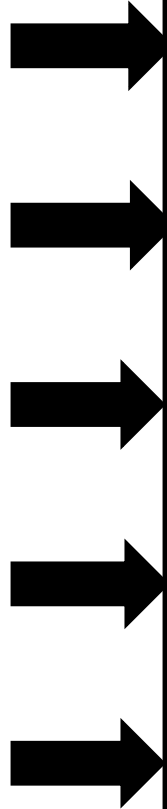
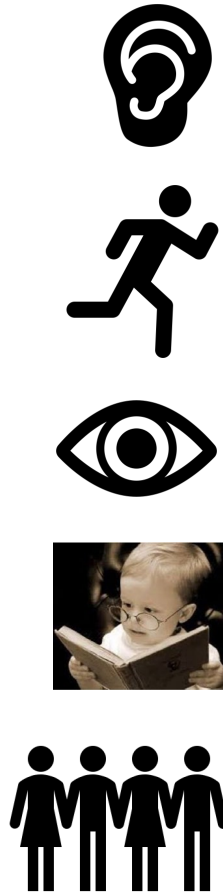


Excitation/Inhibition, le bon équilibre pour apprendre et réapprendre

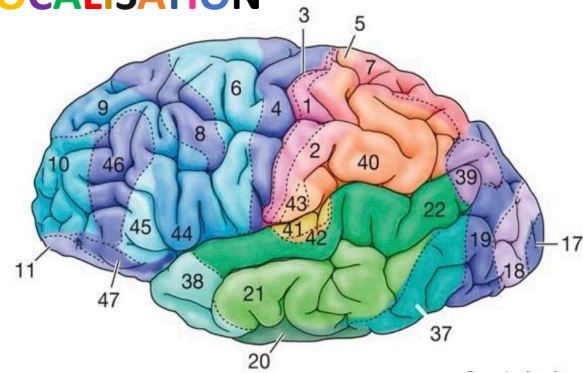
Colloque de Rentrée du Collège de France

Octobre 2023

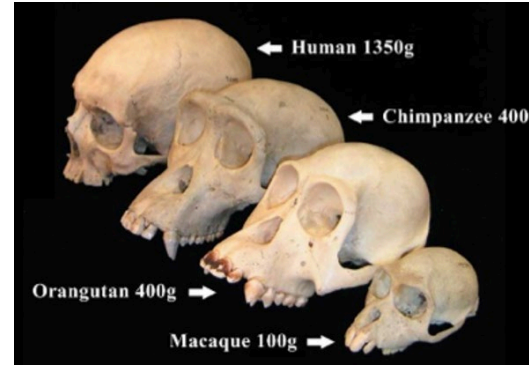
Apprendre



LOCALISATION

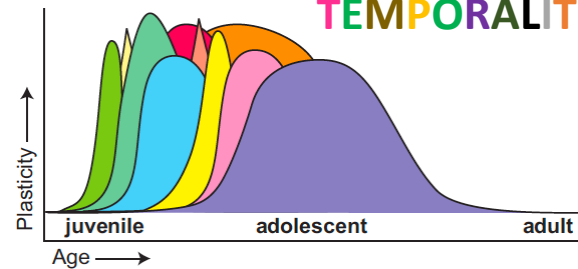


EVOLUTION

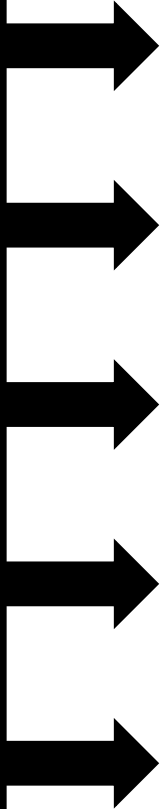


GUERISON ?
Mêmes outils ?

TEMPORALITE



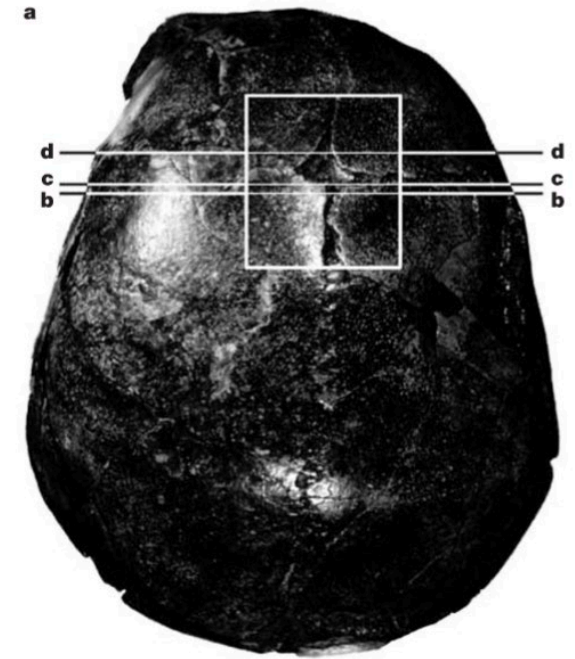
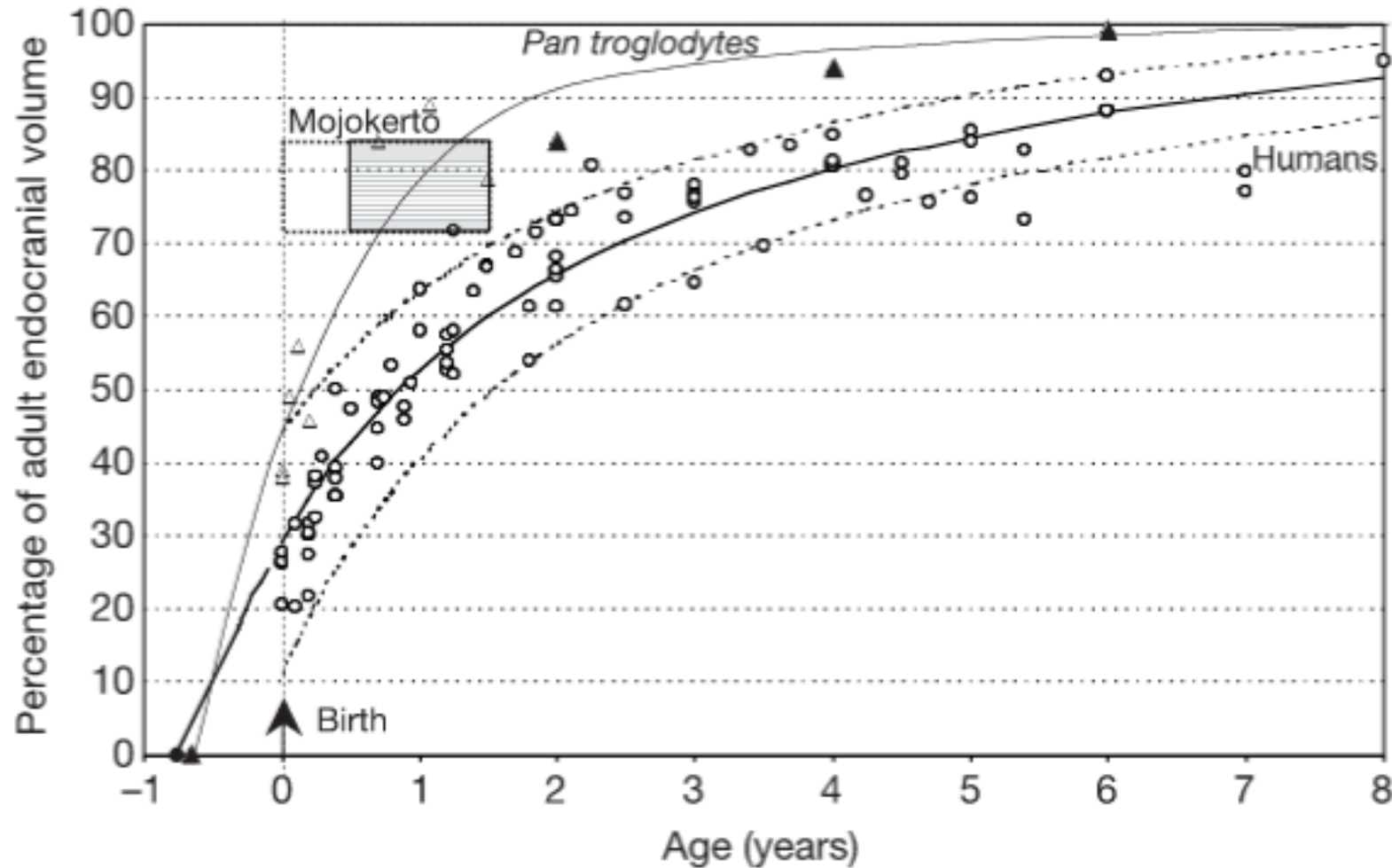
Mécanismes: semblables ou différents ?



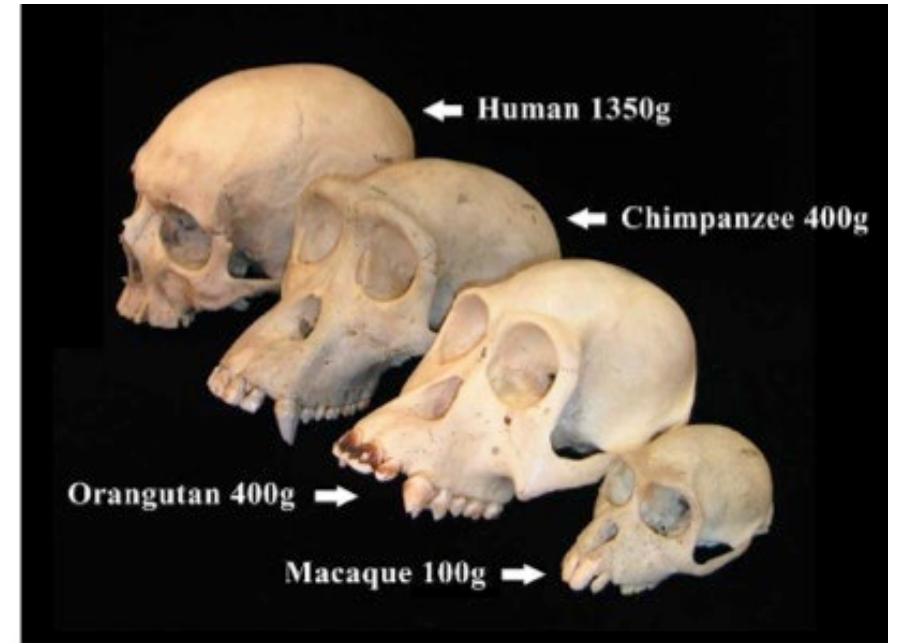
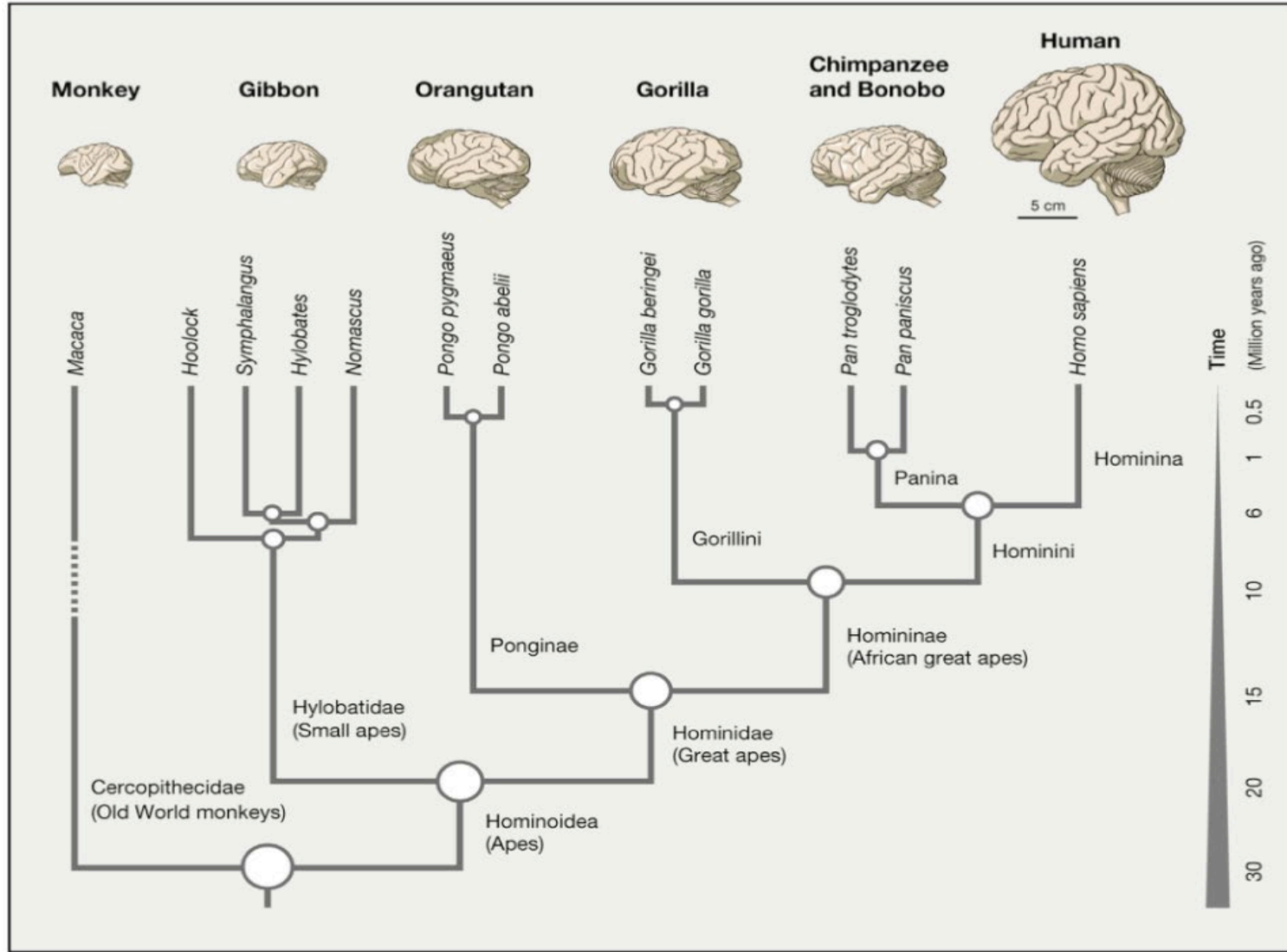
Early brain growth in *Homo erectus* and implications for cognitive ability.

Coqueugniot H, Hublin JJ, Veillon F, Houët F, Jacob T.

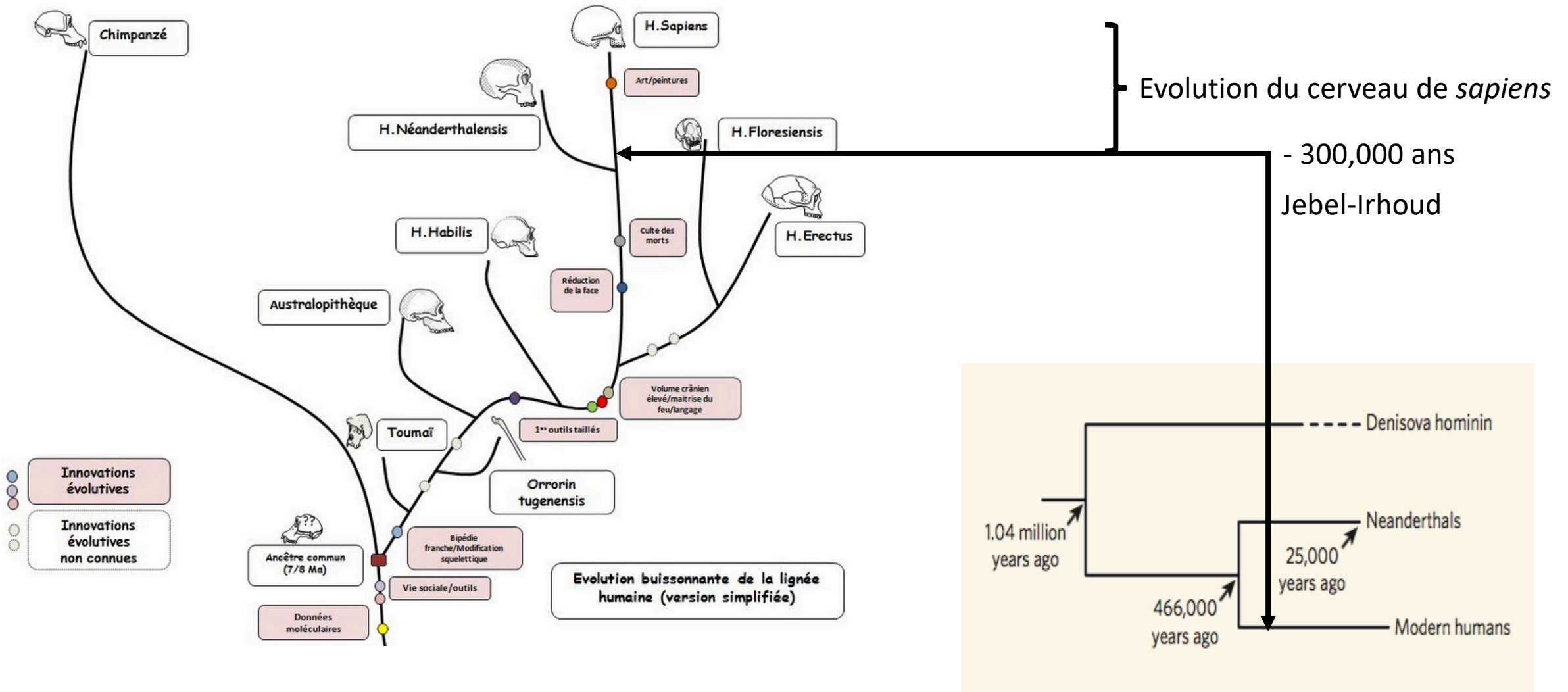
Nature. 2004 Sep 16;431(7006):299-302. doi: 10.1038/nature02852.



A environ 1 an, le jeune erectus (1, 8 millions d'années) a un cerveau qui atteint de 72 à 84% de celui de l'adulte, très proche des grands singes, contre 25% à la naissance et 50% à 1 an pour *sapiens*



Evolution du cerveau chez les hominines



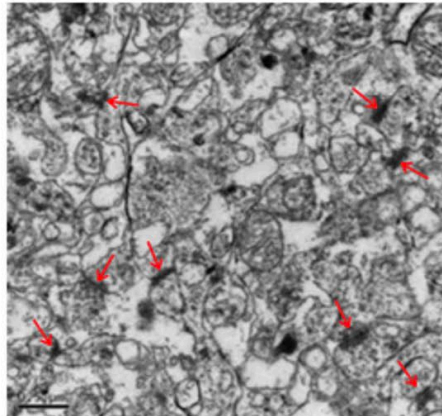
Néoténie Morphologique et Génétique du Développement Cortical Chez *Homo sapiens*

Extension of cortical synaptic development distinguishes humans from chimpanzees and macaques.

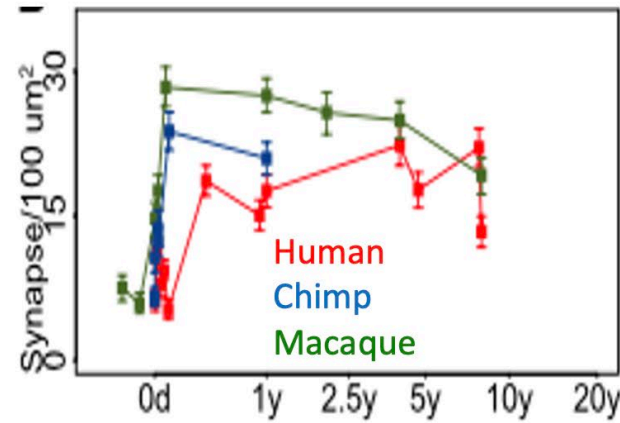
Xiling Liu et al.

Genome Research, 2012 vol. 22 (4) pp. 611-622

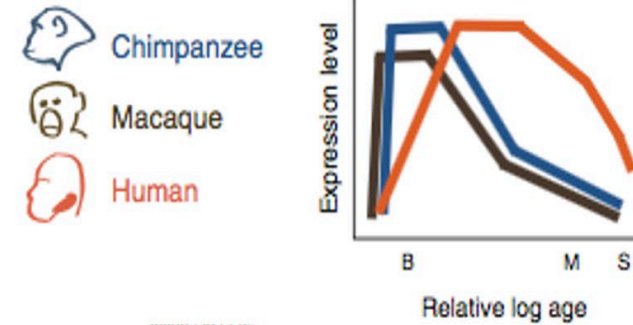
Synapses



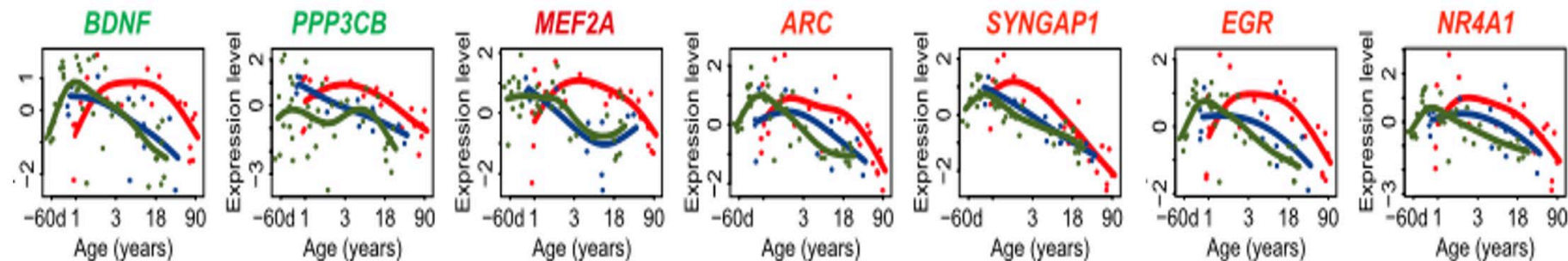
Synapses



Remodelage développemental



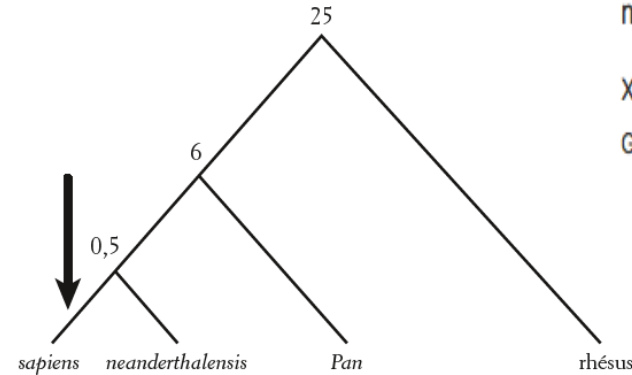
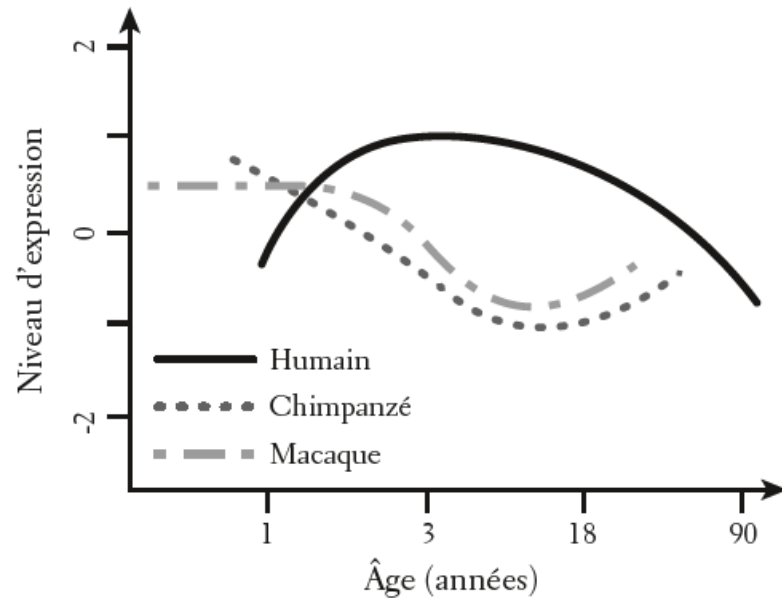
Xiling Liu et al.
Genome Research, 2012 vol. 22 (4) pp. 611-622



Avant ou Après la Séparation sapiens / neanderthalensis ?



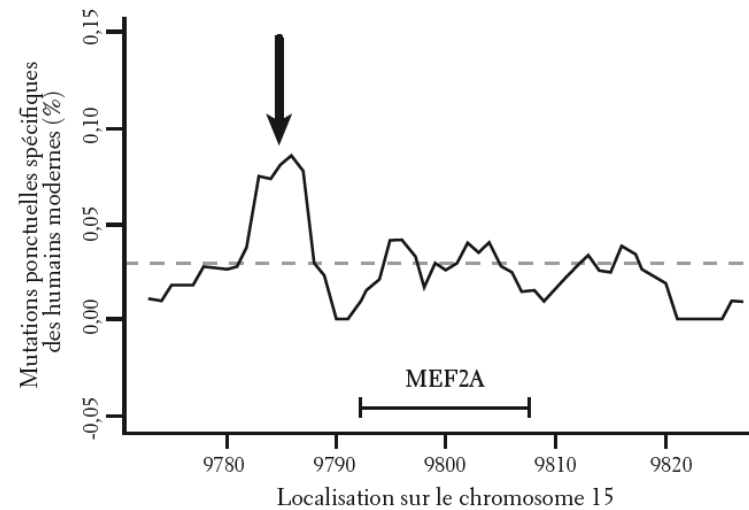
MEF2A



Extension of cortical synaptic development distinguishes humans from chimpanzees and macaques.

Xiling Liu et al.

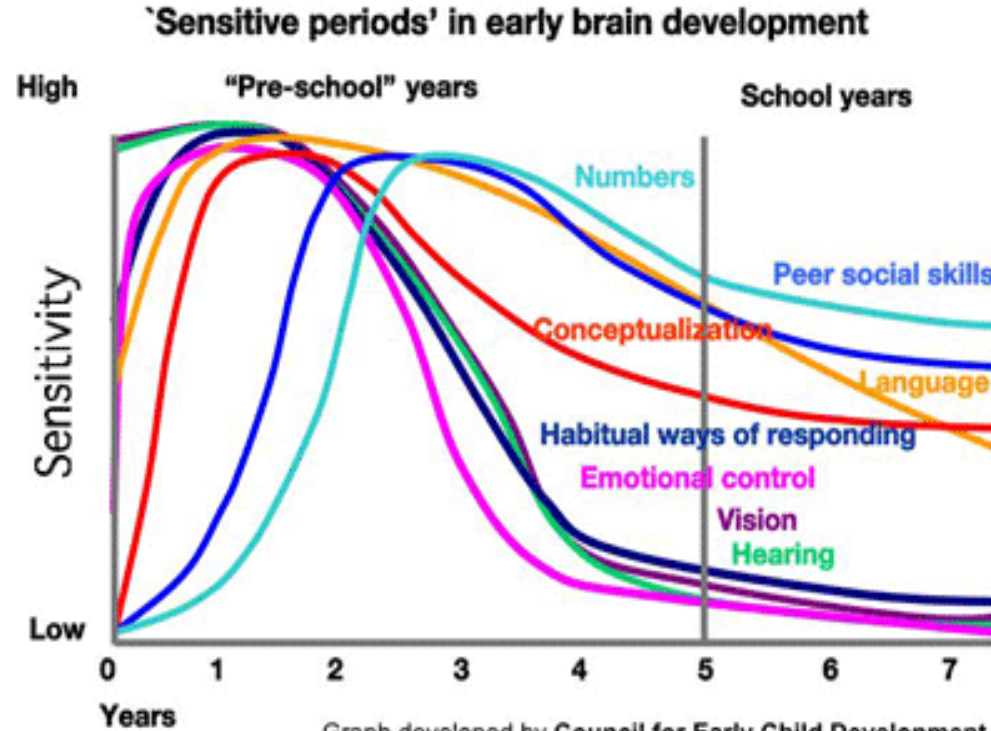
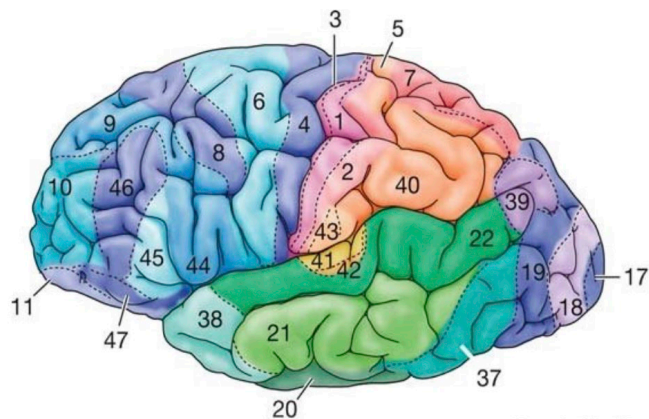
Genome Research, 2012 vol. 22 (4) pp. 611-622



Le développement neuronal continue la vie entière

Mais les périodes critiques sont les plus sensibles

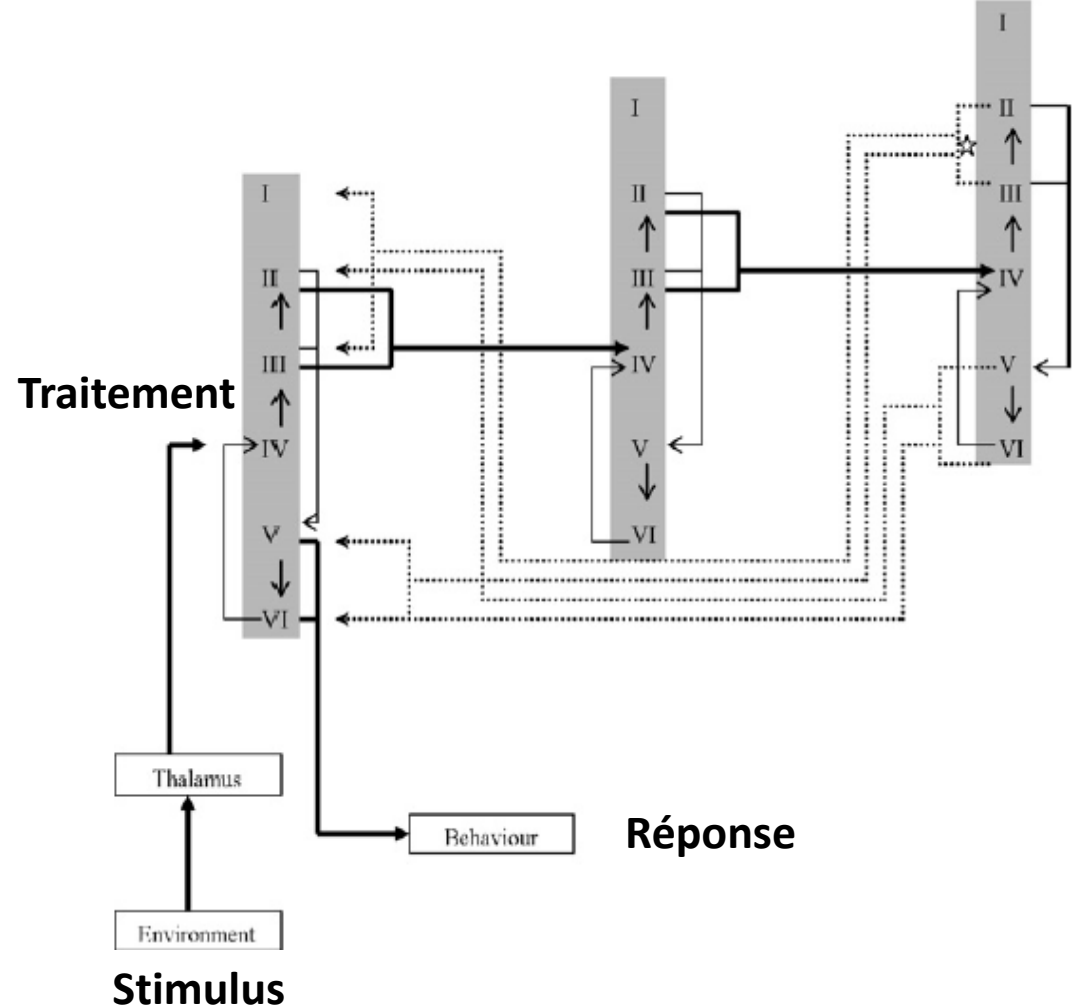
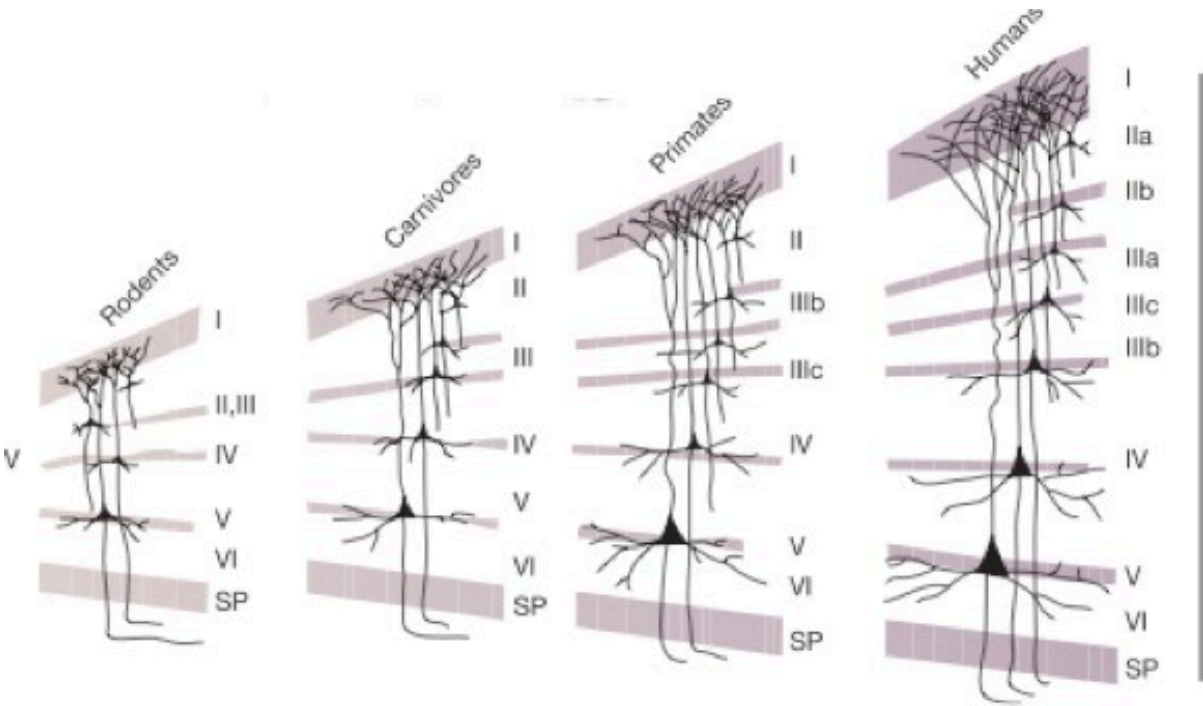
Neuroplasticité: Capacité de modifier les circuits neuronaux et les synapses en réponse à une modification de l'environnement, du comportement, des émotions, des processus cognitifs ou des atteintes à l'intégrité physique



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



Traitement de l'information environnementale (Stimulus) et Réponse



nature Vol 437 | September 2005 doi:10.1038/nature04103

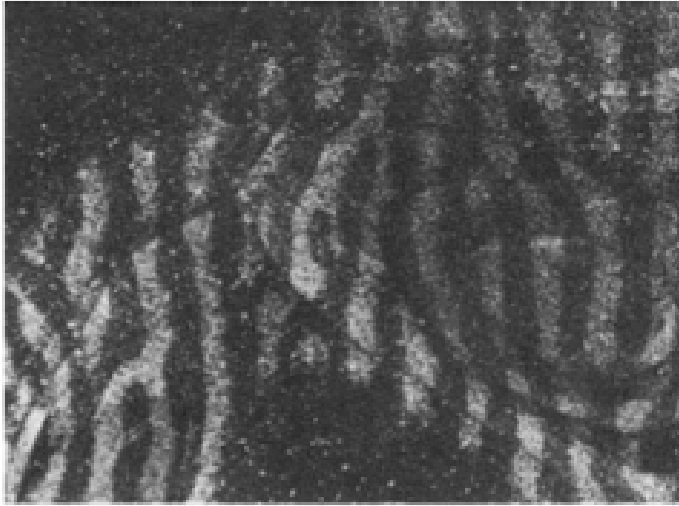
PROGRESS

Molecular insights into human brain evolution

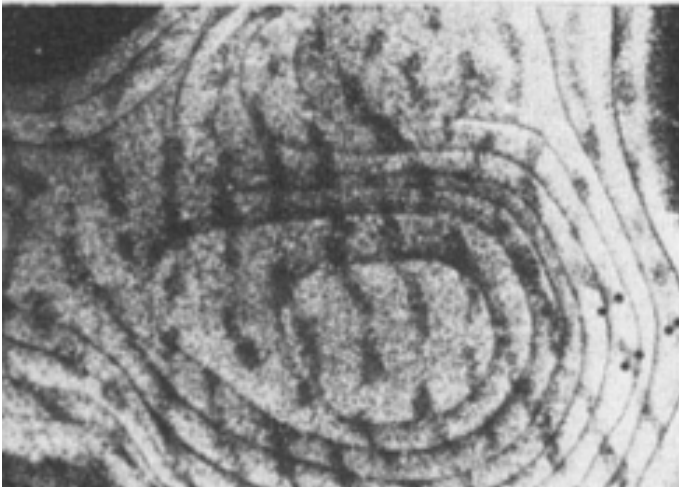
Robert Sean Hill¹ & Christopher A. Walsh¹

Plasticité du cortex visuel binoculaire

Les réseaux de neurones cérébraux et la physiologie s'adaptent à un monde monoculaire pendant une période critique du développement



Normal



After deprivation in right eye

Nature Vol. 299 14 October 1982

583

REVIEW ARTICLE

Postnatal development of the visual cortex and the influence of environment

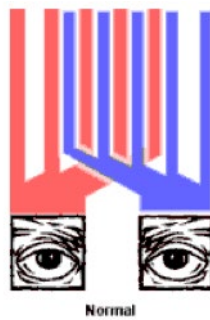
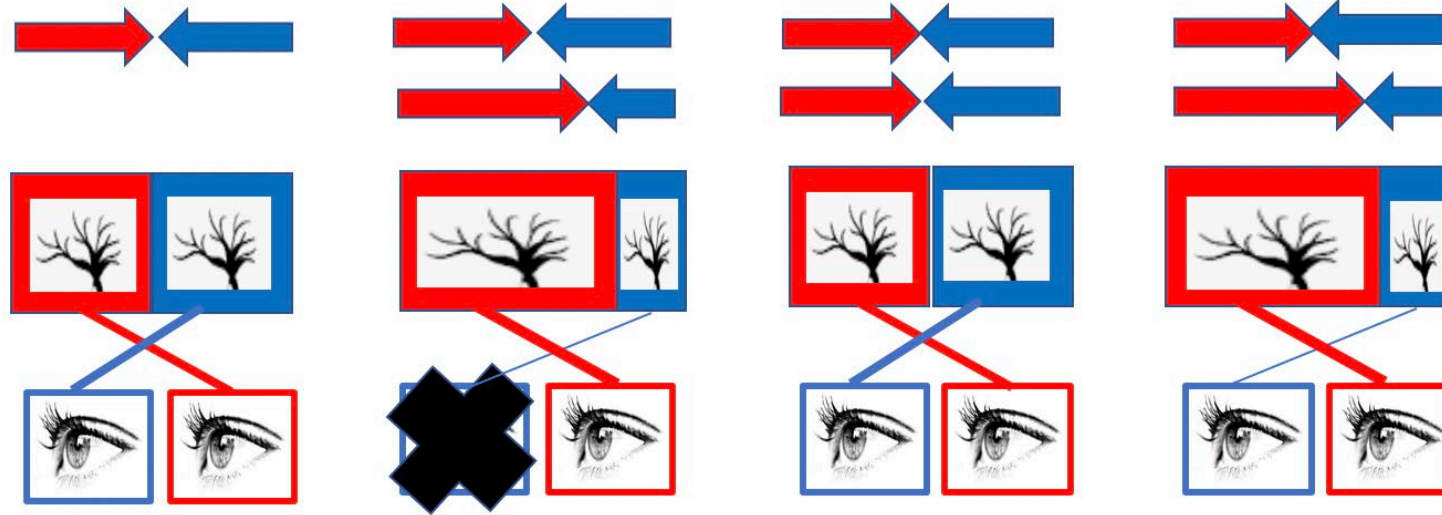
Torsten N. Wiesel*



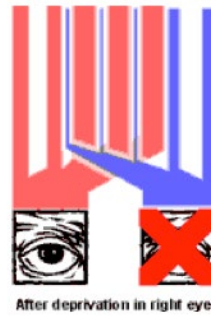
HUBEL ET WIESEL, Prix Nobel en Physiologie ou Médecine 1981

Plasticité du cortex visuel binoculaire

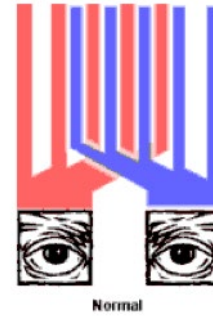
Les réseaux de neurones cérébraux et la physiologie s'adaptent à un monde monoculaire pendant une période critique du développement



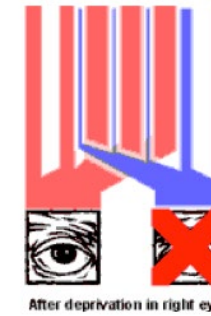
Control



Fermeture pendant CP
Amblyopie

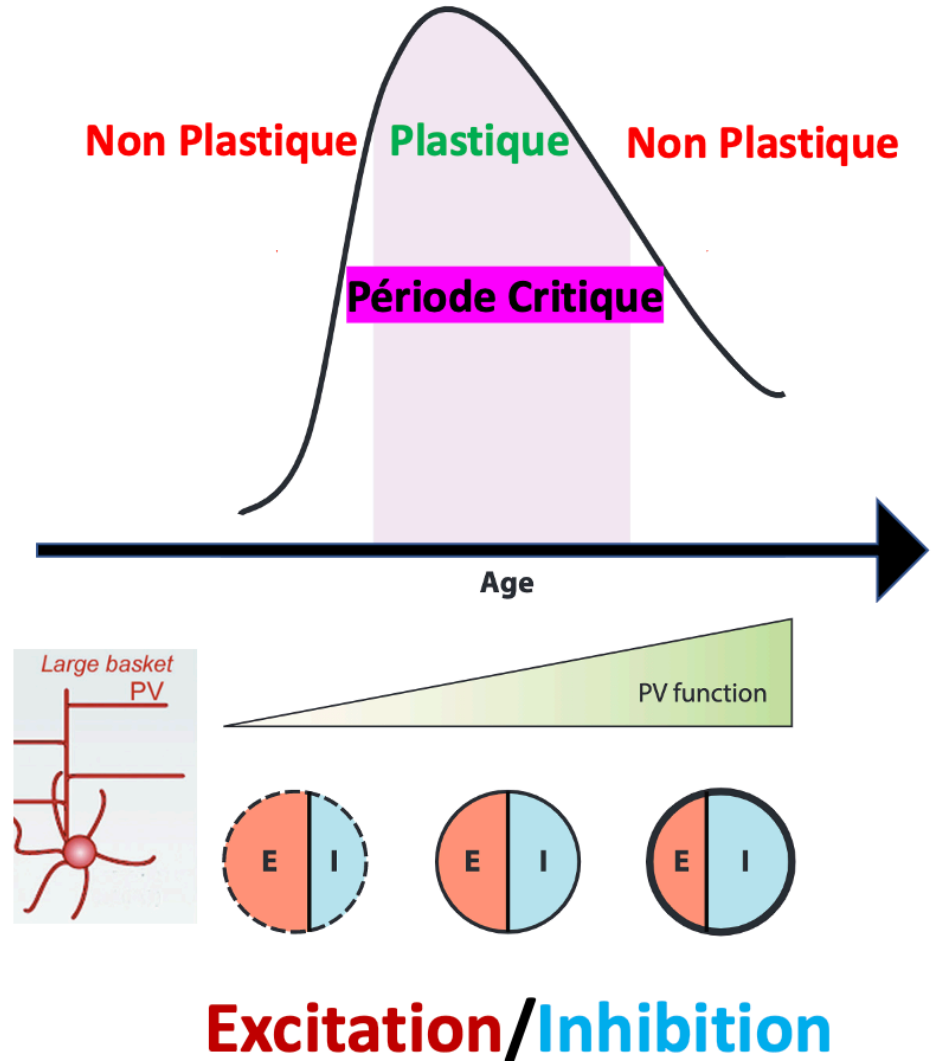
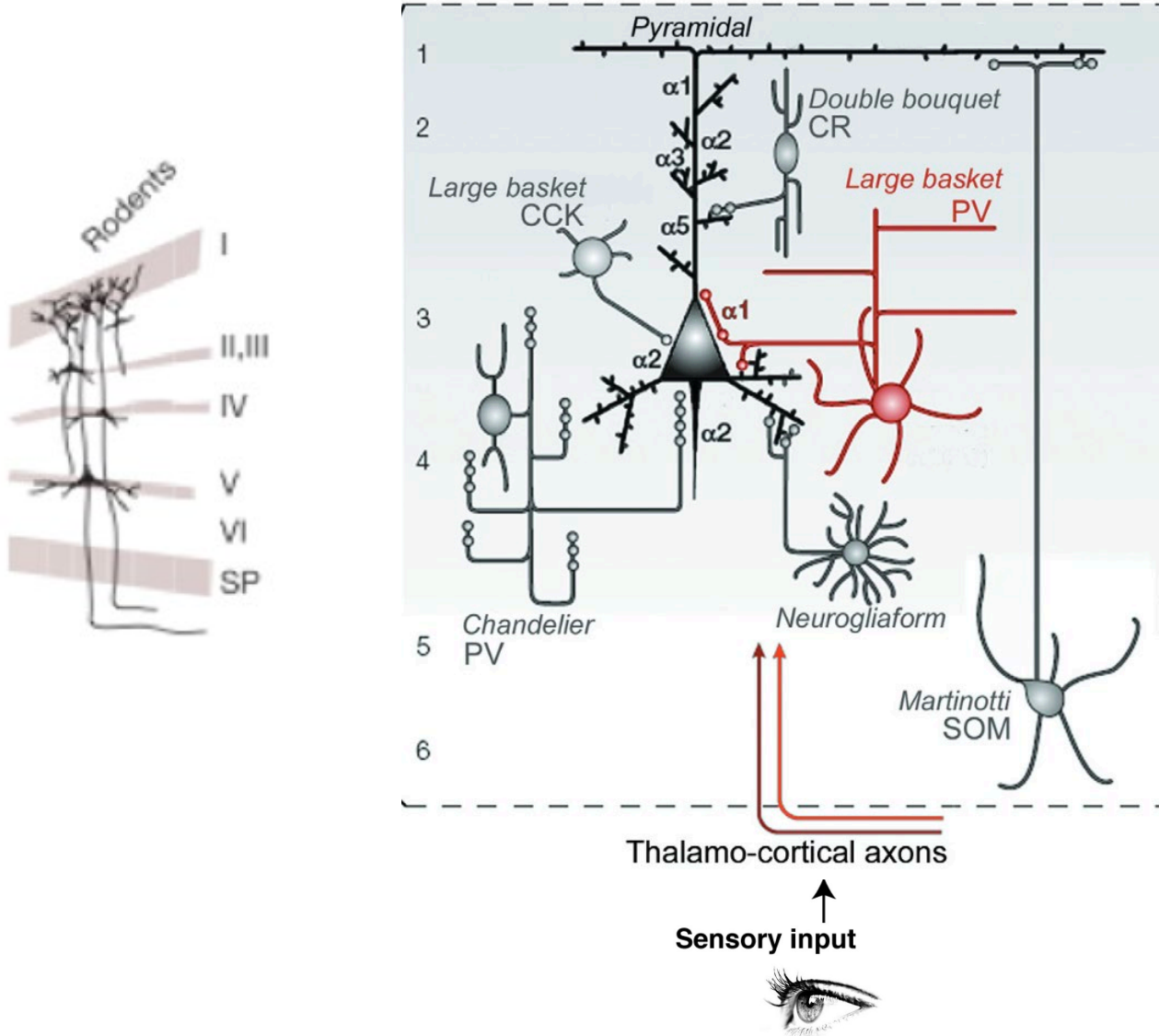


Rouverture pendant CP
Réparation

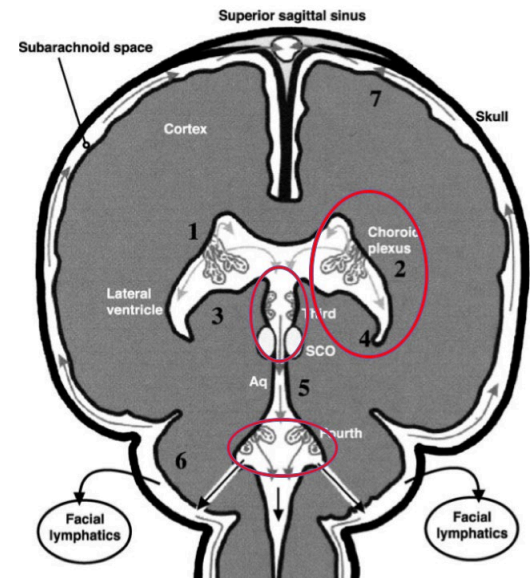


Rouverture après CP
Amblyopie

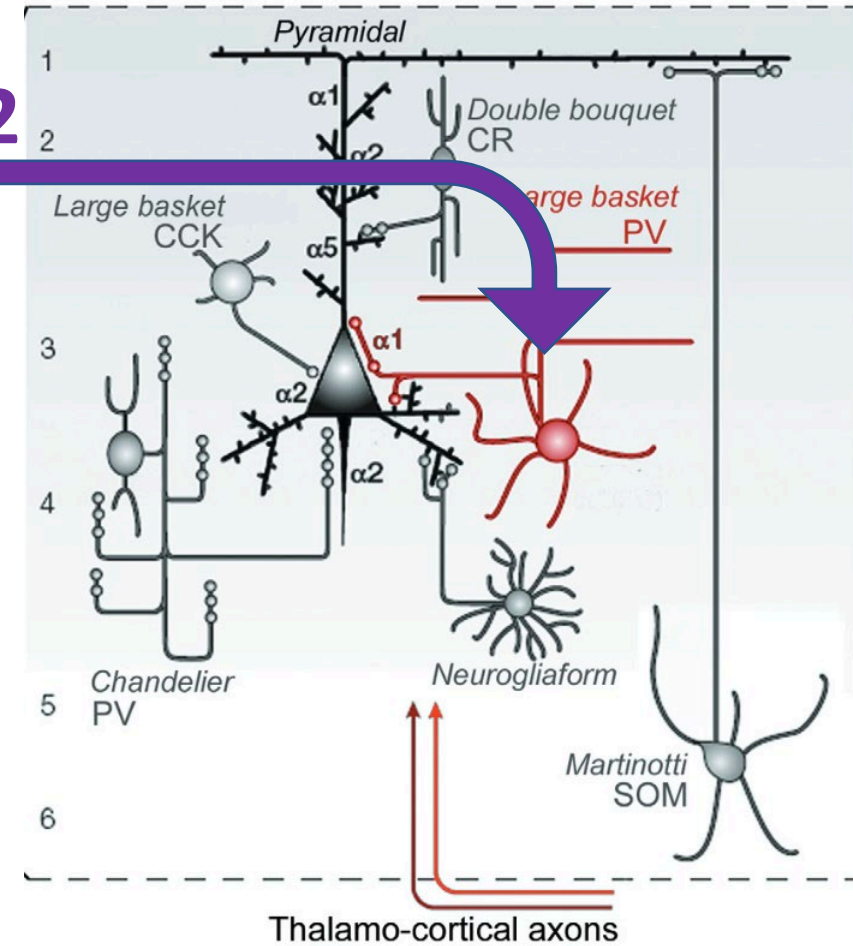
L'activité des interneurones PV inhibiteurs regule la chronologie des périodes critiques



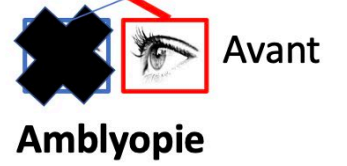
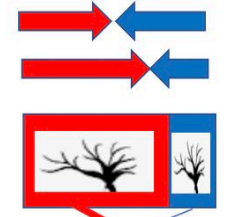
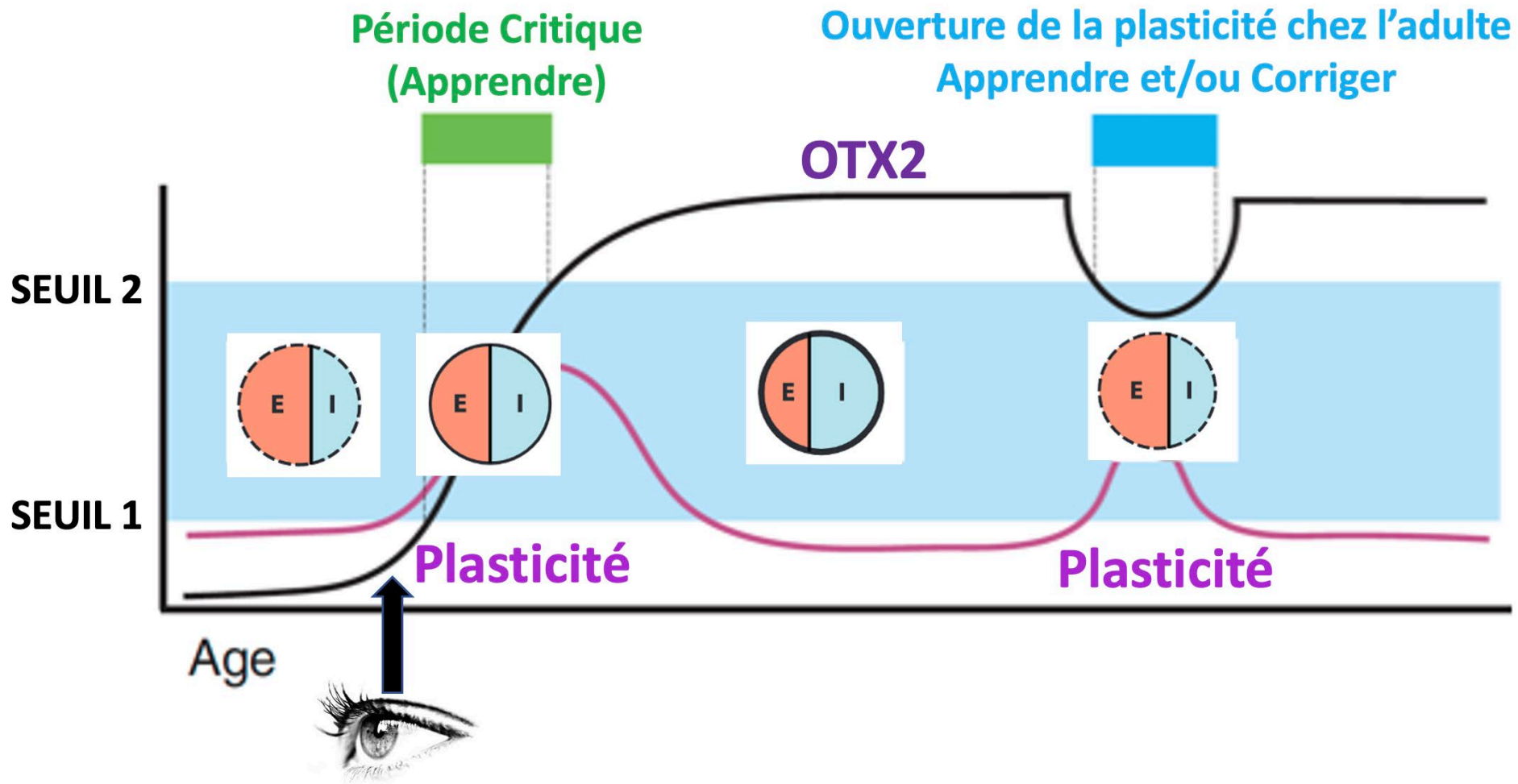
La Protéine OTX2 sécrétée par les Plexus Choroides est capturée par les Cellules PV du Cortex



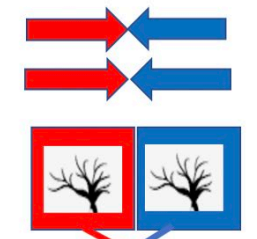
OTX2



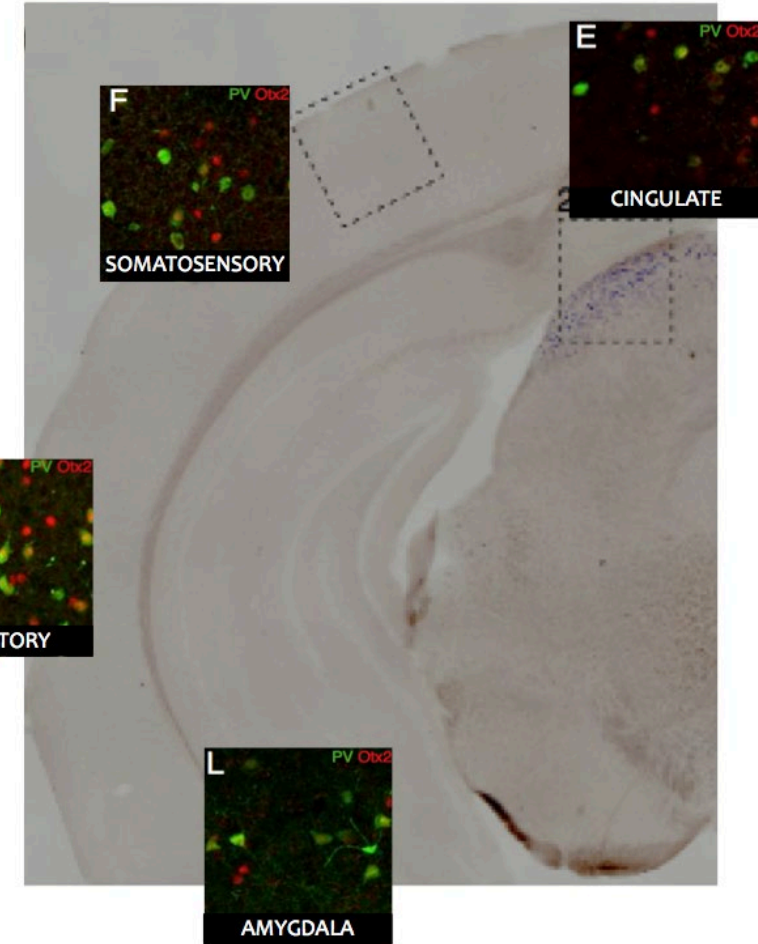
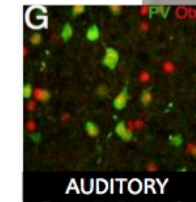
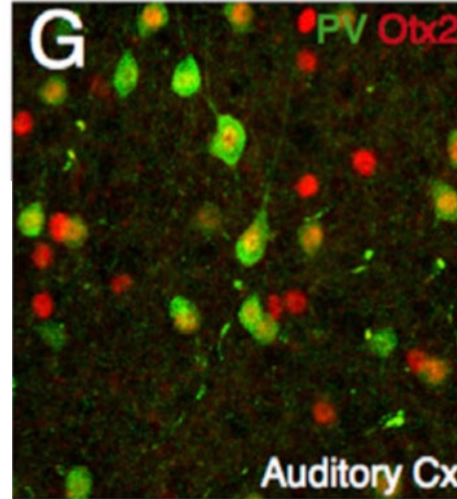
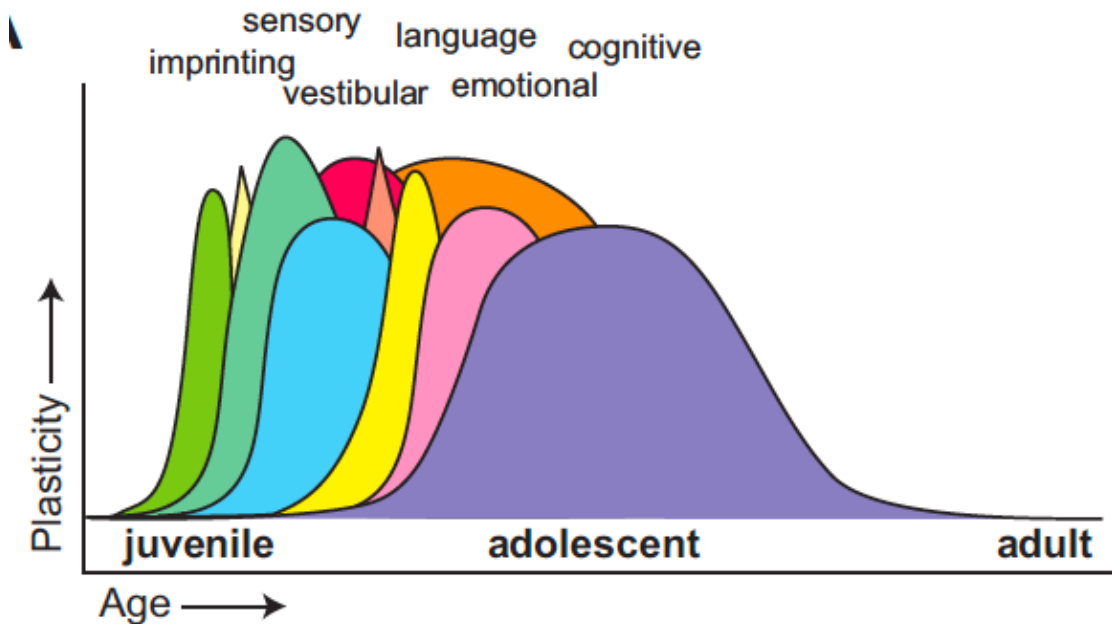
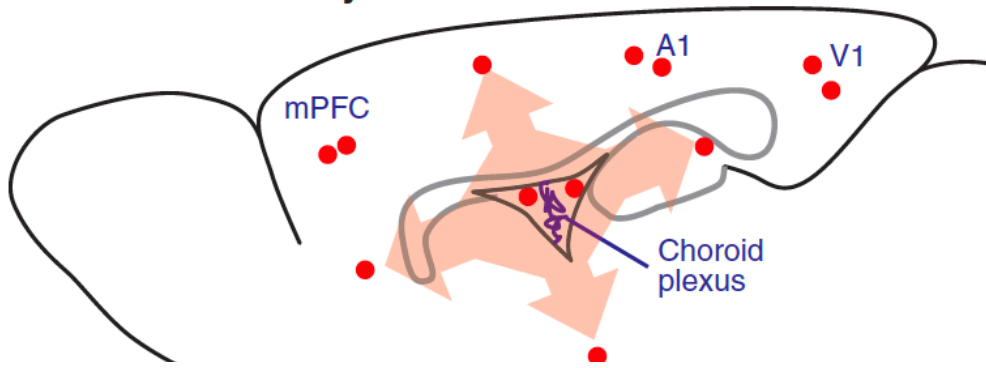
Excitation/Inhibition, Apprendre et Ré-apprendre



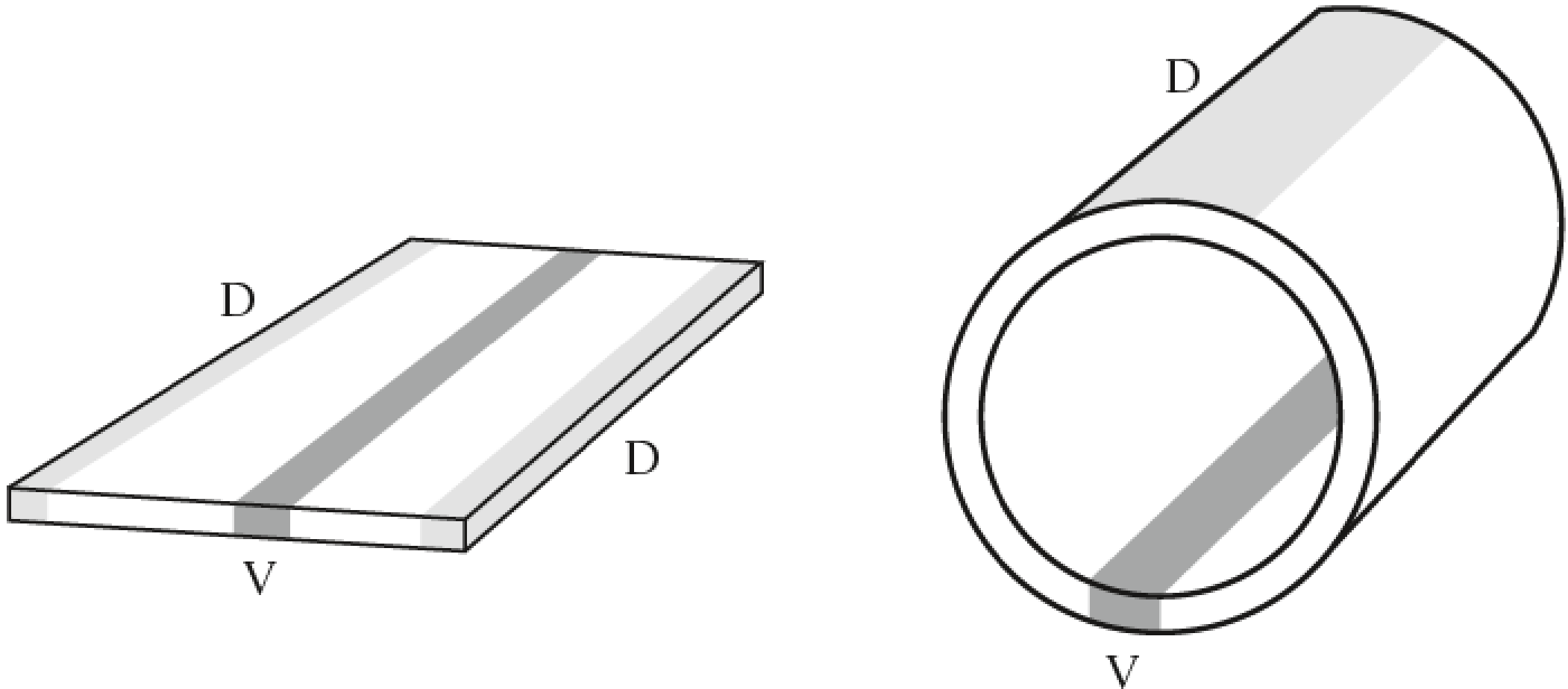
OTX2 → **OTX2**



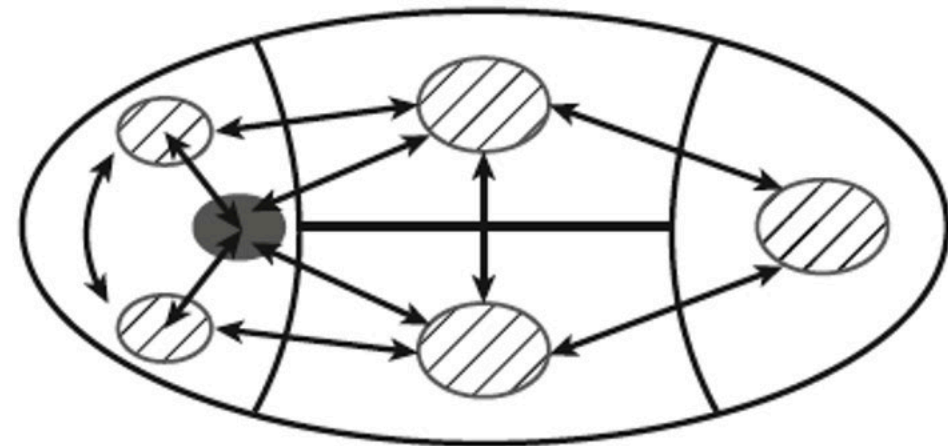
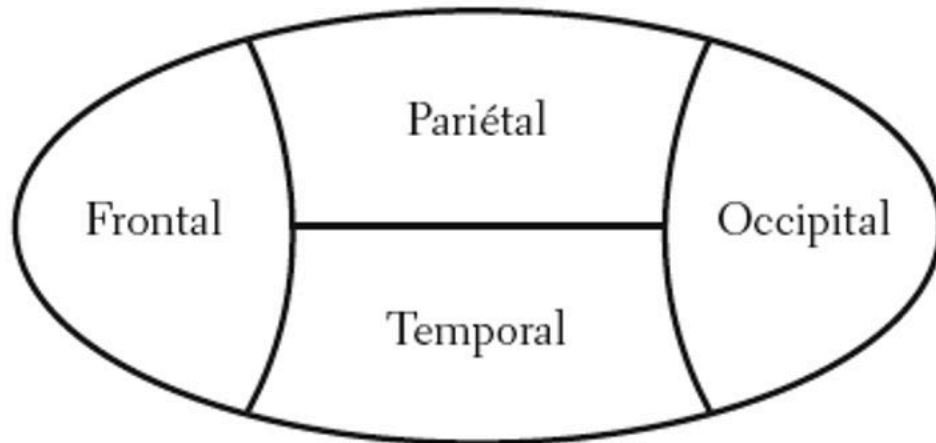
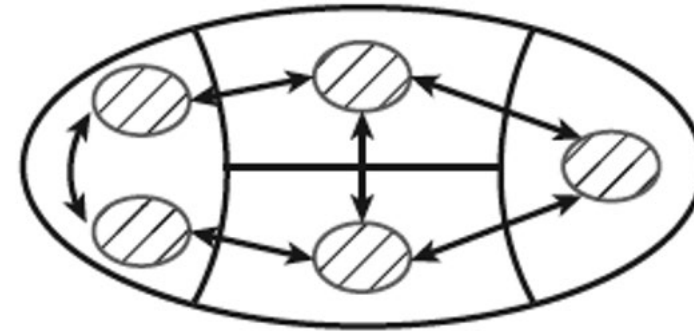
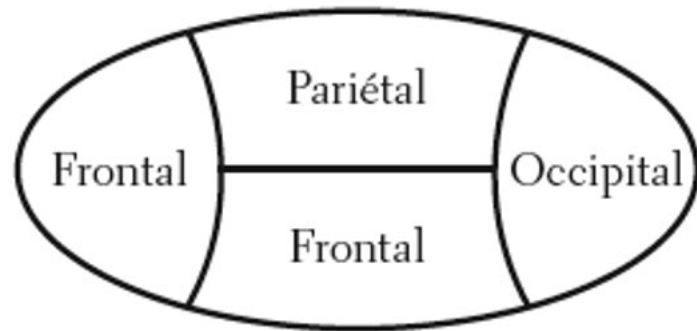
OTX2 present dans toutes les cellules PV est-il un Régulateur Général de la Plasticité Corticale ?



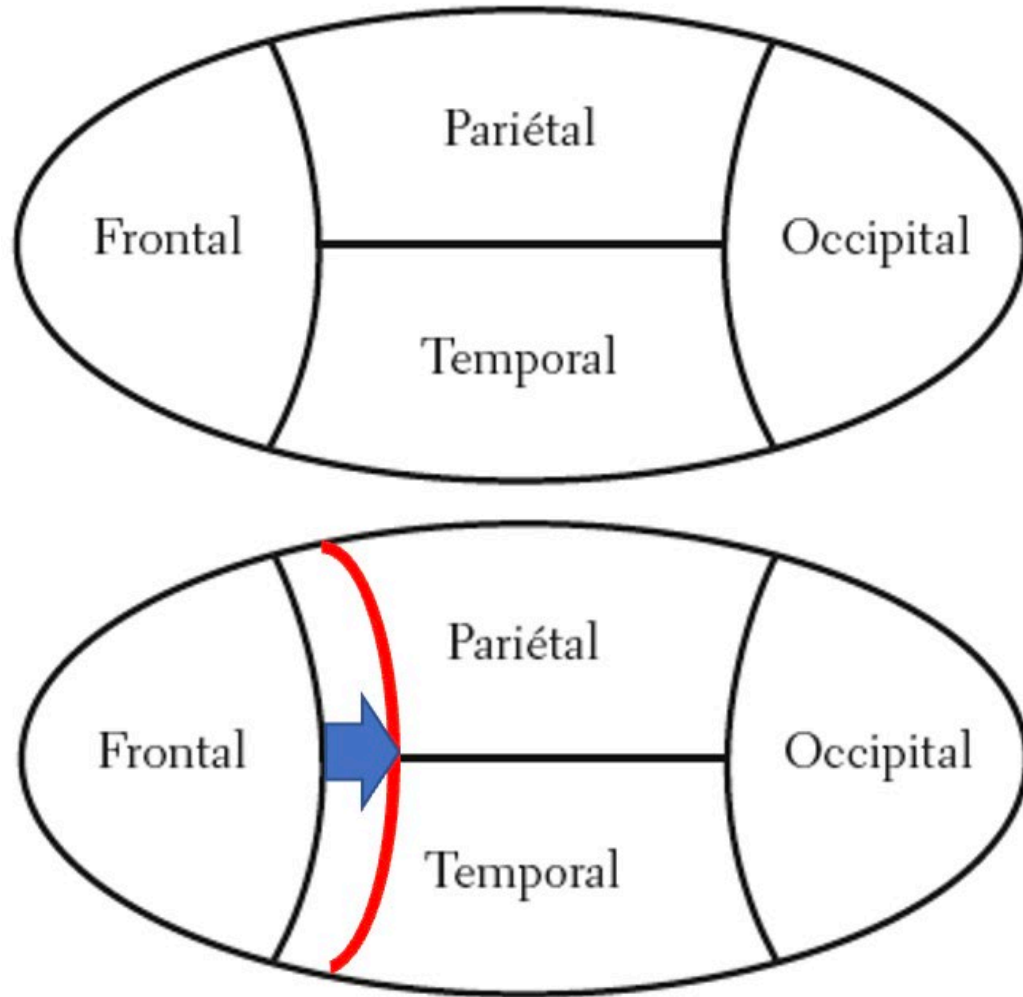
Le Tube Neural est un Plan



Agrandissement Homothétique, Insertion de Nouvelles Régions Nouvelles Connexions



Modification des Frontières



Wild type



***Emx2*^{-/-}**



***Pax6* mutant**



E18.5

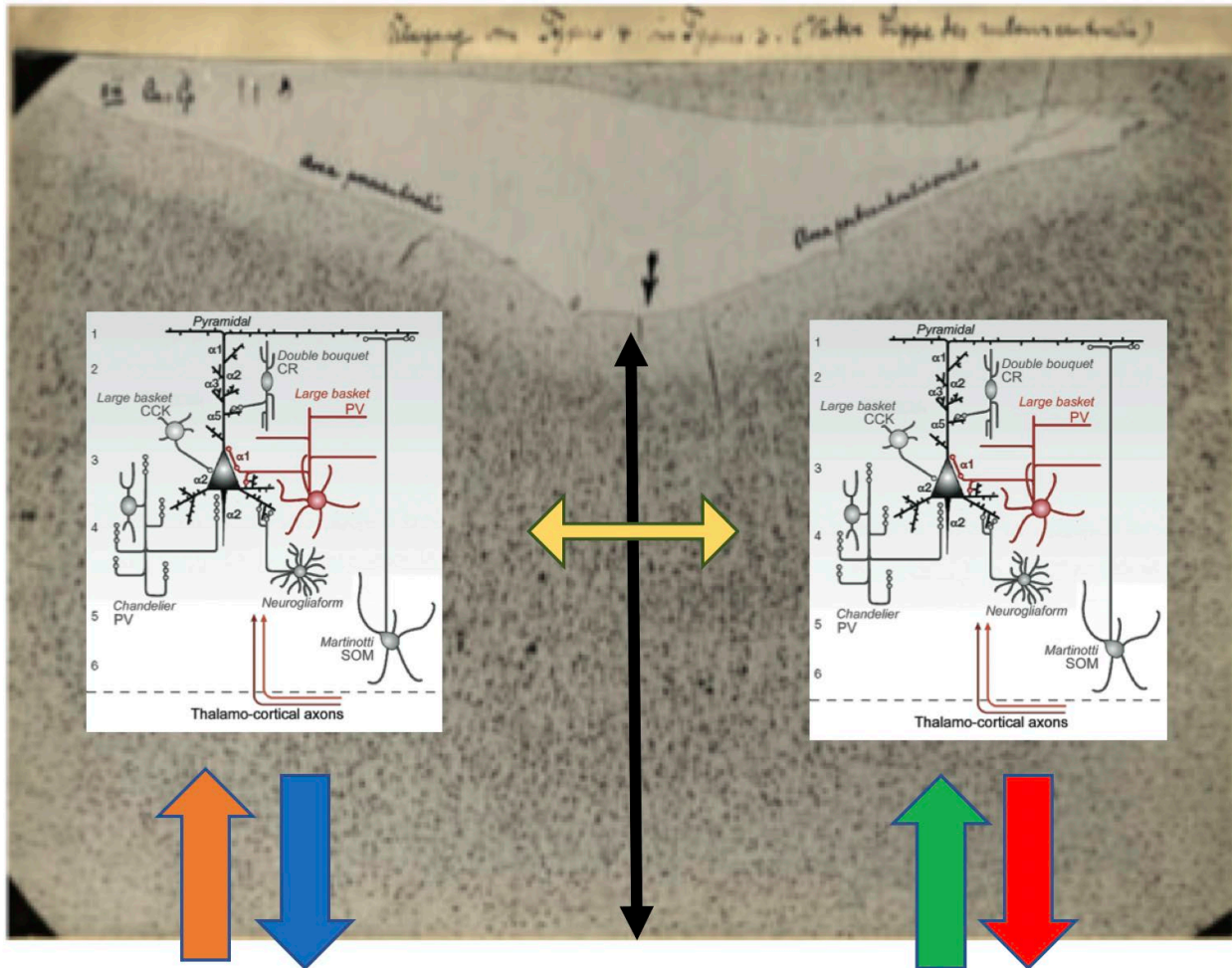
c Human



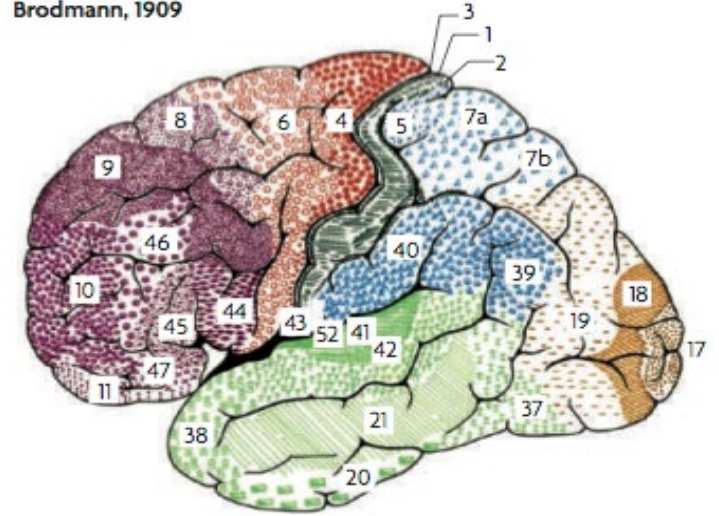
b Macaque



Le Cortex, une Structure Uniforme et Répétitive, Nécessité Evolutive



Brodmann, 1909



Augmentation de la taille
Augmentation du nombre des aires
Déplacement des bord
Changement des circuits

TIMELINE

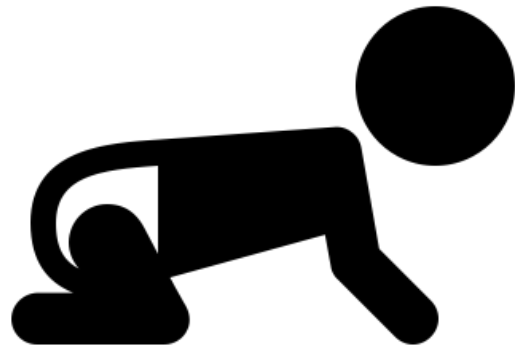
Centenary of Brodmann's map —
conception and fate

Karl Zilles and Katrin Amunts

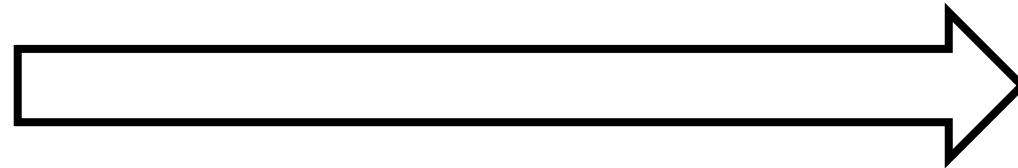
Prenatal and early-life adversity and psychiatric disorders

Adversité pendant période critique
(Fond génétique ou prénatal)

Dépression
Psychose maniaco-dépressive
Anxiété
Syndromes post-traumatique
Schizophrénies
.....



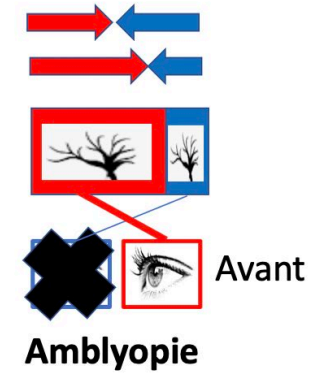
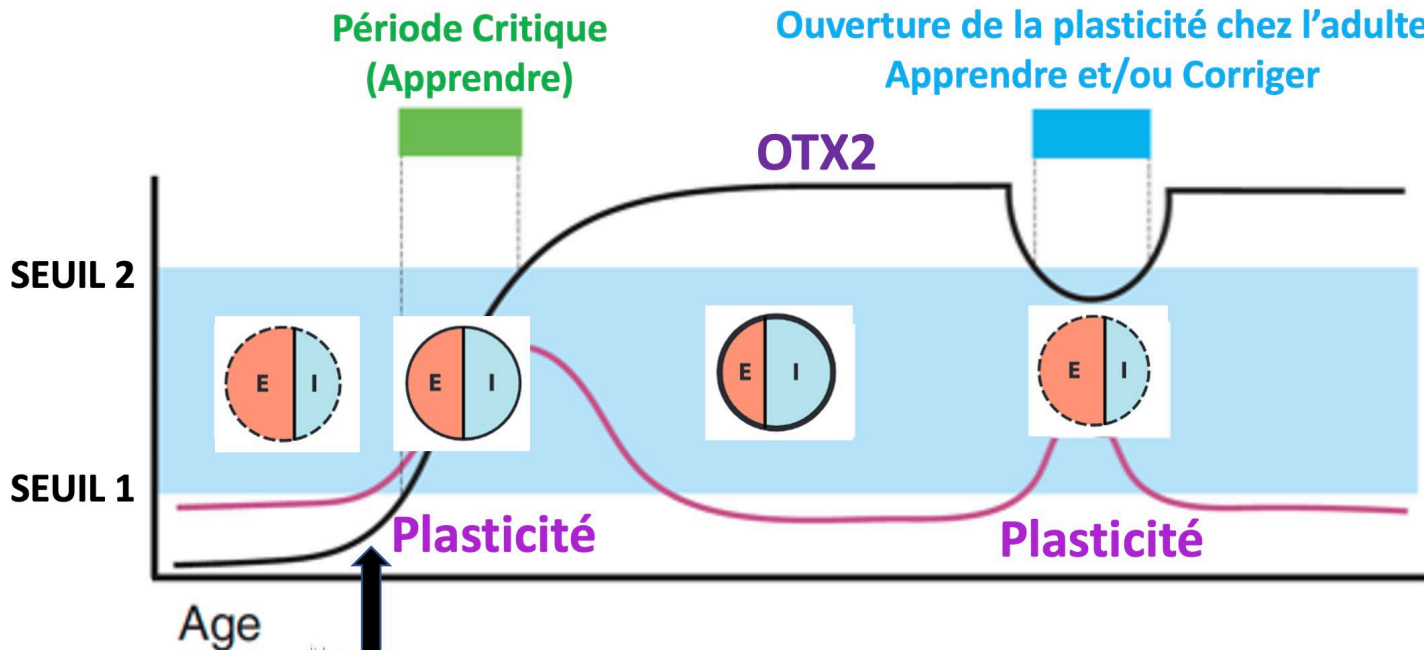
Modifications épigénétiques stables



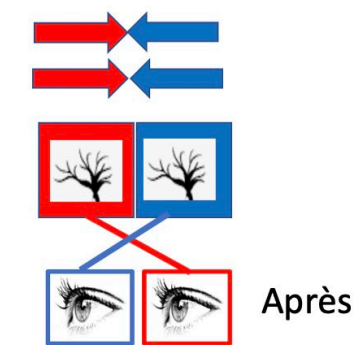
Réparable ?



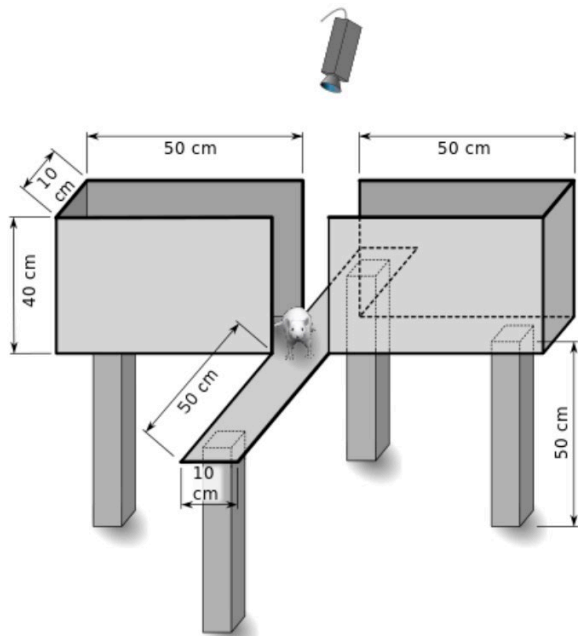
Un désordre comportemental peut-il être corrigé chez la souris adulte, sur le modèle de l'amblyopie ?



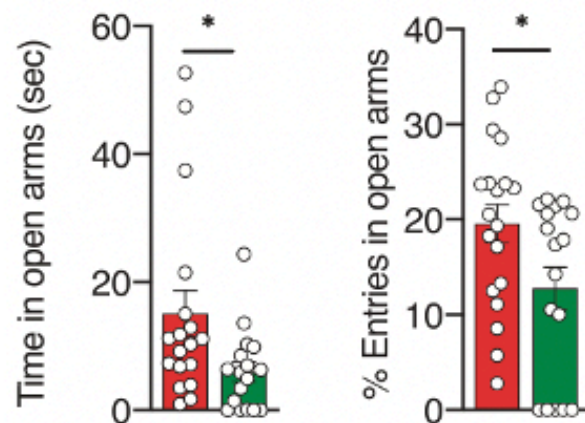
OTX2 → **OTX2**



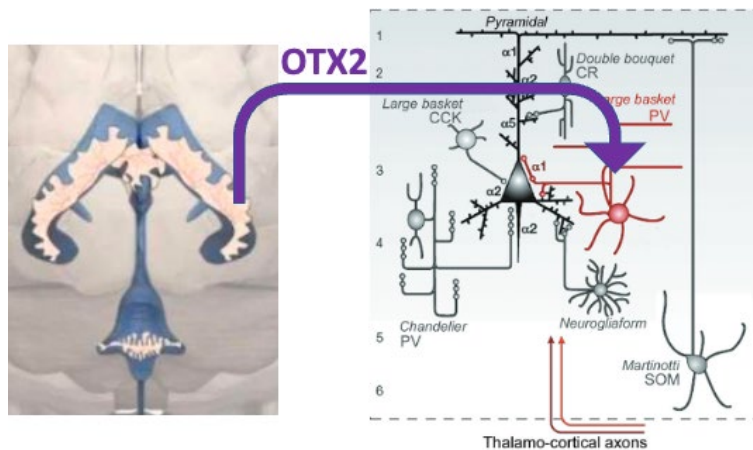
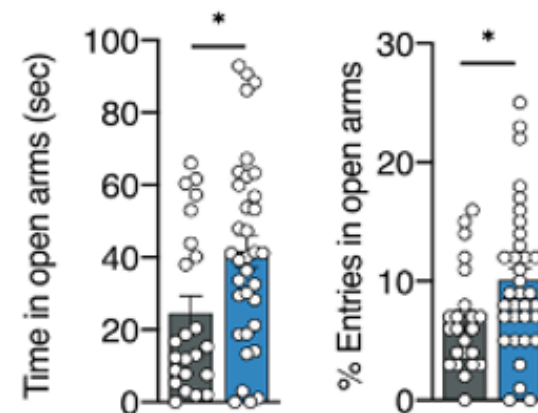
Modification d'un comportement de type anxieux chez la souris adulte



Souris hypo-anxieuse



Souris « normalement » anxieuse



Avant

OTX2

Après



Avant

OTX2

Après

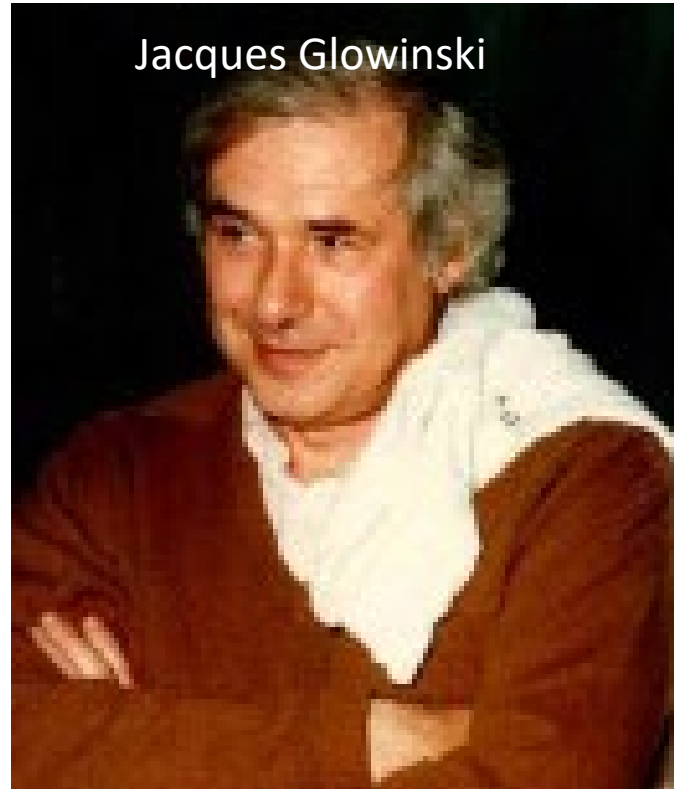


Takao Hensch



Harvard Medical School

Jacques Glowinski



Ariel Di Nardo

