Chair Professor Distinguished Lecture Series,
Department of Chinese and Bilingual Studies,
April 18, 2023.

Language, Cognition, and Neuroscience

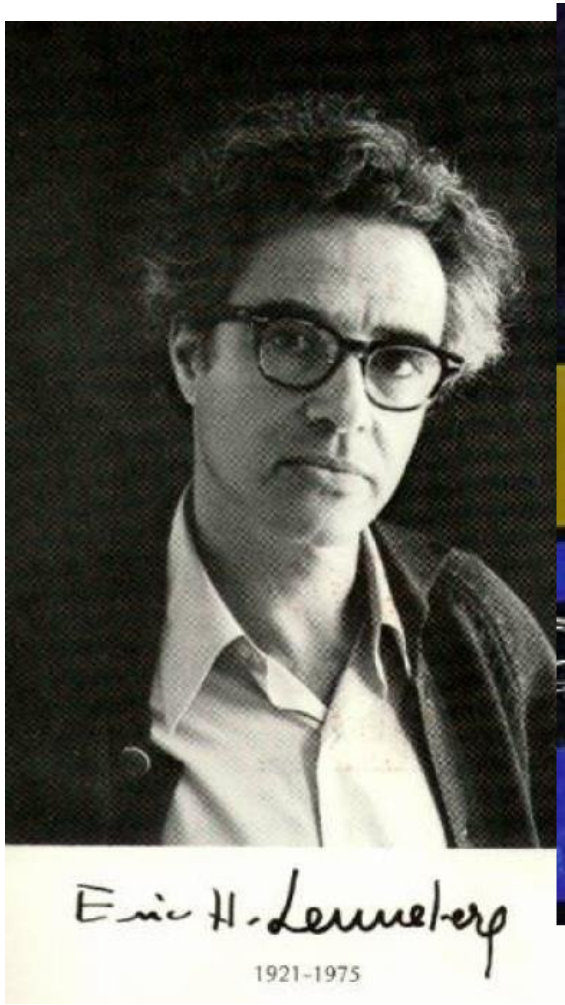
"Biological Foundations of Language",

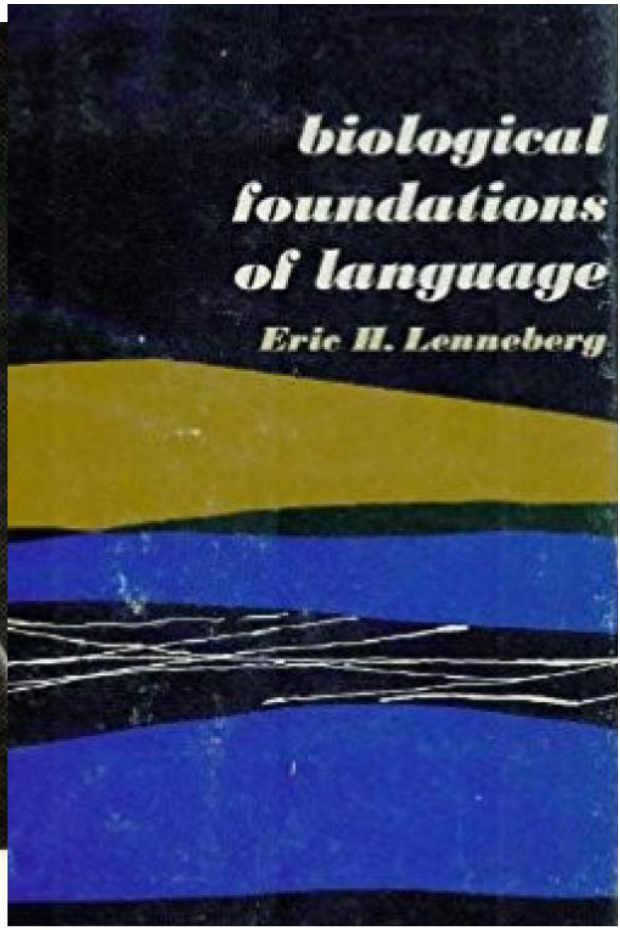
since 1967.

WANG Shiyuan 王士元.
Research Center for Language, Cognition, & Neuroscience.
Hong Kong Polytechnic University.
PDF available from: wsywang@polyu.edu.hk.

This time in linguistics history: A 50th anniversary tribute to Eric H. Lenneberg's Biological Foundations of Language

1. The conceptual framework
2. Morphological correlates
3. Some physiological correlates
4. Language in the context of growth & maturation
5. Neural aspects of speech & language
6. Language in the light of evolution & genetics
7. Primitive stages in language development
8. Language & cognition
9. Toward a biological theory of language development





1967. Wiley.

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Review

Rethinking foundations of language from a multidisciplinary perspective ☆

Tao Gong [a,b,*], Lan Shuai [b], Yicheng Wu [c,**]

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Abstract

The issue of language foundations has been of great controversy ever since it was first raised in Lenneberg's (1967) monograph *Biological Foundations of Language*. Based on a survey of recent findings relevant to the study of language acquisition and evolu-

UNIVERSITY OF CAMBRIDGE

Language machine Rule conflict Eureka! Significance

Solving grammar's greatest puzzle

How a determined student made Sanskrit's 'language machine' work for the first time in 2,500 years

By Tom Almeroth-Williams

Legacy from a great linguist in India 2,500 years ago.

Stamp issued by India in 2004 to commemorate

Almeroth-Williams, T. (2022). "Solving grammar's greatest puzzle." University of Cambridge **Dec 15: https://www.cam.ac.uk/stories/solving-grammars-greatest-puzzle.**

荀子 ca.323 BCE

名无固宜，约之以命，
约定俗成谓之宜。
名无固实，约之以命，
约定俗成谓之实名。
名有固善，径易而不拂，
谓至善名。

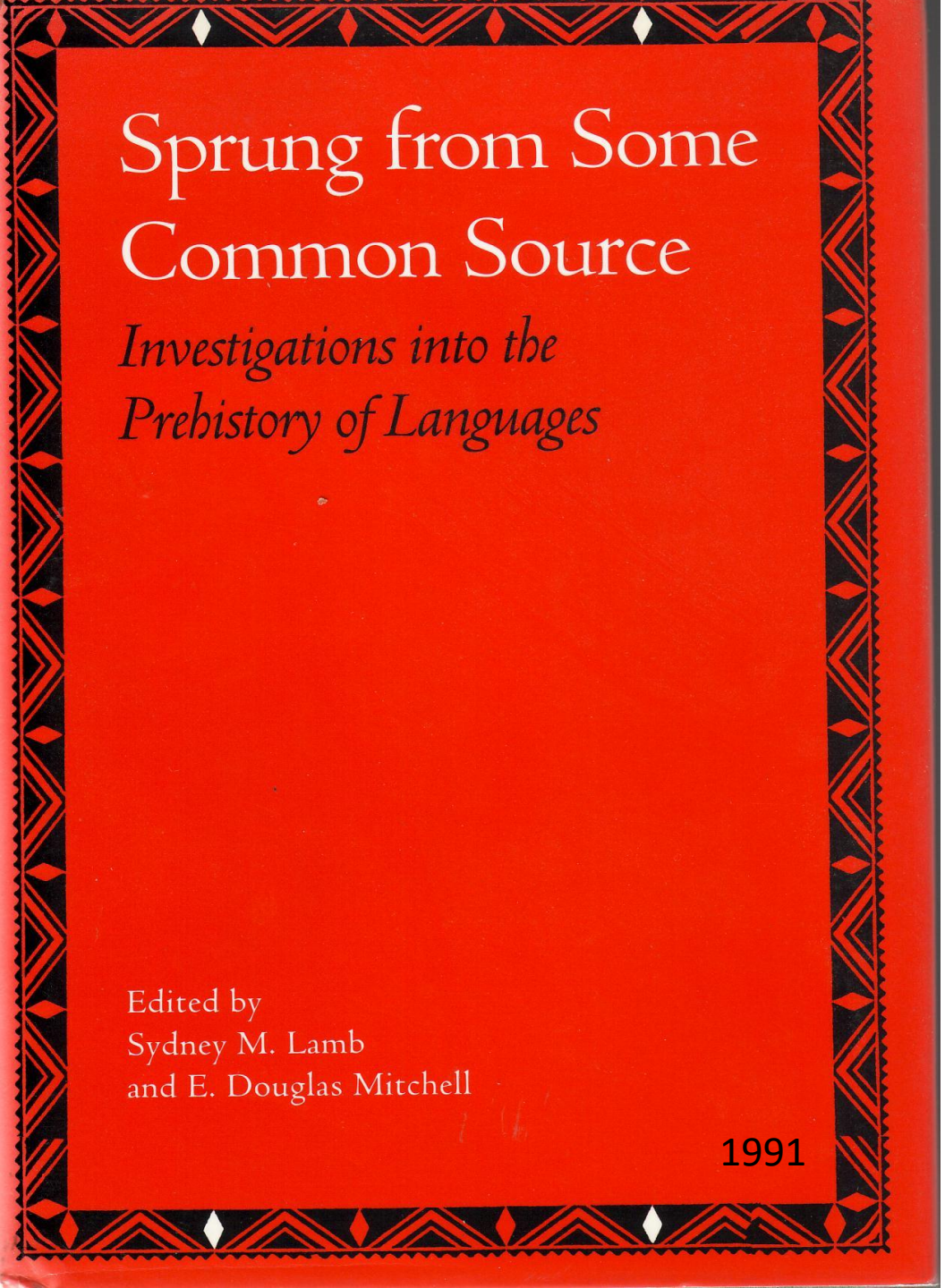
Wang, W.S-Y. 1989.
Language in China: a chapter in the history of linguistics.
Journal of Chinese Linguistics
17.183-222.

Yu, Anthony. 2008.
Cratylus and Xunzi on Names.
Classical, Comparative, and Contemporary: Essays on Literature, Religion, and Other Topics.
Columbia University Press.

陳第 1540-1620. 毛詩古音考

- 盖时有古今，
- 地有南北，
- 字有更革，
- 音有转移，
- 亦势所必至.

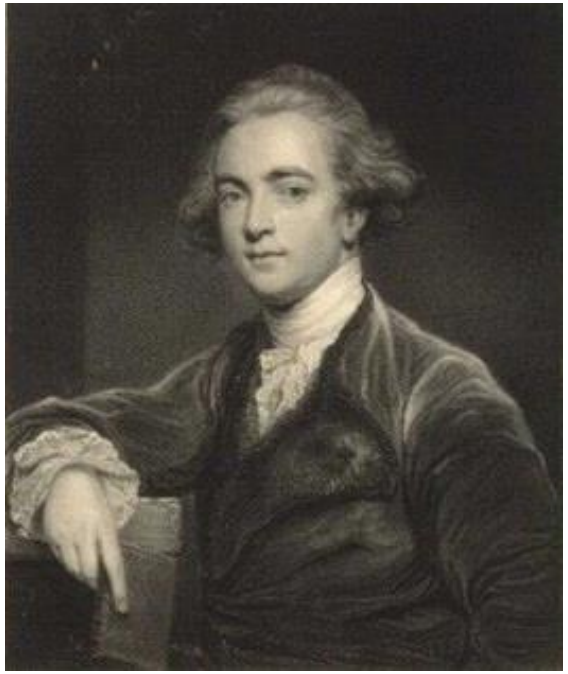
Time, there is past and present;
Space, there is south and north;
Writing, there is change and reform;
Speech, there is shift and movement;
It is the natural scheme of things.



William Jones,

(1746-1794).

Lecture in Kolkata 1786.



"The Sanscrit language, whatever be its antiquity, is of a wonderful structure; more perfect than the Greek, more copious than the Latin, and more exquisitely refined than either, yet bearing to both of them a stronger affinity … than could possibly have been produced by accident; so strong indeed, that no philologer could examine them all three, without believing them to have ***sprung from some common source****, which, perhaps, no longer exists."*

Grimm's Law: PIE > Germanic

b^h > b

b^hratr, brother

b > p

lab-, lip

p > f

ped-, foot

d^h > d

mad^{h}u, mead

d > t

dec-, ten

t > θ

dent-, tooth

g^h > g

g > k

genu, knee

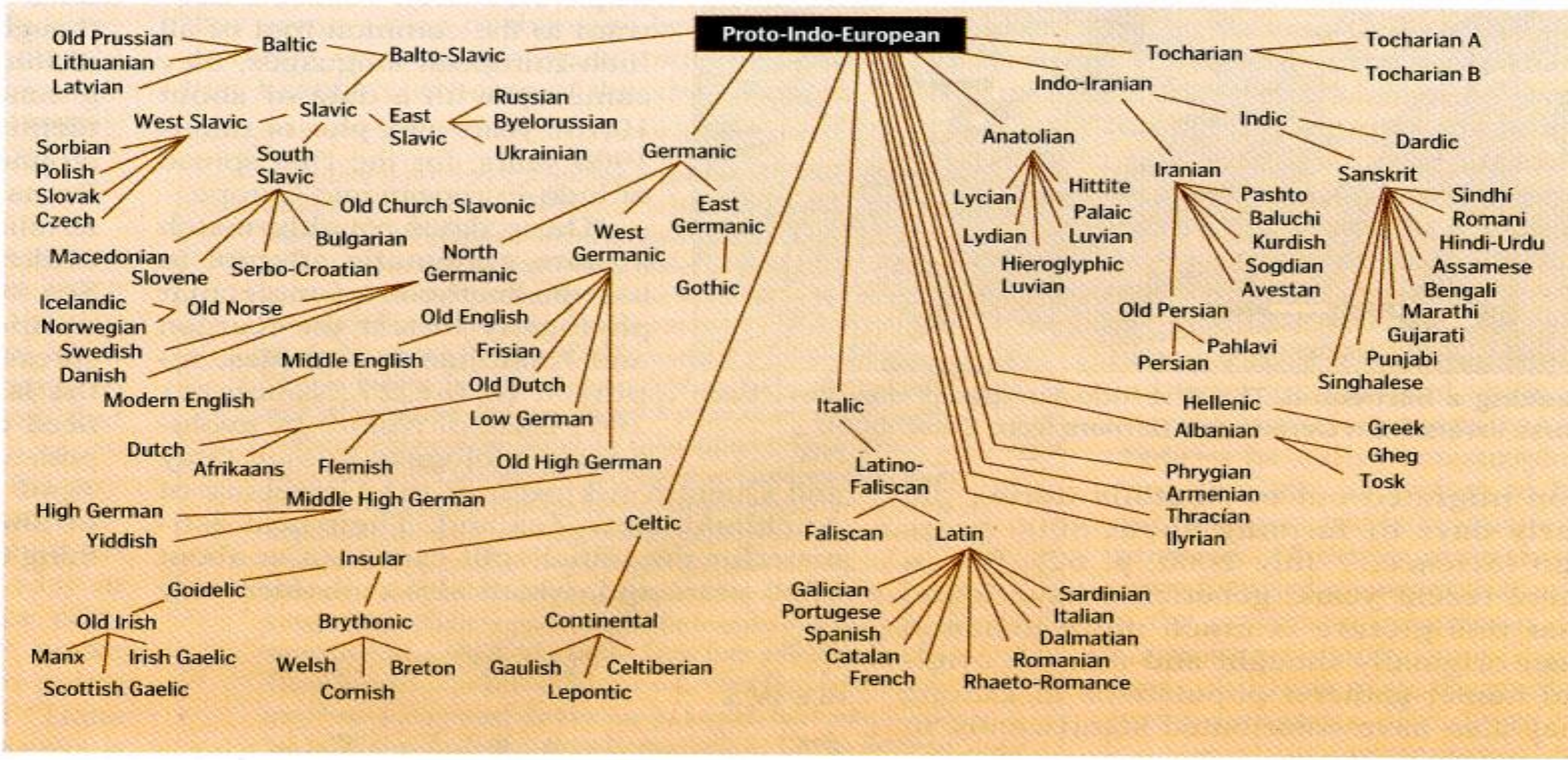
k > h

canis, hound

Examples from Chinese dialects:

d>t：	头	抬	地
上海	dø	dɛ	di
p>f：	房	饭	肥
台湾	pang	png	pui
k>h：	考	口	可
香港	haau	hau	ho

Science Feb.27,2004.



Say it in Indo-European. The 144 languages of this family descend from one ancient mother tongue.

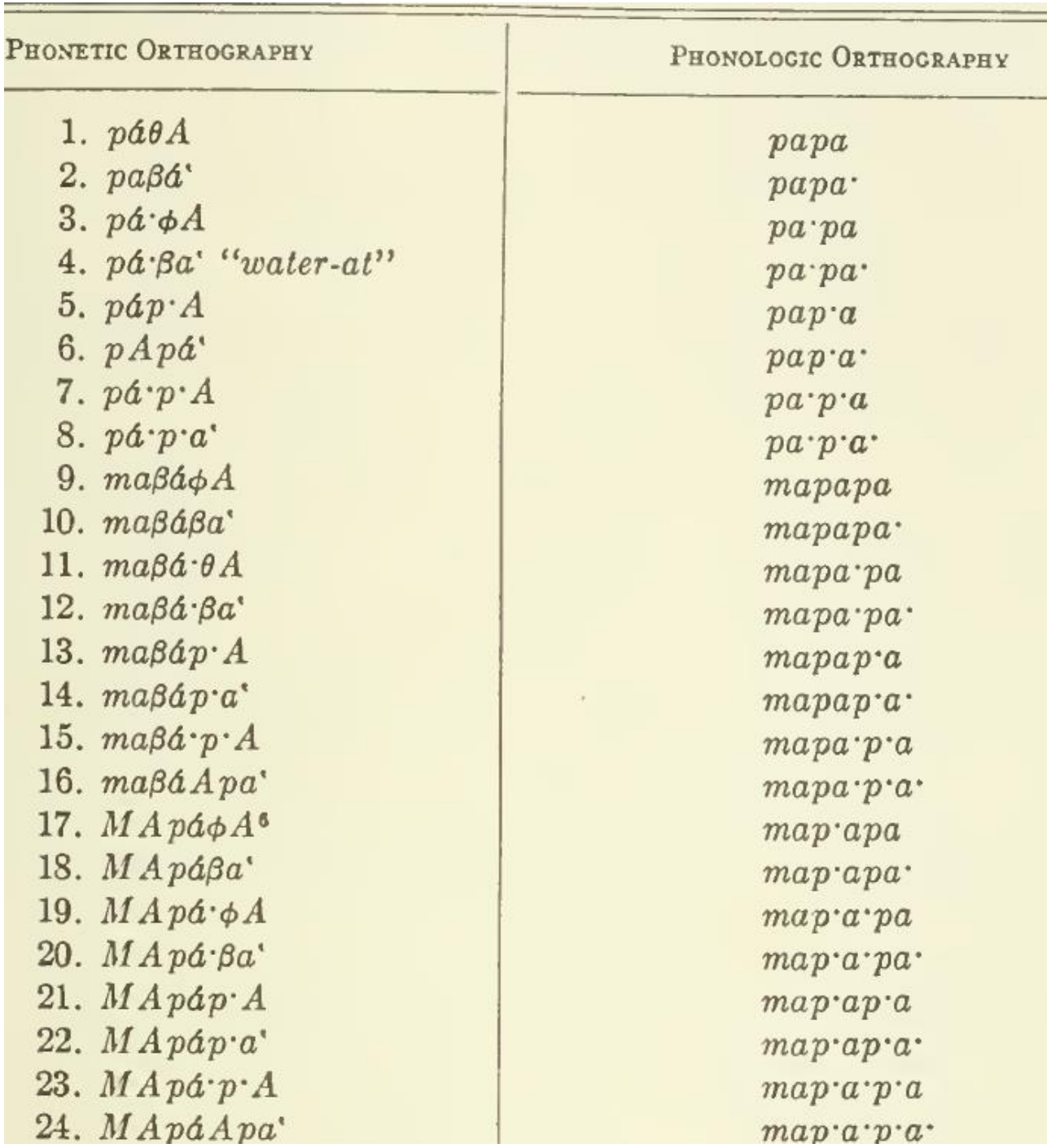
p.9."Physiologically, speech is an **overlaid function**, or, to be more precise, a group of overlaid functions. It gets what service it can out of organs and functions, nervous and muscular, that have come into being and are maintained for very different ends than its own."

p.23."The universality and the diversity of speech lead to a significant inference. We are forced to believe that language is an immensely ancient heritage of the human race, whether or not all forms of speech are the historical outgrowth of a single pristine form. It is doubtful if any other cultural asset of man, be it the art of drilling for fire or of chipping stone, may lay claim to a greater age. I am inclined to believe that it antedated even the lowliest developments of **material culture**, that these developments, in fact, **were not strictly possible until language, the tool of significant expression, had itself taken shape."**

Edward Sapir (1884-1939).

1921. **Language**. *Harcourt.*

Note: For Sapir's ***overlaid function***, the new term is ***EXAPTATION***, introduced in Gould & Vrba in 1982.



Phonetic Orthography	Phonologic Orthography
1. páθA	papa
2. paβá'	papa·
3. pá·ϕA	pa·pa
4. pá·βa' "water-at"	pa·pa·
5. páp·A	pap·a
6. pApá'	pap·a·
7. pá·p·A	pa·p·a
8. pá·p·a'	pa·p·a·
9. maβáϕA	mapapa
10. maβáβa'	mapapa·
11. maβá·θA	mapa·pa
12. maβá·βa'	mapa·pa·
13. maβáp·A	mapap·a
14. maβáp·a'	mapap·a·
15. maβá·p·A	mapa·p·a
16. maβáApa'	mapa·p·a·
17. MApáϕA[6]	map·apa
18. MApáβa'	map·apa·
19. MApá·ϕA	map·a·pa
20. MApá·βa'	map·a·pa·
21. MApáp·A	map·ap·a
22. MApáp·a'	map·ap·a·
23. MApá·p·A	map·a·p·a
24. MApáApa'	map·a·p·a·

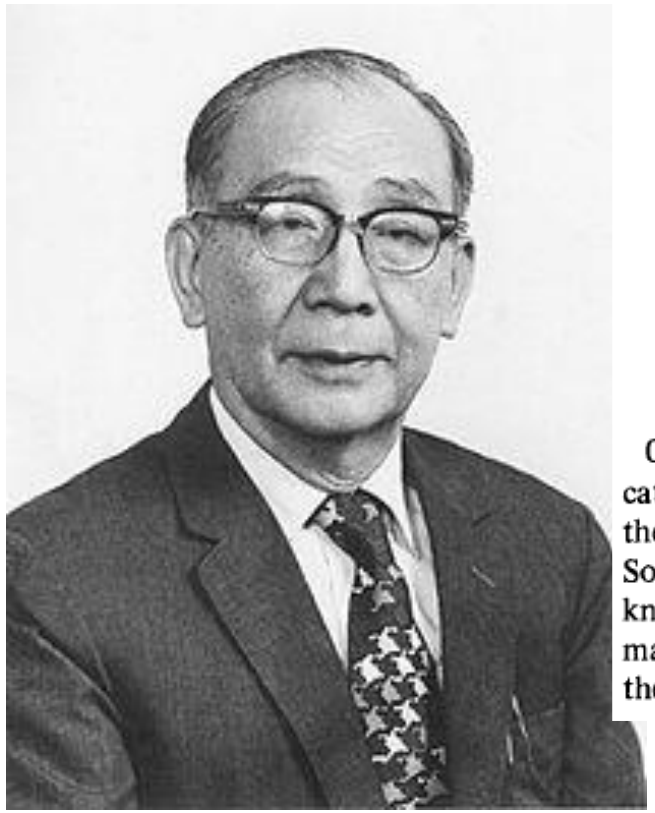
These are some sample forms from Southern Paiute according to E.Sapir (1949: 51). Phonetic orthography presents the forms in acoustically accurate terms in detail. In phonologic orthography each morpheme is presented in a constant form for easier identification. A newer term for phonologic is **morphophonemic**.

As Sapir put it: "*All this has an important bearing on the construction of a maximally correct orthography of Southern Paiute, if by 'maximally correct' we mean, not most adequate phonetically, but most true to the sound patterning of the language.*"

"*Southern Paiute, then,*" Sapir went on to conclude, "*is a language in which an unusually simple phonemic structure is actualized by a more than ordinarily complex phonetic one.*"

Sapir, E. (1933). " La réalité psychologique des phonèmes." J. Psychol. Norm. Pathol. **30**: 247-265.

--. 1949. The psychological reality of phonemes. 46-60. Selected Writings in Language, Culture and Personality. Berkeley.



李方桂
1902 – 1987

LANGUAGES AND DIALECTS OF CHINA*

Fang-Kuei Li
University of Hawaii

The languages and dialects of China present a complicated linguistic picture. In this article these languages are systematically classified into families and branches according to their characteristics. The simplified picture looks thus:

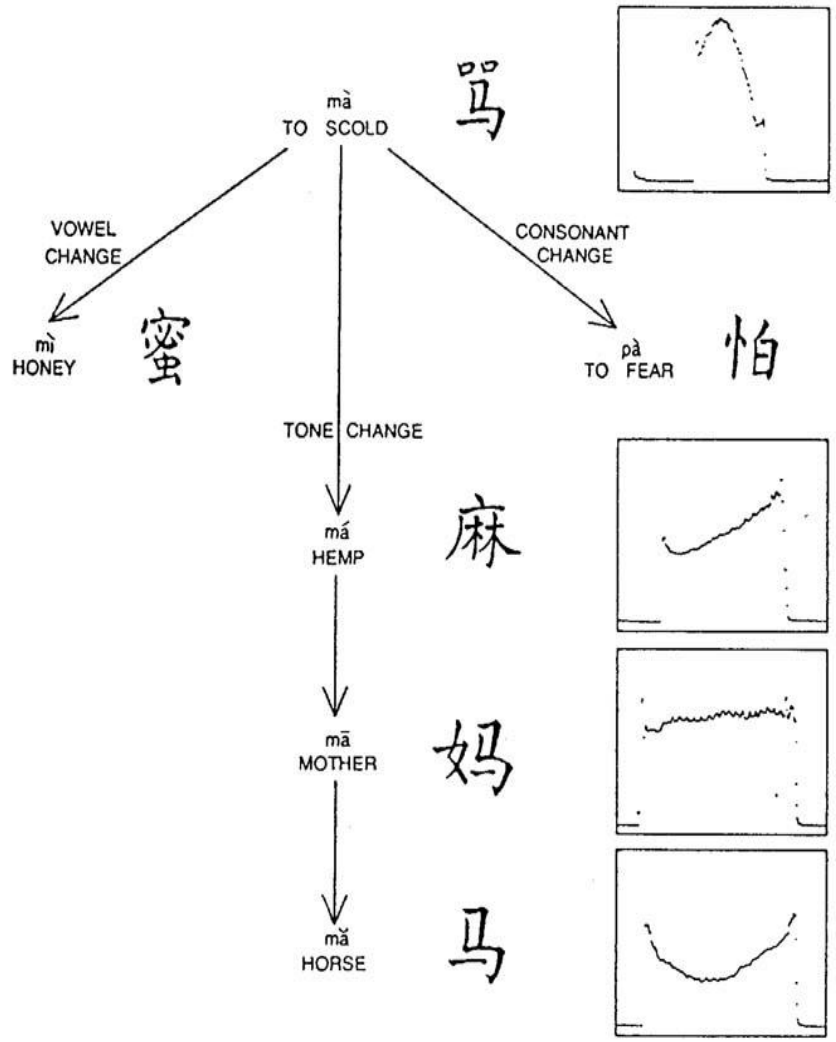
1. Indo-Chinese: a) Chinese, b) Kam-Tai, c) Miao-Yao, d) Tibeto-Burman
2. Austro-Asiatic: Mon-Khmer
3. Altaic: a) Turkish, b) Mongolian, c) Tungus
4. Indo-European: Tokharian (extinct)

0. INTRODUCTION. The linguistic situation in China is a very complicated one. Aside from the Chinese language with its numerous dialects, there are many other languages, our knowledge of which is incomplete. Some of them have not been adequately studied, some of them are scarcely known to us, and many of them have not been sufficiently recorded. The material of these languages is therefore scanty, their history unknown, and their relation with other groups very vaguely understood.

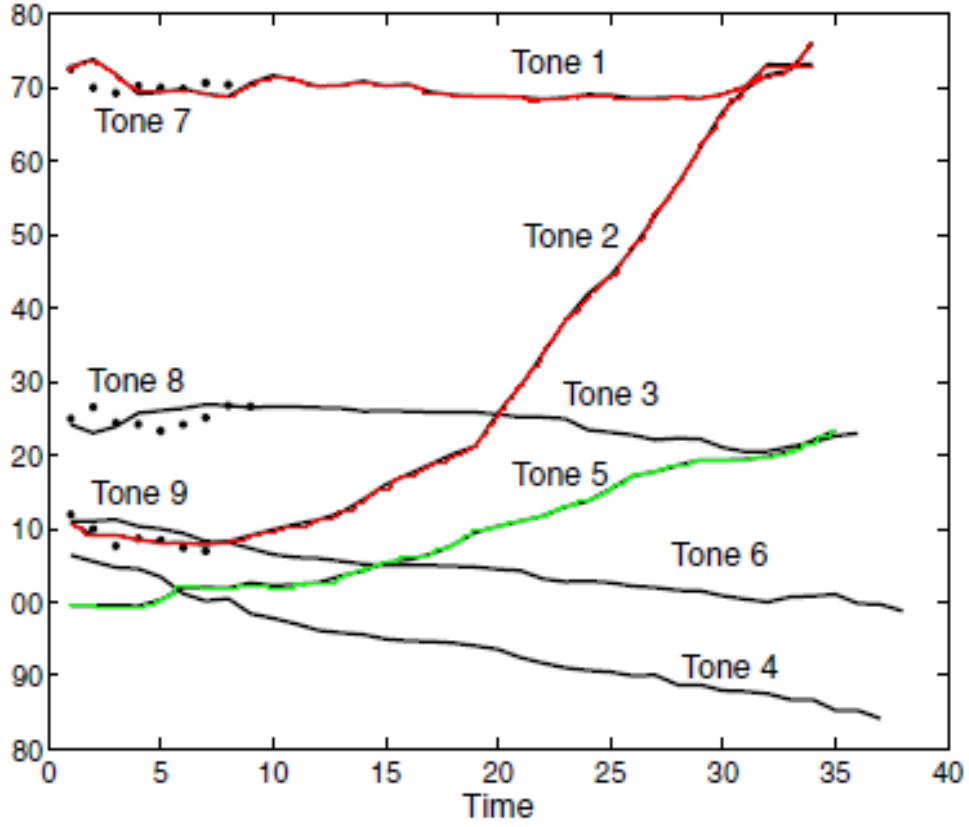
The above paper by Professor LI was published at the invitation of the Editor of the Journal of Chinese Linguistics, & appeared on page 1 on the inaugural issue of that journal in 1973.

Some publications of F.K.LI:

- 1945. Some Old Chinese loan words in the Tai languages. Harvard Journal of Asiatic Studies 8(3/4): 333-342.
- 1956. The inscription of the Sino-Tibetan treaty of 821-822. T'oung Pao 44(1-2): 1-99.
- 1971. 上古音研究。商务印书馆。
- 1977. A Handbook of Comparative Tai, University of Hawaii Press.
- 1980. Laryngeal features and tone development. Bulletin of the Institute of History and Philology 51(1): 1-13.
- 1986. Linguistics East and West: American Indian, Sino-Tibetan, and Thai. China Scholars Series.



W.S-Y.Wang.Feb.1973. *Scientific American*.
See also: Wang, W. S.-Y. and K. P. Li (1967). "Tone 3 in Pekinese." Journal of Speech and Hearing Research **10(3): 629-636.**

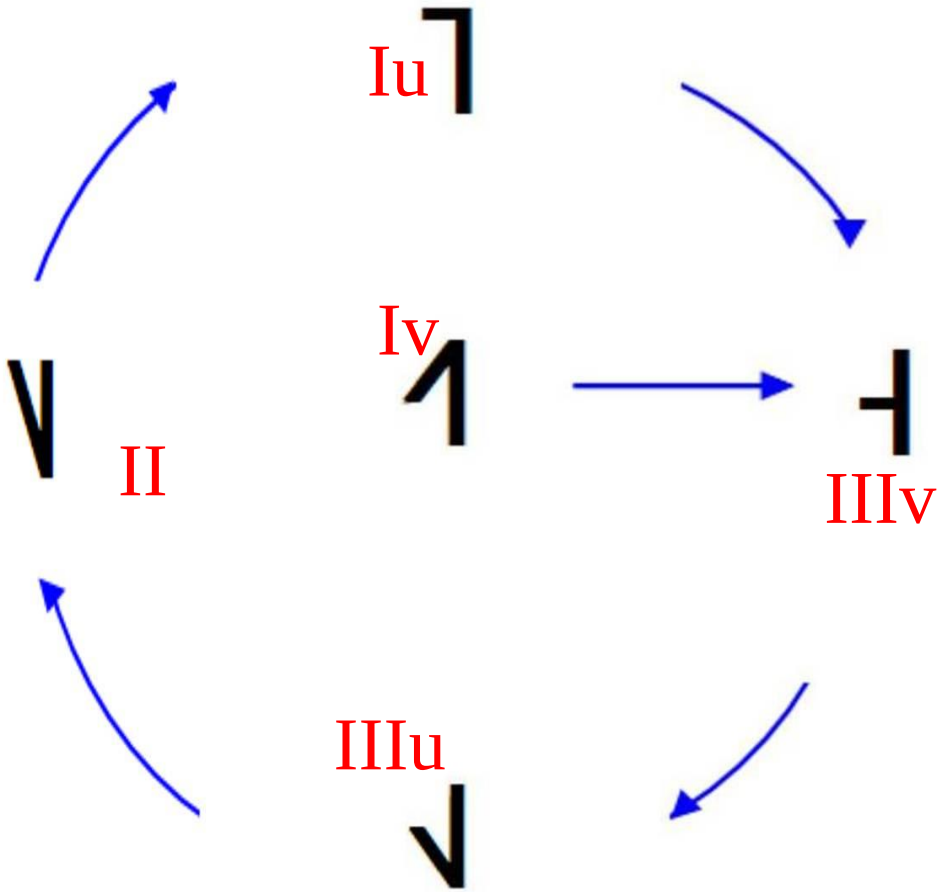


Cantonese tones in the monosyllable /i/ uttered in isolation. The solid lines are for long tones on unchecked syllables, while the dotted lines are for short tones on checked syllables. (Adapted from Peng & Wang, 2005)

Citation tone	Sandhi tone	Example	
lu ˥ (55) ➔	˧ (33)	開 khui	車 tshia lu ˥ (55) 教育部 台灣閩南語 常用詞辭典
lv ˧˥ (24) ➔	˧ (33)	還 hîng	
ll ˨˦ (51) ➔	˥ (55)	買 bé	
lllu ˩ (21) ➔	˨˦ (51)	看 khuànn	
lllv ˧ (33) ➔	˩ (21)	賣 bē	

	理大 有四个 停車場
Taiwanese Romanization System by Taiwan's Ministry of Education 臺灣閩南語 羅馬字拼音方案	lí-tāi ū sì ê thîng-tshia-tiûnn ll lllv lllv lllu lv lv lu lv
Citation tone levels	51 33 33 21 24 24 55 24
Sandhi tone in connected speech	55 21 51 33 33 33

Tone circle in Taiwanese.



Taiwanese has 5 long tones, inherited from the 4 tones of Middle Chinese, MC. The traditional names, Ping, Shang, Qu, Ru, can be written with Roman numerals, **I**, **II**, **III**, **IV**, respectively. The IV tones are not included in the diagram. The MC tones often bifurcated in historical development according to whether the initial consonant of the syllable was unvoiced, traditionally named Yin, or unvoiced, traditionally named Yang; these are written **u** or **v** in the diagram. *Wang,W.S. & Cheng,C.C. 1987.*

Tone sandhi in Taiwanese is shown by arrows in the diagram. The input to an arrow is the citation tone, while the output is the sandhi tone. The fact that both Iu & Iv change to the same tone suggests that the sandhi event took place before the bifurcation.

Feature analysis of Taiwanese tone circle.

+ high	. . . . .	- high	- high	+ high	+ high
- falling		- falling	. . . . . + falling	+ falling	- falling

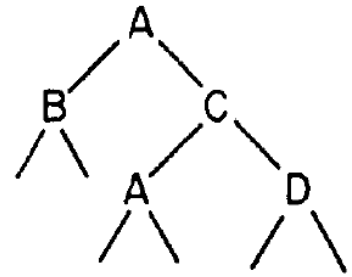
$$\begin{bmatrix} \alpha\text{high} \\ \beta\text{falling} \end{bmatrix} > \begin{bmatrix} \beta\text{high} \\ -\alpha\text{falling} \end{bmatrix}$$

Wang, W. S.-Y. (1967). "Phonological features of tone." International Journal of American Linguistics **33(2): 93-105.**

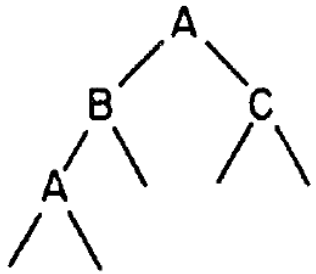
“Tone sandhi rules in Taiwanese are generally considered to be fully productive in a treatment along the line of generative phonology. Our study suggests that not only do speakers lack any knowledge of this set of rules but also that they have morpheme alternants listed in their lexicons instead, We are therefore justified in suspecting that at least some phonological rules are unreal and hence that generative phonology as a theory has questionable psychological reality.” *1976:18.*

Hsieh, H.-I. (1976). "On the unreality of some phonological rules." Lingua **38**: 1-19.

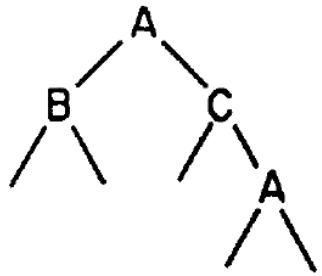
Miller, G. A. (1962). **Some psychological studies of grammar**. American Psychologist 17(11): 748-762.



self-embedding



left-recursive



right-recursive

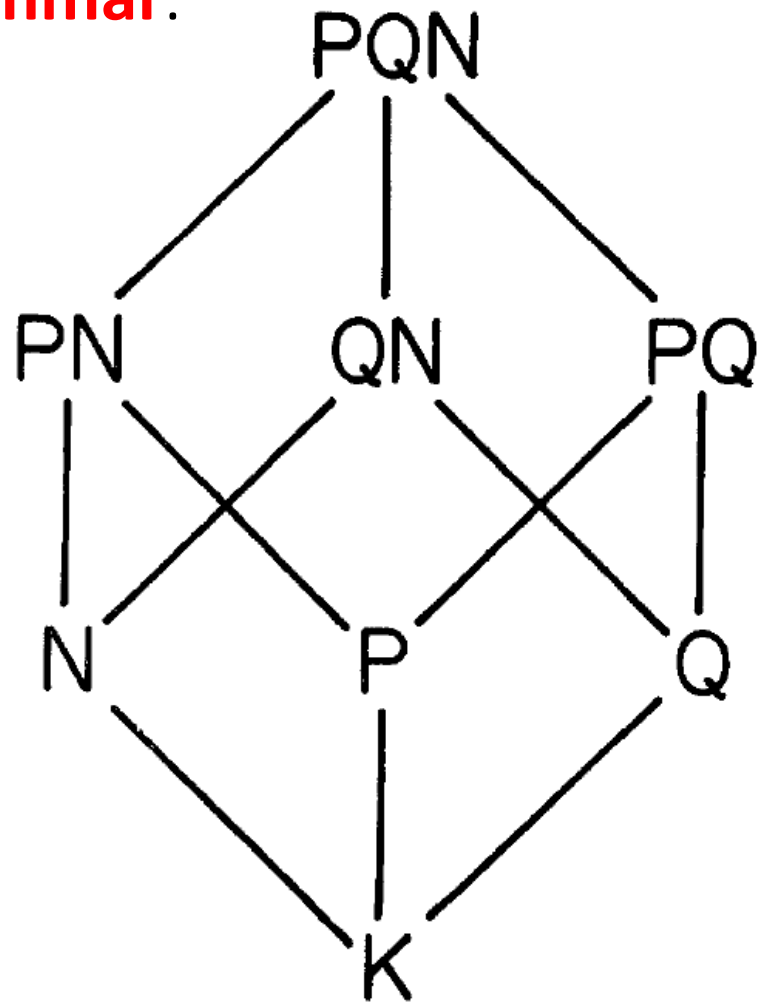
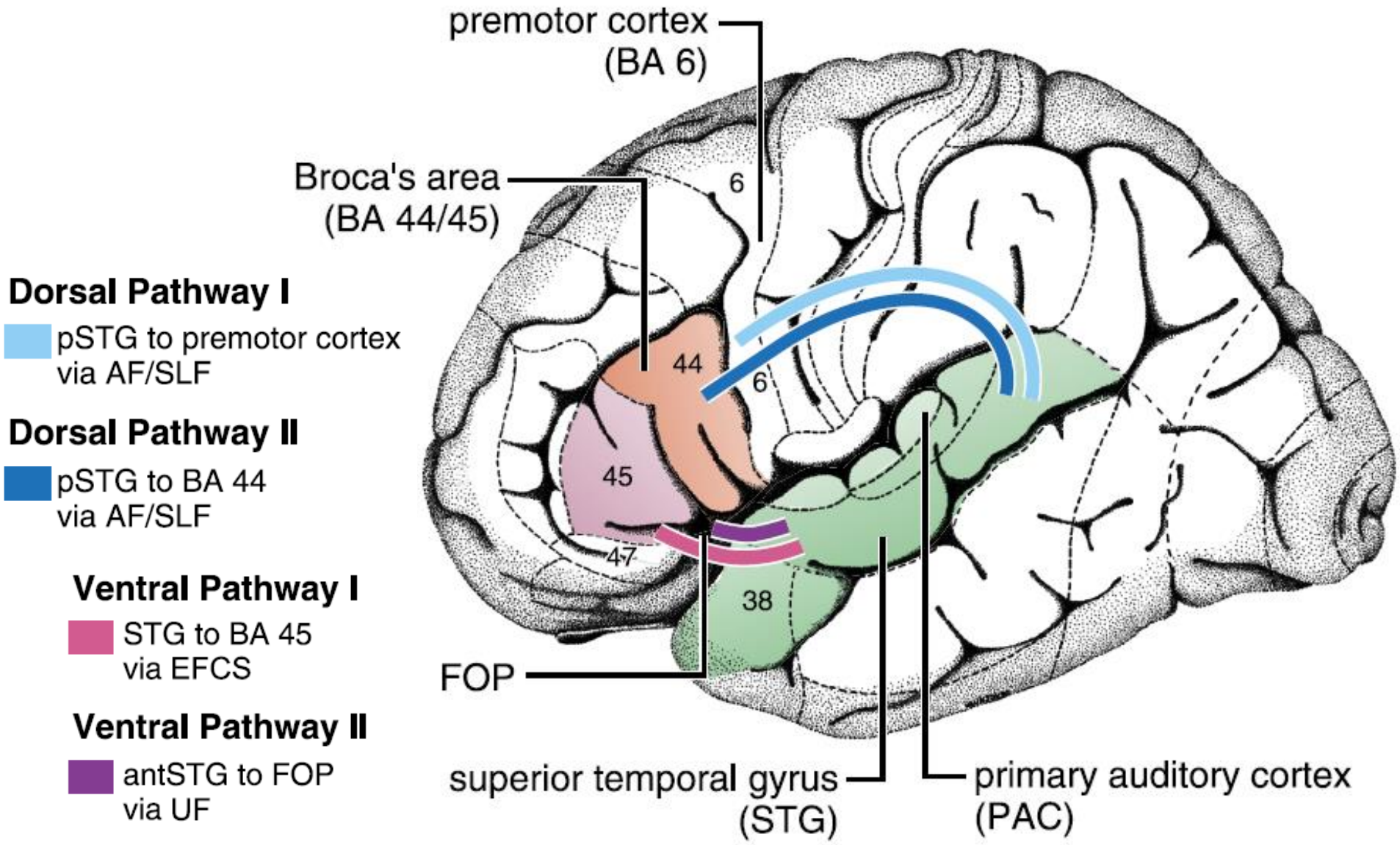
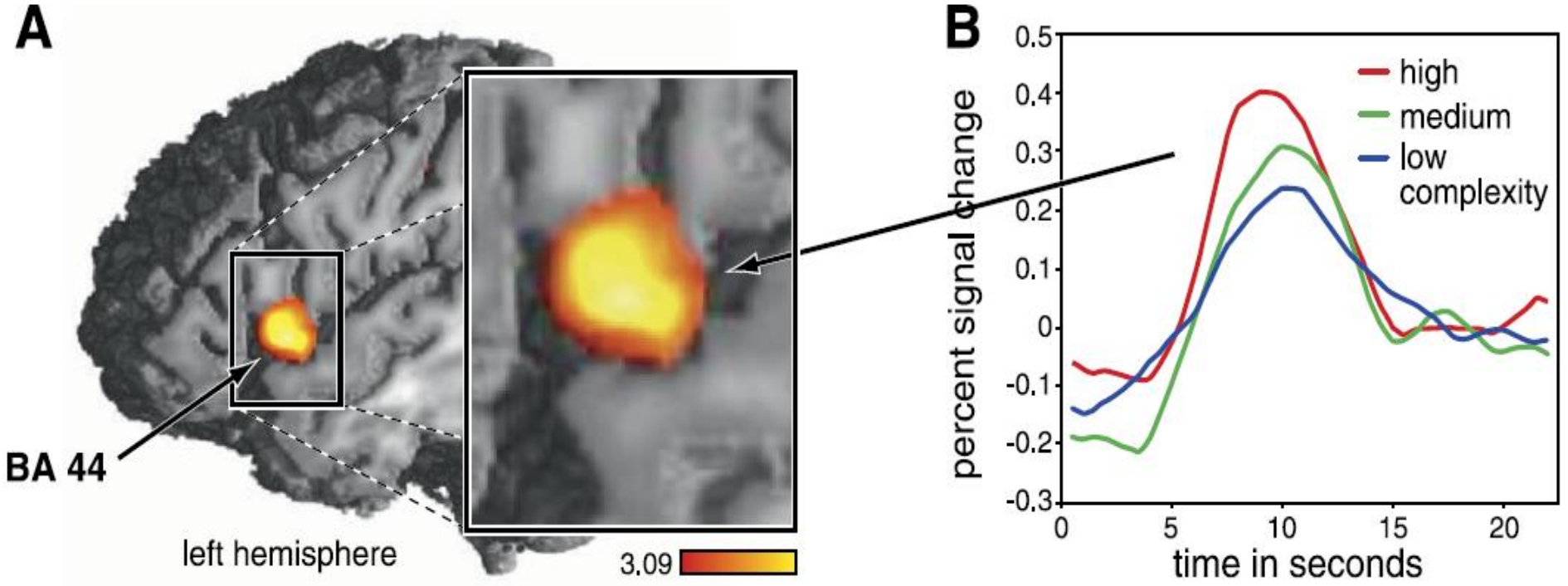


FIG. 12. Graph indicating relations among eight types of sentences formed by negative (N), passive (P), and interrogative (Q) transformations.

Friederici, A. D. (2011). **The Brain Basis of Language Processing: From Structure to Function**. Physiol Rev 91: 1357-1392.

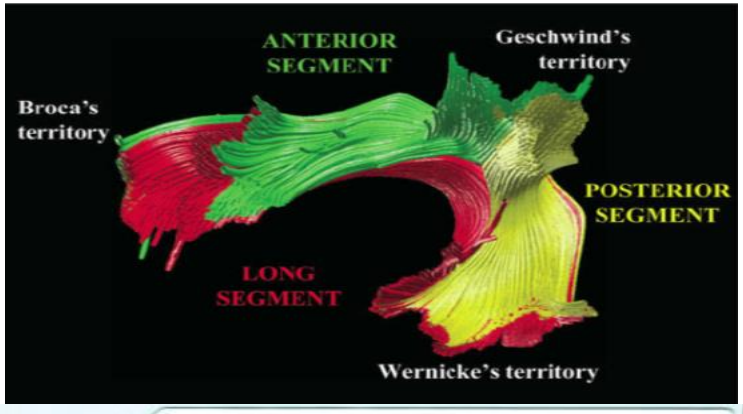


Friederici, A.D. 2011:1371.



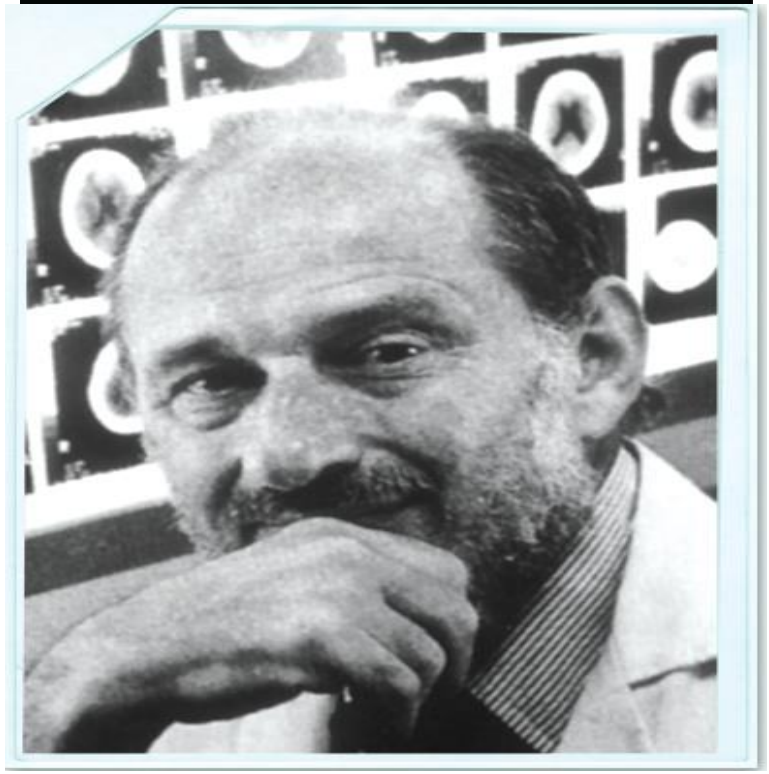
Low	*Heute hat der Opa dem Jungen den Lutscher geschenkt.*
Medium	*Heute hat **dem Jungen** der Opa den Lutscher geschenkt.*
High	*Heute hat **dem Jungen den Lutscher** der Opa geschenkt.*

Geschwind, N. 1976. Selected Papers on Language and the Brain.86-104.



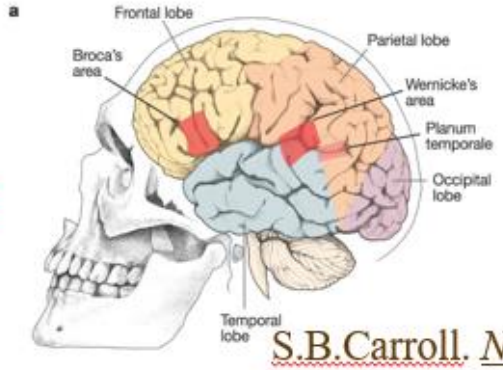
'...a real understanding of language will not be achieved until we have a reasonable notion of its neurological mechanisms' .

除非我們對**語言的神經機制**有合理的概念，否則無法真正理解語言。



Norman Geschwind
(1926 – 1984)

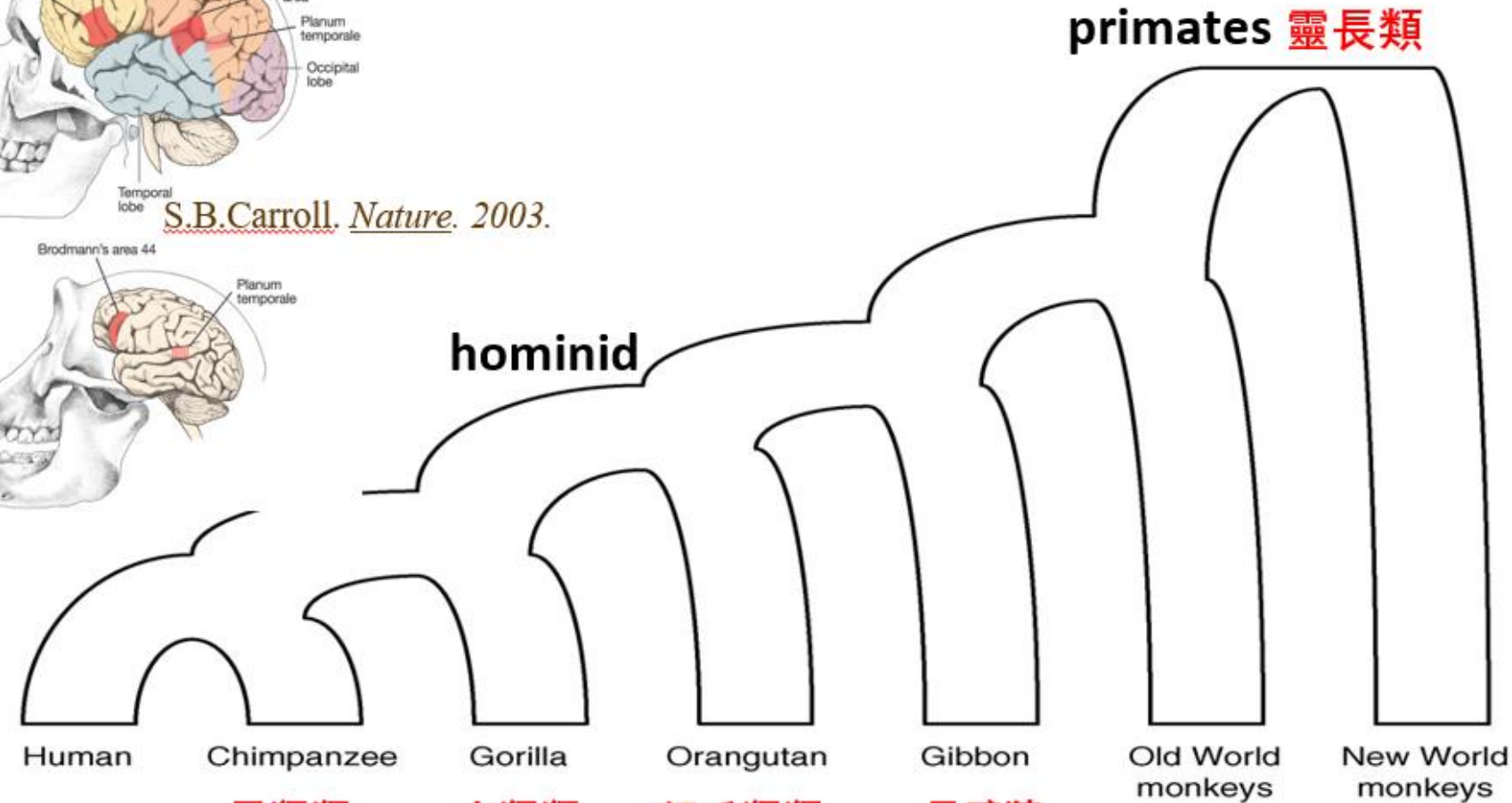
Genetic basis of human brain evolution. 2008. Vallender, Eric, et al. *Trends in Neuroscience*.



S.B.Carroll. *Nature*. 2003.

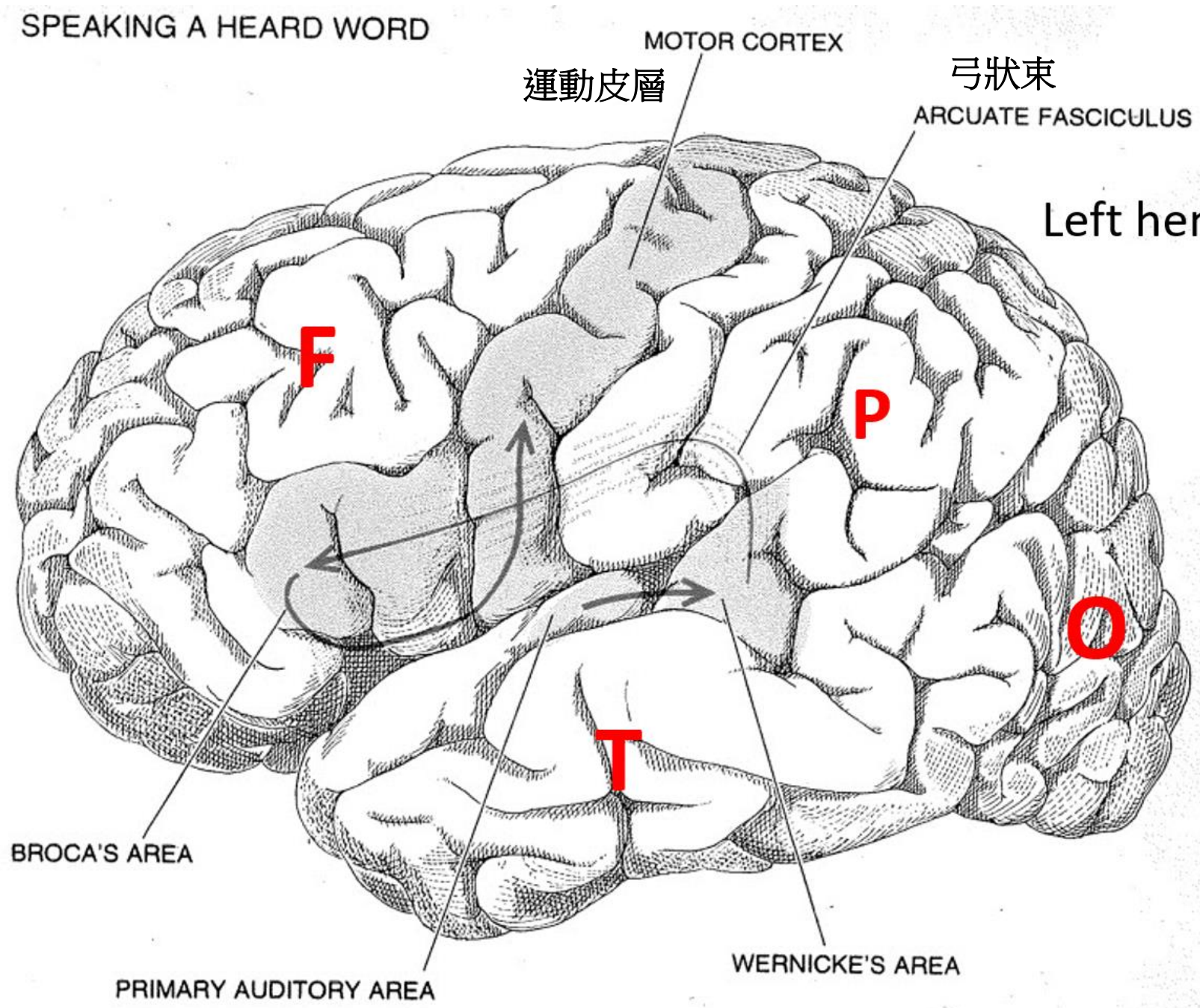
hominin

南方古猿 Australopithecus
巧人 Homo habilis
直立人 Homo erectus
智人 Homo sapiens



	Human	Chimpanzee 黑猩猩	Gorilla 大猩猩	Orangutan 红毛猩猩	Gibbon 長臂猿	Old World monkeys	New World monkeys
Millions of years since last common ancestor with human	---	5–7	7–9	~14	~18	~25	35–40
Genetic difference from human	---	~1.2%	~1.6%	~3.1%	~4.0%	~6.5%	~11.5%
Brain volume in cm^3	1129–1685	230–415	400–565	300–400	70–152	33–205	74–123

TRENDS in Neurosciences



Reprinted in 王士元 *2008.*
語言湧現: 發展與演化.
中央研究院 語言學研究所.

Left hemisphere & its four lobes:

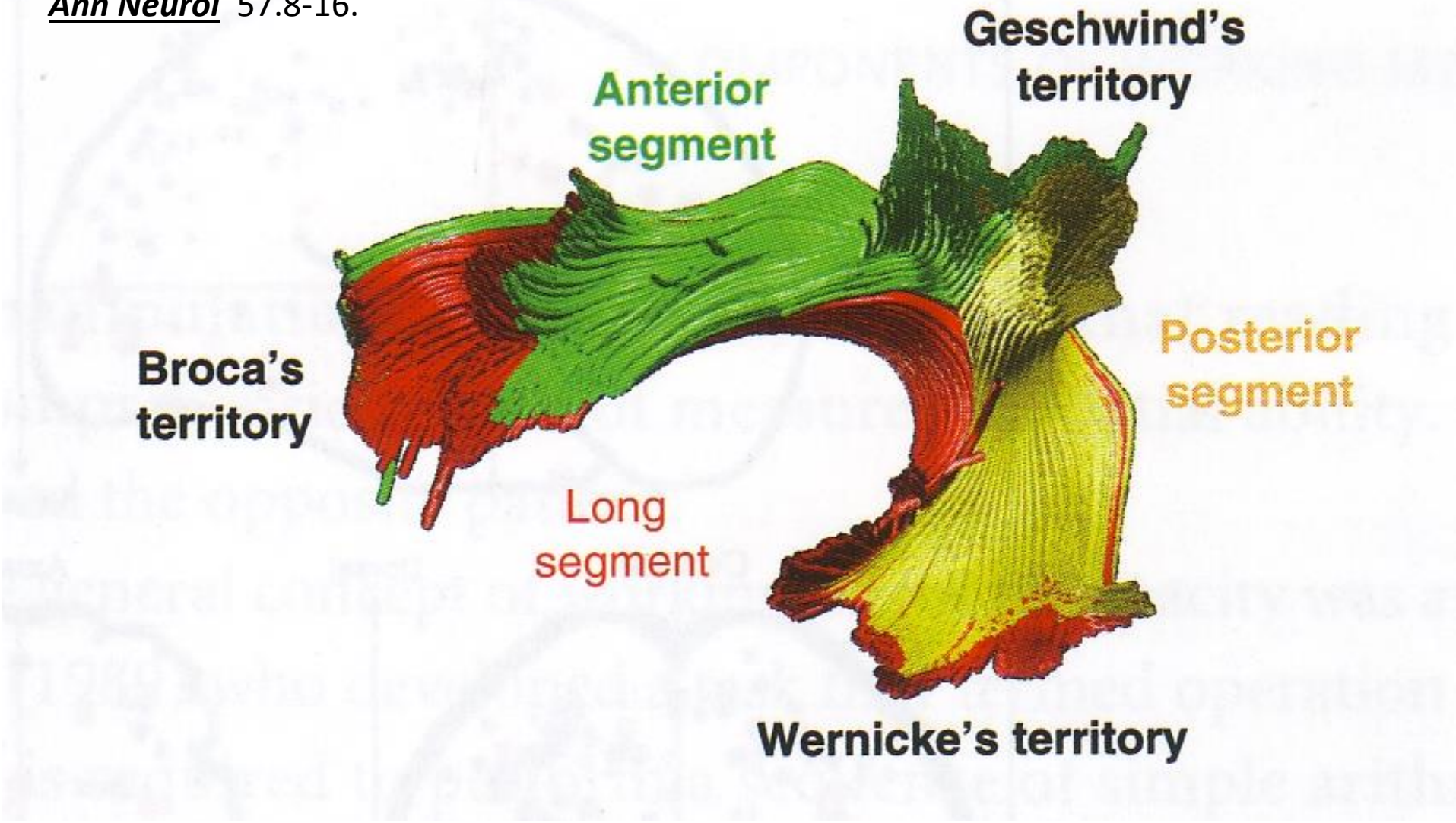
Frontal, 額葉
Parietal, 頂葉
Temporal, 顳葉
Occipital. 枕葉

Geschwind, Norman. 1979.

Specializations of the human brain.

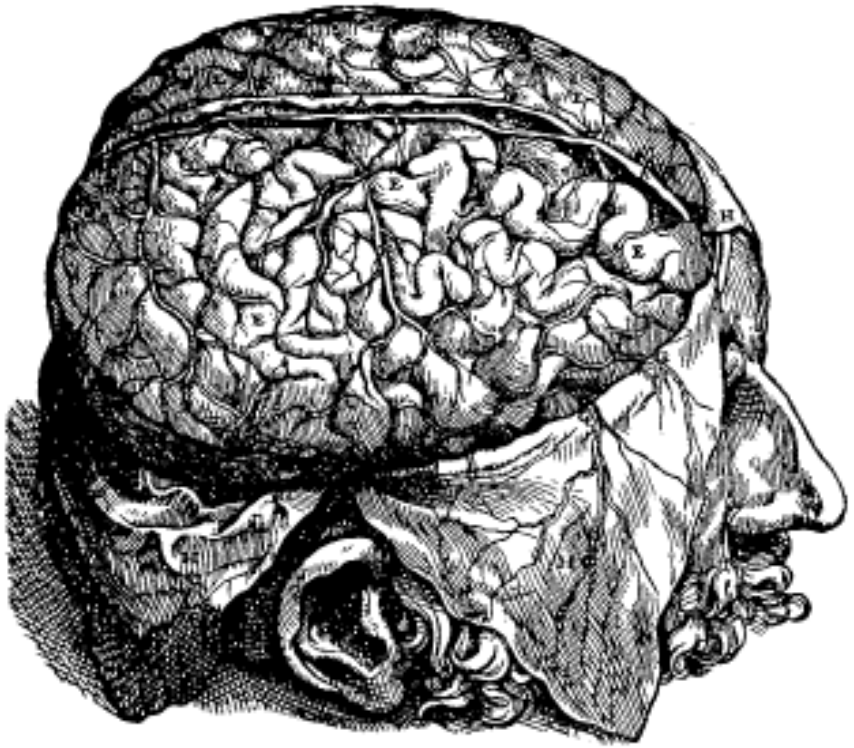
Scientific American 241.158-68.

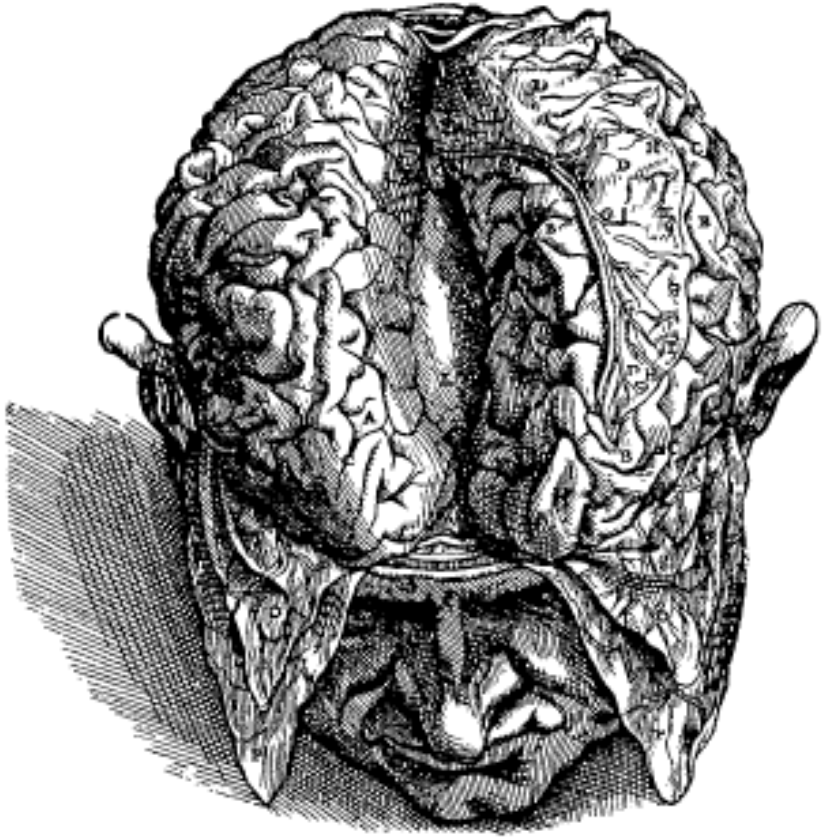
Catani, Marco, Derek K. Jones & Dominic H. ffytche. 2005.
Perisylvian Language Networks of the Human Brain.
Ann Neurol 57.8-16.

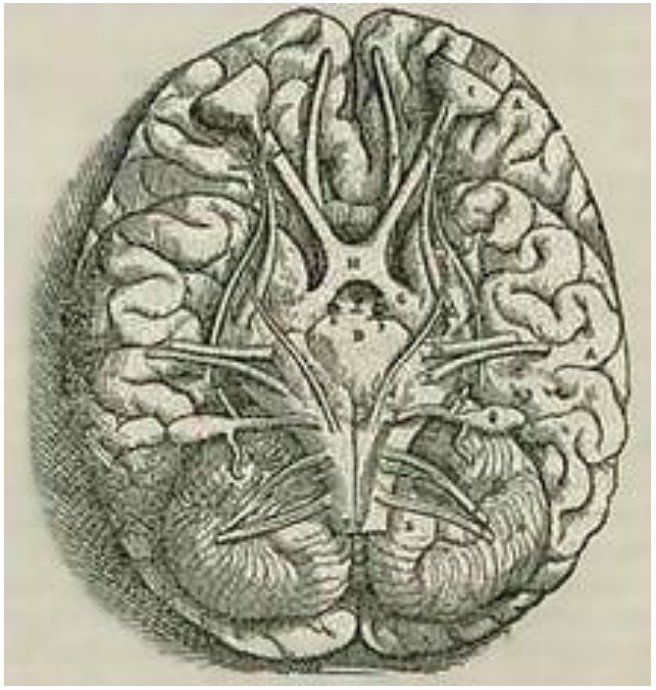


‘This is from perhaps the most important book in the history of medicine, the "***Fabric of the Human Body***", published in 1543 by Andreas Vesalius.’

Fundamental Neuroscience, 2 ed. 2003:40.



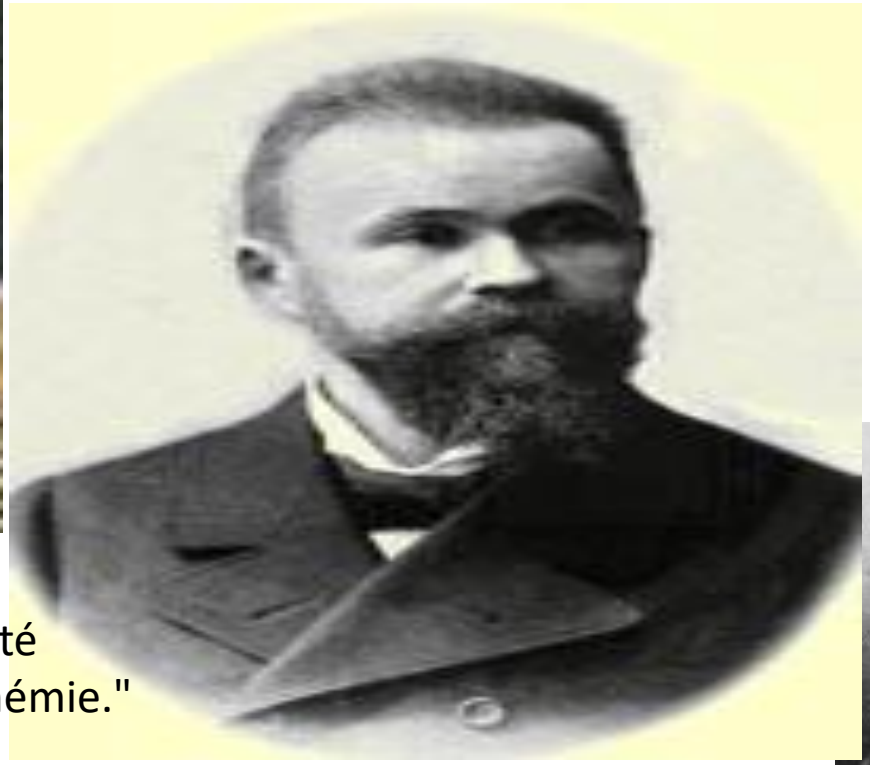




Three pioneers in studies of Language Disorders & Brain.

研究語言障礙的三位先驅。

Paul Pierre Broca (1824- 1880)



Carl Wernicke
(1848-1904)

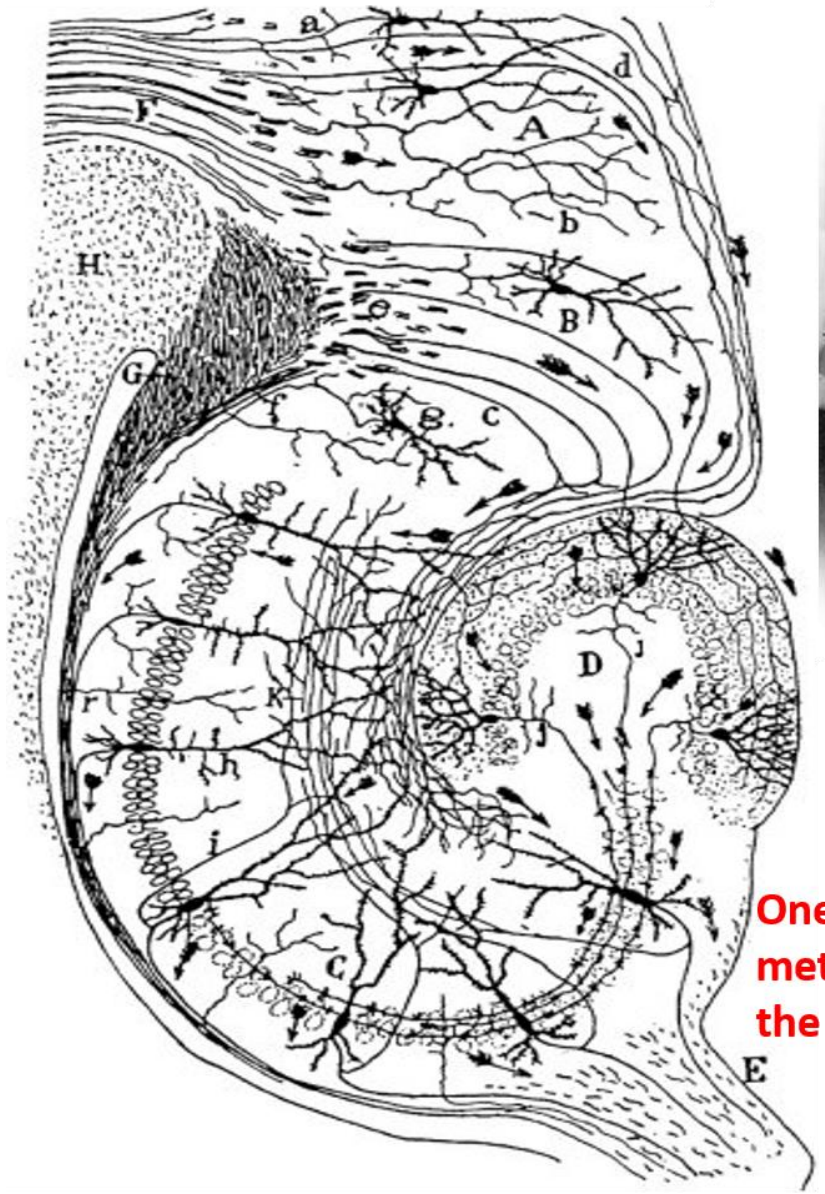
Jules Dejerine
(1849-1917)

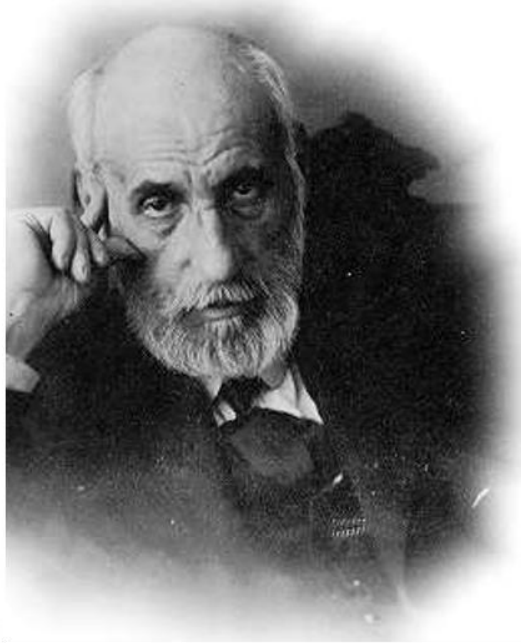
Broca, P. (1861). "Remarques sur le siège de la faculté du langage articulé; suivies d'une observation d'aphémie." Bulletin de la Société d'Anthropologie 2: 330-357.

Broca, P. (1861). "Nouvelle observation d'aphémie produite par une lésion de la moitié postérieure des deuxième et troisième circonvolution frontales gauches." Bulletin de la Société Anatomique 36: 398-407.

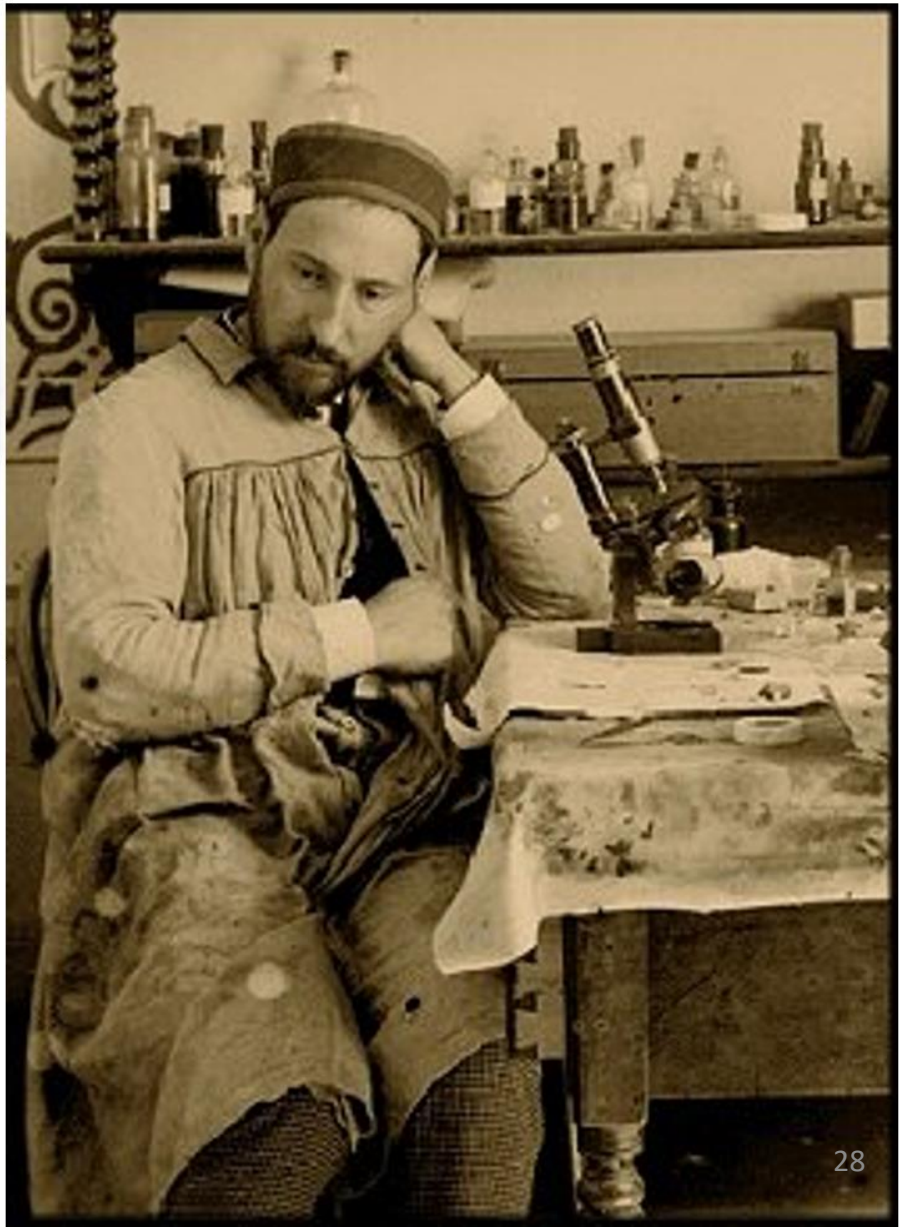
Ramon Santiago y Cajal

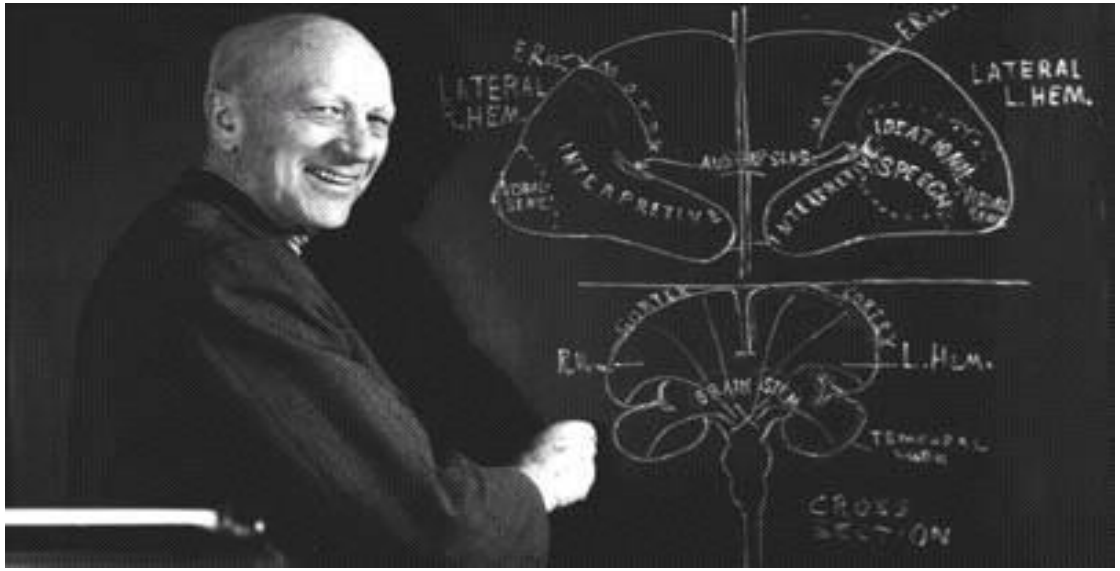
1852-1934. Nobel Prize 1906.





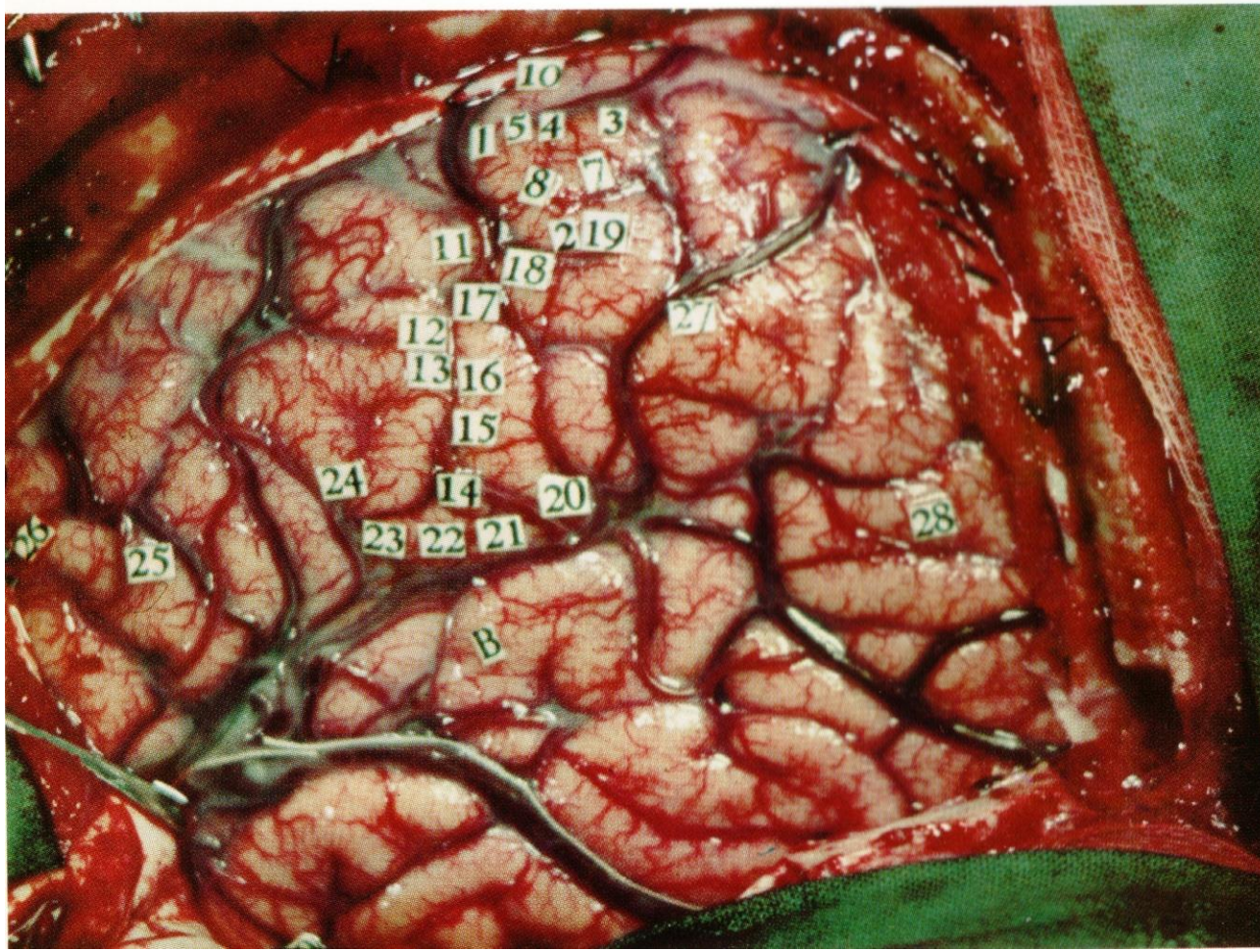
One of Cajal's numerous meticulous drawings of the brain's neural circuits.





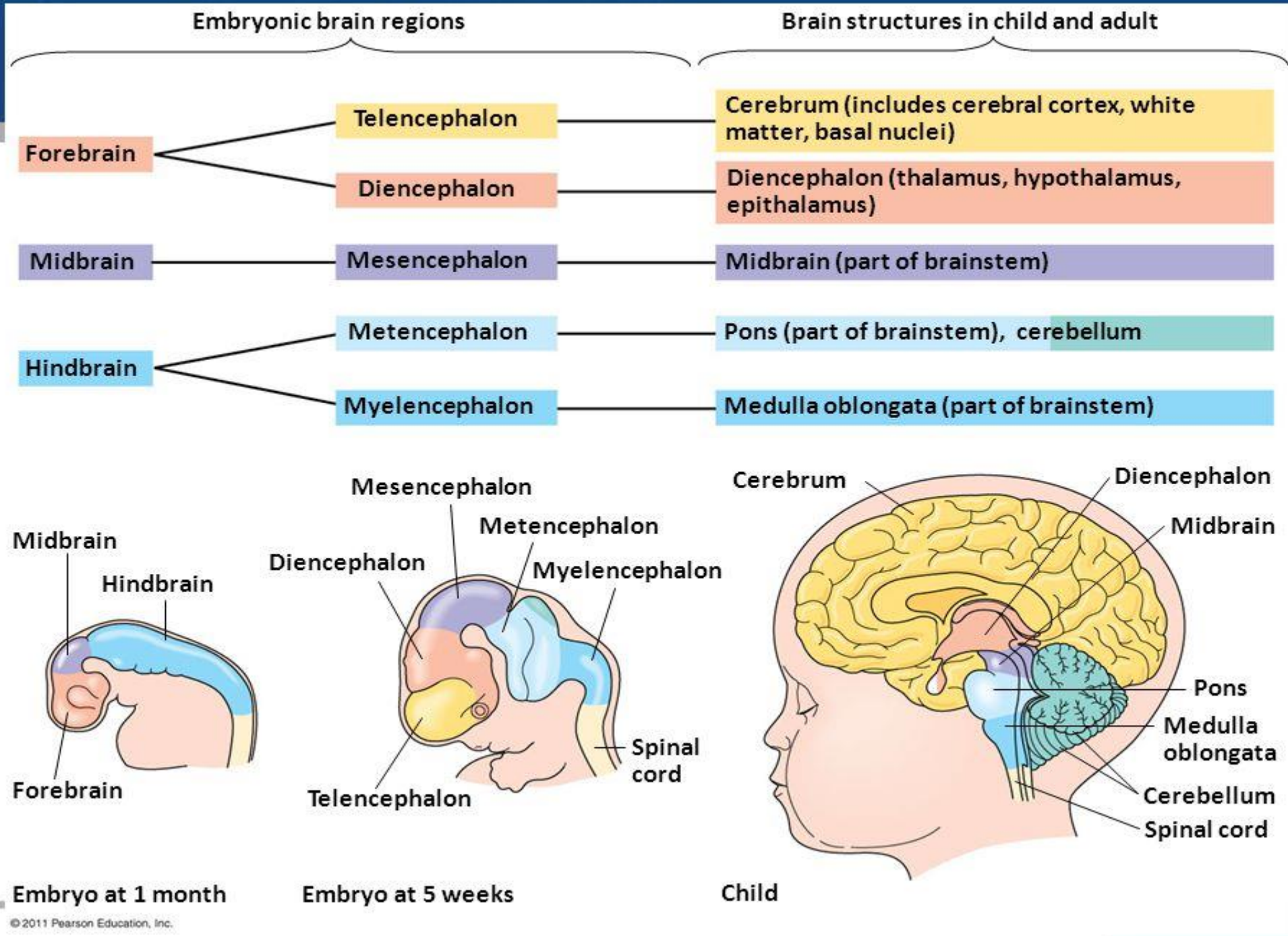
Wilder Penfield 1891-1976.

Before the age of nine to twelve, a child is a specialist in learning to speak. At that age he can learn two or three languages as easily as one. …
… for the purposes of learning languages, the human brain becomes progressively stiff and rigid after the age of nine. [1939; reprinted 1959:235.]



Penfield, W. & L. Roberts. **1959**. *Speech & Brain Mechanisms*. Princeton U.P.

Penfield, Wilder. **1965**. Conditioning the uncommitted cortex for language learning ***Brain*** 88.787-98.



© 2011 Pearson Education, Inc.

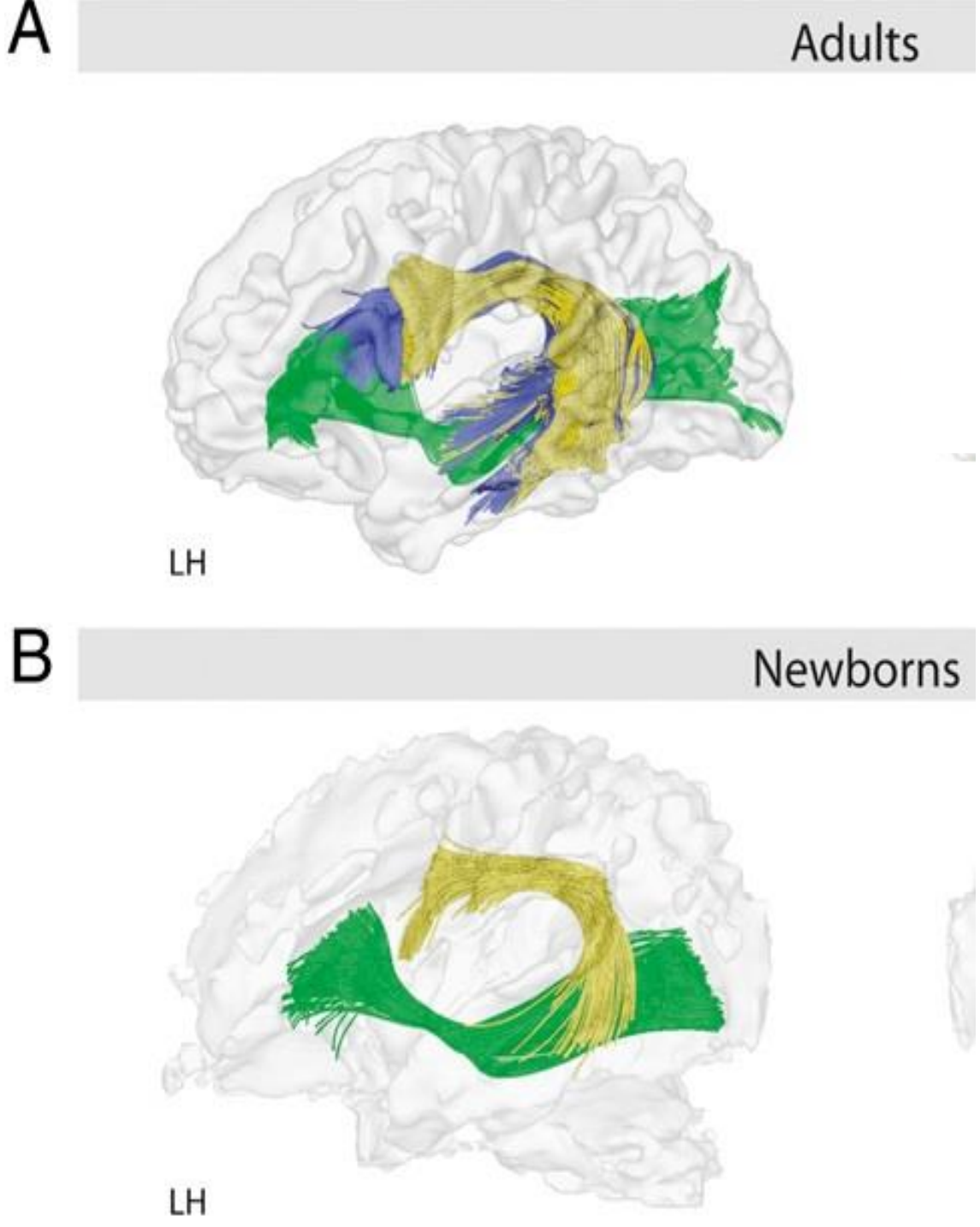
"Four orofacial gestures of a fetus at approximately 28 weeks GA.

(Top left) Grimacing;
(Top right) Finger sucking;
(Bottom left) TP to the side;
(Bottom right) tongue thrust. "

Keven, N. & K.Akins. 2016.

Neonatal Imitation in Context: Sensory-Motor Development in the Perinatal Period.

Behavioral and Brain Sciences Fig.2.

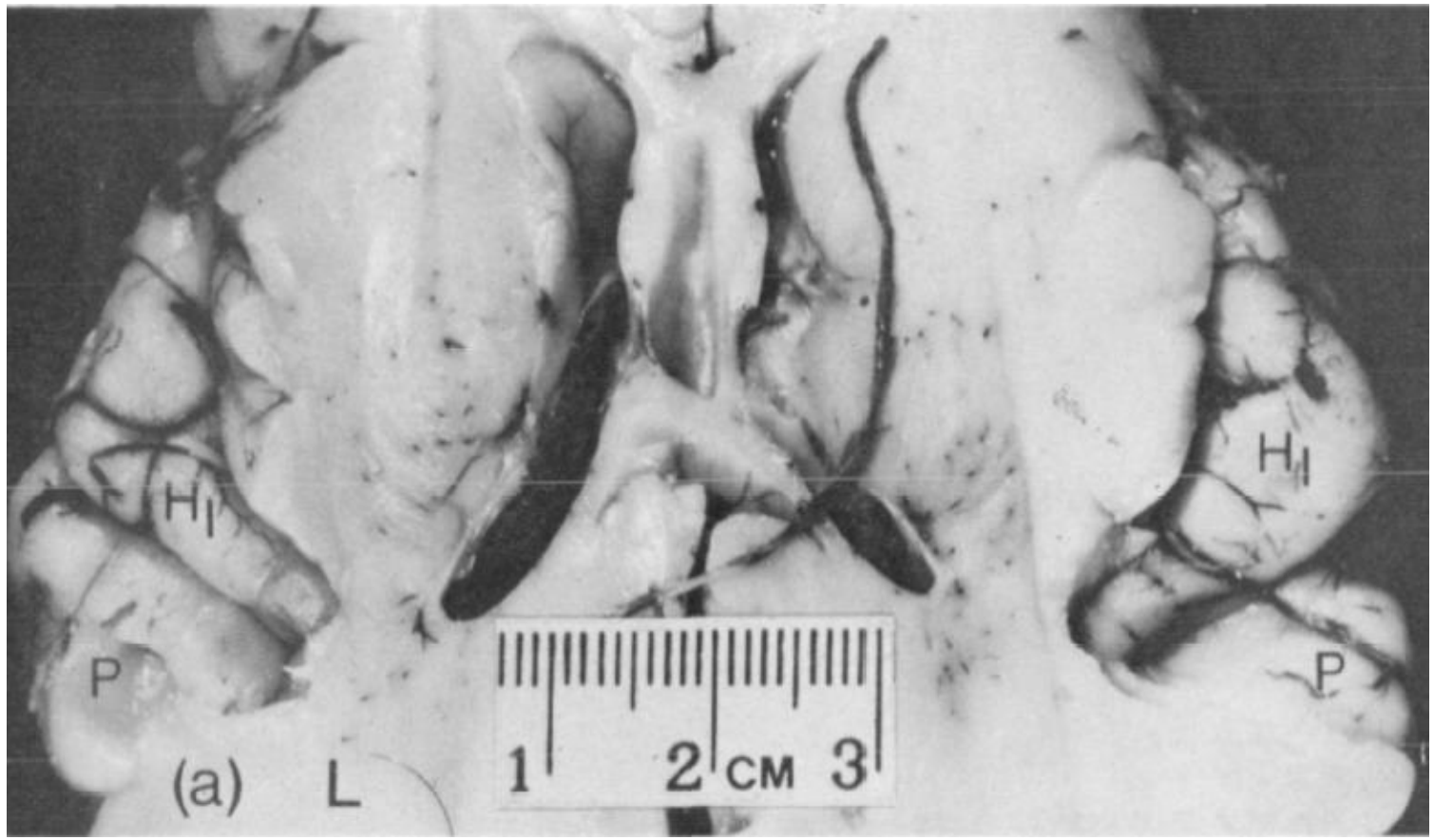


Perani, Daniela, et al. 2011.

Neural language networks at birth.

PNAS 108.16056–61.

WITELSON, S. F. & W. PALLIE. 1973.
Left hemisphere specialization for language in the newborn
Neuroanatomical evidence of asymmetry. *Brain* 96.641-46.



infant brain
2 days old

The size of the left-right difference in the neonates was proportionately at least as large as that in the adult sample. A possible sex difference in left-right asymmetry of the planum in neonates was also observed. The anatomical difference was not as marked for males as for females within the first few days of life.

Kuhl, P. K., et al. 2008. Phonetic learning as a pathway to language. *Phil. Trans. R. Soc. B* 363.979–1000.

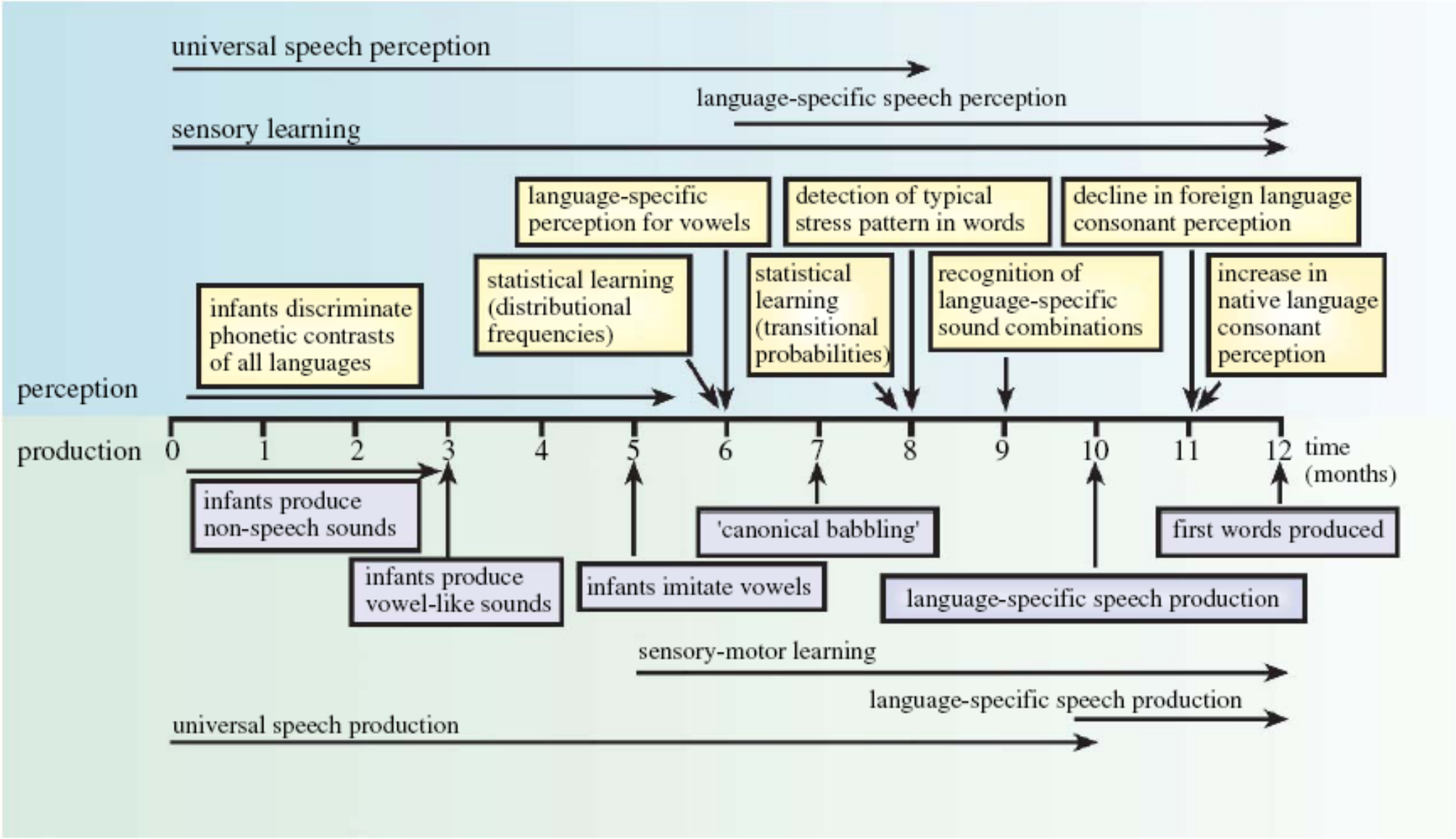
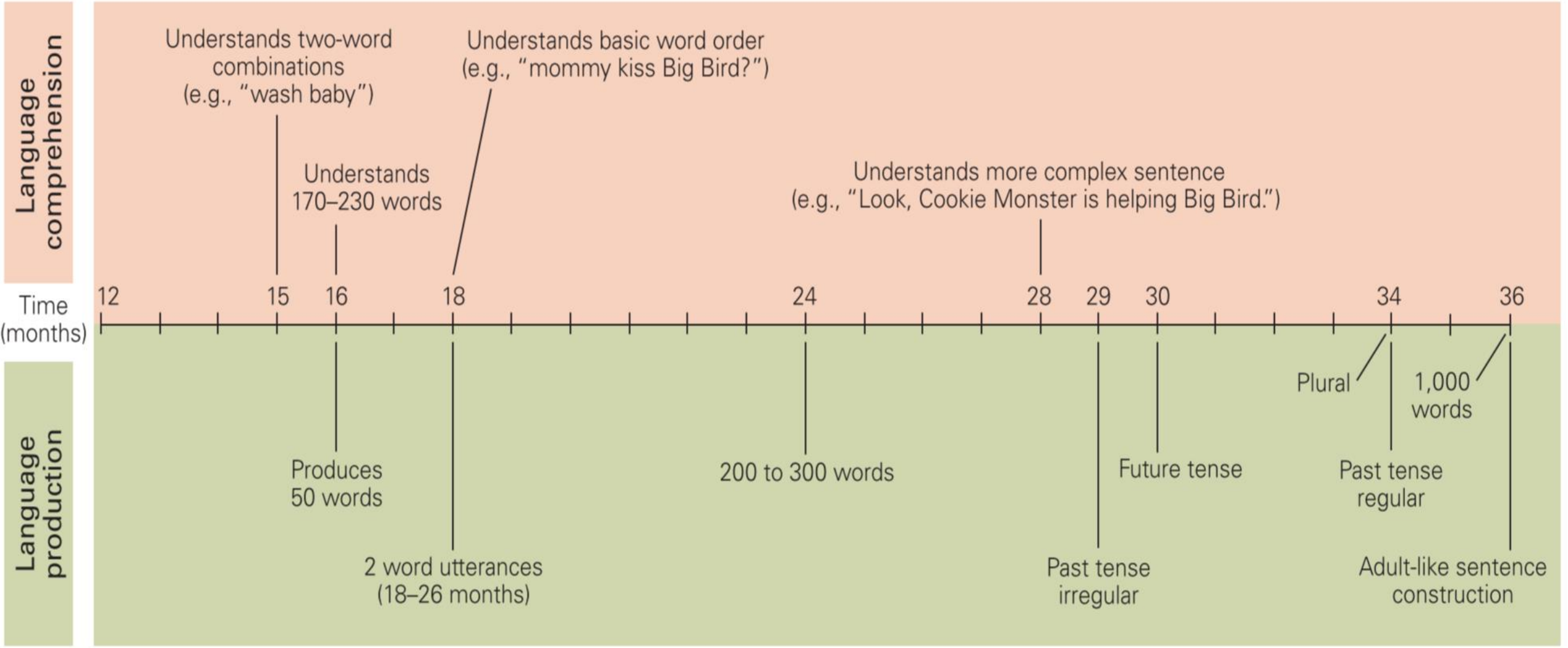


Figure 1. Universal timeline of infants' perception and production of speech in the first year of life. Modified from Kuhl (2004).



Kuhl, P. K., & Damasio, A. R. (2013). In E. R. Kandel, et al. (Eds.)

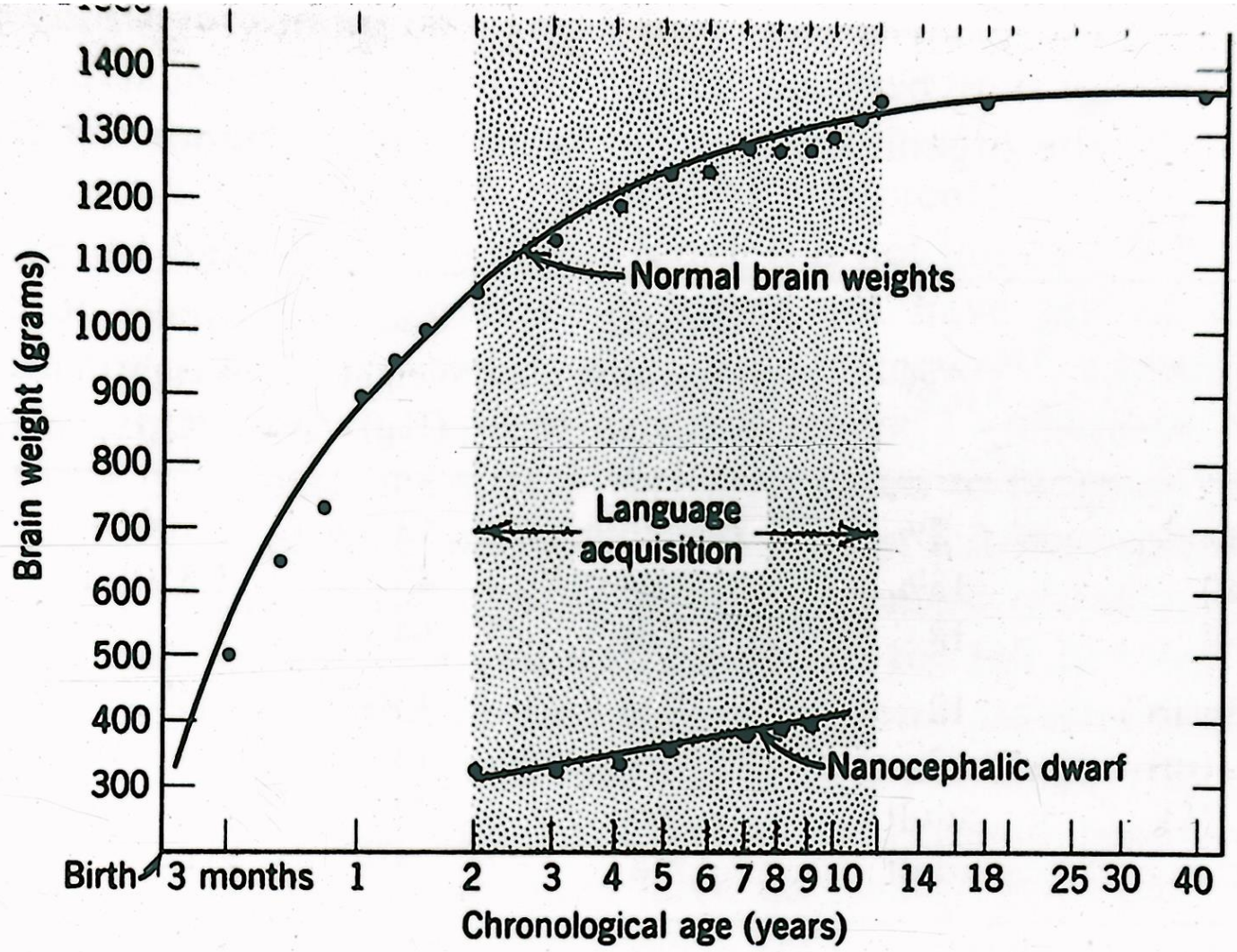


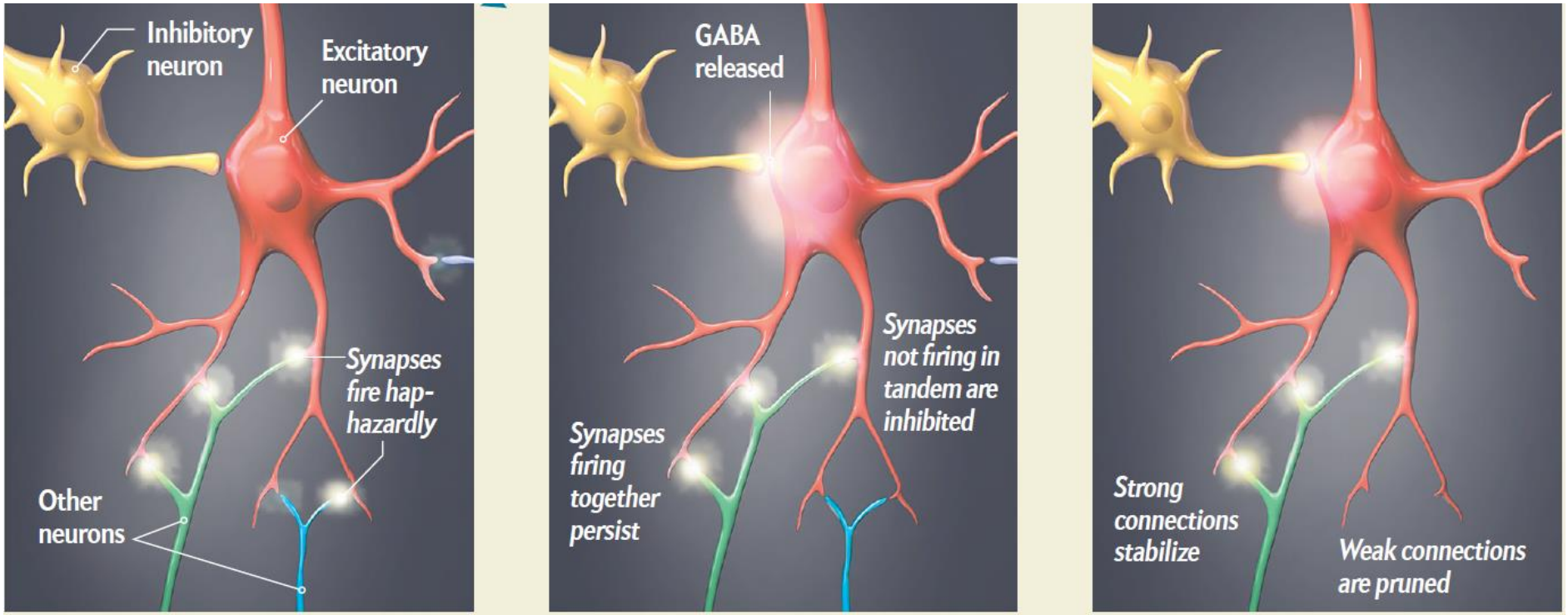
FIG. 2.25. Brain weights determined at autopsy plotted as function of patients' chronological age; data from Coppoletta and Wolbach (1933). *Bottom plot:* various measurements of head-circumference of patient described by Seckel (1960), converted to estimates of brain weight.

Lenneberg, E. H. (1967).

Biological Foundations of Language.

Wiley.

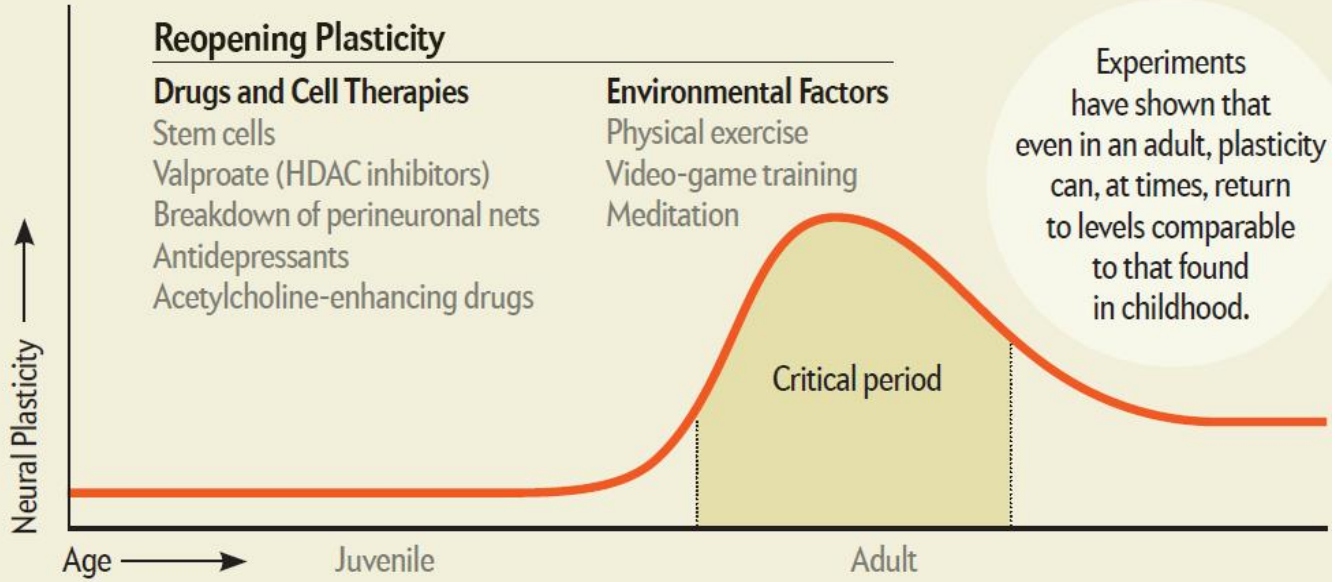
See also: Wang, W. S.-Y. (2018). Critical Periods for language. Comment on 'Rethinking foundations of language from a multidisciplinary perspective by T. Gong et al.'
Physics of Life Reviews 26-27: 179-183.



Hensch, T. K. (2016). "The power of the infant brain." Scientific American Febr: 64-9.

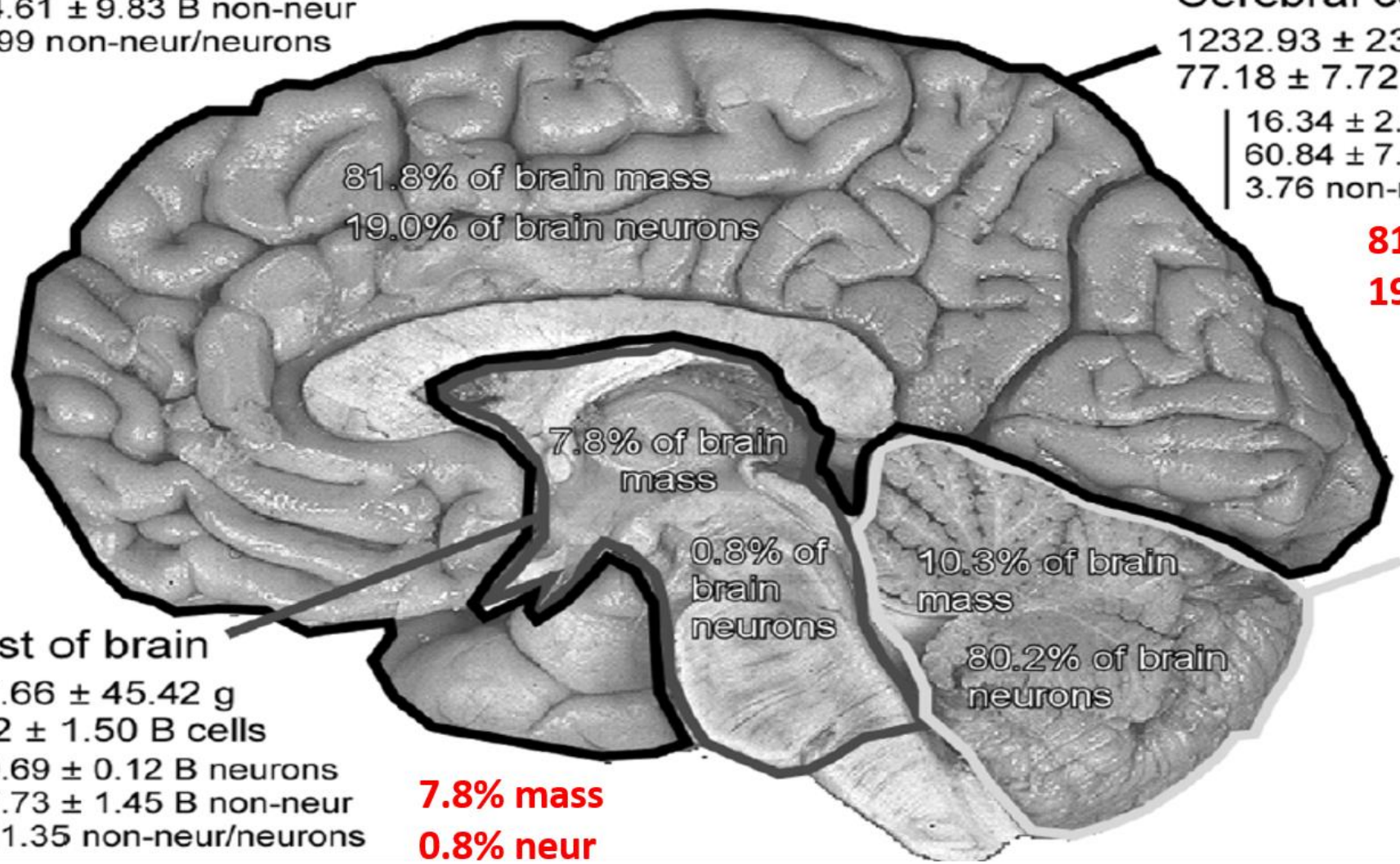
A Restart

Understanding of the molecular processes in the brain that bring about the plasticity of the critical period has enabled scientists to use drugs or behavioral measures, such as physical exercise, to demonstrate that the brain's connections can be molded at much later ages than once thought possible.



Azevedo, F. et al. 2009. Equal numbers of neuronal and nonneuronal cells make the human brain an isometrically scaled-up primate brain. *Journal of Comparative Neurology* 513.532-41.

Whole brain
1508.91 ± 299.14 g
170.68 ± 13.86 B cells
- 86.06 ± 8.12 B neurons
- 84.61 ± 9.83 B non-neur
- 0.99 non-neur/neurons



Cerebral cortex (GM+WM)
1232.93 ± 233.68 g
77.18 ± 7.72 B cells
- 16.34 ± 2.17 B neurons
- 60.84 ± 7.02 B non-neur
- 3.76 non-neur/neurons

81.8% mass
19.0% neur

Rest of brain
117.66 ± 45.42 g
8.42 ± 1.50 B cells
- 0.69 ± 0.12 B neurons
- 7.73 ± 1.45 B non-neur
- 11.35 non-neur/neurons

7.8% mass
0.8% neur

Cerebellum
154.02 ± 19.29 g
85.08 ± 6.92 B cells
- 69.03 ± 6.65 B neurons
- 16.04 ± 2.17 B non-neur
- 0.23 non-neur/neurons

10.3% mass; 80.2% neur

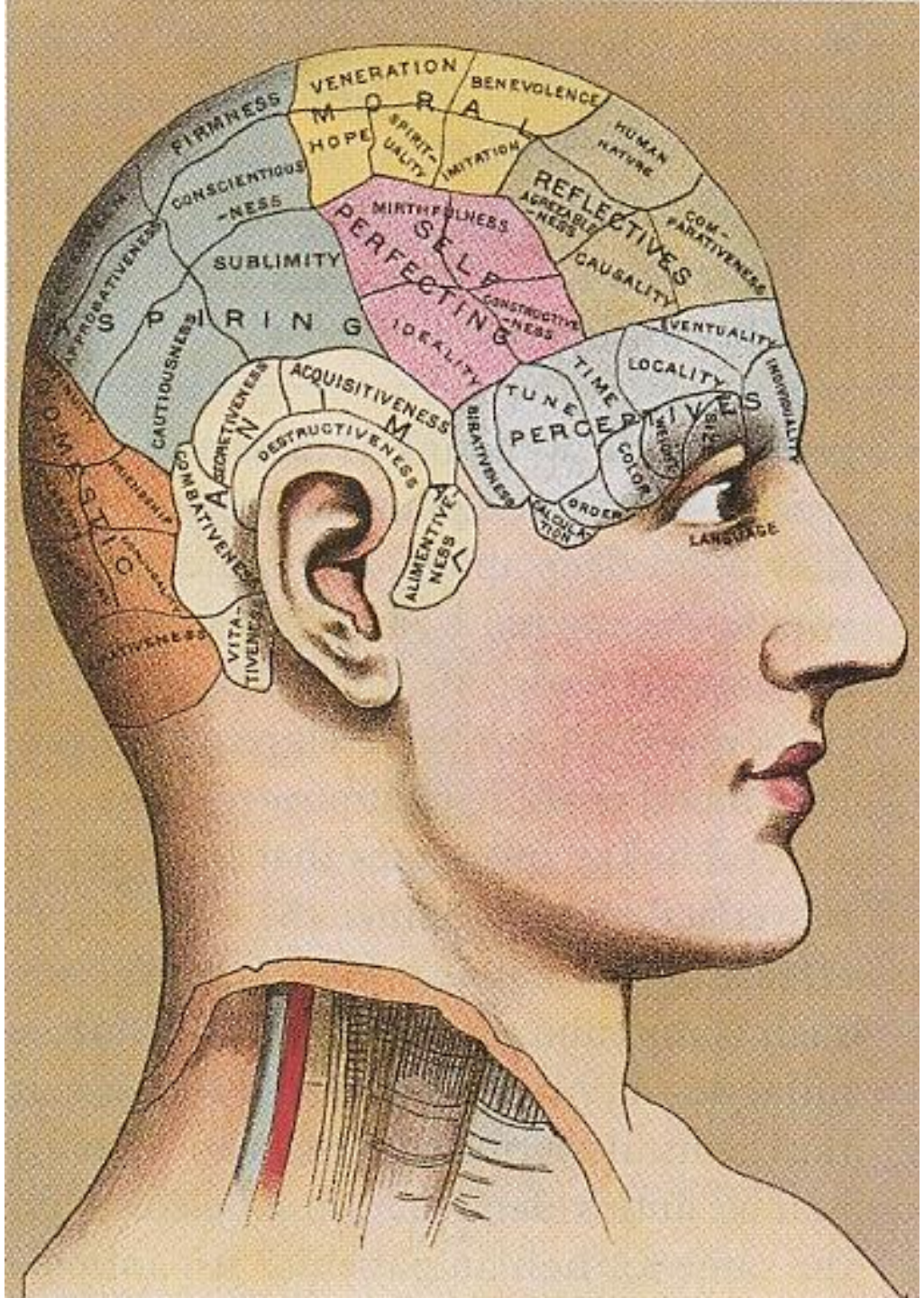
"The status of linguistics as a science". ***LANGUAGE*** 1929.

p.214: "**It is peculiarly important that linguists**, who are often accused, and accused justly, of failure to look beyond pretty patterns of their subject matter, **should become aware of what their science may mean for the interpretation of human conduct in general**."

Photo by Florence M. Hendershot, Chicago, Ill.

"语言学家时常被指控无法跳脱研究主题的优美模式,这样的指控并不为过,所以这些人必须意识到,他们的语言科学所探讨的结果,应该也适用于对人类一般行为的诠释。"

Edward Sapir
1834-1939



Blunders about the brain.

Aristotle 以为大脑的功能是让血液冷却。

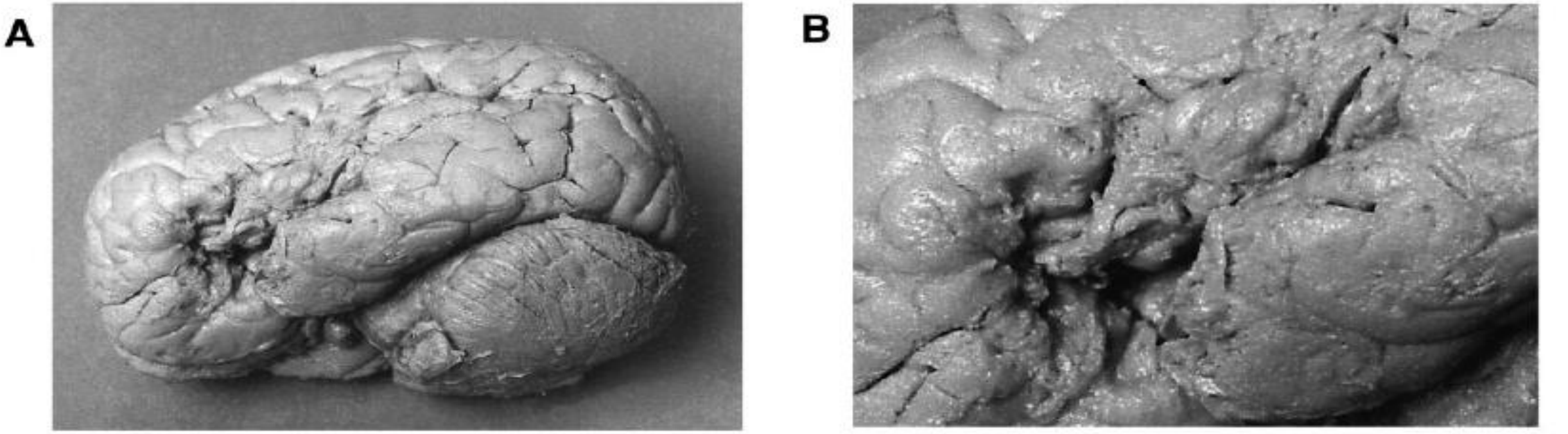
Localization in Phrenology
19世纪想象中的大脑组织。

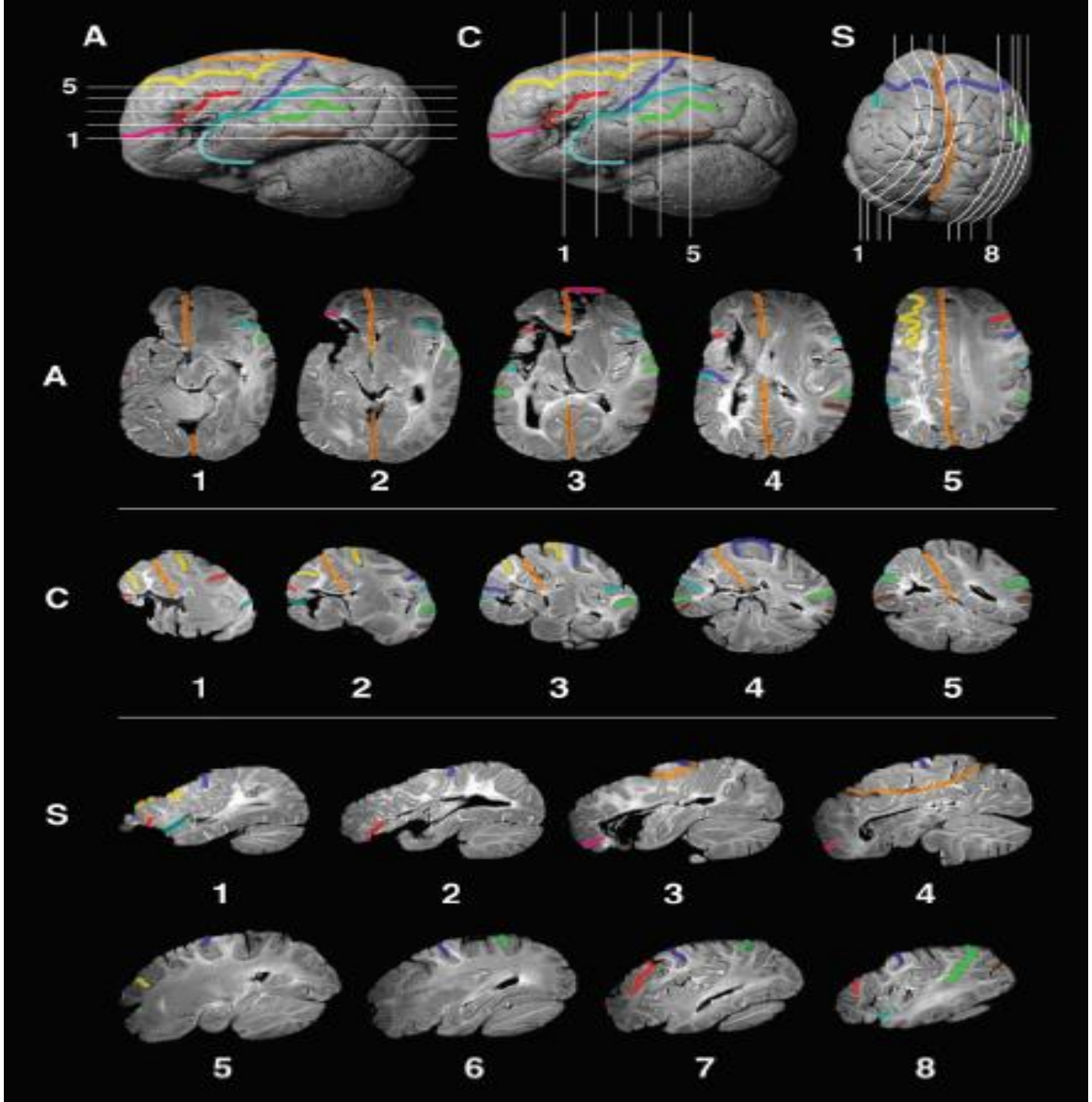
Tremblay, P. and A. S. Dick (2016).

Broca and Wernicke are dead, or moving past the classic model of language neurobiology.

Brain & Language 162: 60-71.

Dronkers, N. F., O. Plaisant, M. T. Iba-Zizen & E. A.Cabanis. 2007. Paul Broca's historic cases: high resolution MR imaging of the brains of Leborgne and Lelong. *Brain* 130.1432-41.



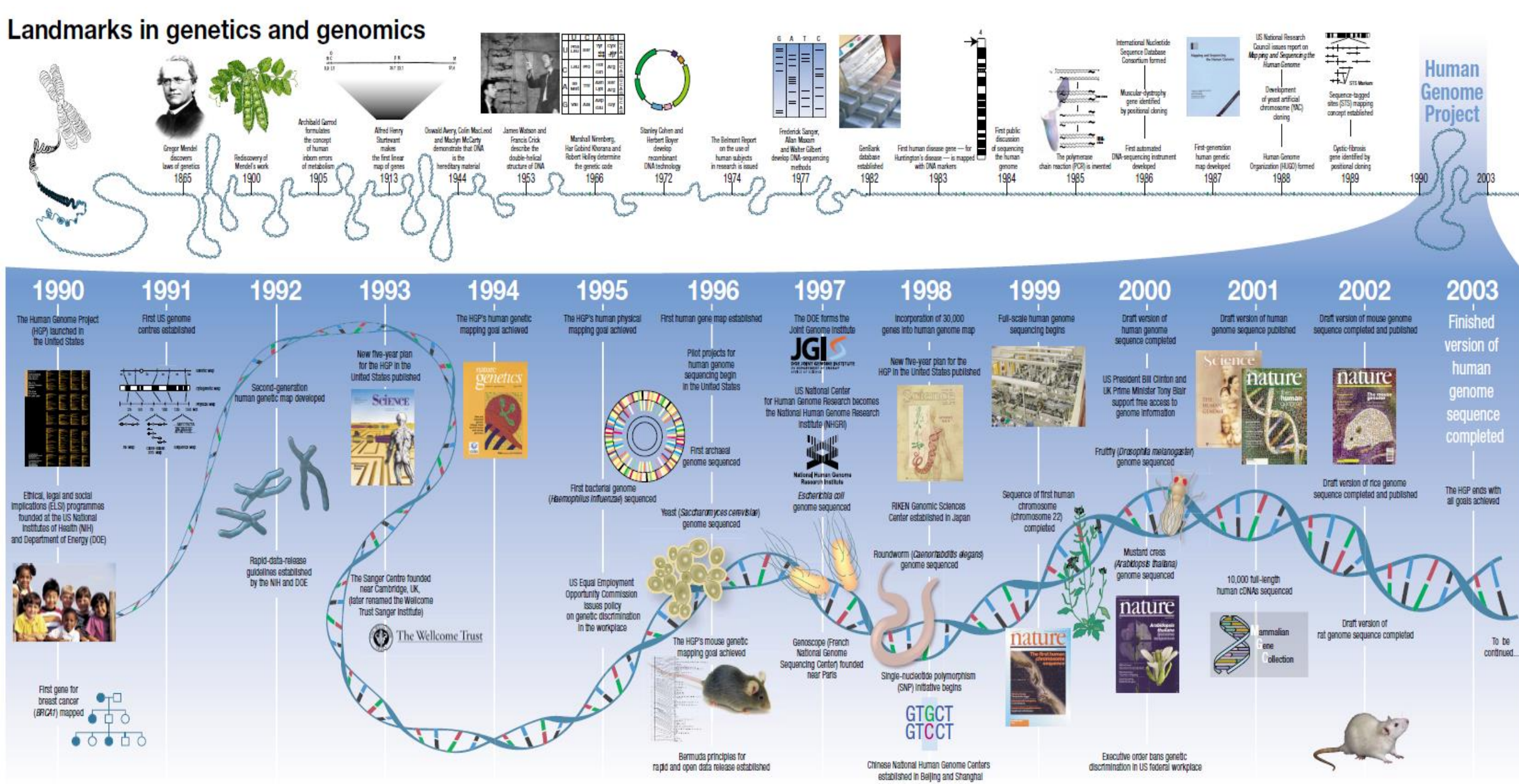


Dronkers, N. et al. 2007.

Paul Broca's historic cases: high resolution MR imaging of the brains of Leborgne & Lelong.

Brain 130.1432-41. Fig.4.

"Sagittal, axial and coronal slices through the brain reveal lesions in the left inferior frontal gyrus, deep inferior parietal lobe and anterior superior temporal lobe. In addition, there is extensive subcortical involvement including the claustrum, putamen, globus pallidus, head of the caudate nucleus and internal and external capsules. The insula is completely destroyed. The entire length of the superior longitudinal fasciculus is also obliterated, along with other frontal-parietal periventricular white matter. The medial subcallosal fasciculus is also affected." *p.1436.*



Downloaded from U.S. National Human Genome Research Institute, 2023.0325.

Svante Pääbo

Neanderthal Man

In Search of Lost Genomes

New York 2014
Basic Books

Major breakthrough in studying prehistory:

ANCIENT DNA

从化石中萃取DNA！

Just won the 2022

NOBEL PRIZE

for Physiology or Medicine.

Professor Charles Kuen Kao (高錕) (1933-2018), was the recipient of a Nobel Prize in Physics in 2009, & was known as the
"Father of Fibre Optics".
He had Alzheimer's Disease, as did his father.

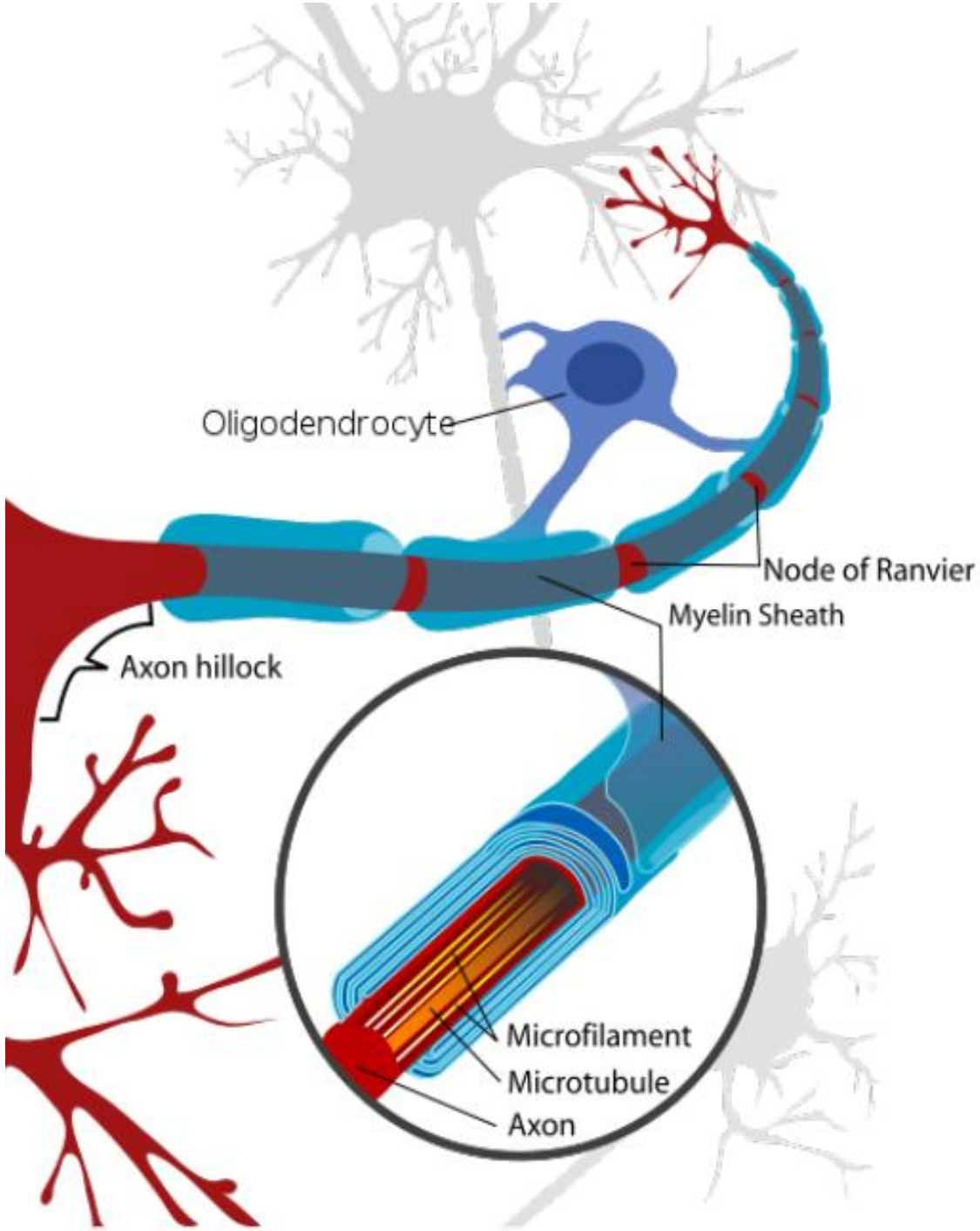
www.thelancet.com/healthy-longevity **Vol 3 July 2022.**

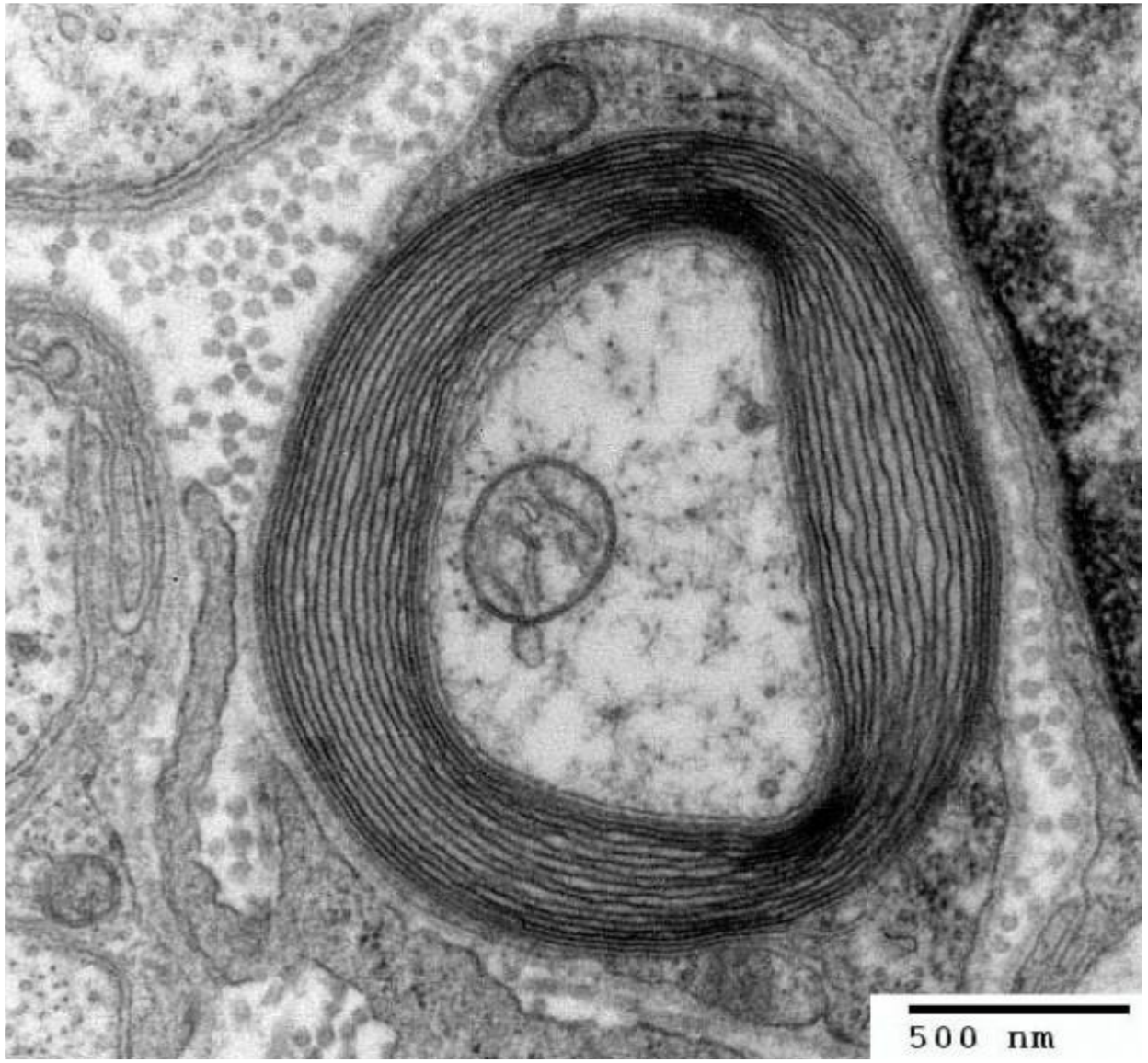
How "old age" was withdrawn as a diagnosis from ICD-11

Published Online
June 2, 2022
https://doi.org/10.1016/
S2666-7568(22)00102-7

The classification of the causes of death and diseases dates back to the 18th century. The International Statistical Institute adopted the first international classification of diseases in 1893. After 1948, WHO assumed responsibility for publishing the International Classification of Diseases (ICD) as a global, multilingual catalogue of known human diseases, medical conditions, and mental health disorders, to standardise disease diagnosis. The 11th revision (ICD-11) was and progress in older ages". The intention for including the additional code was to provide a greater focus on the biological aspects of ageing in global health policy and better opportunities for the development of new biological therapies. However, because of societal ageism, and because biological ageing and chronological ageing are not synonymous, the addition of these two codes left the ICD-11 proposal with potential for unintended negative consequences. We outline the

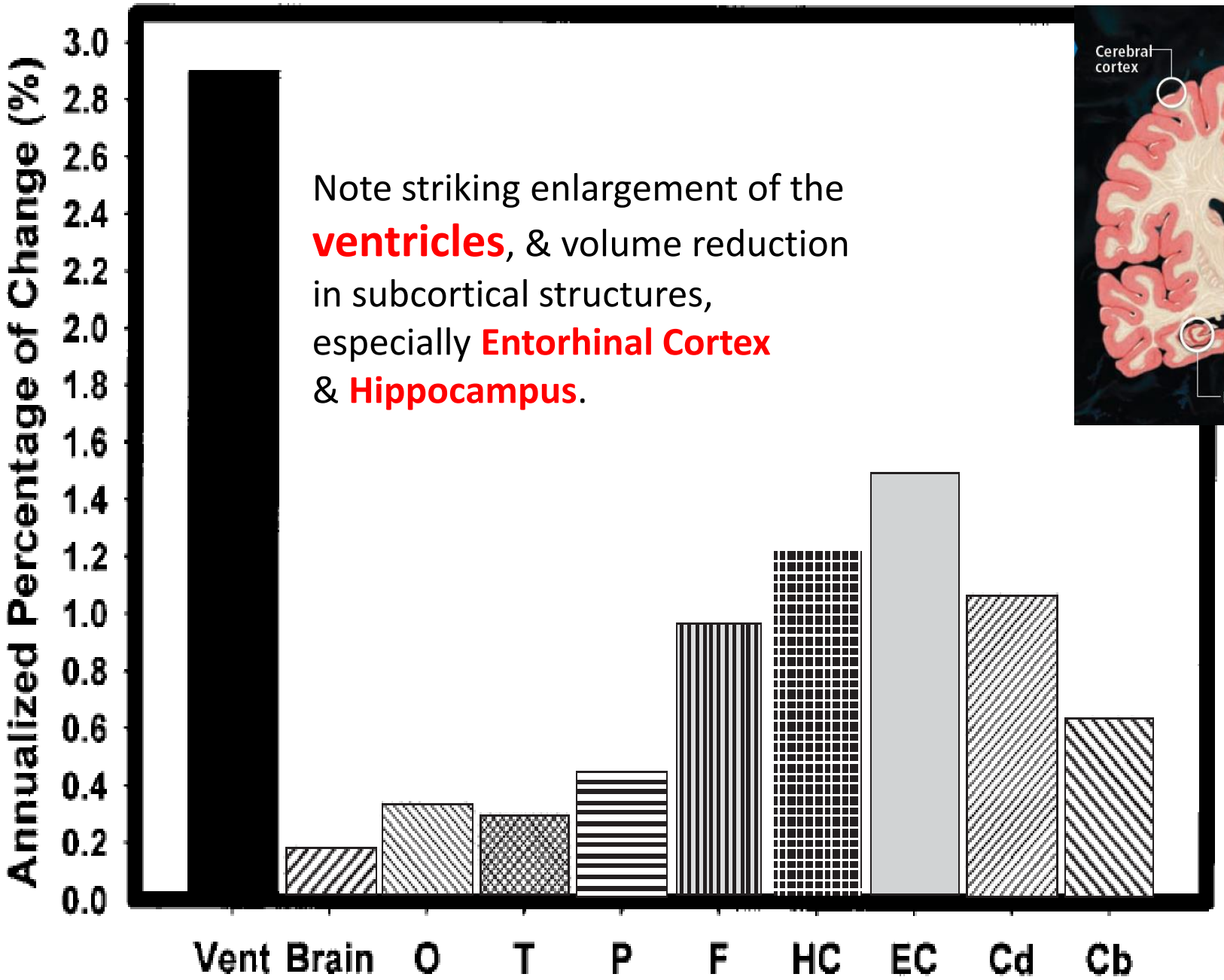
… Violations of older people's human rights have led to increased global attention and sensitivity to the topic of AGEISM.
… The response to our global advocacy effort was ultimately fruitful. WHO felt that our "dialogue helped to find a way forward in this matter" and allocated a dedicated process for review of the term "old age". The review led to the retraction of the term "old age" as a category title and index listings from ICD-11, having been replaced by "ageing associated decline in intrinsic capacity". Additionally, use of the term "pathological" as an extension code (XT9T) to describe the normal process of "ageing" has been replaced by the much more appropriate term, "biological".



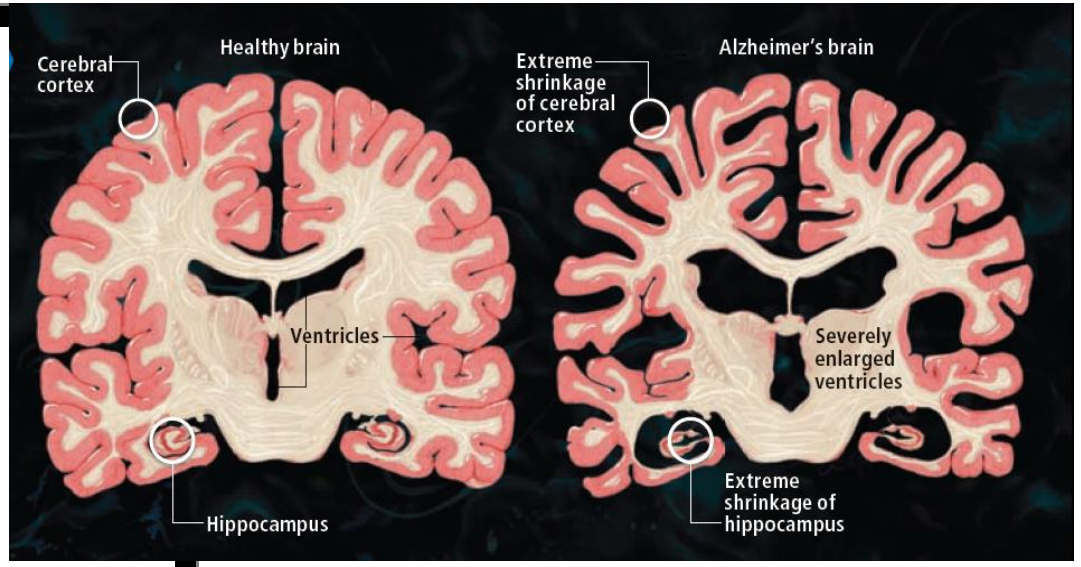


Transmission electron micrograph of a myelinated axon. The myelin layer (concentric) surrounds the axon of a neuron, showing cytoplasmic organs inside.

Generated and deposited into the public domain by the Electron Microscopy Facility at Trinity College. (Wikimedia Commons, Roadnottaken)

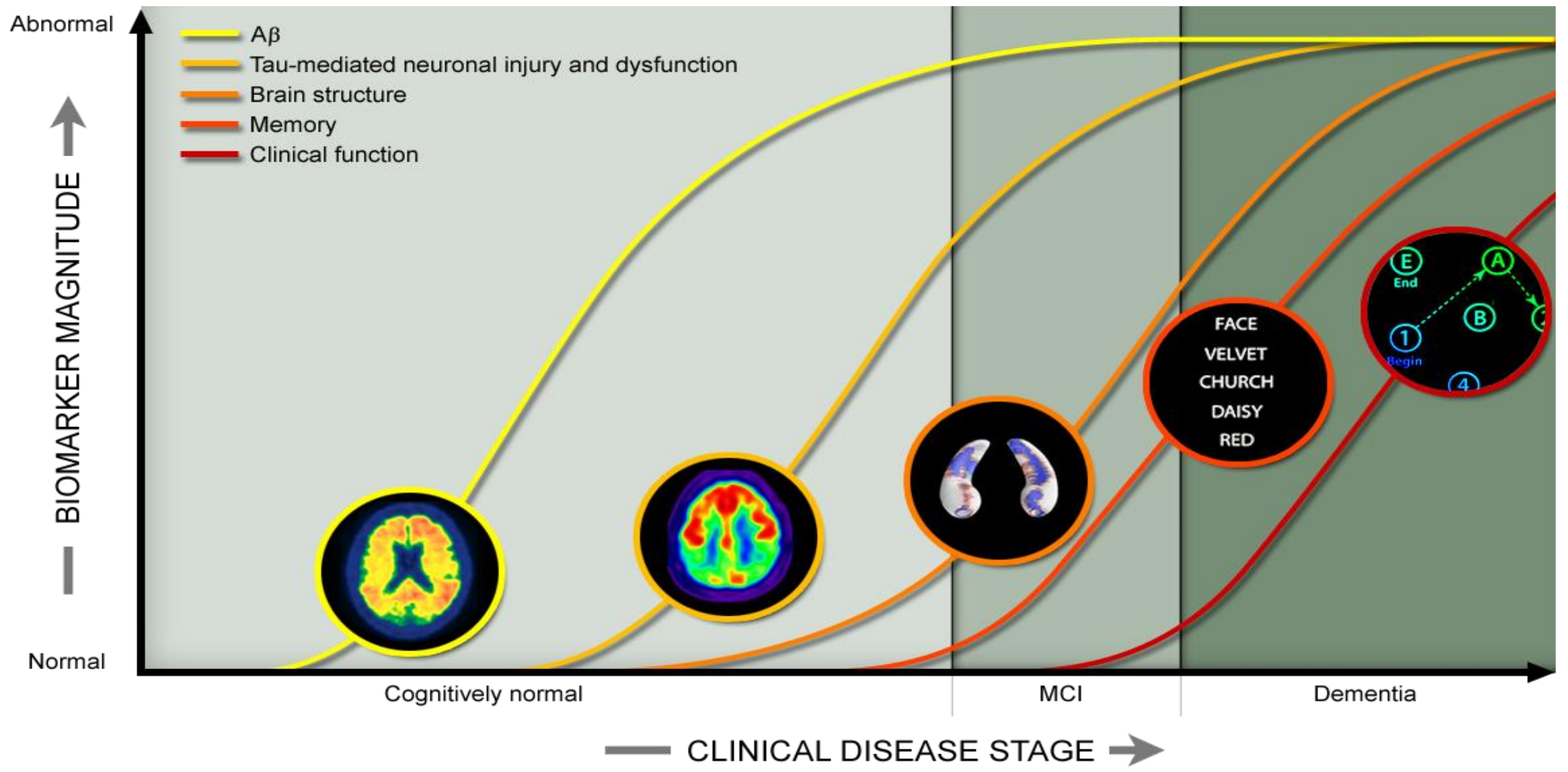


Note striking enlargement of the **ventricles**, & volume reduction in subcortical structures, especially **Entorhinal Cortex** & **Hippocampus**.

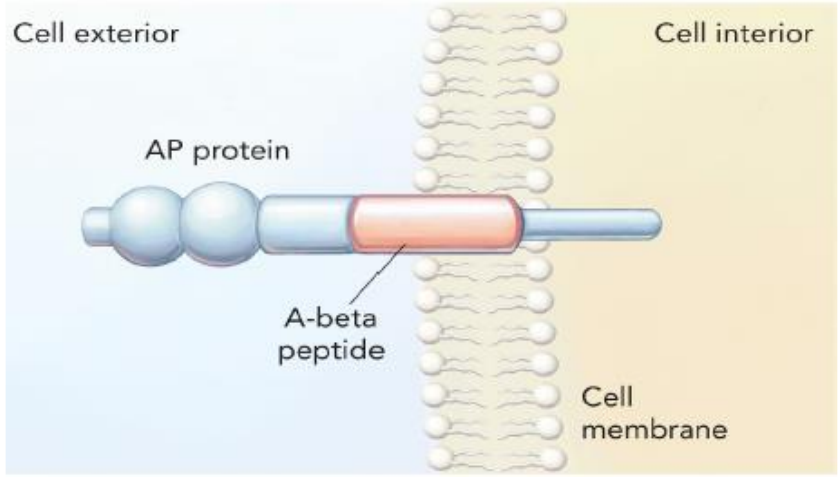


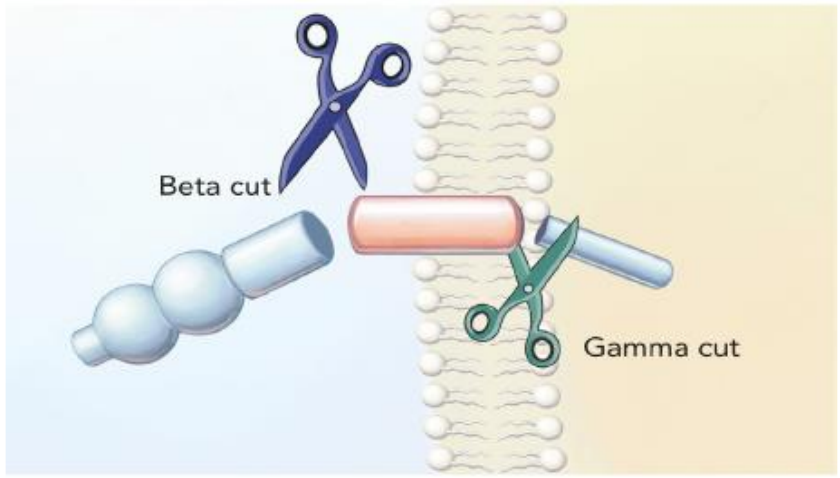
Cabeza, R.et al. eds. 2005:41. *Cognitive Neuroscience of Aging Linking Cognitive and Cerebral Aging*: Oxford University Press.

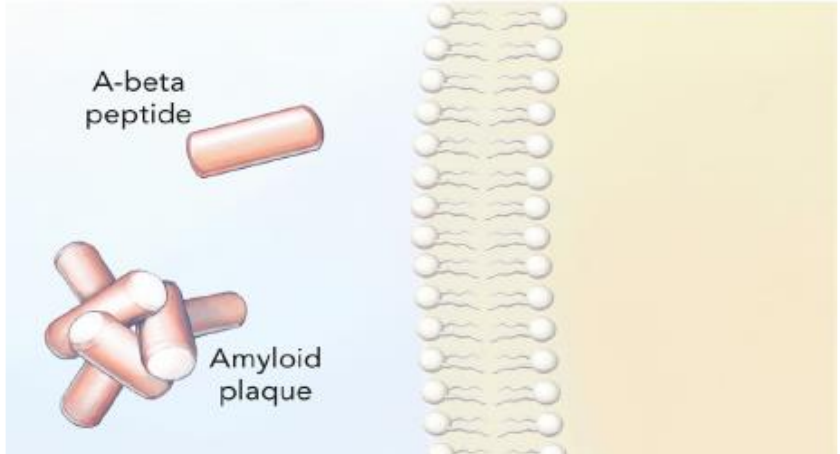
Stix, G. 2010. Alzheimer's: Forestalling the darkness. *Scientific American* 50-7.

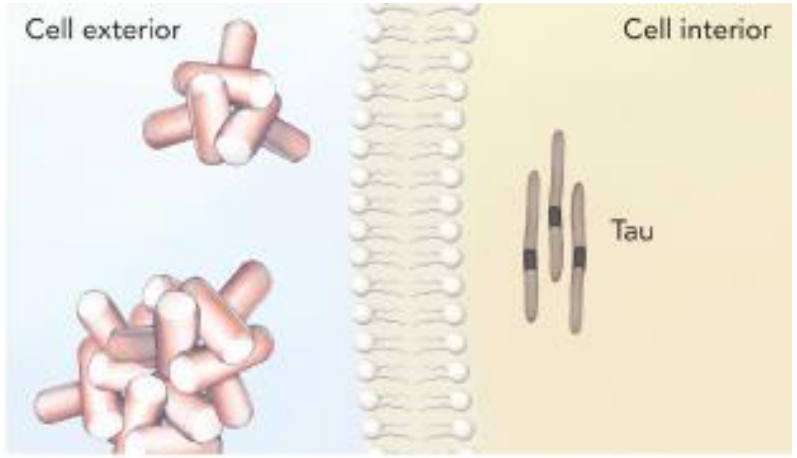


http://adni.loni.usc.edu/studydesign/background-rationale/ Based on Jack, C.R., et al. (2010). Hypothetical model of dynamic biomarkers of the Alzheimer's pathological cascade. *Lancet Neurol.* *9*(1), 119-128.









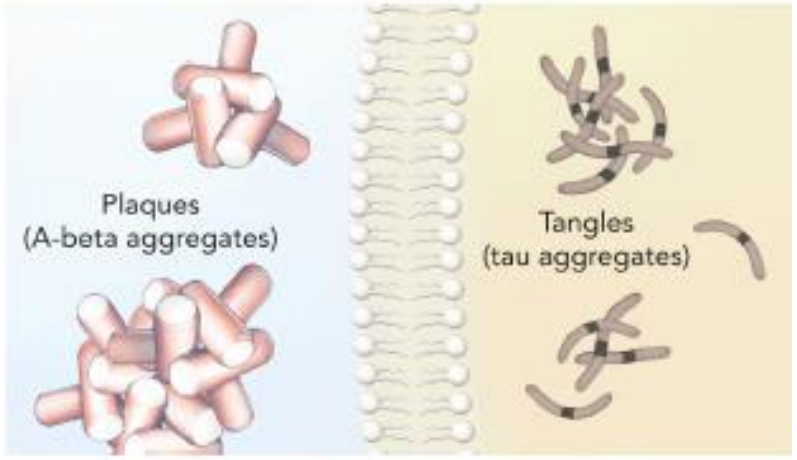


Figure 5.7. The amyloid precursor protein (APP), which is lodged in the cell membrane, contains the amyloid-beta (A-beta) peptide (*top*). Two enzymes make cuts through the amyloid precursor protein: the beta cut, followed by the gamma cut (*middle*). These cuts release the amyloid-beta peptide into the space outside the cell, where it may form amyloid plaques (*bottom*).

Figure 5.8. A molecular defect causes the tau protein to fold incorrectly. When this happens, the protein clumps inside the cell, forming neurofibrillary tangles.

Kandel, E. R. 2018.

The Disordered Mind.

What Unusual Brains Tell us about Ourselves. New York.

- Science Insider Brain & Behavior 13 Apr 2023 Charles Piller

- **Clinical trial participant's autopsy and brain exam stoke Alzheimer's drug fears.**
- **Amyloid-clearing antibody lecanemab faces key FDA hearing in June.**

- A full autopsy and detailed examination of the brain of a 79-year-old Florida woman who died after receiving **lecanemab**, an experimental Alzheimer's therapy, in a pivotal clinical trial has deepened some researchers' concerns that it poses serious risks for patients who share the woman's hard-to-diagnose, preexisting condition.
- The patient's history and autopsy "strongly suggests that lecanemab infusions were a catalyst leading to the events resulting in her death," says Vanderbilt University pathologist Hannah Harmsen, co-author of a recently completed case report, which *Science* has obtained. The authors say the woman's fatal brain swelling and hemorrhaging likely resulted when the drug, a monoclonal antibody, attacked the abnormal protein deposits that had built up in her blood vessels.

T1 MP-RAGE

TE = 2.29 ms TR = 2000 ms TI = 900 ms

Video produced by Manson Fong, 2017.

Young

Old

Changes in **Total Ventricular Volume** across Time

Analyses by Manson Fong.

		Session 1 (SIAT) 17.10.10	**Session 2** (HKU) 20.09.16	**Session 3** (PolyU) 21.11.22	**Session 4** (PolyU) 22.09.07
Subject 1	Age (year)	84.2	87.1	88.3	89.1
	Ventricular volume (cm^3)	**73.853**	**84.258**	**84.797**	**86.068**
Subject 2	Age (year)	33.1	36.1	37.3	37.9
	Ventricular volume (cm^3)	**14.806**	**16.346**	**16.132**	**15.586**

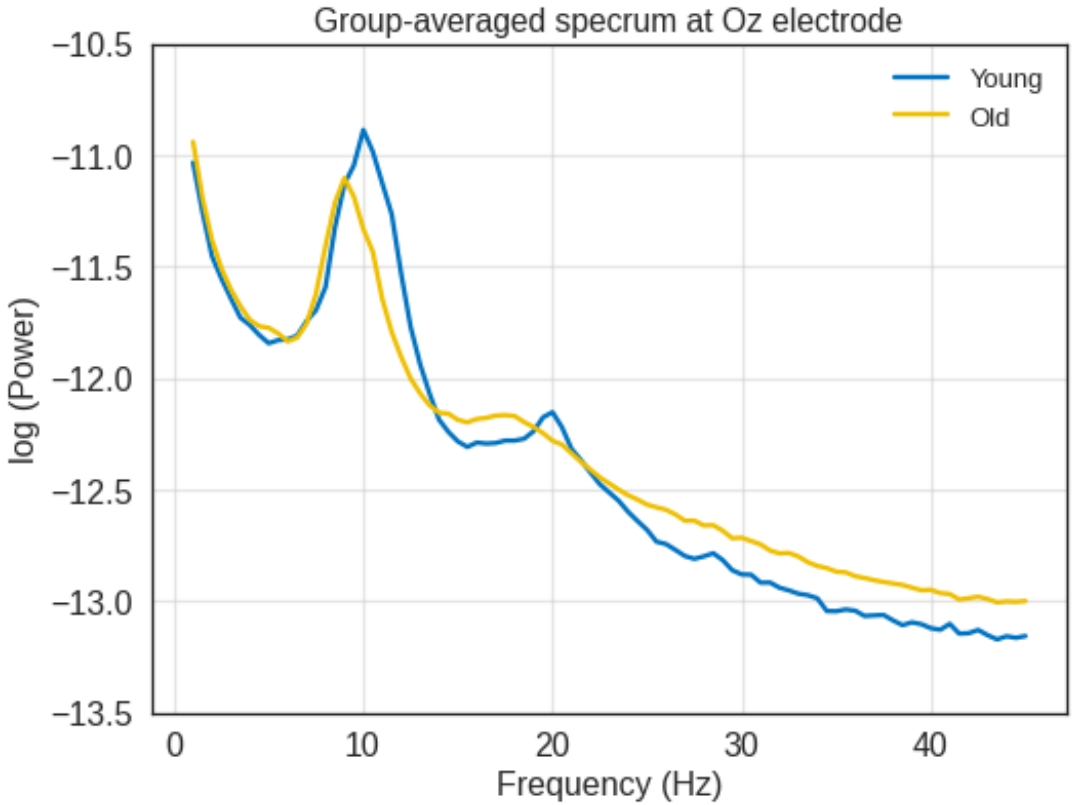
Age-related changes in EEG spectral characteristics *(Matthew Ma)*

Age-related spectral changes in resting-state EEG has been investigated since 1940s.

- Five traditionally defined EEG bands:

Delta (2-4 Hz)	Beta (13-30 Hz)
Theta (4-8 Hz)	Gamma (30-45 Hz)
Alpha (8-13 Hz)	

- The most consistent findings were the (1) **slowing of the dominant frequency** and (2) **decreasing alpha amplitude** (Celesia, 1986; Scally et al., 2018).
- Findings about other bands (delta, theta) in normal ageing have been inconsistent (Babiloni et al., 2006; Rossini et al., 2007; Vlahou et al., 2015).



- A sample power spectrum from **young** (n=27, age 19 - 26 (2.23)) and the **old** (n=68, age 60.2 – 81.3 (4.59)) participants **collected by our team**.
- Showed both slowing and decreased alpha amplitude.

Tzeng, O. J. L. and W. S.-Y. Wang. 1983. The first two R's. American Scientist **71**: 238-243.

Stroop, J. R. 1935. Studies of interference in serial verbal reactions. Journal of Experimental Psychology **18**: 643-662.

BLUE
GREEN

PURPLE
BLUE

GREEN
RED

RED
PURPLE

紅
藍

紫
綠

綠
紅

藍
紫

Some Recent Publications by our team members.

Wang, W. S.-Y. (2019). Language and the brain in the sunset years. The Routledge Handbook of Chinese Applied Linguistics. C.-R. Huang, Z. Jing-Schmidt and B. Meisterernst, eds. Routledge.

Mai, G. and W. S.-Y. Wang (2019). "Delta and theta brain entrainment of acoustic envelopes during phonological and semantic processing in speech perception." bioRxiv: Feb. 21, 2019.

Fong, C.-M. M., et al. (2020). "Which cognitive functions subserve clustering and switching in category fluency? Generalizations from sixteen semantic categories using linear mixed-effects modelling." Quarterly Journal of Experimental Psychology 73(12): 2132-2147.

Hui, N.-Y., et al. (2020). "L2 proficiency predicts inhibitory ability in L1-dominant speakers." International Journal of Bilingualism 24(5-6) 984–998.

Fong, M. C.-M., et al. (2021). "Can inhibition deficit hypothesis account for age-related differences in semantic fluency? Converging evidence from Stroop color and word test and an ERP flanker task." Brain and Language 218: 104952**.**

Ma, M. K.-H., et al. (2021). "Regularity and randomness in ageing: Differences in resting-state EEG complexity measured by largest Lyapunov exponent." Neuroimage: Reports 1(4): 100054.

Zou, I. Y. and W. S.-Y. Wang (2021). "Music as social bonding: A cross-cultural perspective." Behavioral and Brain Sciences 44: e95, 93-95, doi:10.1017/S0140525X20001326. .

Feng, Y., et al. (2022). "Categorical perception of lexical tones in Mandarin-speaking seniors." Journal of Speech, Language, and Hearing Research **65: 2789–2800.**

Fong, M. C.-M., et al. (2022). "Foreign Language Learning in Older Adults: Anatomical and Cognitive Markers of Vocabulary Learning Success." Frontiers in Human Neuroscience **16.**

PhD Theses just completed in 2022/23:

Nga-Yan Hui. *Experience and bilingual advantage: an exploration of individual variation.*

Xie, Chenwei. *An experimental investigation into older adults of production/comprehension asymmetries and declarative/procedural memory contributions: a Chinese context.*

Matthew Ma *The resting brain in ageing: spectral, spatiotemporal and complexity analysis in EEG.*

Language is enabled by a **broad mosaic of biological and social skills**, including sensory & motor skills for input and output, as well as memory & computational skills for storing, analyzing, & retrieving linguistic constructions. They also include semantic and pragmatic skills to relate these constructions to the social and affective context.

Language begins even when the fetus is in the womb, which then develops along various timelines across the lifespan. At present we know a lot more about this development during the early years of its acquisition than during the **sunset years**, when some of the enabling skills decline & we lose much of our language together with the ability to take care of ourselves. **Cognitive decline** is an urgent challenge across the world, especially in China.

With the remarkable advances in many Life Sciences in recent decades, particularly in **imaging the brain**, we now have a much deeper understanding of the processes of ageing, often with **senescence** caused by illness. Let us hope the day will come soon when the old Chinese saying of Lifespan as 生老病死 (birth, age, illness, death) may change to 生老 病 死, with the 病 removed or at least much reduced.

Cognitive decline is an immense area of research because the brain is so incredibly complex & so little understood so far, especially within a Chinese context. Yet the challenges of ageing are pressing & urgent at all levels of society – personal, familial, community, & government.

Language is a natural window for research on cognition & its decline. The efforts of our team at PolyU are no more than 沧海一粟. We need many more talented & dedicated **researchers** to join in, as well as much more support in various **resources** for its early success.

Our journey today started with Lenneberg's book of 1967. That book stimulated the transition of linguistics from primarily grammar description & comparison of languages to their psychological and neural foundations, within an evolutionary perspective. We discussed how language acquisition & learning follow **timelines of biological development**, determined by genetic information interacting with the ever changing physical and social environment.

The scientific landscape has changed greatly since 1967. We believe that the increasing knowledge in basic science, gained from the coordinated multidisciplinary advances in linguistics, neuropsychology, genetics, & computer science, can be integrated to **help meet a critical challenge the world now faces**, brought about by the rapid increase in the elderly population over the past century – debilitating cognitive decline due to neurodegeneration.

Thank you !!

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