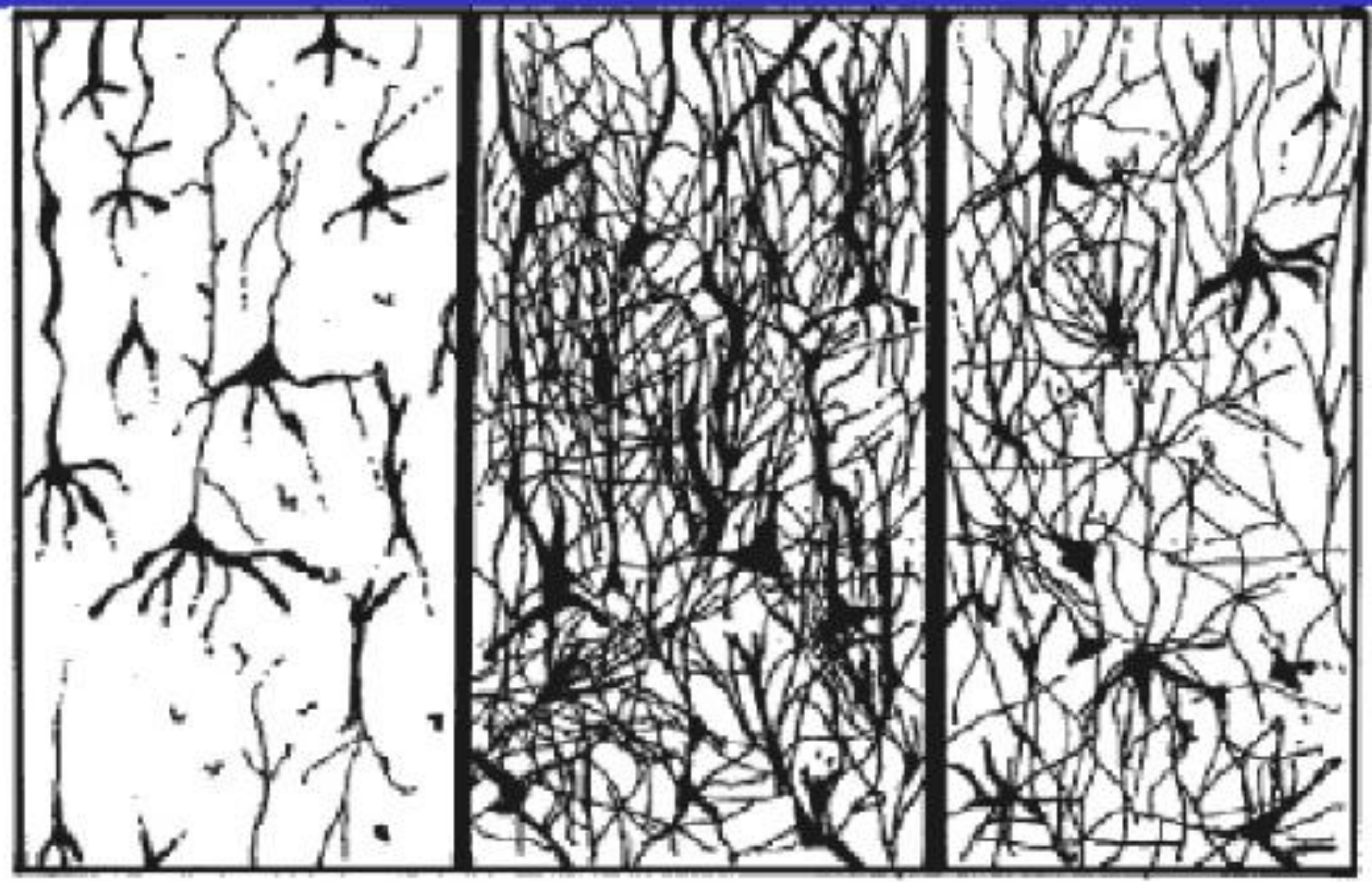
1. **Synaptogenesis:** is genetic i.e. the rapid expansion in synaptic formation in order to deal with bombardment of sensory input.
2. **Synaptic pruning:** reduction in the number of synaptic connections

- Which enables more efficient synaptic configurations (thus more efficient brain functioning – hence ongoing learning)
- Synaptic pruning is determined by experience – connections not used are pruned.



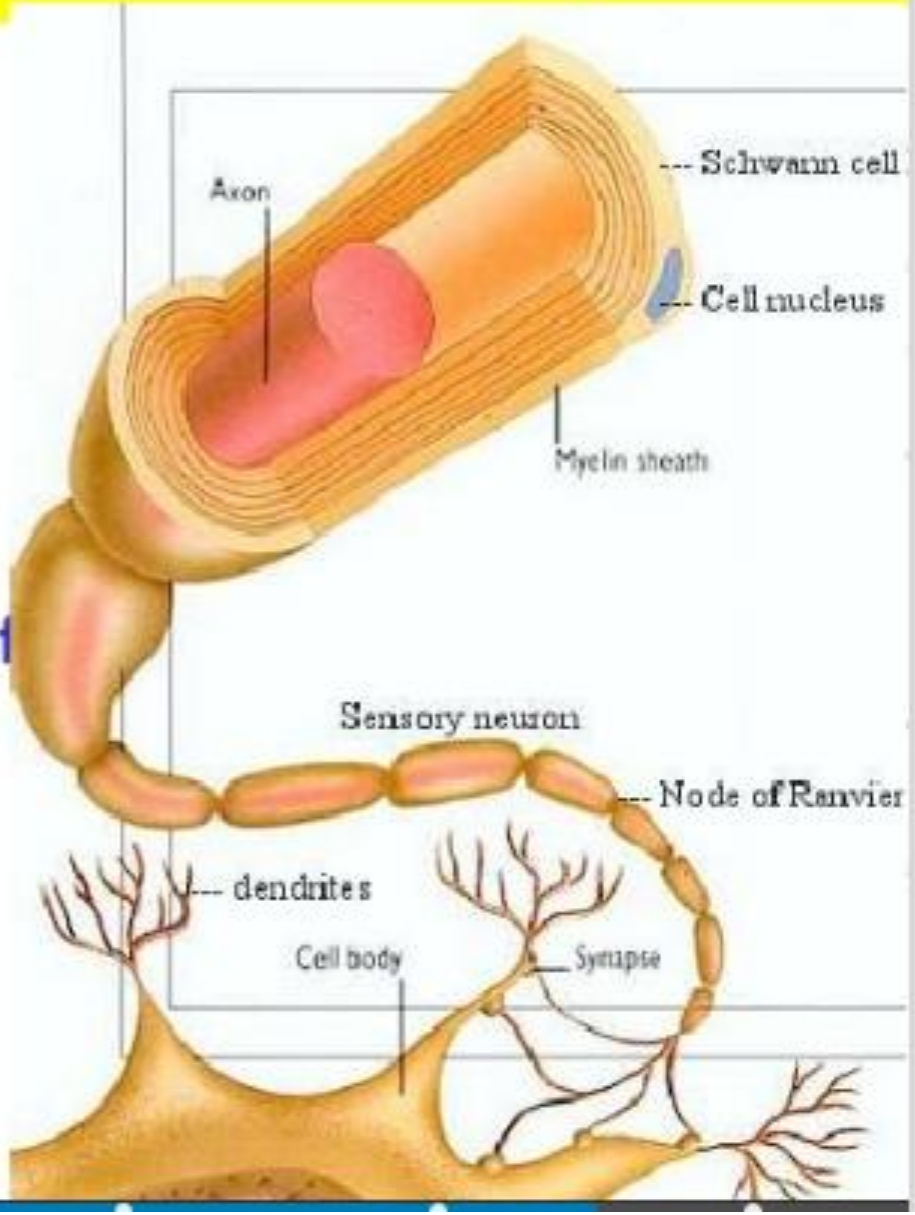
Newly formed granule cells in an adult rat, with DNA stained green

Developmental Plasticity



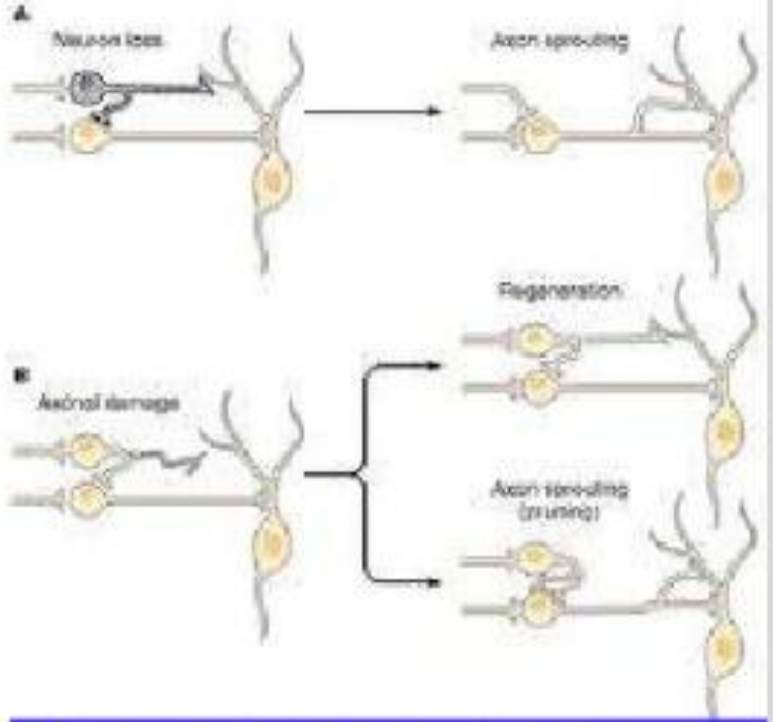
Developmental Plasticity

3. Neural Migration occurs from 8 weeks to 29 weeks (i.e. movement of neurons to different parts of the brain
4. Myelination starts during fetal development through to adolescence - a process of protecting & insulating neurons to aid the transmission of impulses from 1 nerve cell to the next.



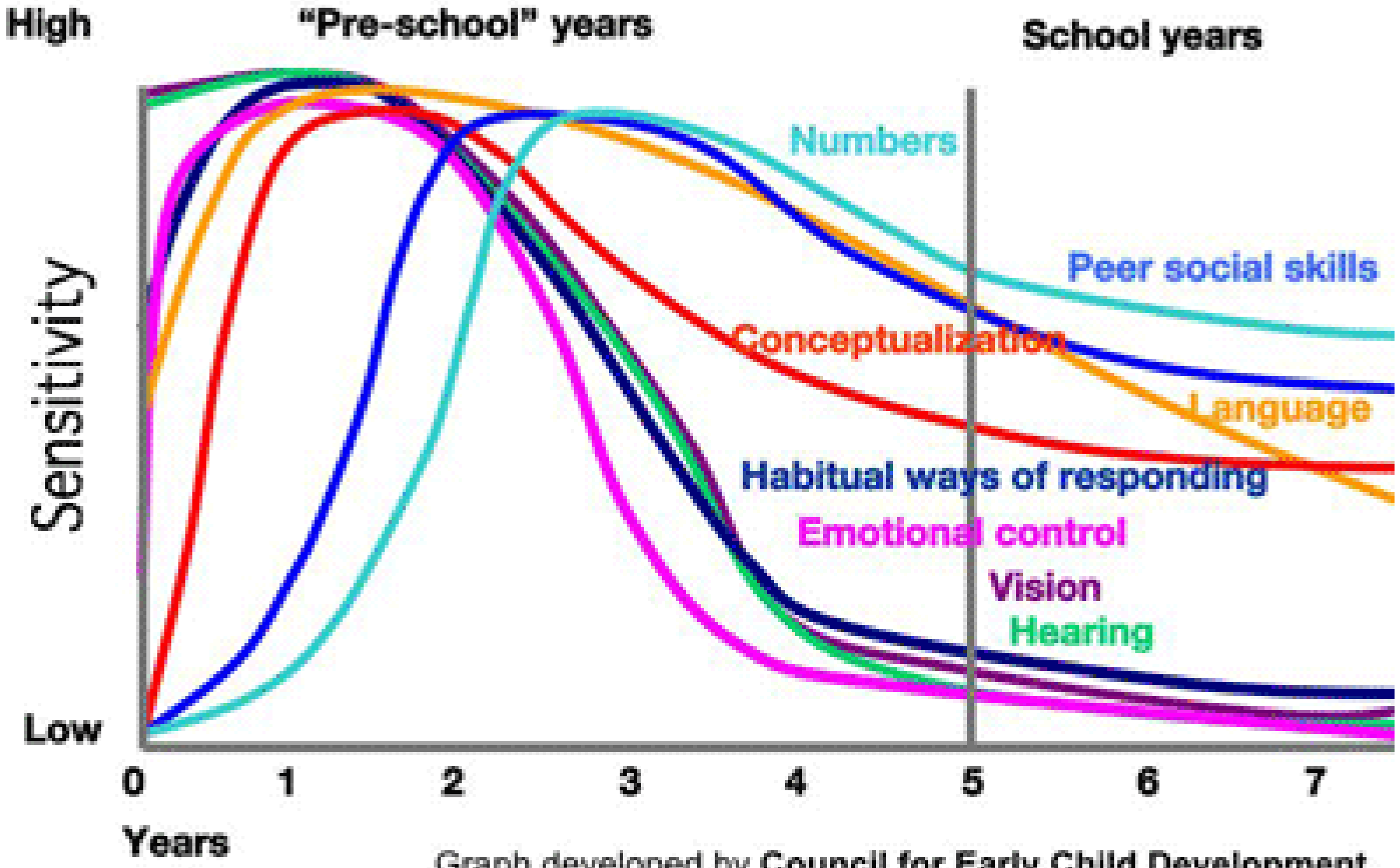
Adaptive plasticity

1. **Rerouting:** new neural connections are made between a neuron and other active neurons
2. **Sprouting:** growth of new dendritic fibres enabling the neuron for form new connections with other (more) neurons

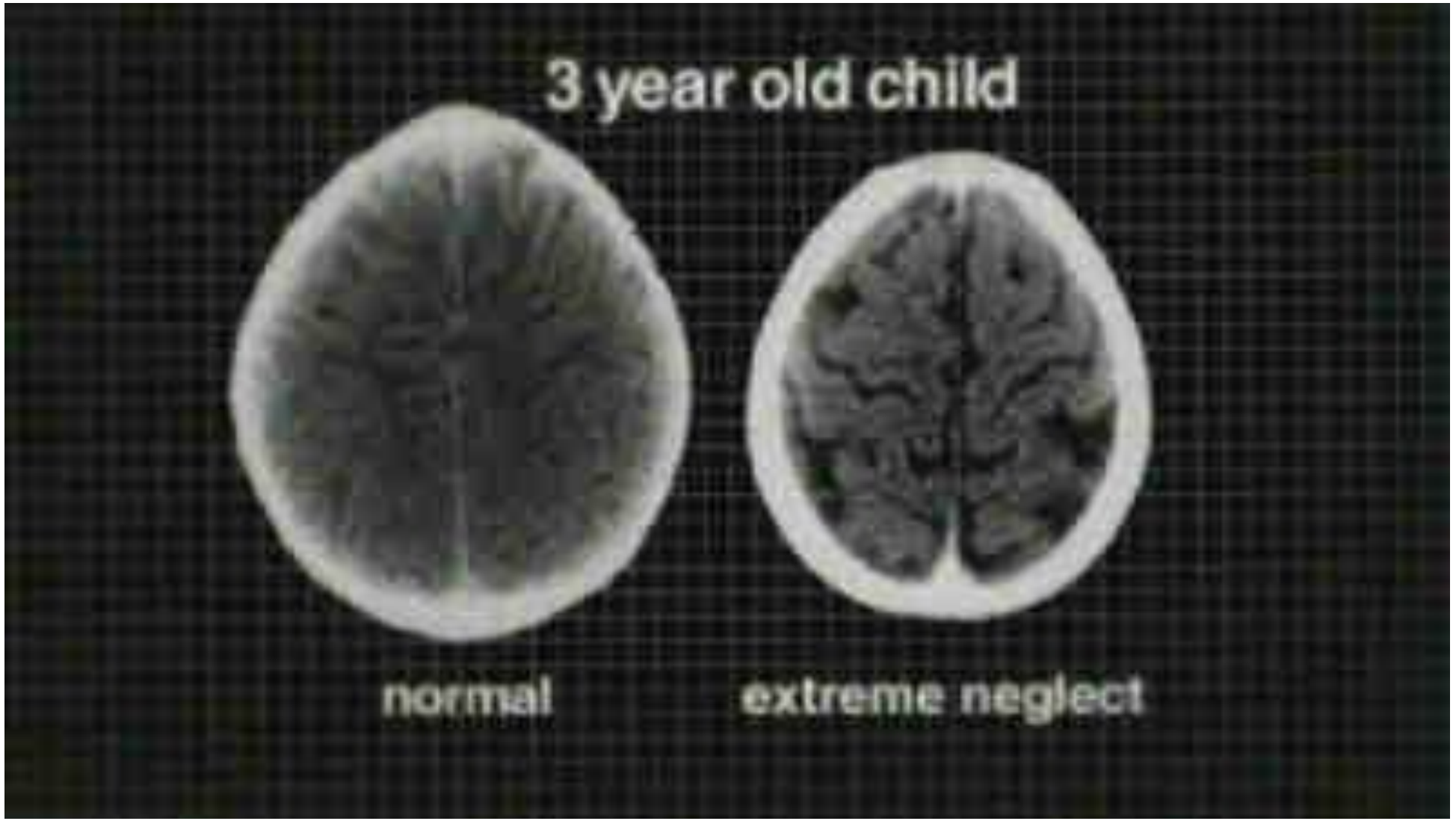


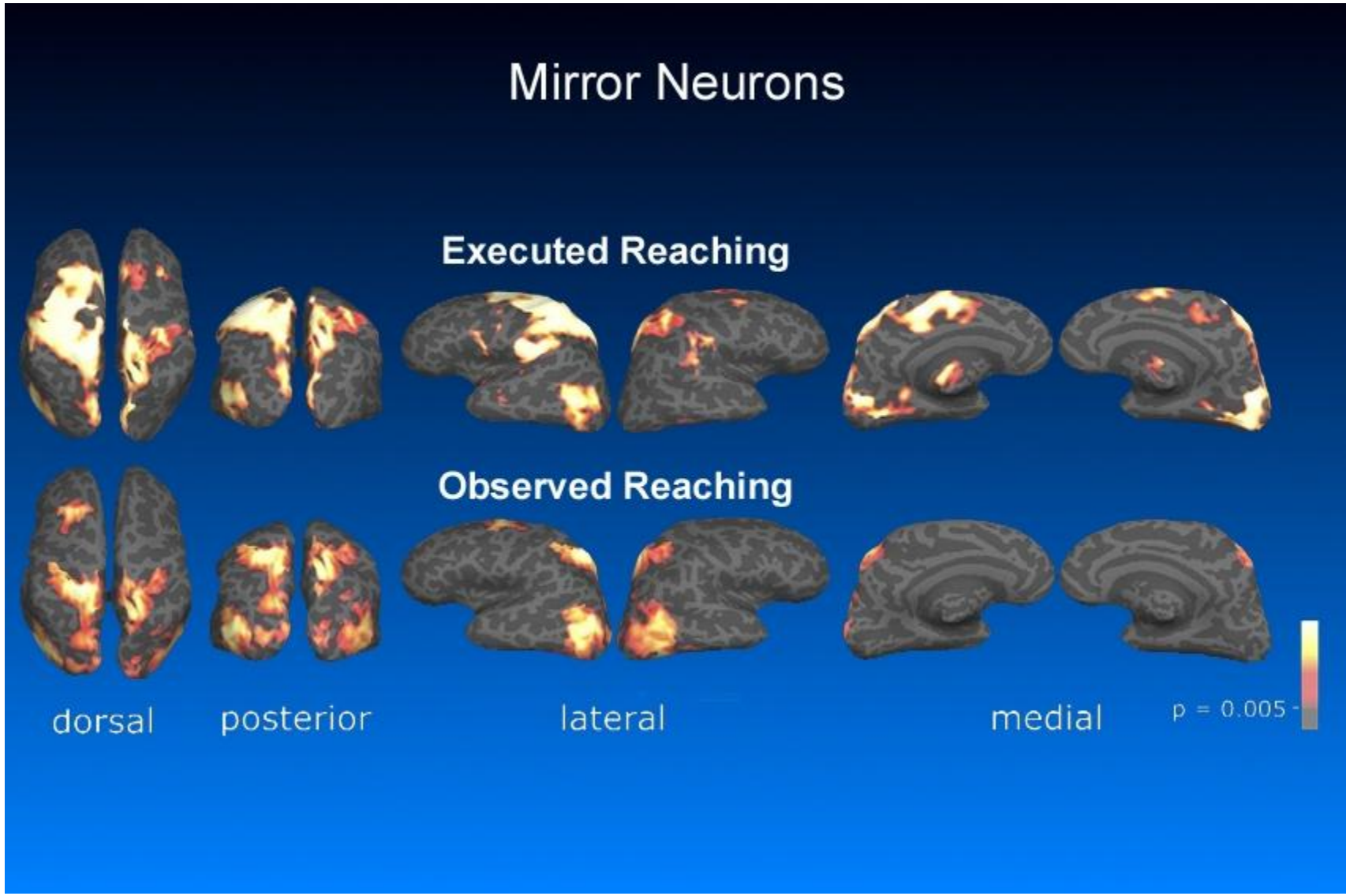
Adaptive plasticity enables brains to adapt (by growing) for individuals with the acquisition of expertise in a certain area e.g. Students, London Cab drivers, bilinguals, musicians, etc.

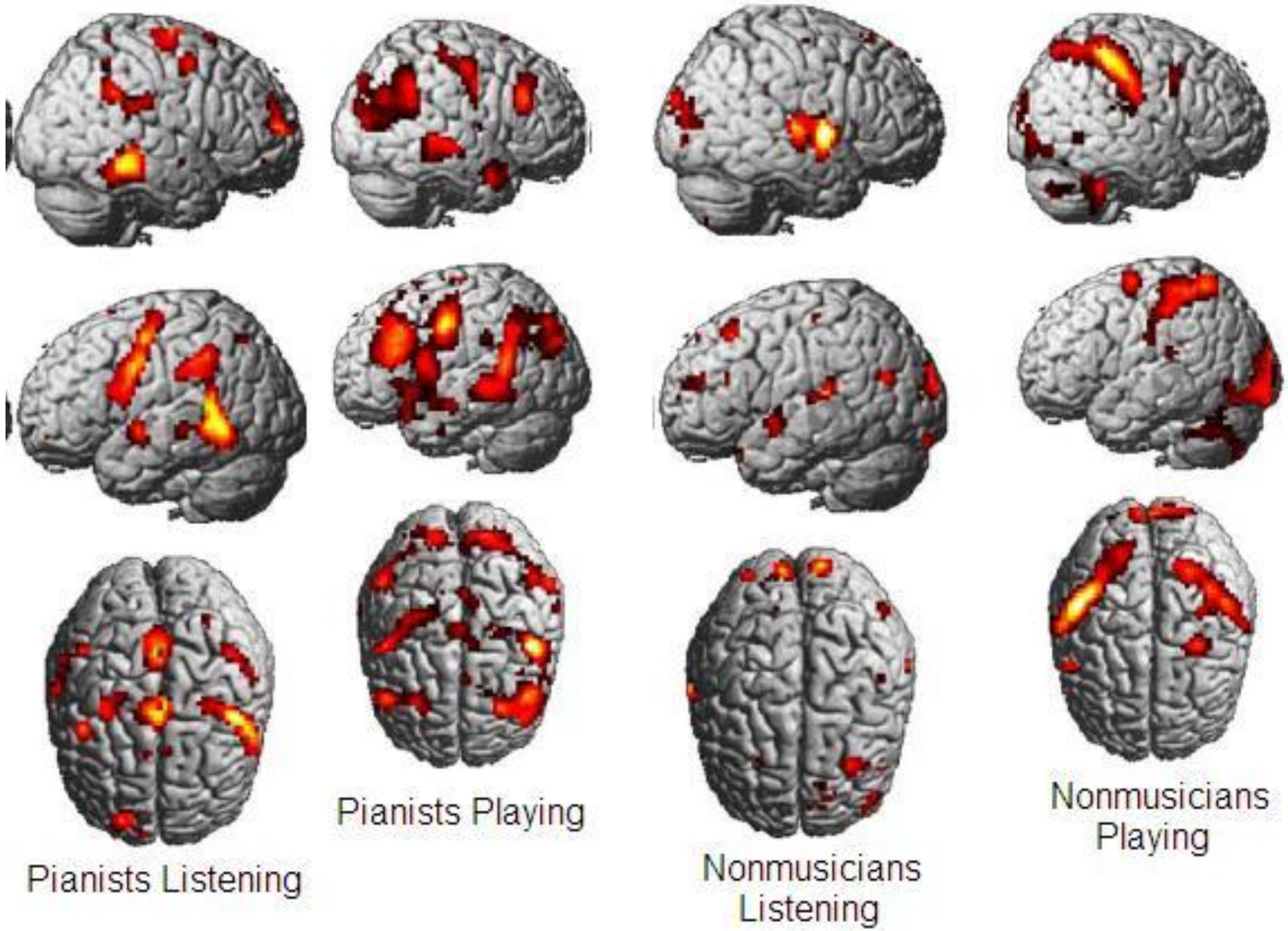
`Sensitive periods' in early brain development

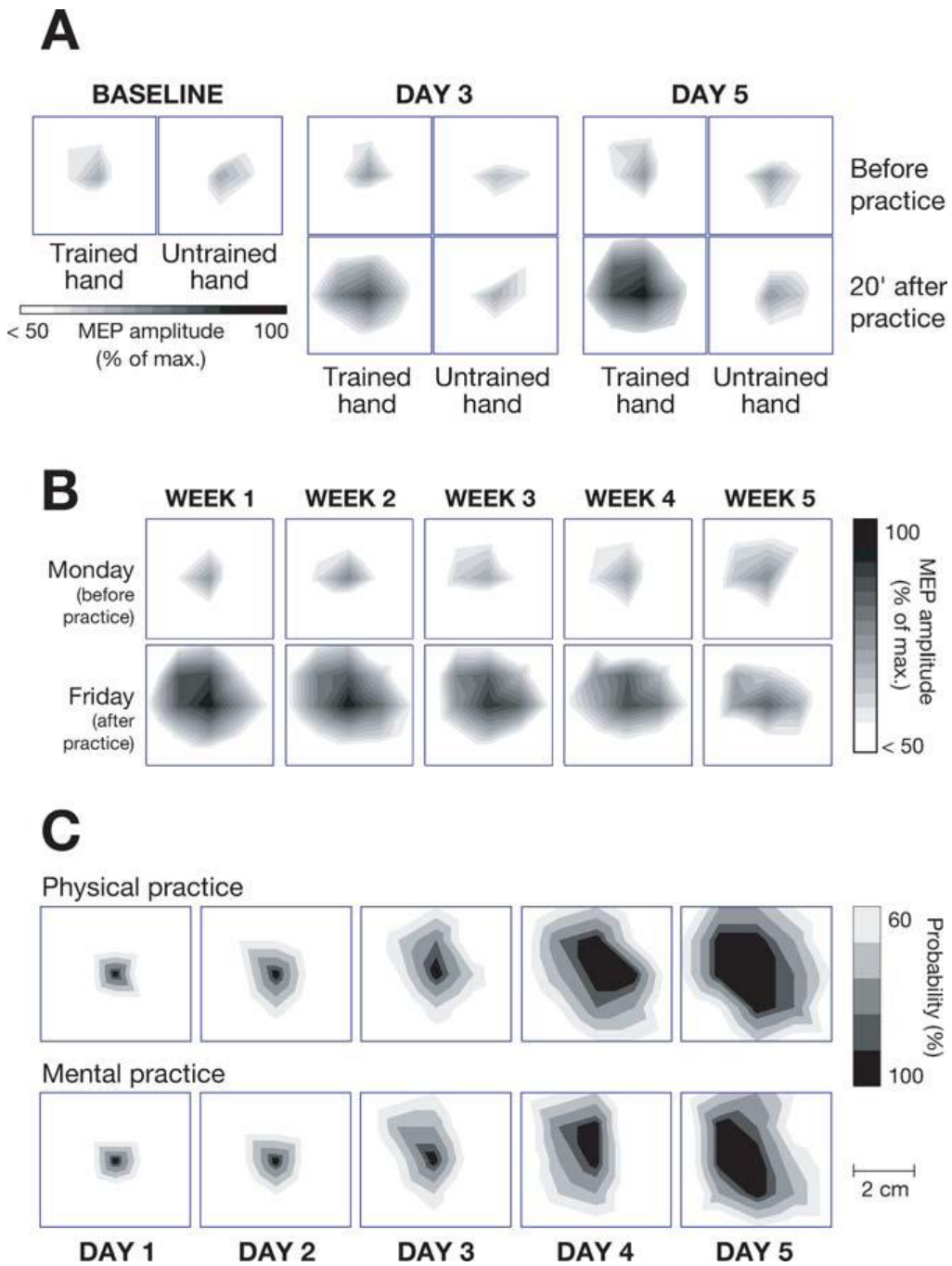


Graph developed by **Council for Early Child Development**
(ref: Nash, 1997; *Early Years Study*, 1999; Shonkoff, 2000.)

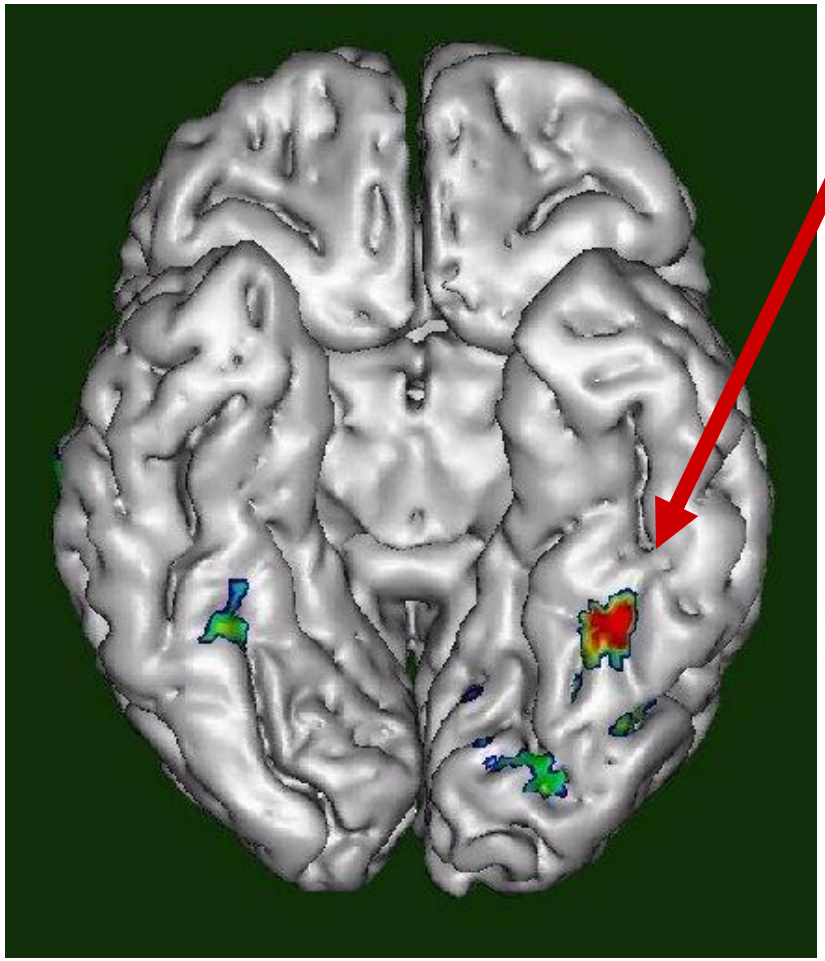

3 year old child
normal
extreme neglect

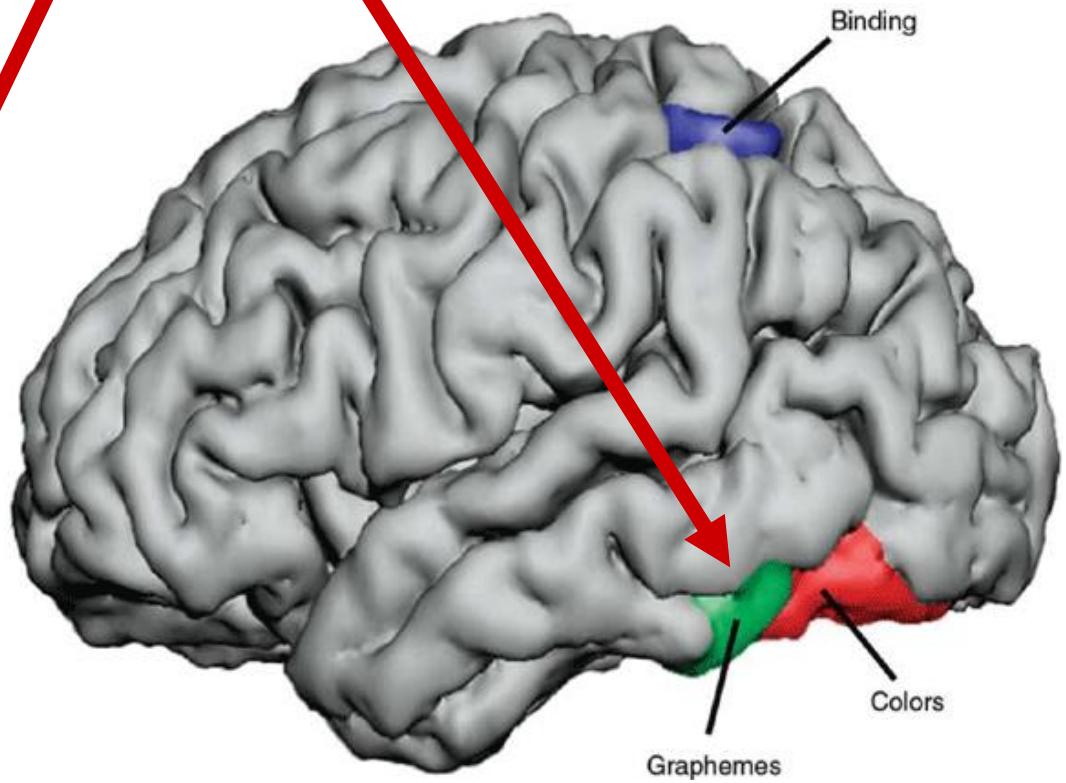

Mirror Neurons
Executed Reaching
Observed Reaching
dorsal
posterior
lateral
medial
p = 0.005

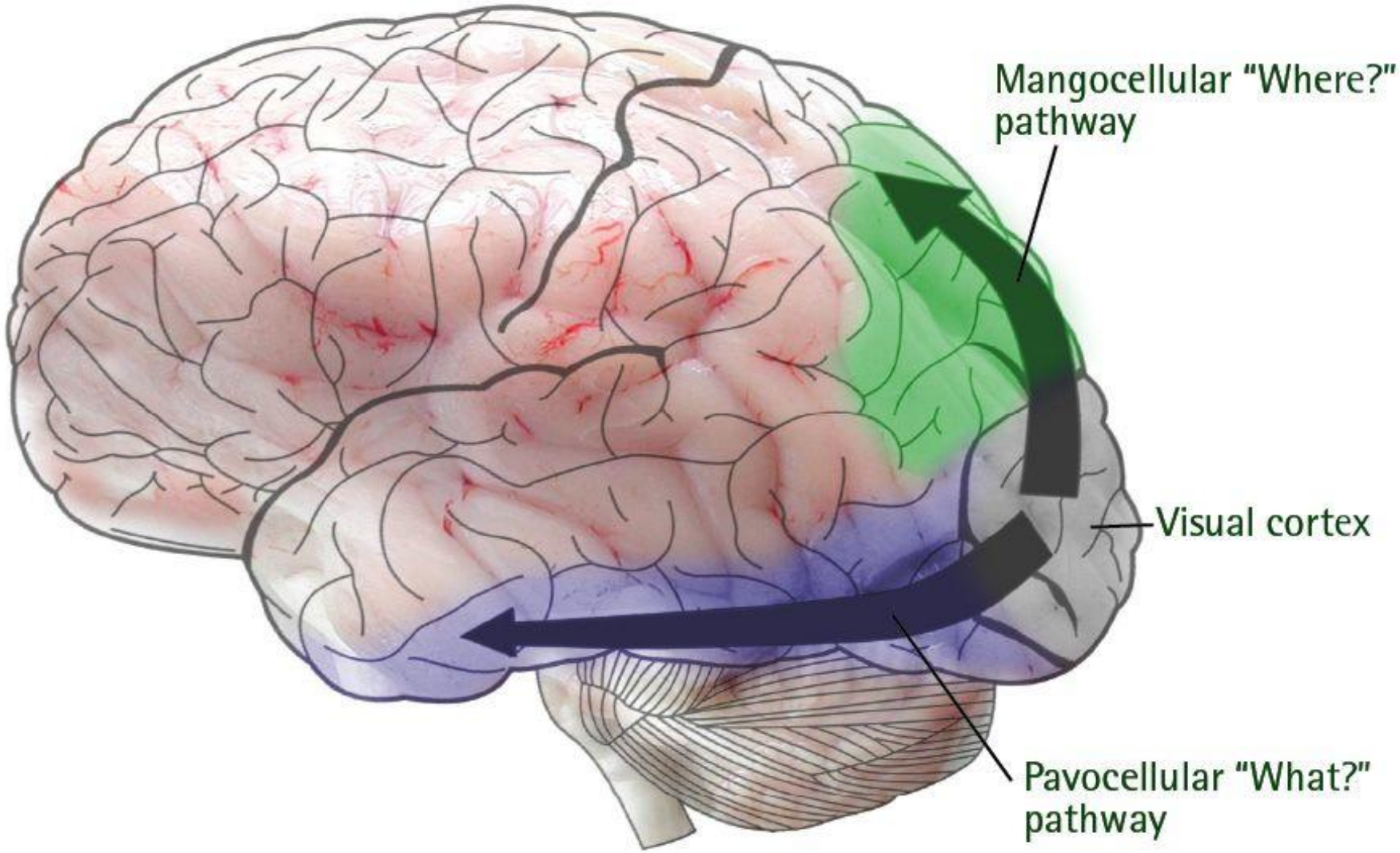

Pianists Listening
Pianists Playing
Nonmusicians Listening
Nonmusicians Playing

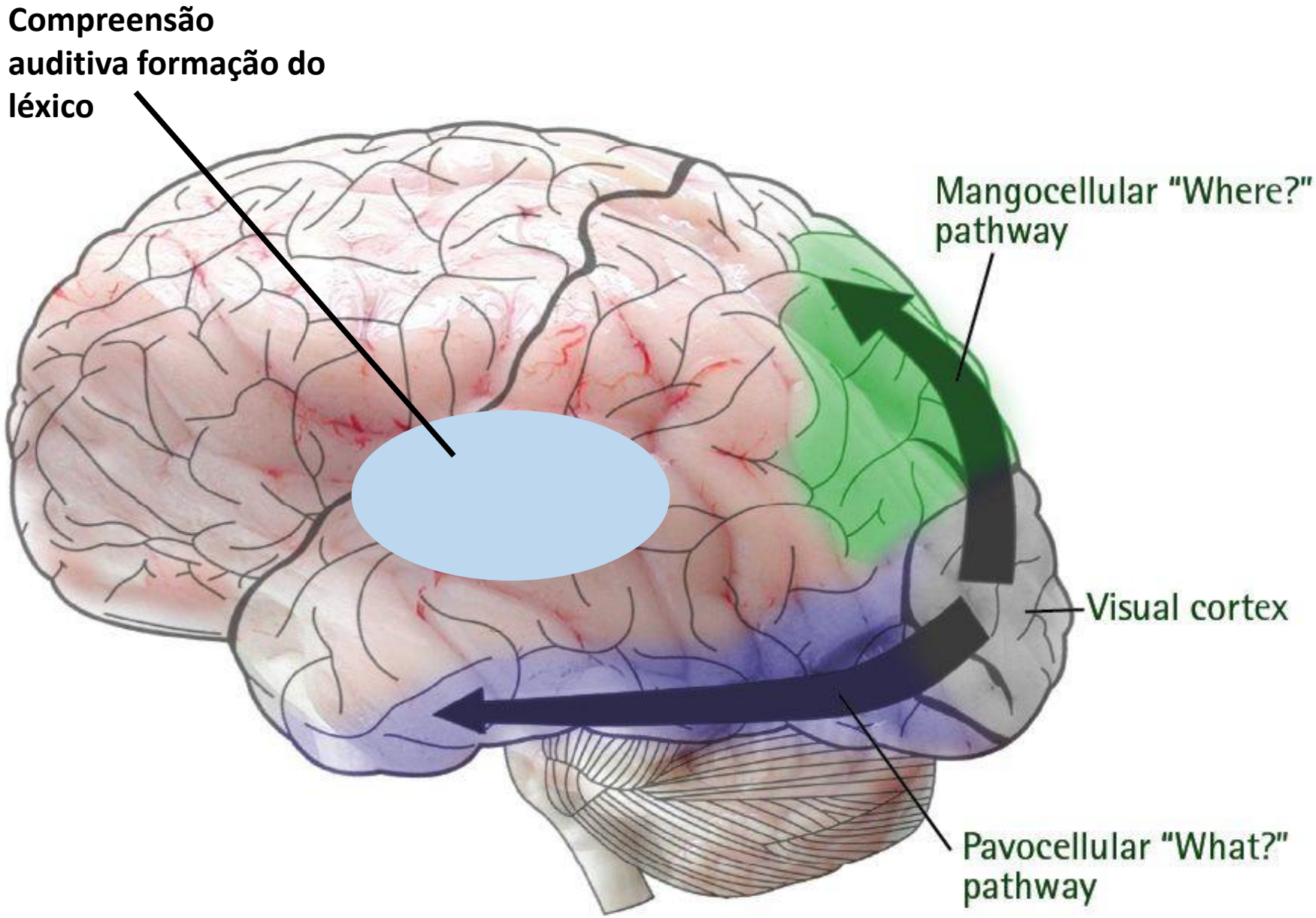

A
BASELINE
DAY 3
DAY 5
Trained hand
Untrained hand
< 50
MEP amplitude (% of max.)
100
Before practice
20' after practice
B
WEEK 1
WEEK 2
WEEK 3
WEEK 4
WEEK 5
Monday (before practice)
Friday (after practice)
100
MEP amplitude (% of max.)
< 50
C
Physical practice
Mental practice
60
Probability (%)
100
2 cm
DAY 1
DAY 2
DAY 3
DAY 4
DAY 5

ÁREA DA FORMA VISUAL DA PALAVRA (VISUAL WORD FORM AREA)

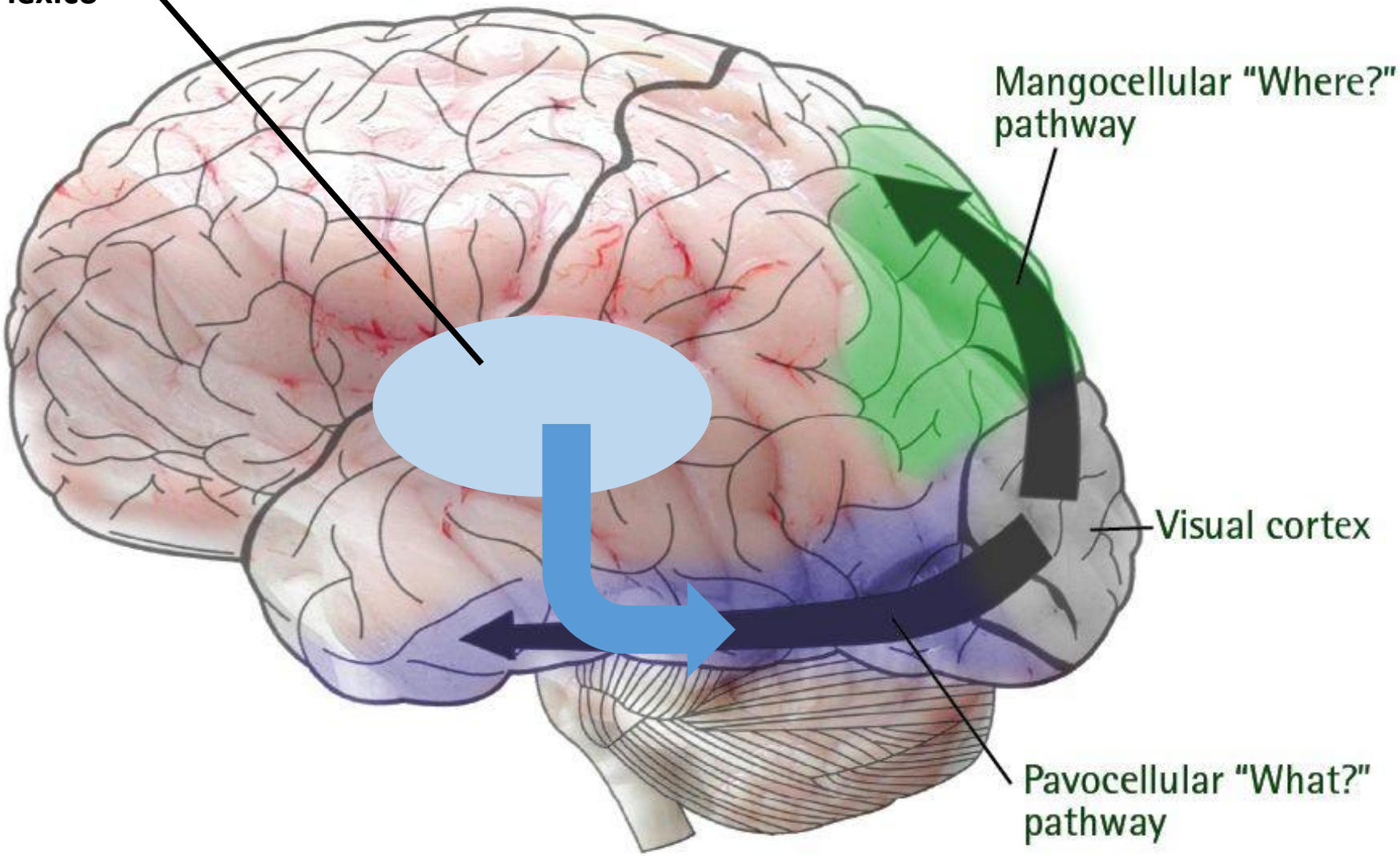


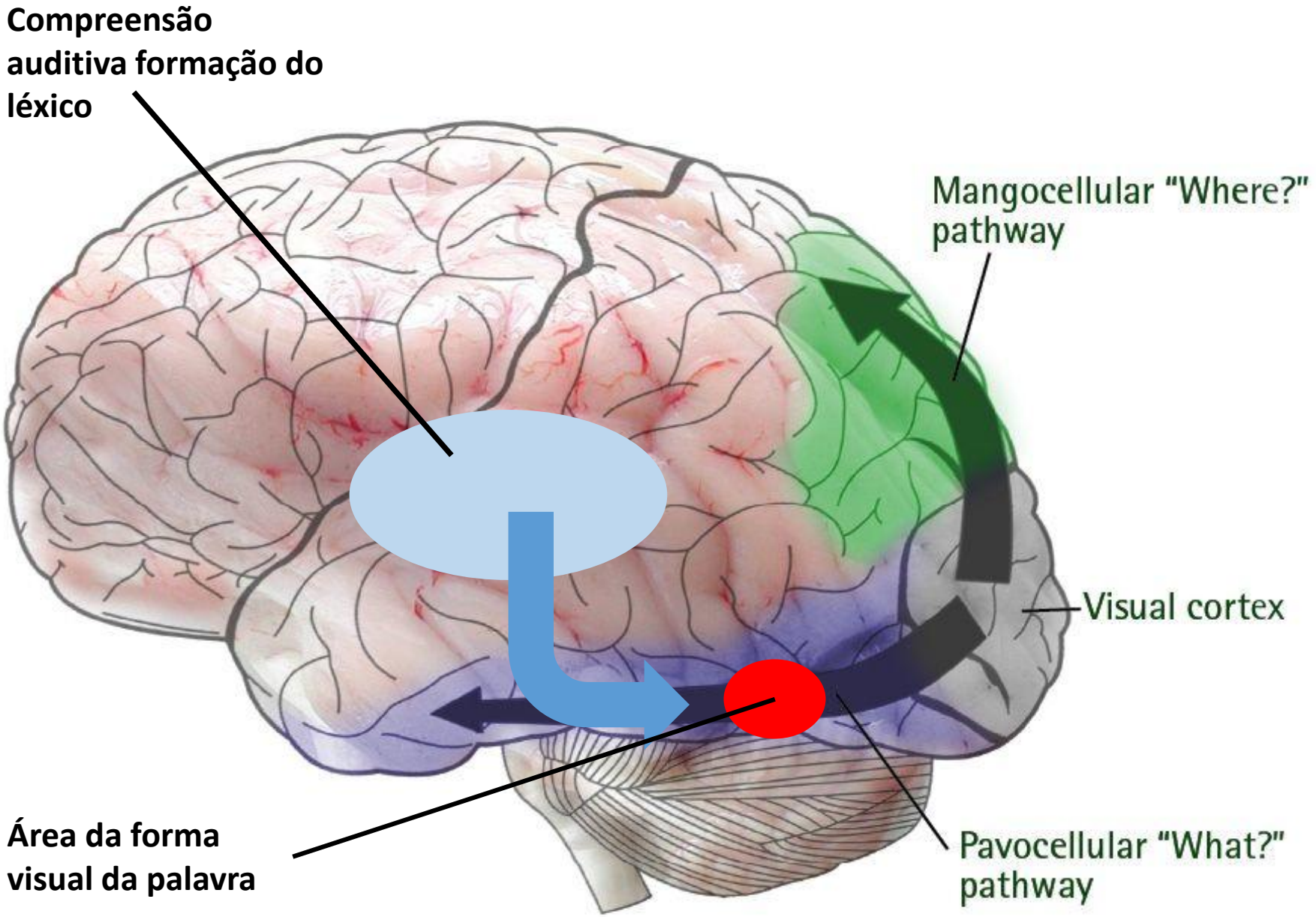



Mangocellular "Where?" pathway
Visual cortex
Pavocellular "What?" pathway

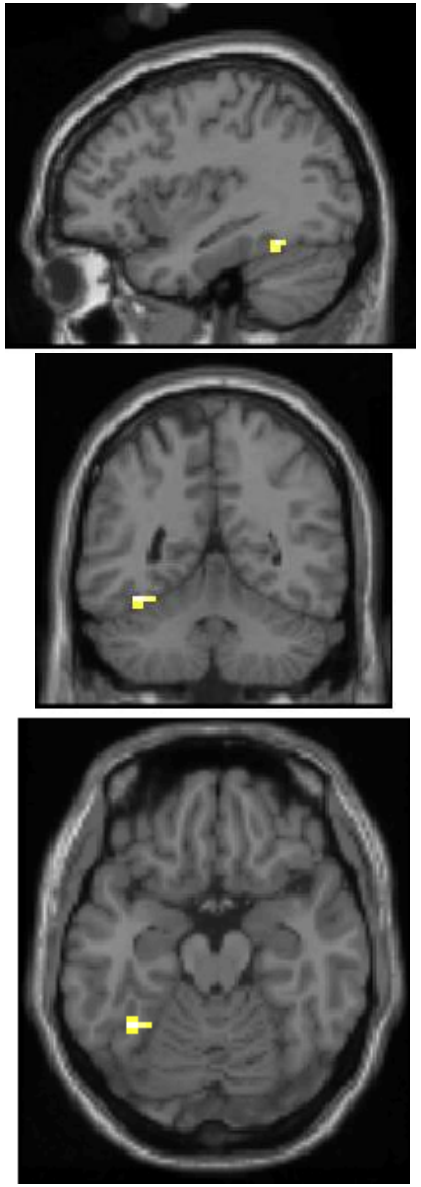

Compreensão auditiva formação do léxico
Mangocellular "Where?" pathway
Visual cortex
Pavocellular "What?" pathway

Compreensão auditiva formação do léxico

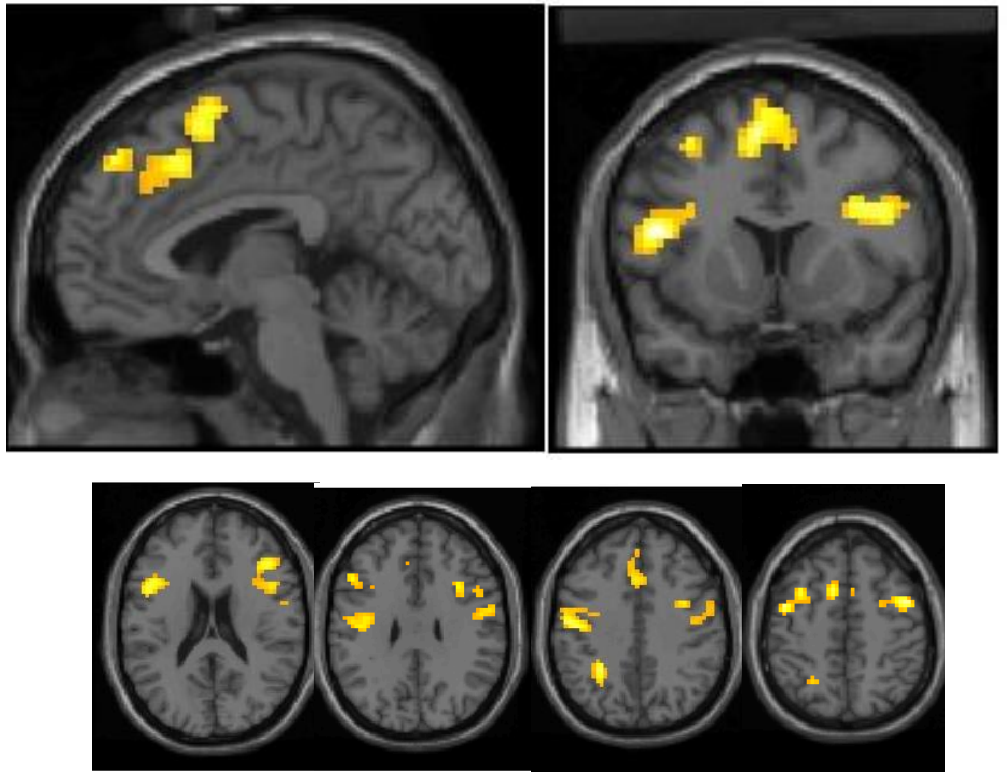



Compreensão auditiva formação do léxico
Mangocellular "Where?" pathway
Visual cortex
Área da forma visual da palavra
Pavocellular "What?" pathway

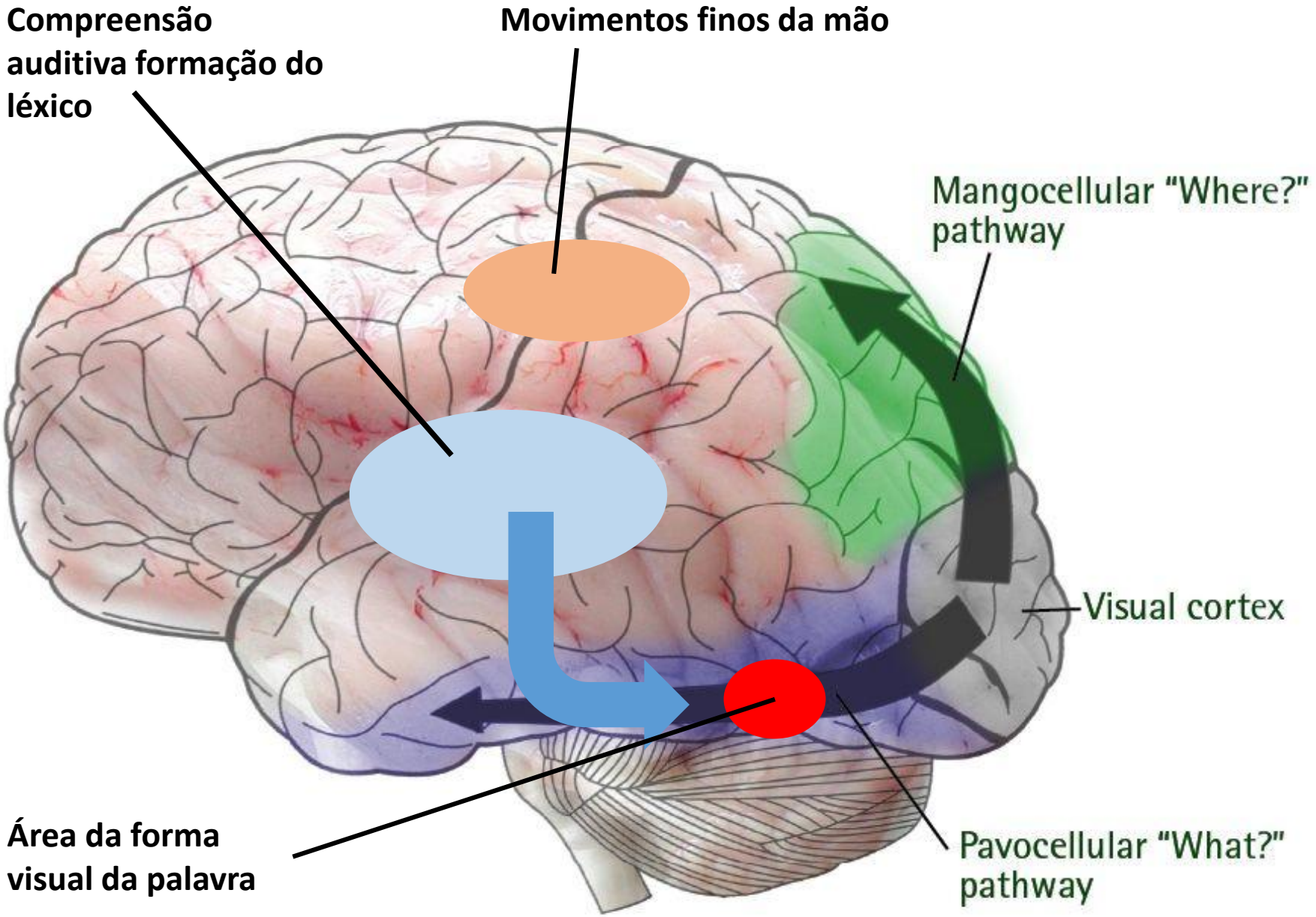
CONTROLS

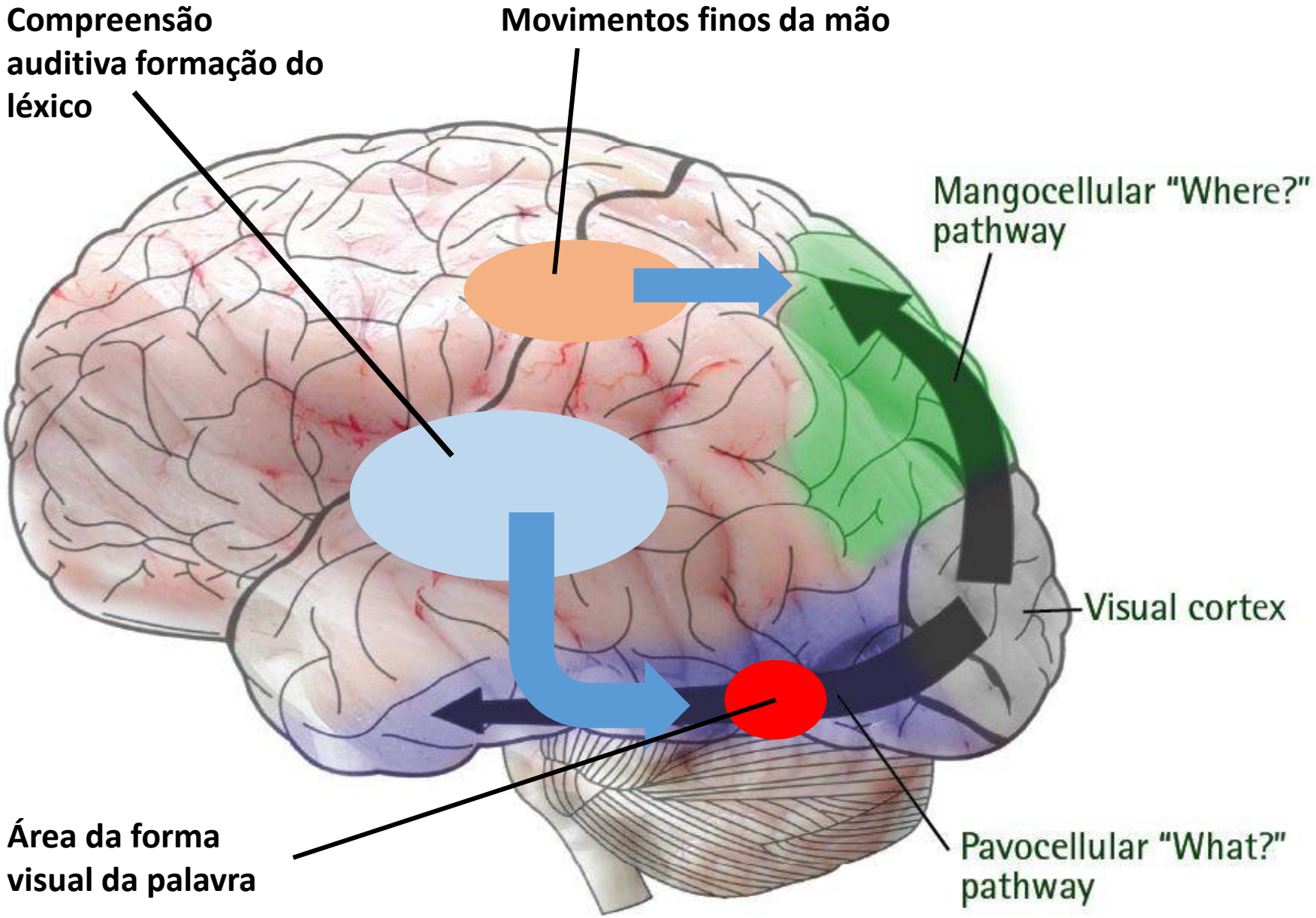


EX ILLITERATES



READING WORDS


Compreensão auditiva formação do léxico
Movimentos finos da mão
Mangocellular "Where?" pathway
Visual cortex
Área da forma visual da palavra
Pavocellular "What?" pathway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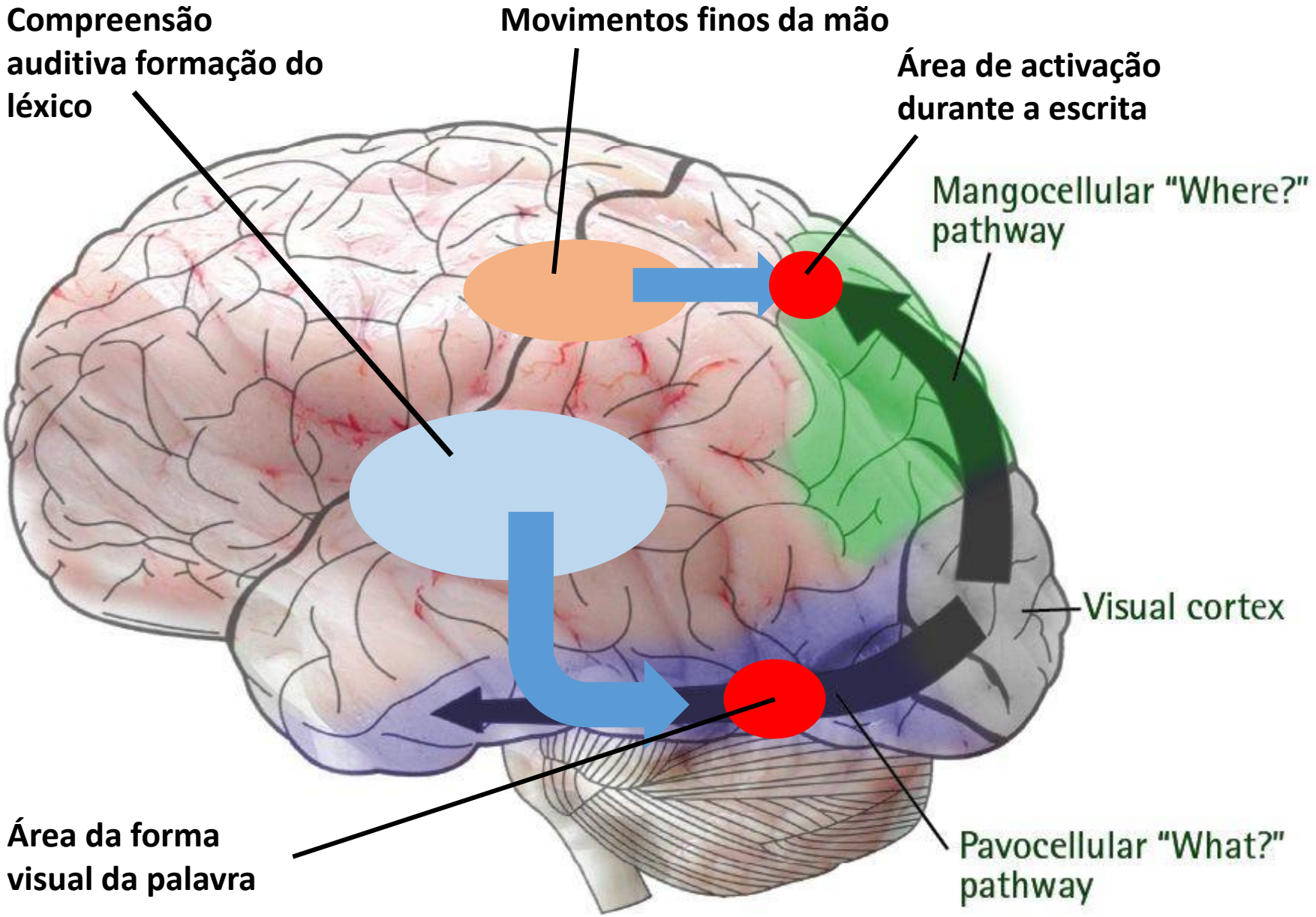
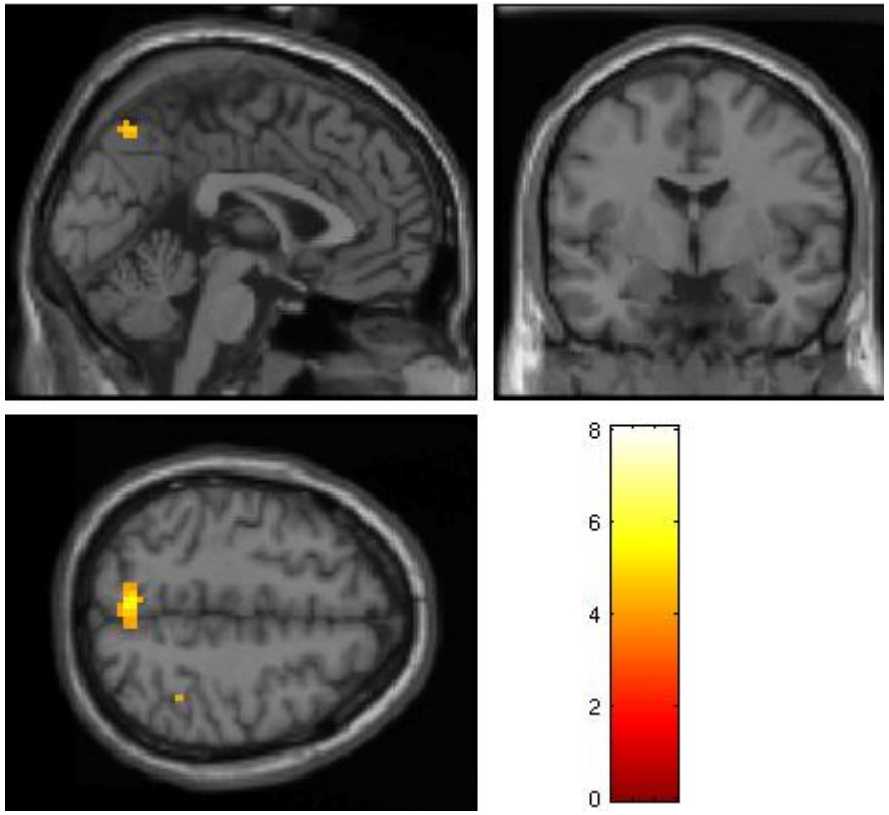
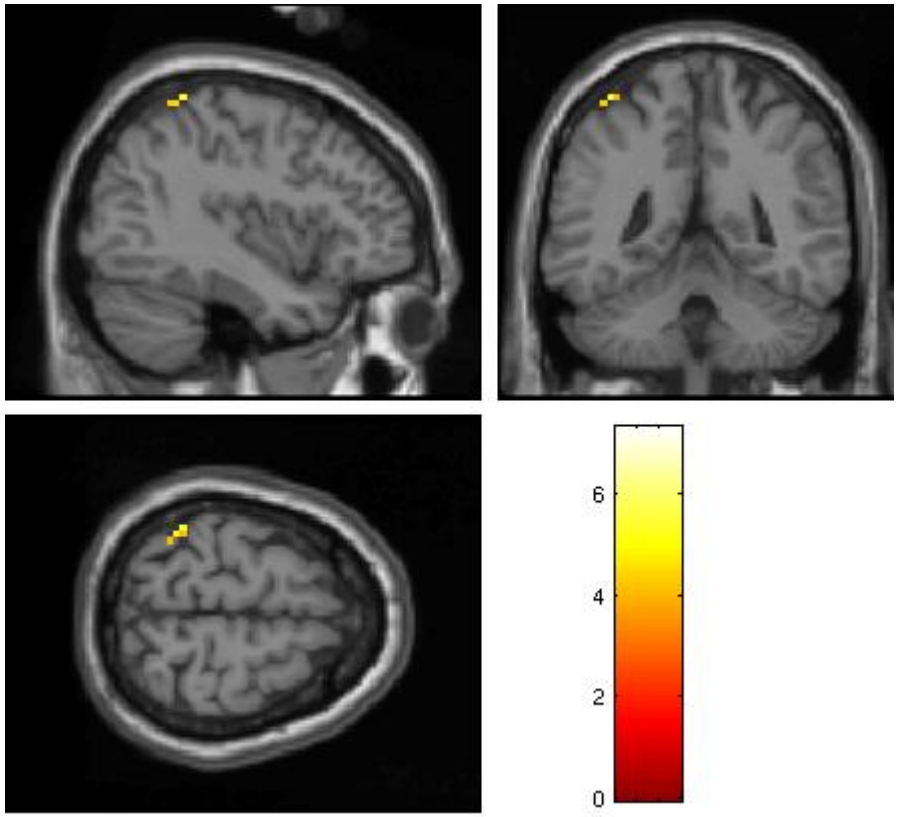

Compreensão auditiva formação do léxico
Movimentos finos da mão
Área de activação durante a escrita
Mangocellular "Where?" pathway
Visual cortex
Área da forma visual da palavra
Pavocellular "What?" pathway

WRITING WITH THE RIGHT HAND

EX-ILLITERATES



CONTROLS



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AMBIENTE RICO

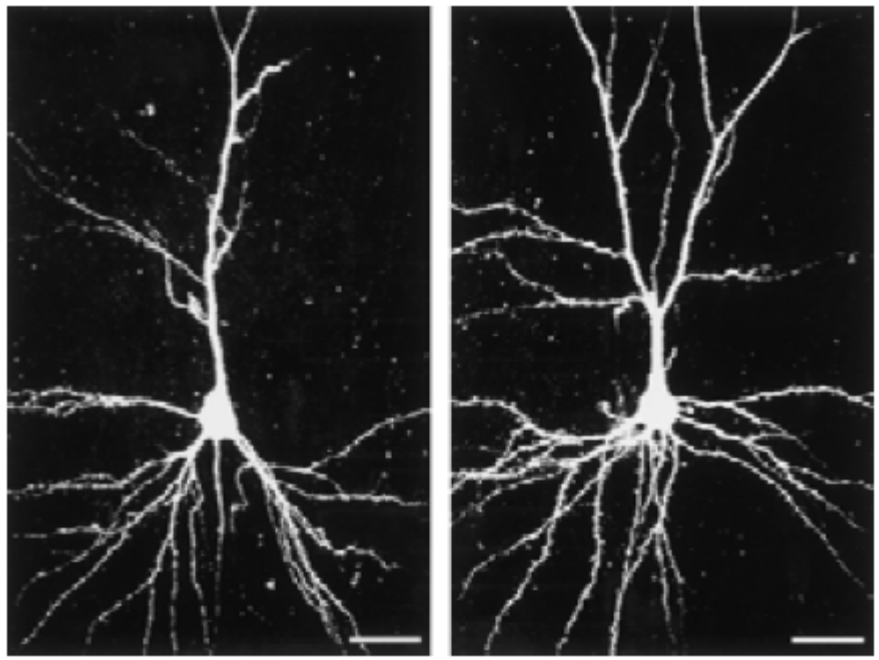


FIG. 1. Dendritic morphology of pyramidal neurons in layer III of the somatosensory cortex in a rat housed in standard (left) and enriched (right) environments, as viewed in confocal imaging after microinjection of Lucifer yellow into the neurons. Bar = 25 μm.

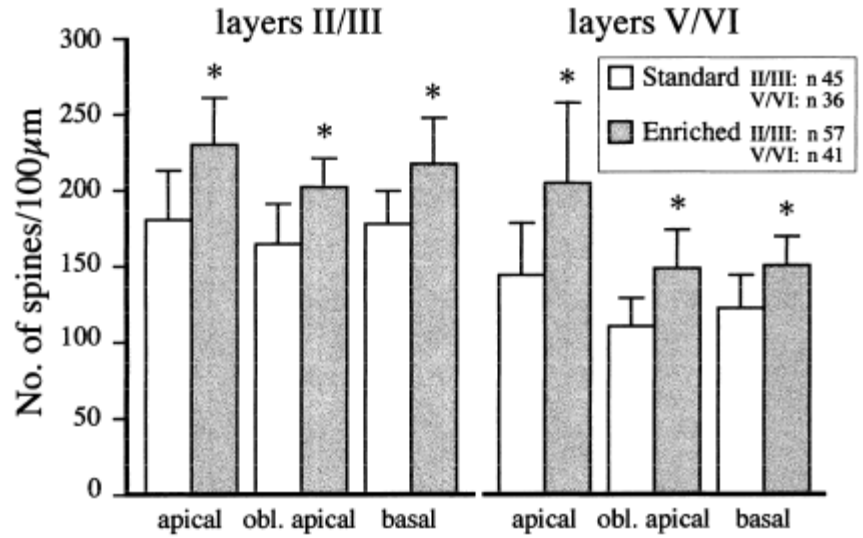
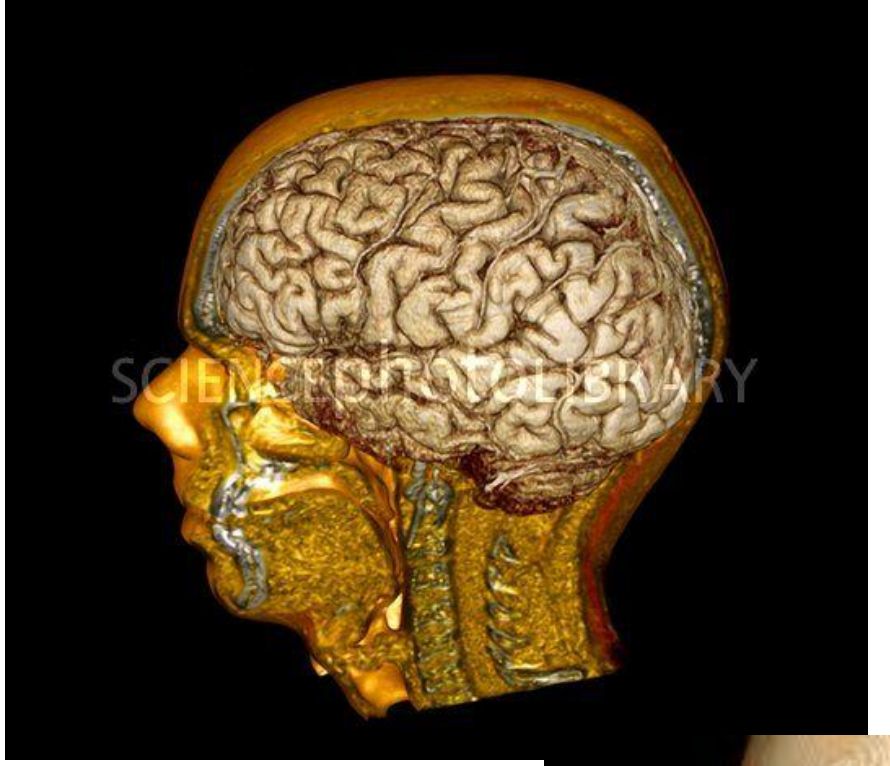
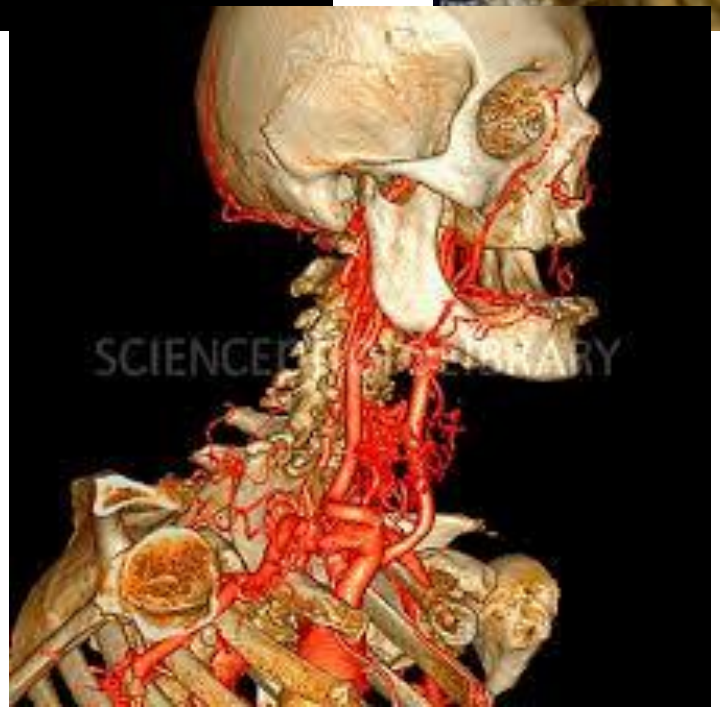
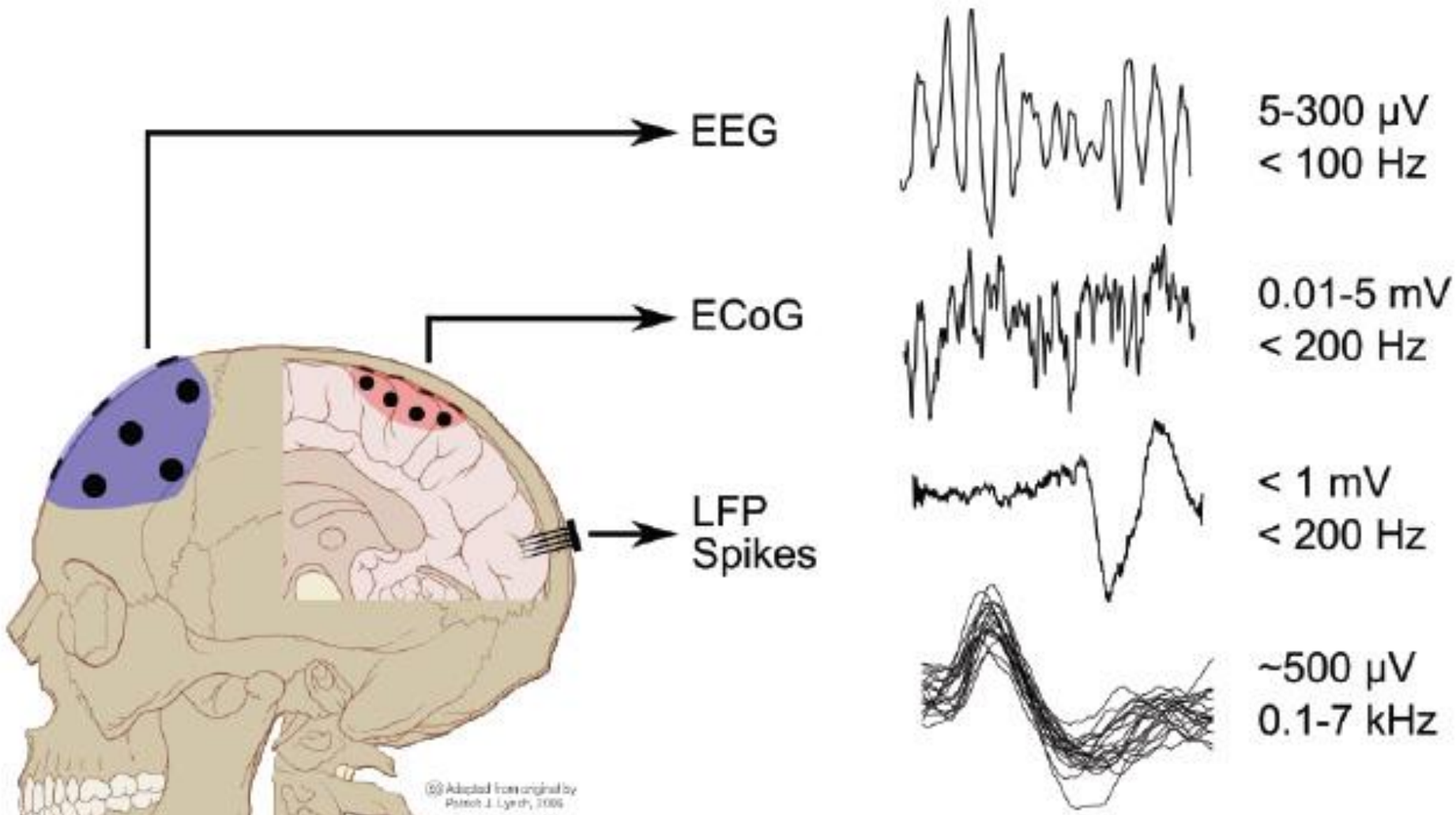
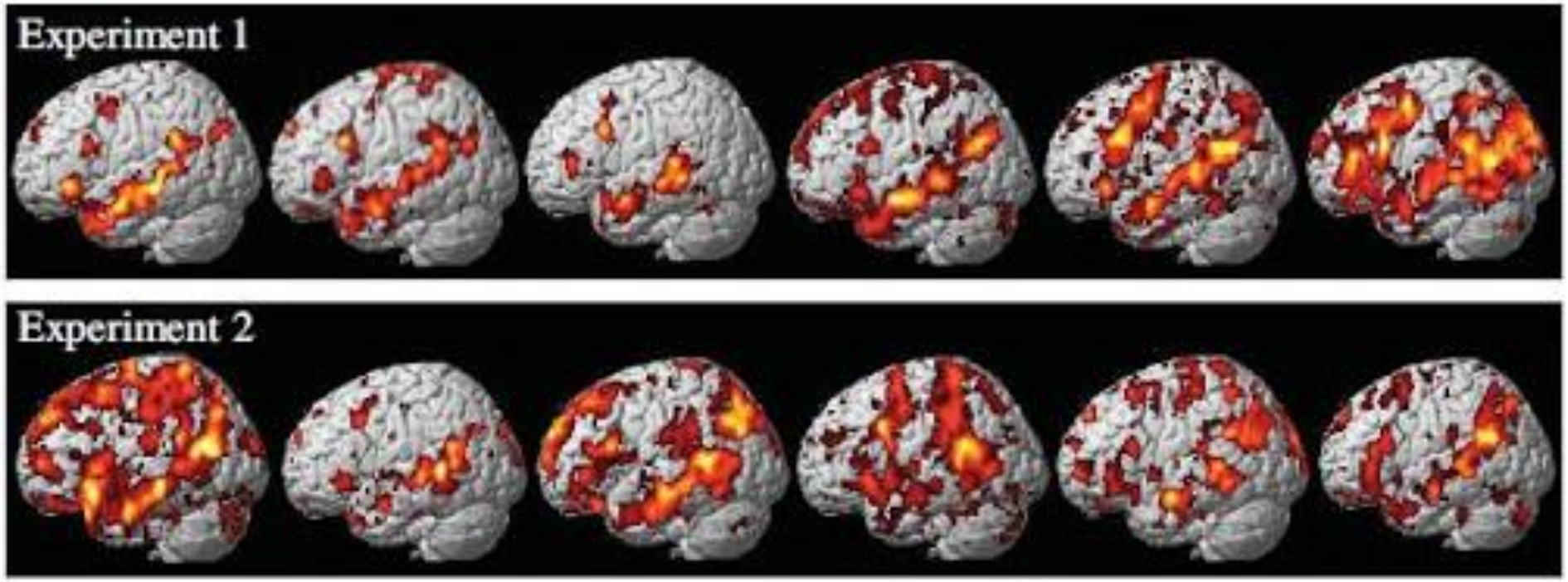


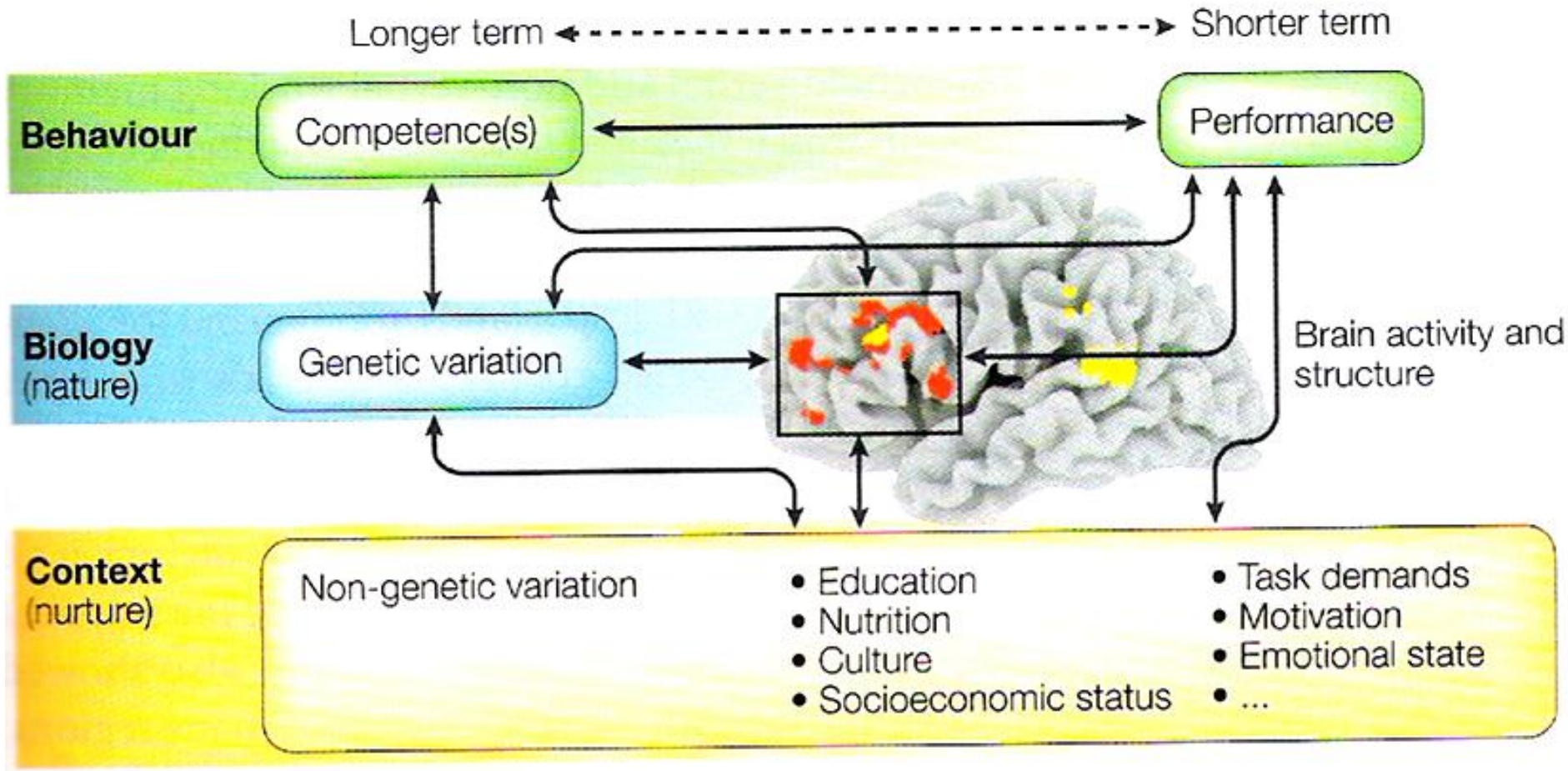
FIG. 2. Dendritic spine density presented as spines per 100-μm length of dendrite on apical, oblique (obl) apical, and basal dendrites of pyramidal neurons in a somatosensory cortex of adult intact rats housed in standard environment or transferred to an enriched environment for 3 weeks. Data are mean ± SD. $^{*}P < 0.05$ for differences between standard and enriched rats.

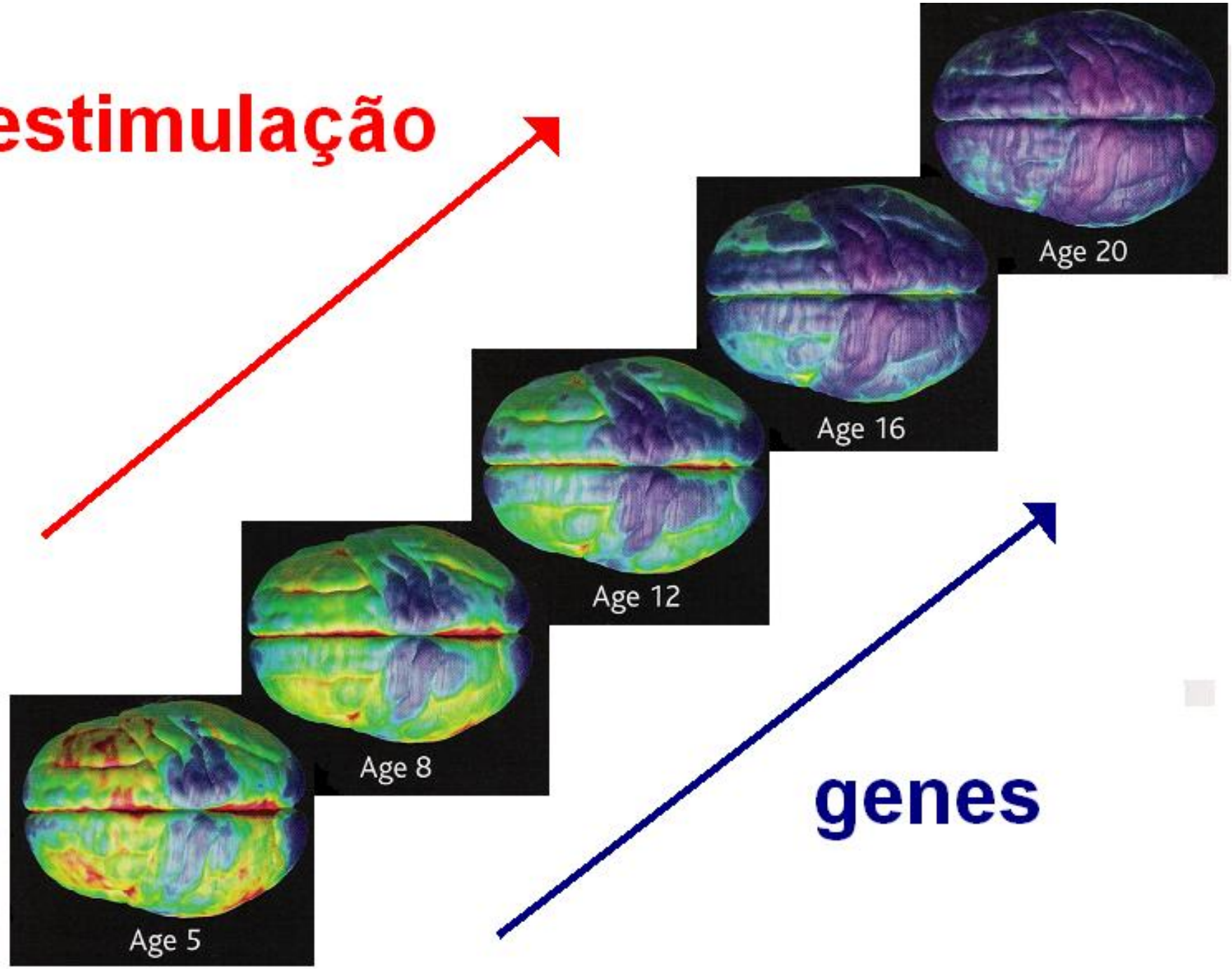


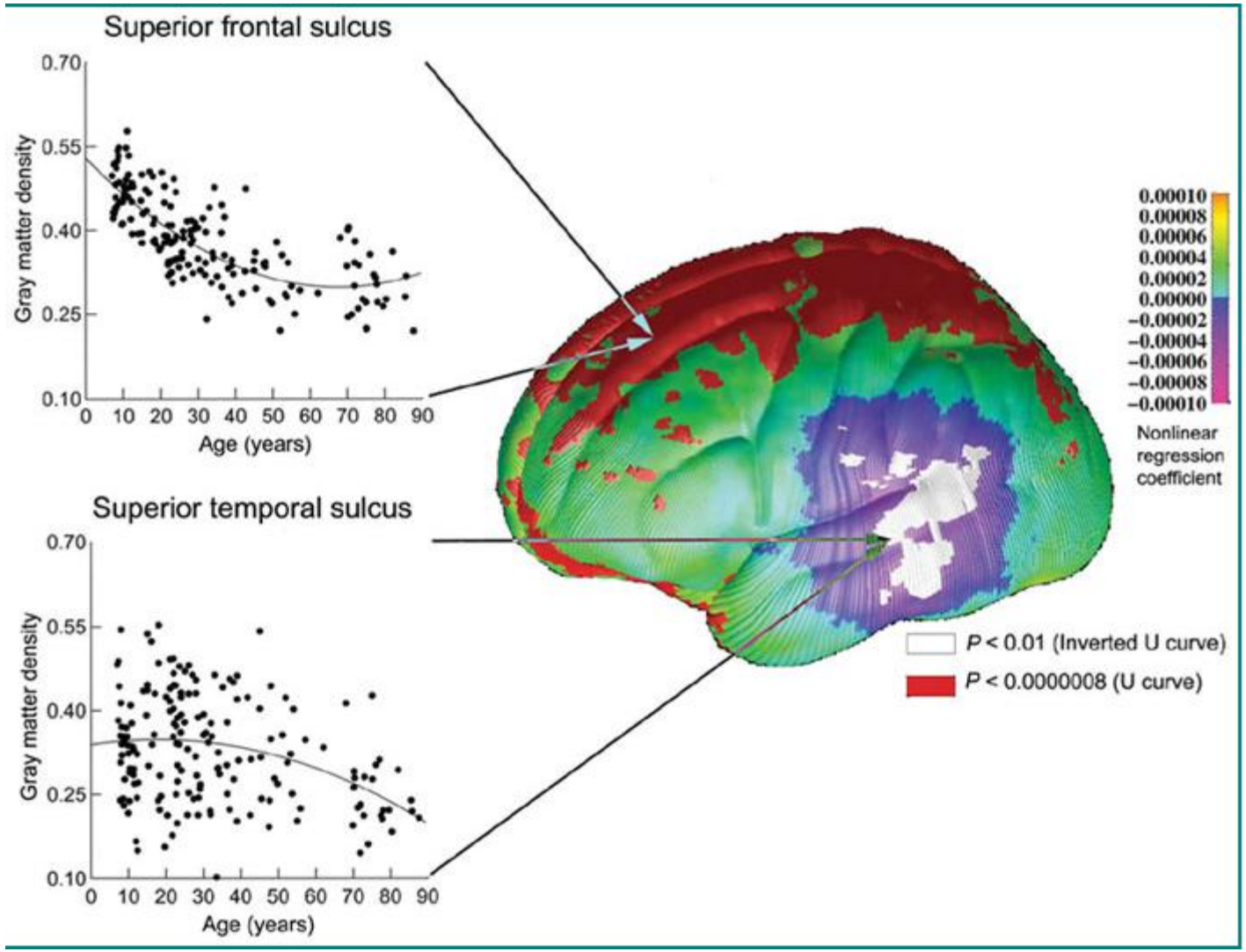



EEG
ECoG
LFP
Spikes
5-300 µV
< 100 Hz
0.01-5 mV
< 200 Hz
< 1 mV
< 200 Hz
~500 µV
0.1-7 kHz


Experiment 1
Experiment 2


Longer term
Shorter term
Behaviour
Competence(s)
Performance
Biology
(nature)
Genetic variation
Brain activity and
structure
Context
(nurture)
Non-genetic variation
• Education
• Nutrition
• Culture
• Socioeconomic status
• Task demands
• Motivation
• Emotional state
• ...

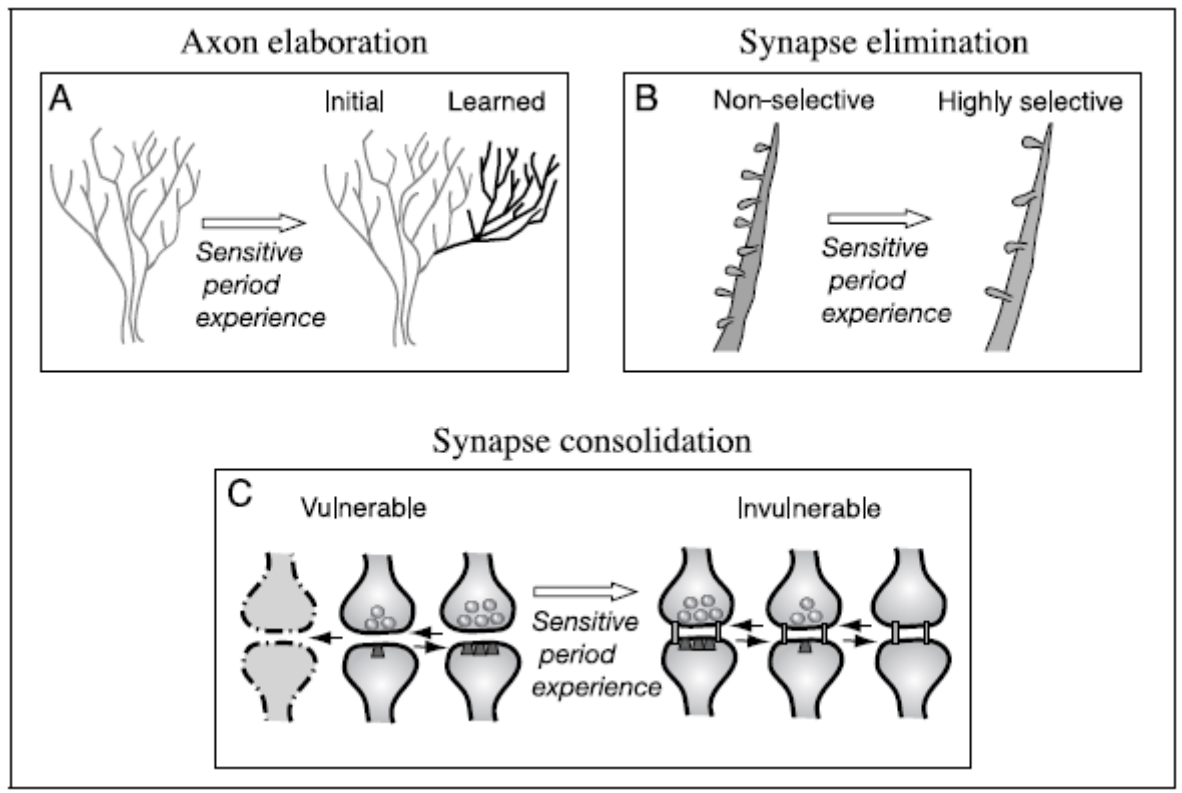

estimulação
Age 20
Age 16
Age 12
Age 8
Age 5
genes


Superior frontal sulcus
Gray matter density
0.70
0.55
0.40
0.25
0.10
0 10 20 30 40 50 60 70 80 90
Age (years)
Superior temporal sulcus
Gray matter density
0.70
0.55
0.40
0.25
0.10
0 10 20 30 40 50 60 70 80 90
Age (years)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
−0.00002
−0.00004
−0.00006
−0.00008
−0.00010
Nonlinear regression coefficient
P < 0.01 (Inverted U curve)
P < 0.0000008 (U curve)

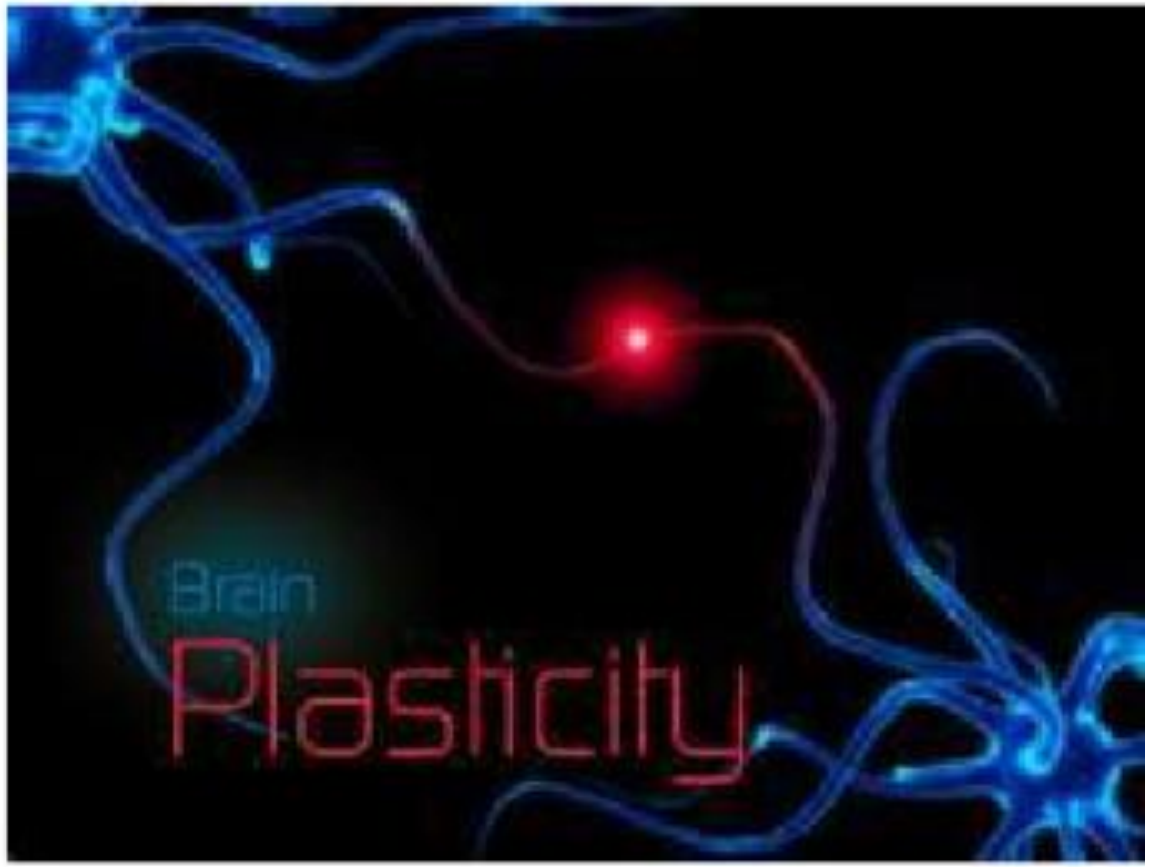
Sensitive Periods in the Development of the Brain and Behavior

Eric I. Knudsen

J Cognitive Neuroscience, 2004



- **Plasticity**: Refers to the brains ability to reorganise neural pathways throughout the lifespan as a result of experience.
- **Put simply: The brains ability to change with learning**.
- **There is a change in the internal structure of neurons, notably the synapses &**
- **increase in the number of synapses**

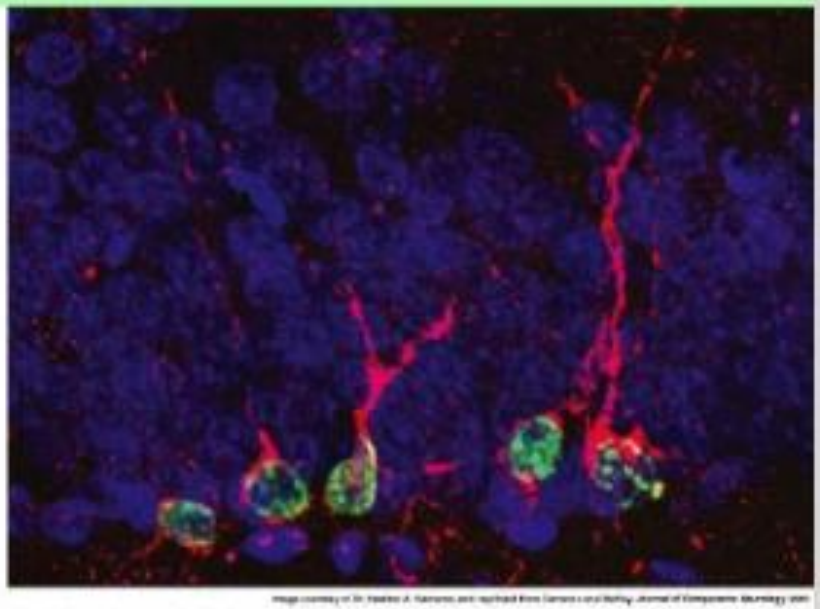


	Developmental Plasticity	Adaptive Plasticity
Definition	Changes in neural connections as a result of interactions with the environment (our experiences during childhood) as a consequence of developmental processes. e.g. development of visual cortex.	The brains ability to compensate for lost functionality due to brain damage as well as in response to interaction with the environment by reorganising its structure
Neuronal Changes	1. Synaptogenesis 2. Synaptic pruning 3. Neural migration 4. Myelination	1. Rerouting 2. Sprouting
Occurs in response to	It is predetermined & occurs in response to the initial processing of sensory information by the immature brain	Compensation for brain injury and in adjustment to new experiences
When it occurs	It occurs over the lifespan, but diminishes with age	Also occurs over the lifespan, but is more efficient and effective during infancy/ early childhood.

Developmental Plasticity

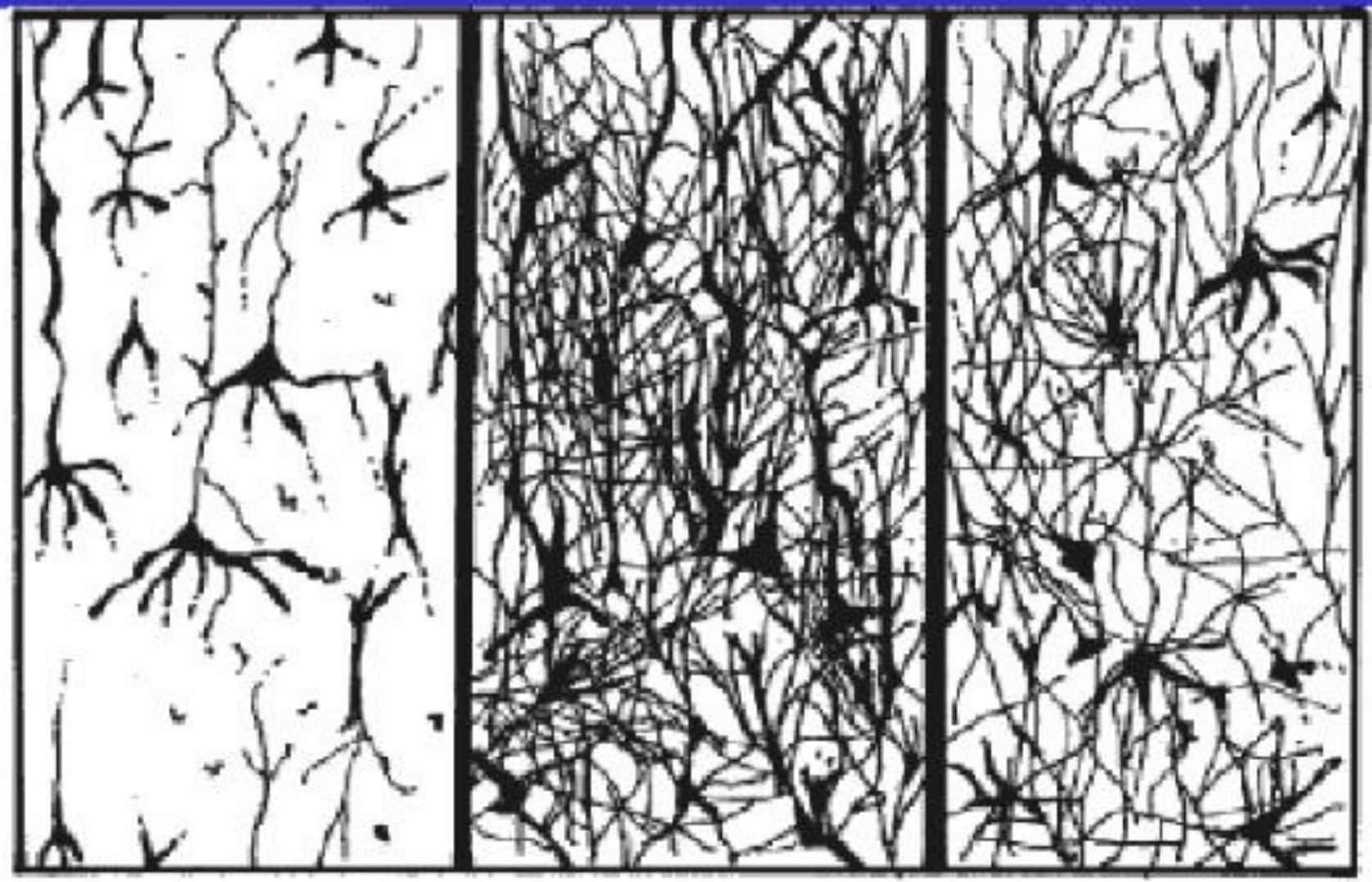
1. **Synaptogenesis:** is genetic i.e. the rapid expansion in synaptic formation in order to deal with bombardment of sensory input.
2. **Synaptic pruning:** reduction in the number of synaptic connections

- Which enables more efficient synaptic configurations (thus more efficient brain functioning – hence ongoing learning)
- Synaptic pruning is determined by experience – connections not used are pruned.



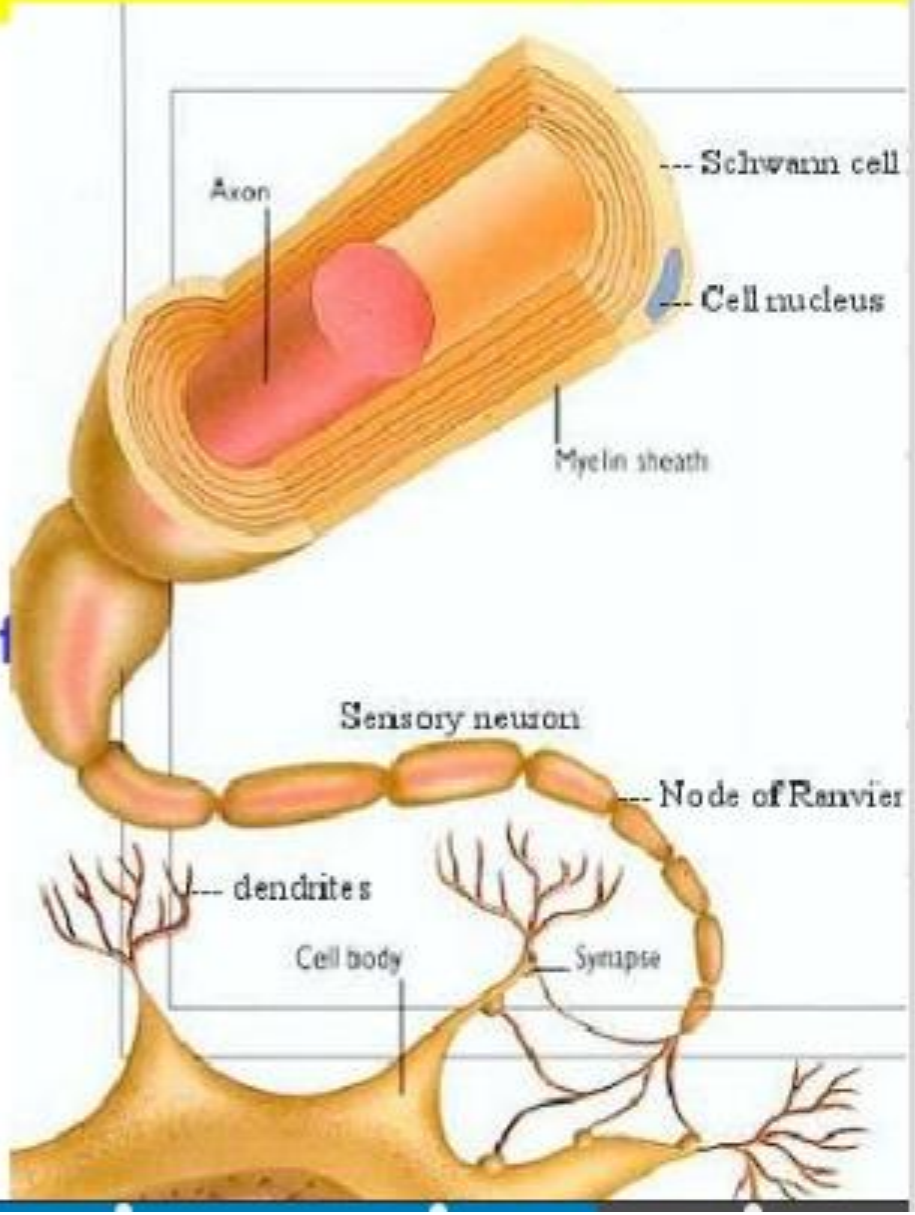
Newly formed granule cells in an adult rat, with DNA stained green

Developmental Plasticity



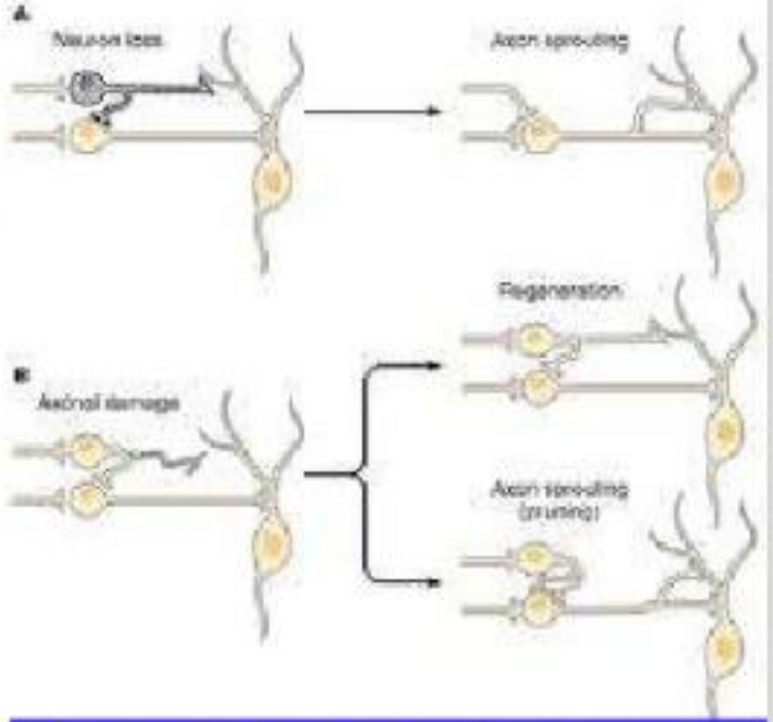
Developmental Plasticity

3. Neural Migration occurs from 8 weeks to 29 weeks (i.e. movement of neurons to different parts of the brain
4. Myelination starts during fetal development through to adolescence - a process of protecting & insulating neurons to aid the transmission of impulses from 1 nerve cell to the next.



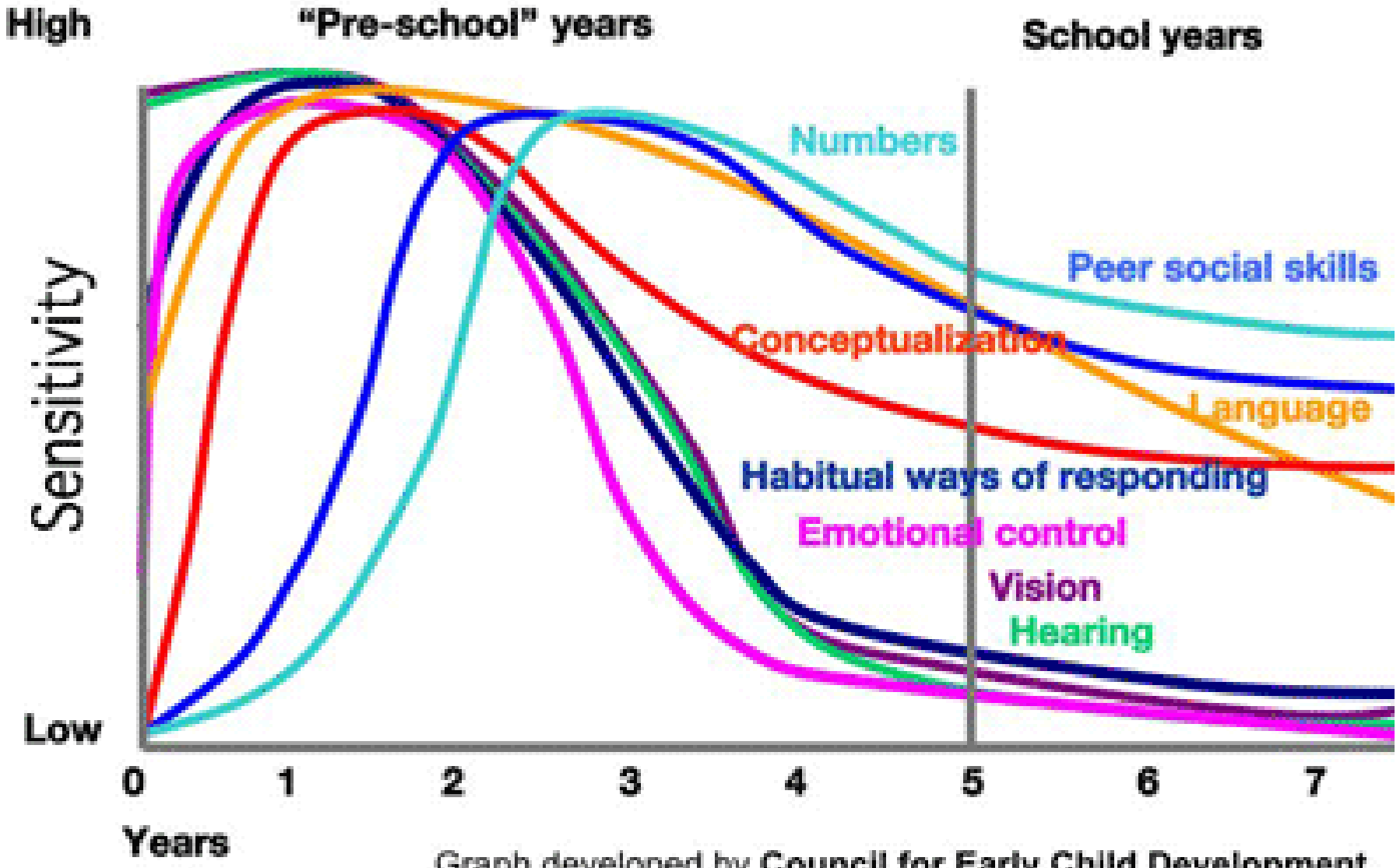
Adaptive plasticity

1. **Rerouting:** new neural connections are made between a neuron and other active neurons
2. **Sprouting:** growth of new dendritic fibres enabling the neuron for form new connections with other (more) neurons

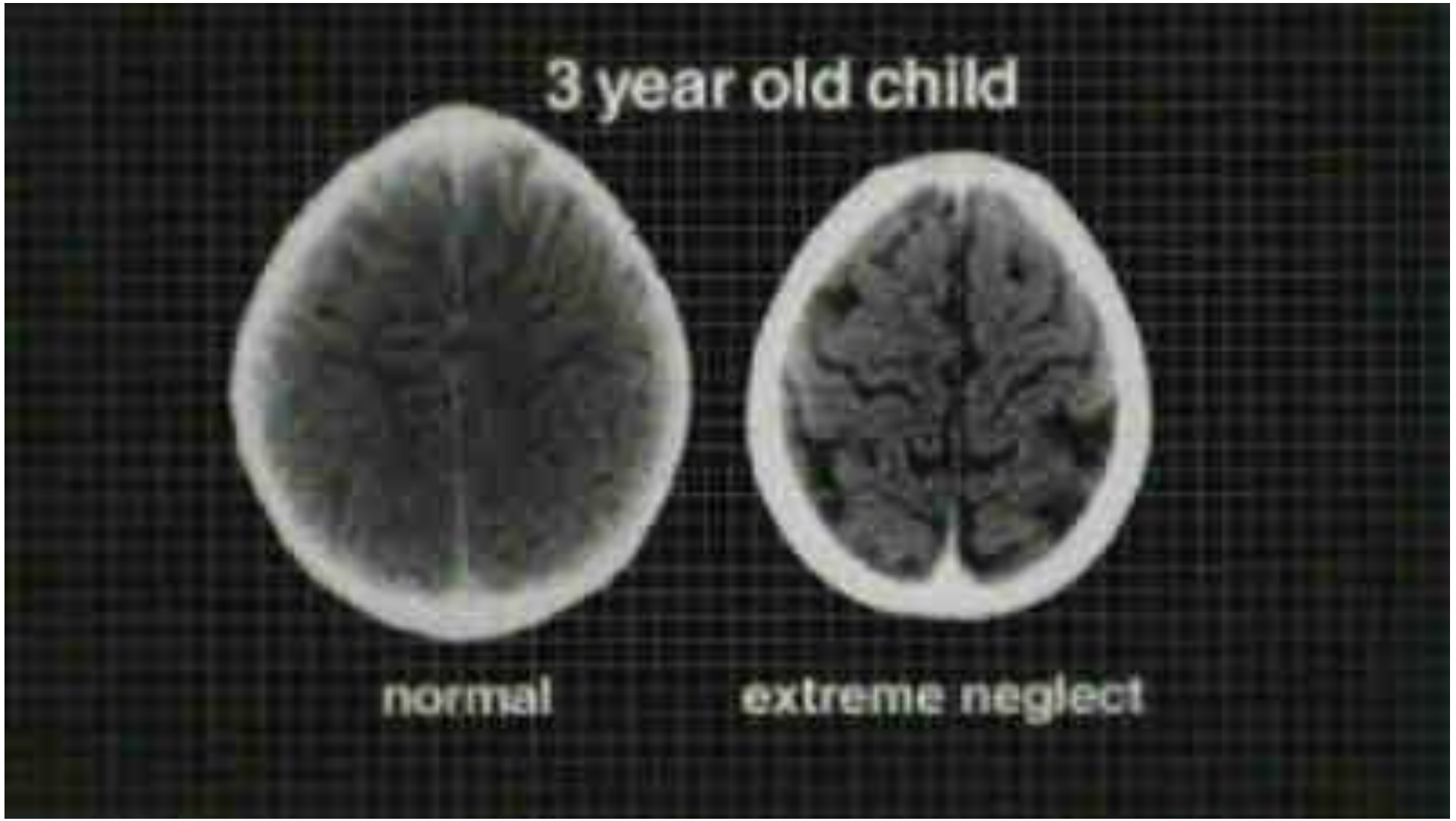


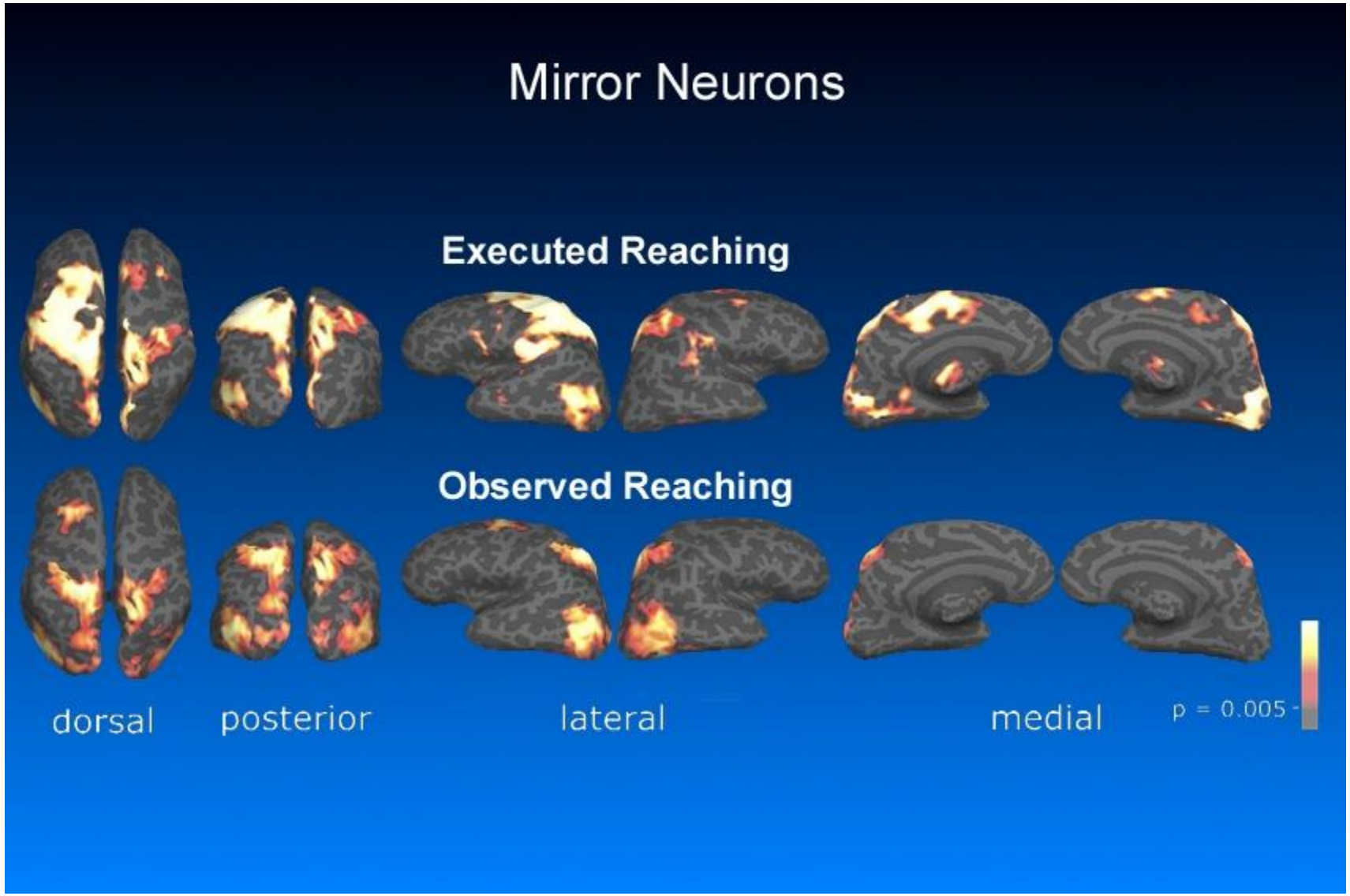
Adaptive plasticity enables brains to adapt (by growing) for individuals with the acquisition of expertise in a certain area e.g. Students, London Cab drivers, bilinguals, musicians, etc.

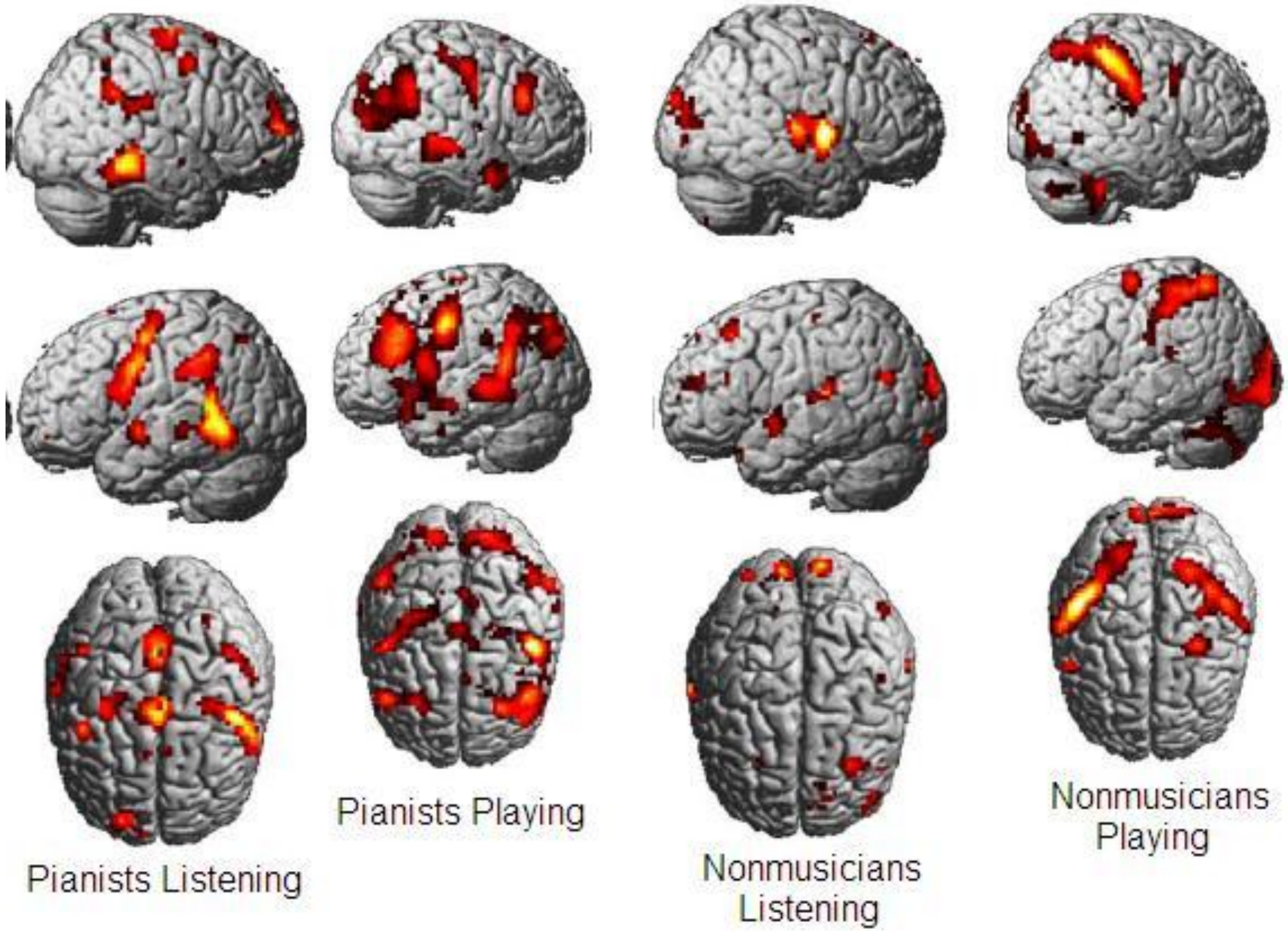
`Sensitive periods' in early brain development

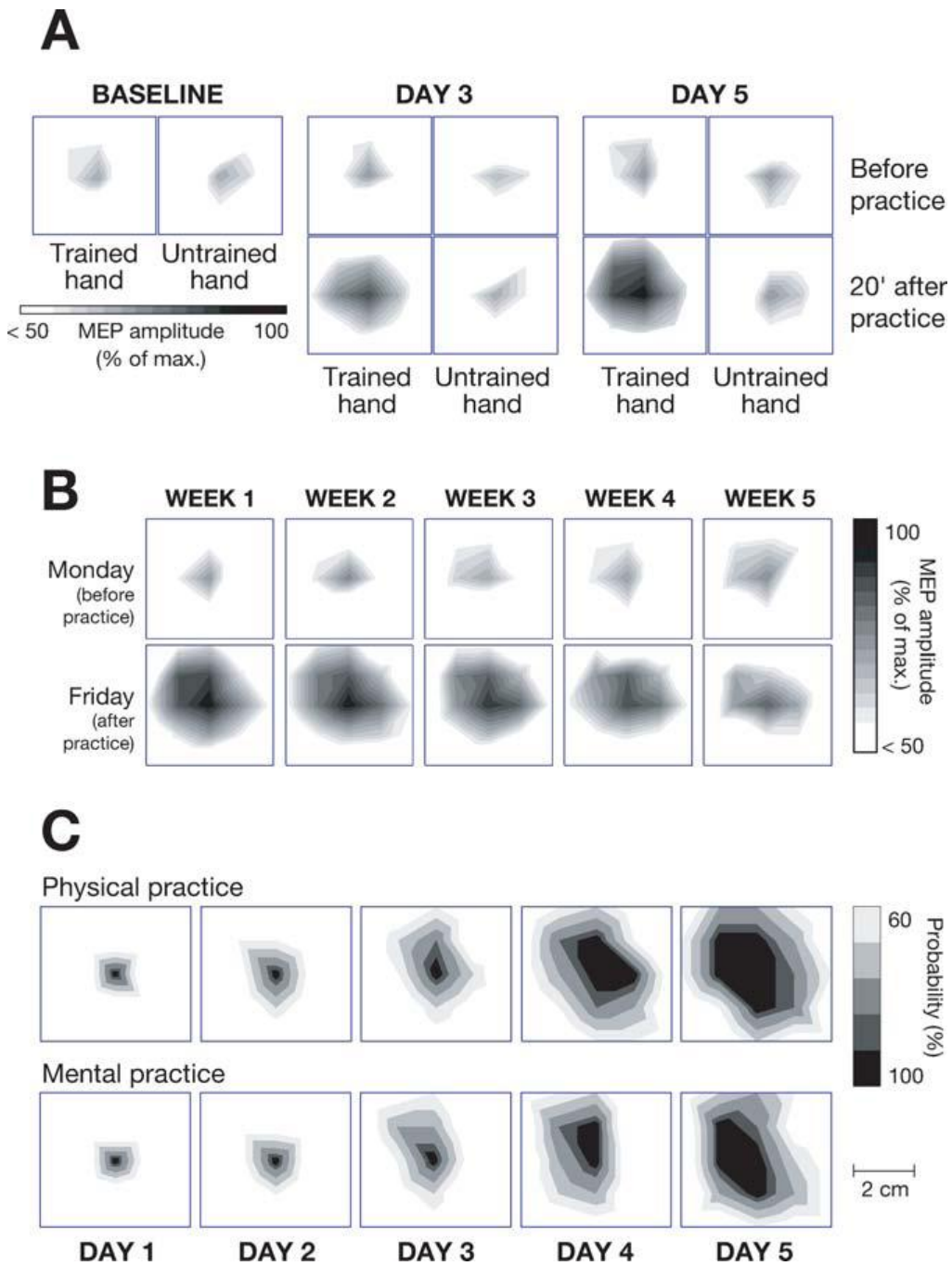


Graph developed by **Council for Early Child Development**
(ref: Nash, 1997; *Early Years Study*, 1999; Shonkoff, 2000.)

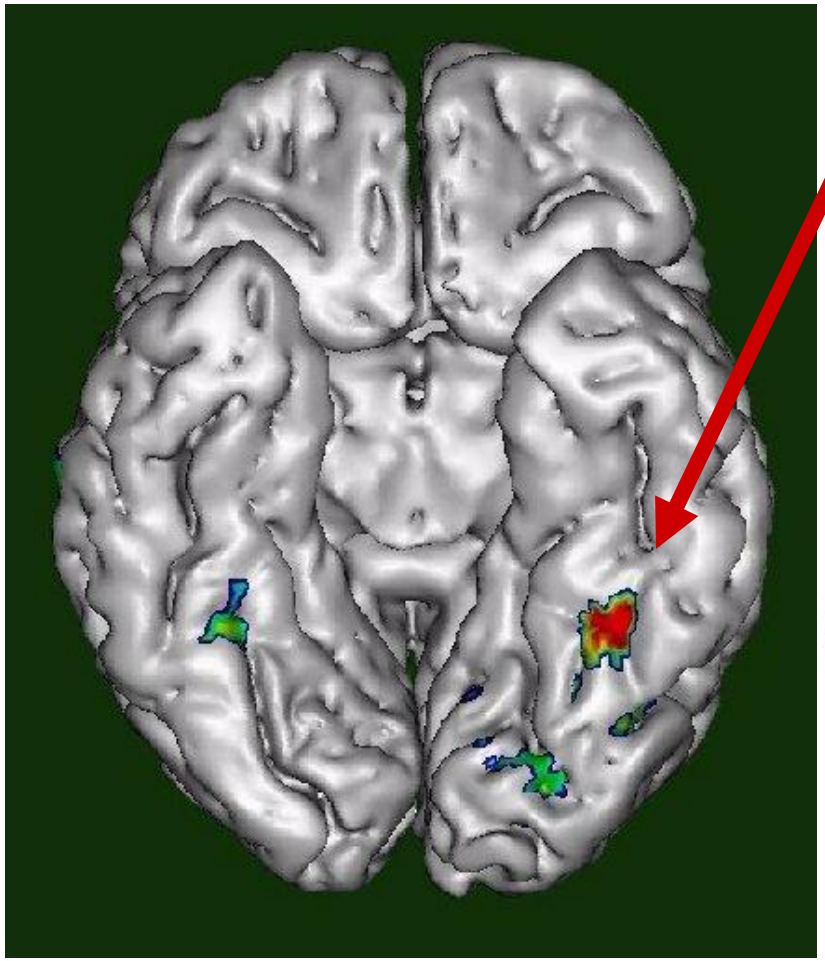

3 year old child
normal
extreme neglect

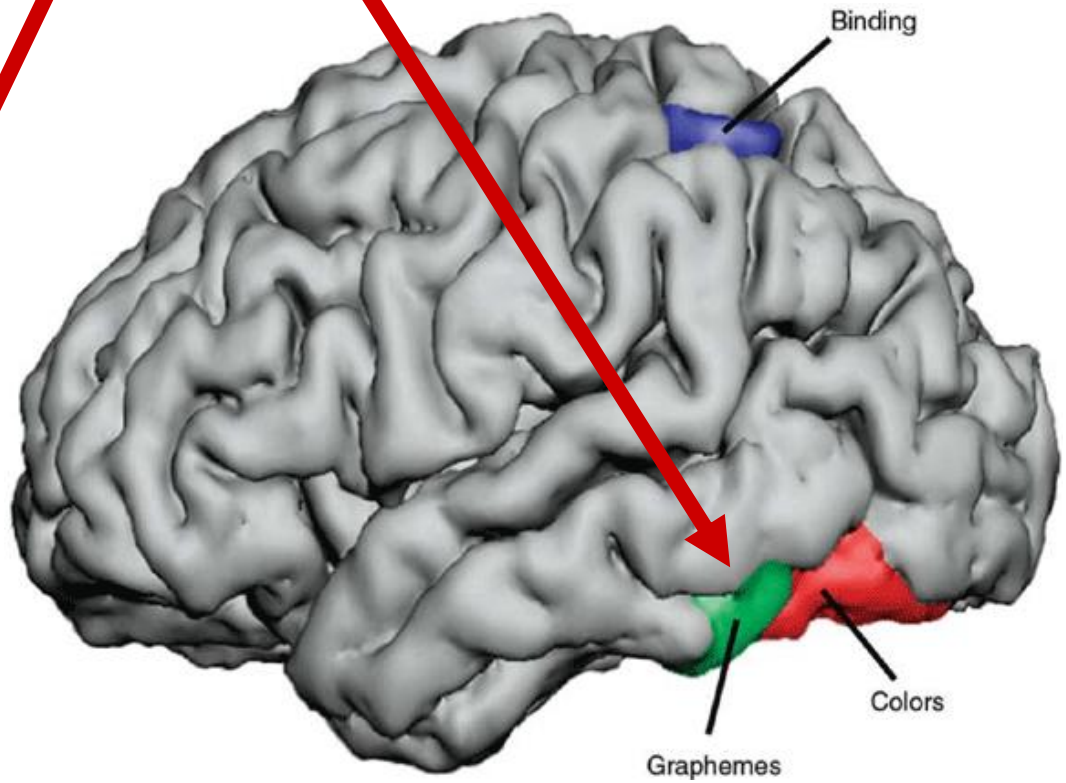

Mirror Neurons
Executed Reaching
Observed Reaching
dorsal
posterior
lateral
medial
p = 0.005

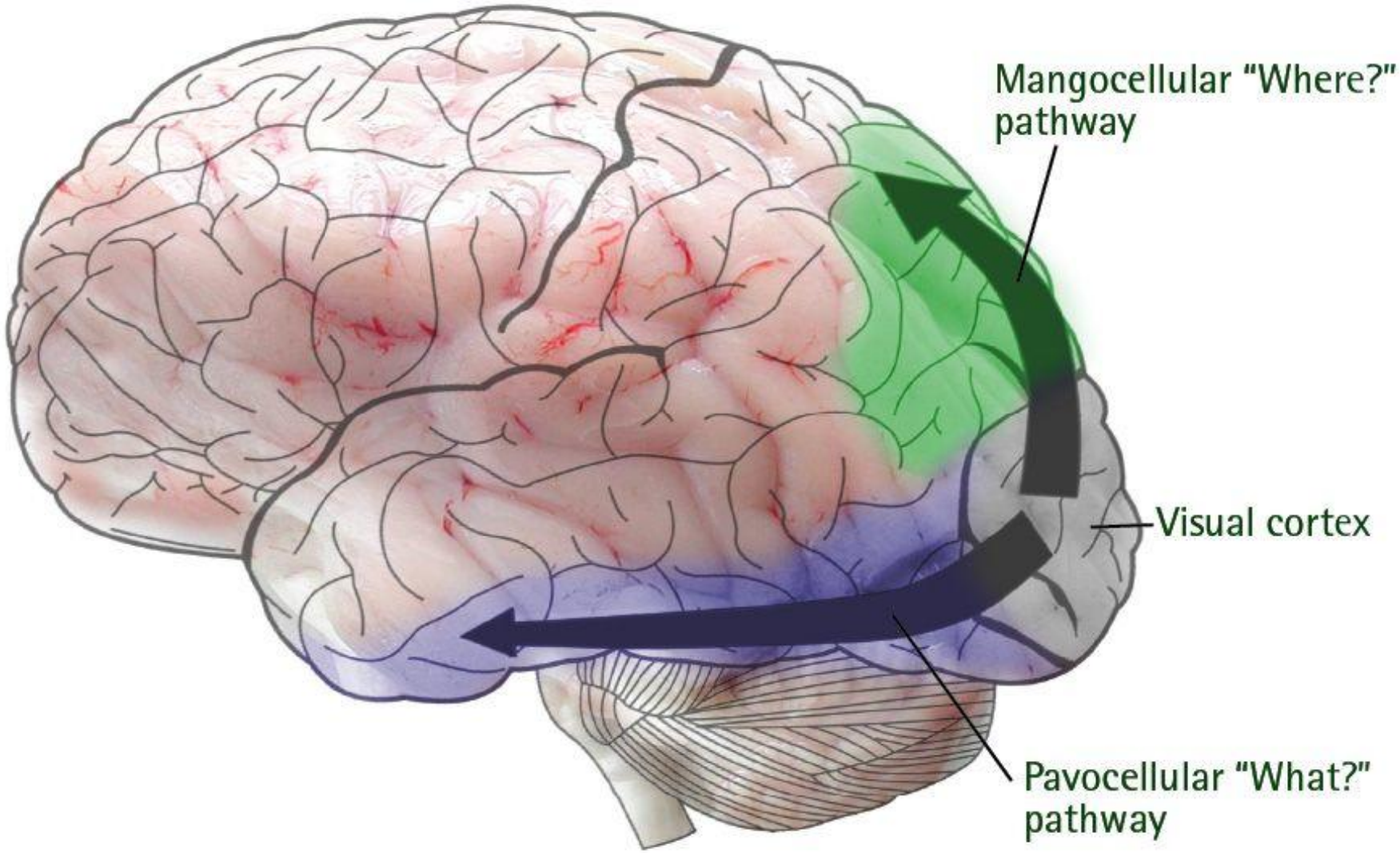

Pianists Listening
Pianists Playing
Nonmusicians Listening
Nonmusicians Playing

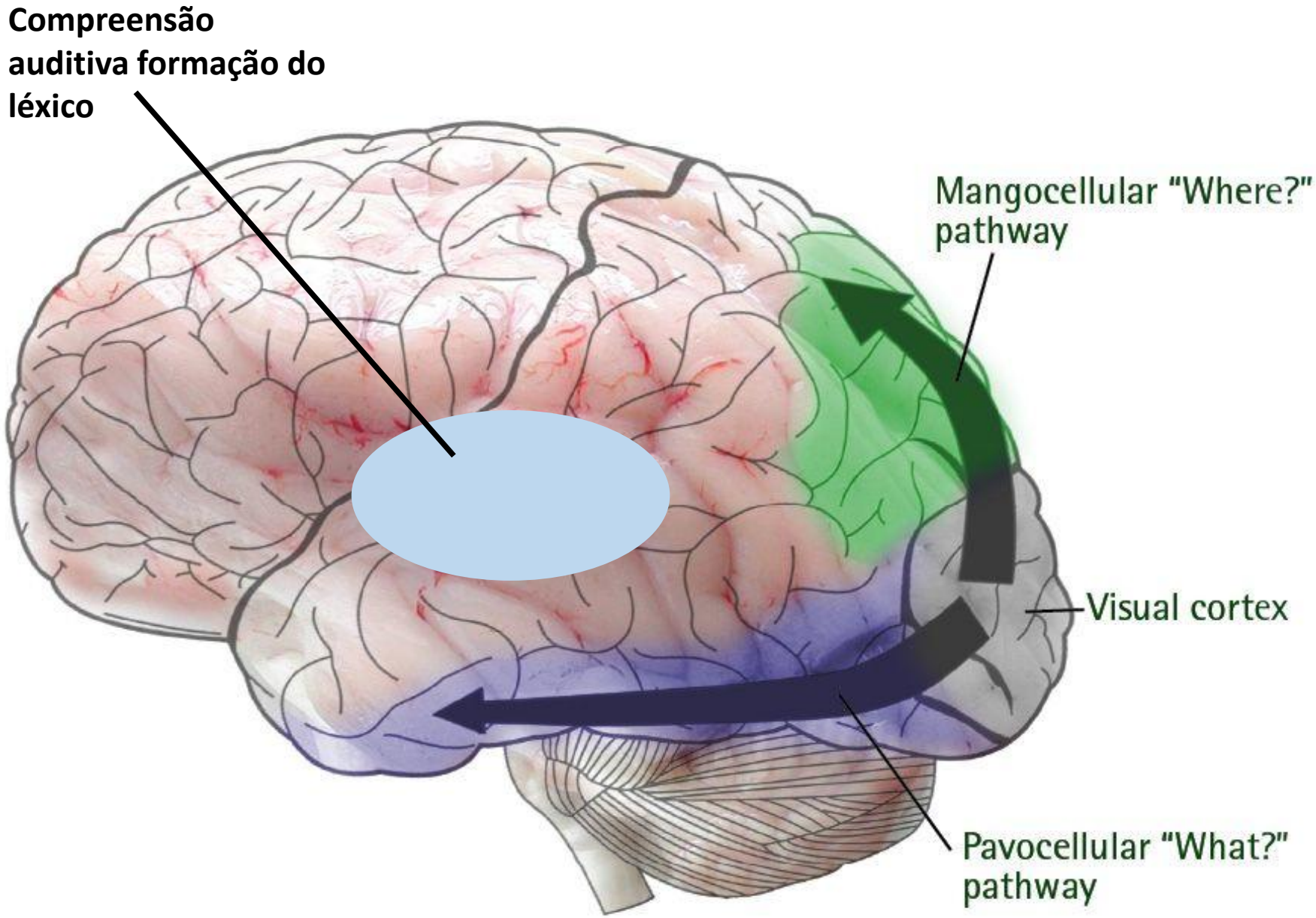

A
BASELINE
DAY 3
DAY 5
Trained hand
Untrained hand
< 50
MEP amplitude (% of max.)
100
Before practice
20' after practice
B
WEEK 1
WEEK 2
WEEK 3
WEEK 4
WEEK 5
Monday (before practice)
Friday (after practice)
100
MEP amplitude (% of max.)
< 50
C
Physical practice
Mental practice
60
Probability (%)
100
2 cm
DAY 1
DAY 2
DAY 3
DAY 4
DAY 5

ÁREA DA FORMA VISUAL DA PALAVRA (VISUAL WORD FORM AREA)

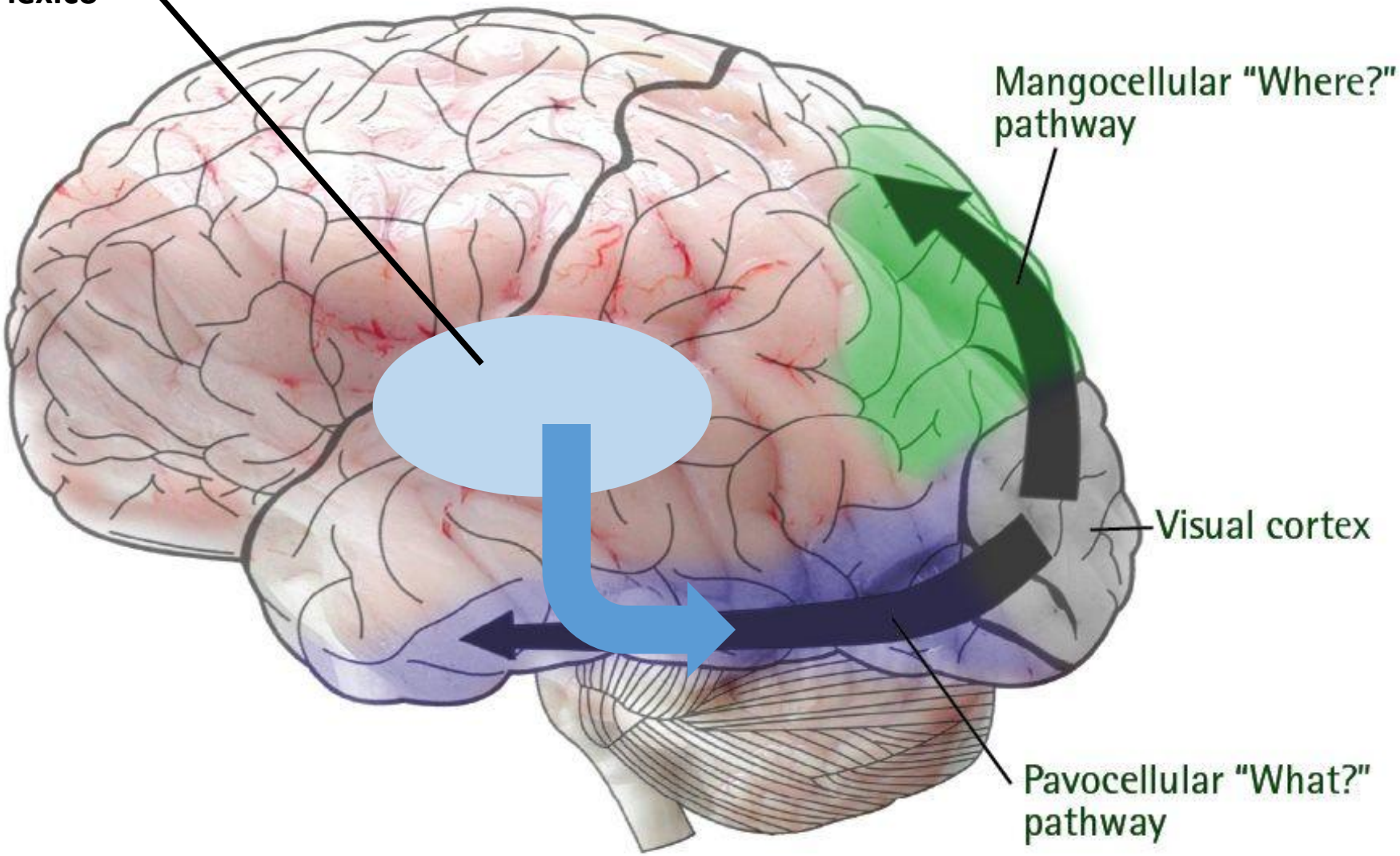


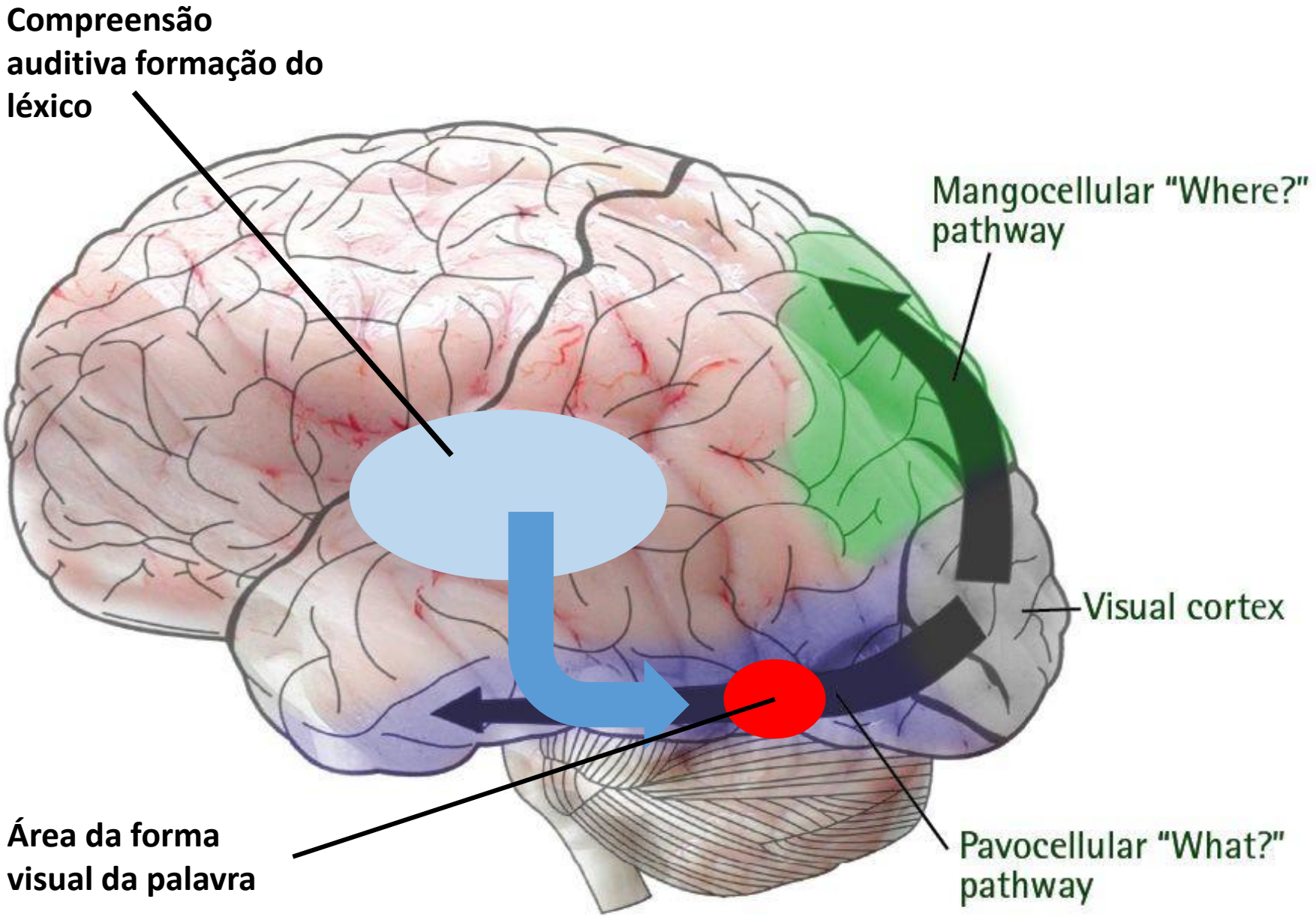



Mangocellular "Where?" pathway
Visual cortex
Pavocellular "What?" pathway

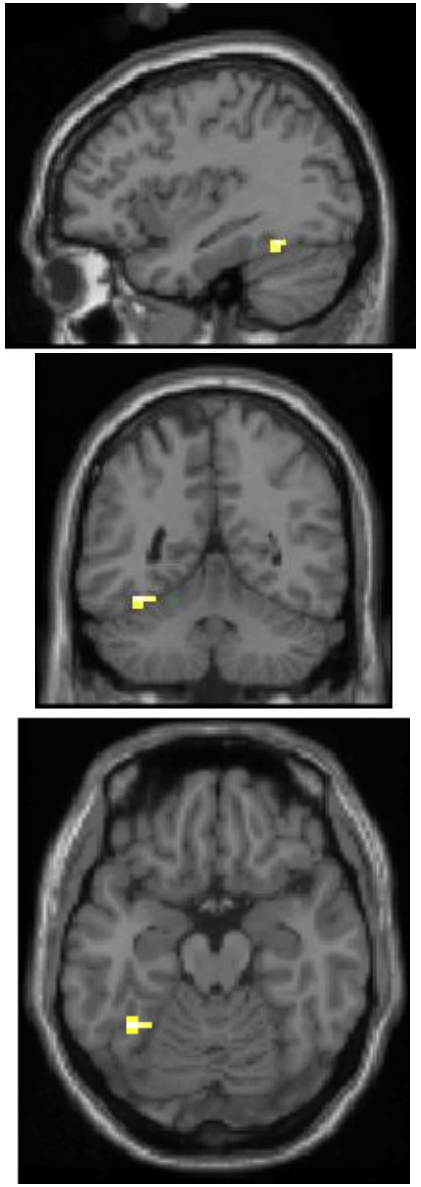

Compreensão auditiva formação do léxico
Mangocellular "Where?" pathway
Visual cortex
Pavocellular "What?" pathway

Compreensão auditiva formação do léxico

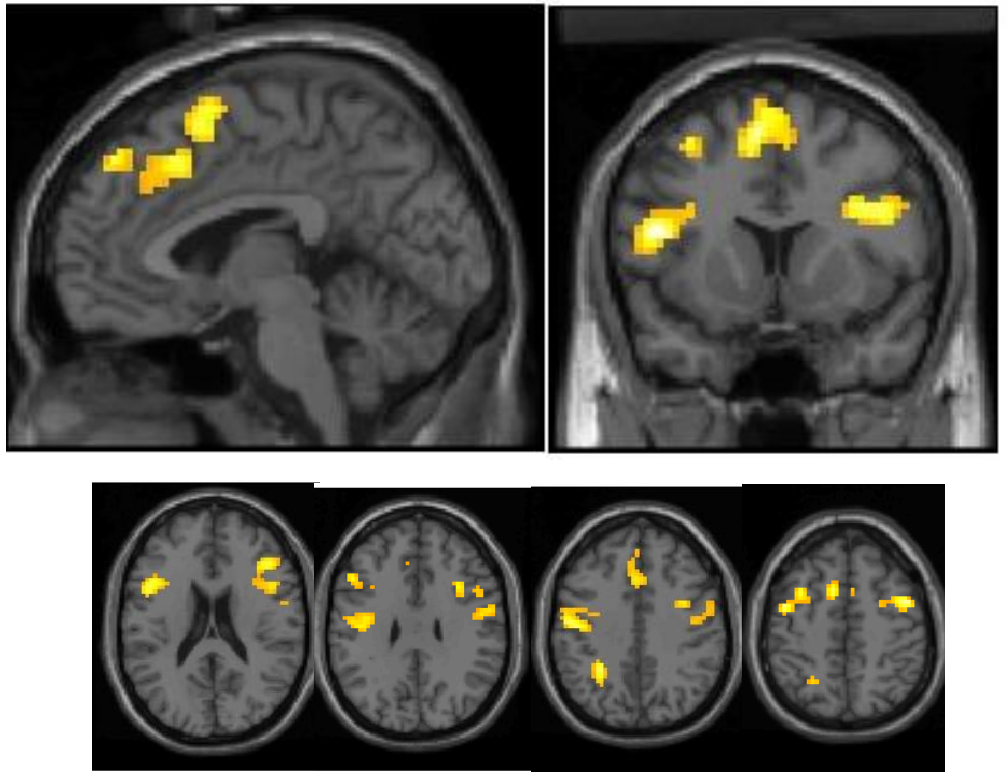



Compreensão auditiva formação do léxico
Mangocellular "Where?" pathway
Visual cortex
Área da forma visual da palavra
Pavocellular "What?" pathway

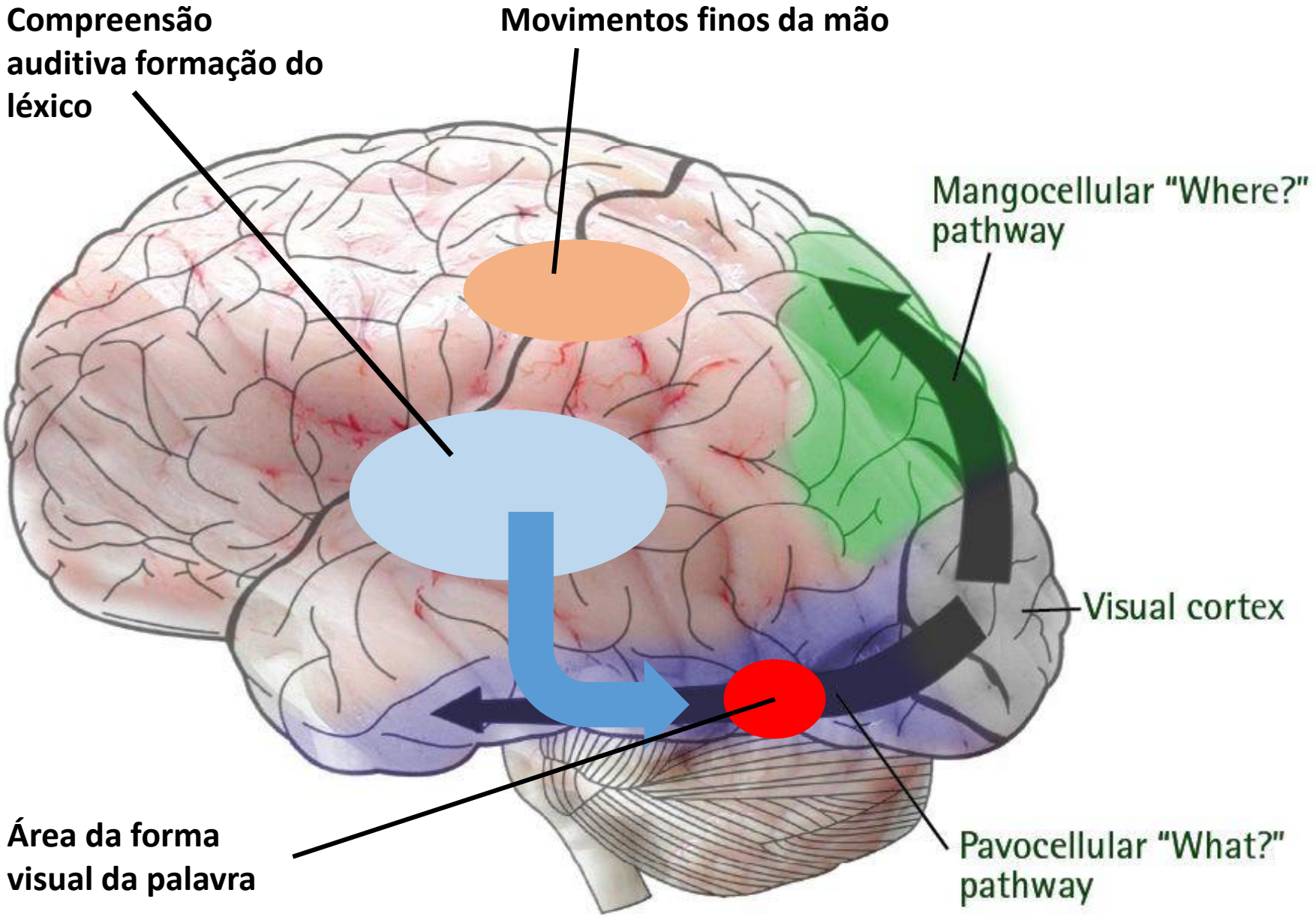
CONTROLS

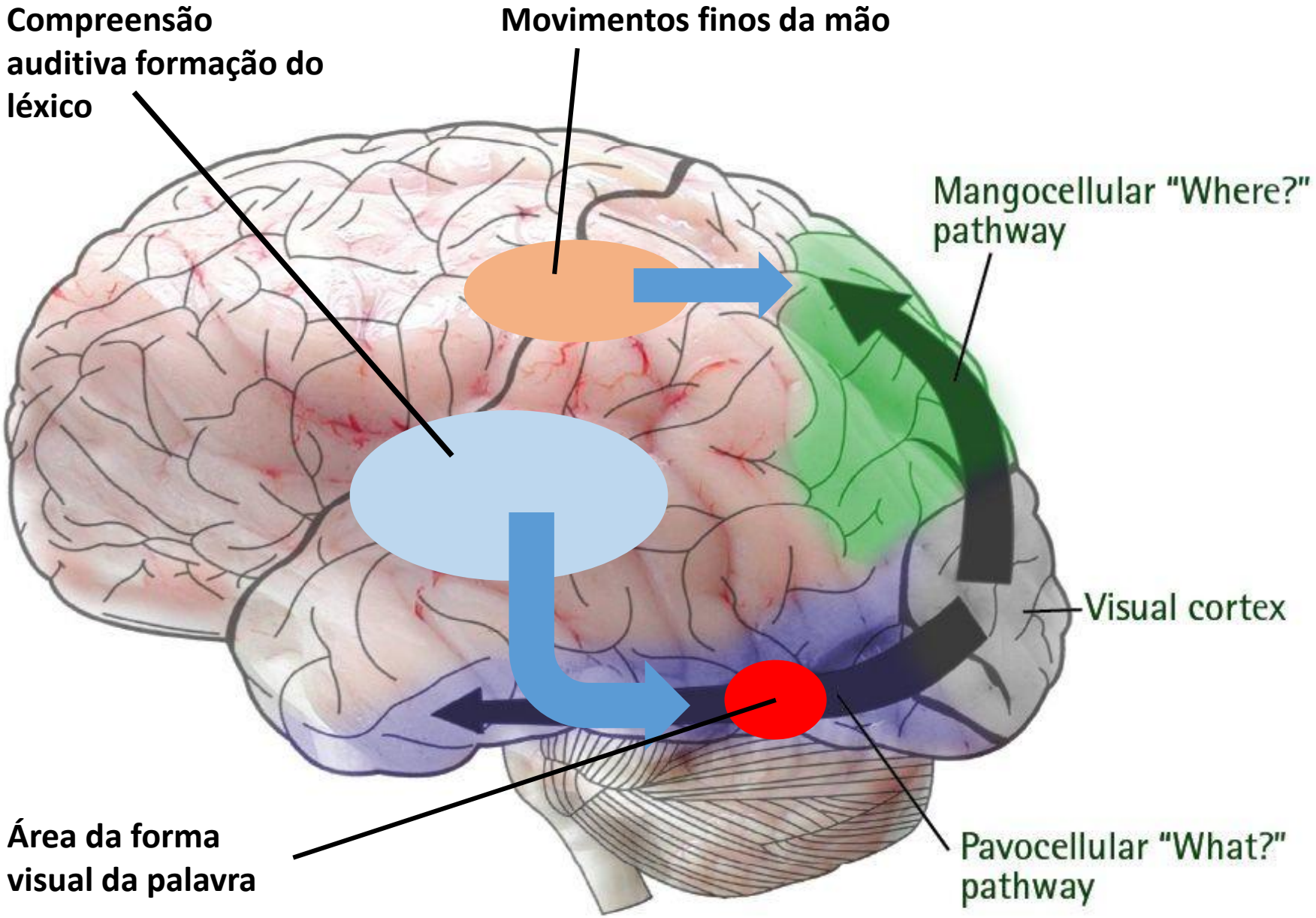


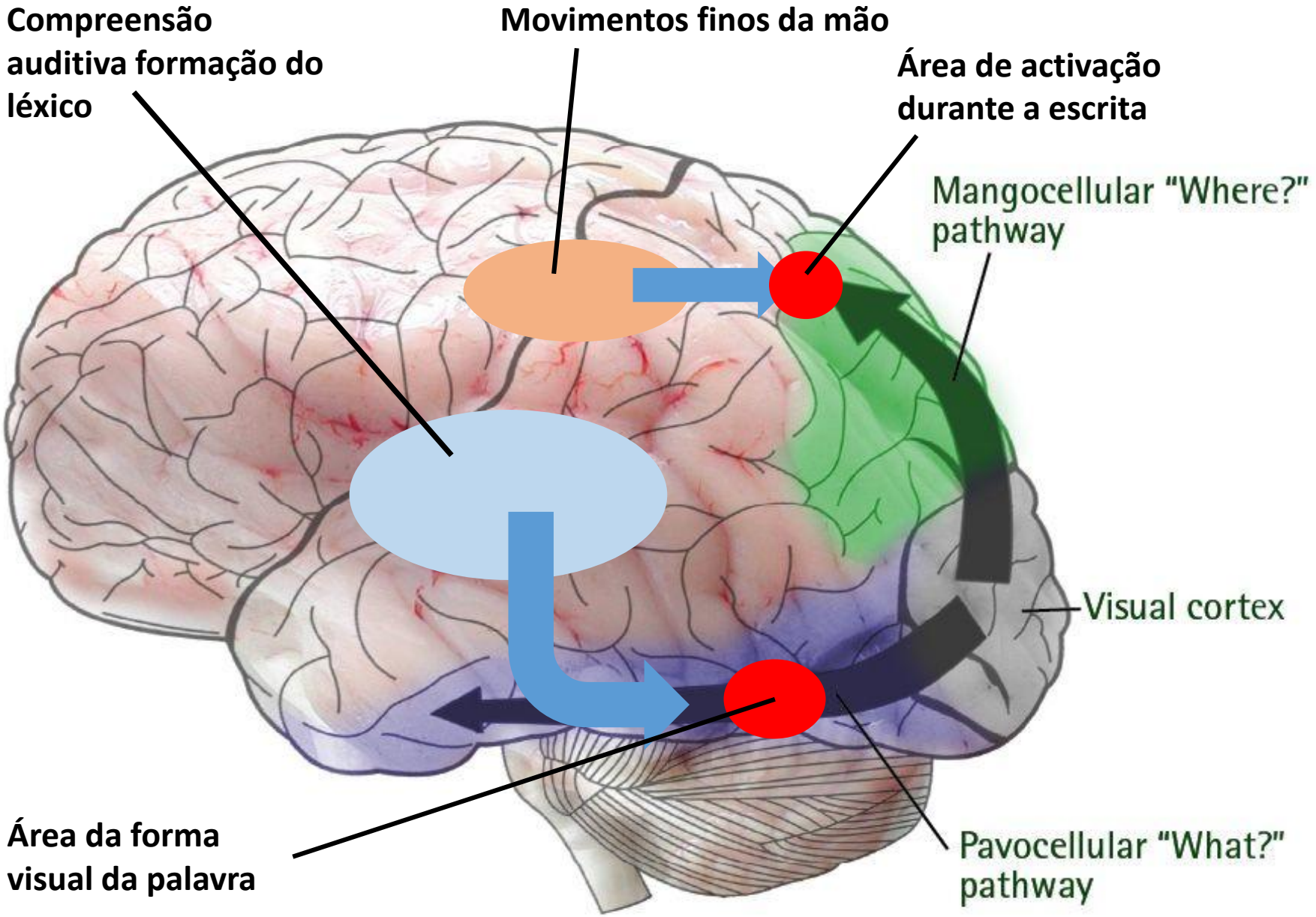
EX ILLITERATES



READING WORDS

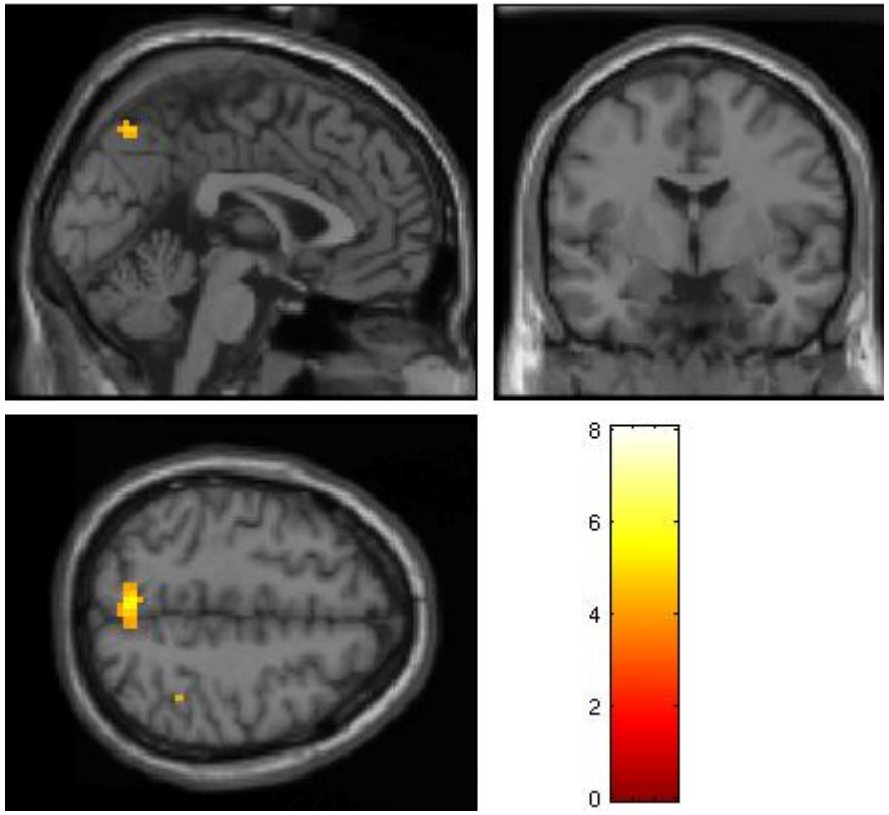

Compreensão auditiva formação do léxico
Movimentos finos da mão
Mangocellular "Where?" pathway
Visual cortex
Área da forma visual da palavra
Pavocellular "What?" pathway


Compreensão auditiva formação do léxico
Movimentos finos da mão
Mangocellular "Where?" pathway
Visual cortex
Área da forma visual da palavra
Pavocellular "What?" pathway


Compreensão auditiva formação do léxico
Movimentos finos da mão
Área de activação durante a escrita
Mangocellular "Where?" pathway
Visual cortex
Área da forma visual da palavra
Pavocellular "What?" pathway

WRITING WITH THE RIGHT HAND

EX-ILLITERATES



CONTROLS