語言工程實驗室
Language Engineering Laboratory

BIOLOGICAL FOUNDATION OF LANGUAGE

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Joint Research Centre for Language and Human Complexity
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In this introductory lecture, I will discuss the importance of language in our private and public communications, within the dual perspectives of evolution theory and complexity theory.

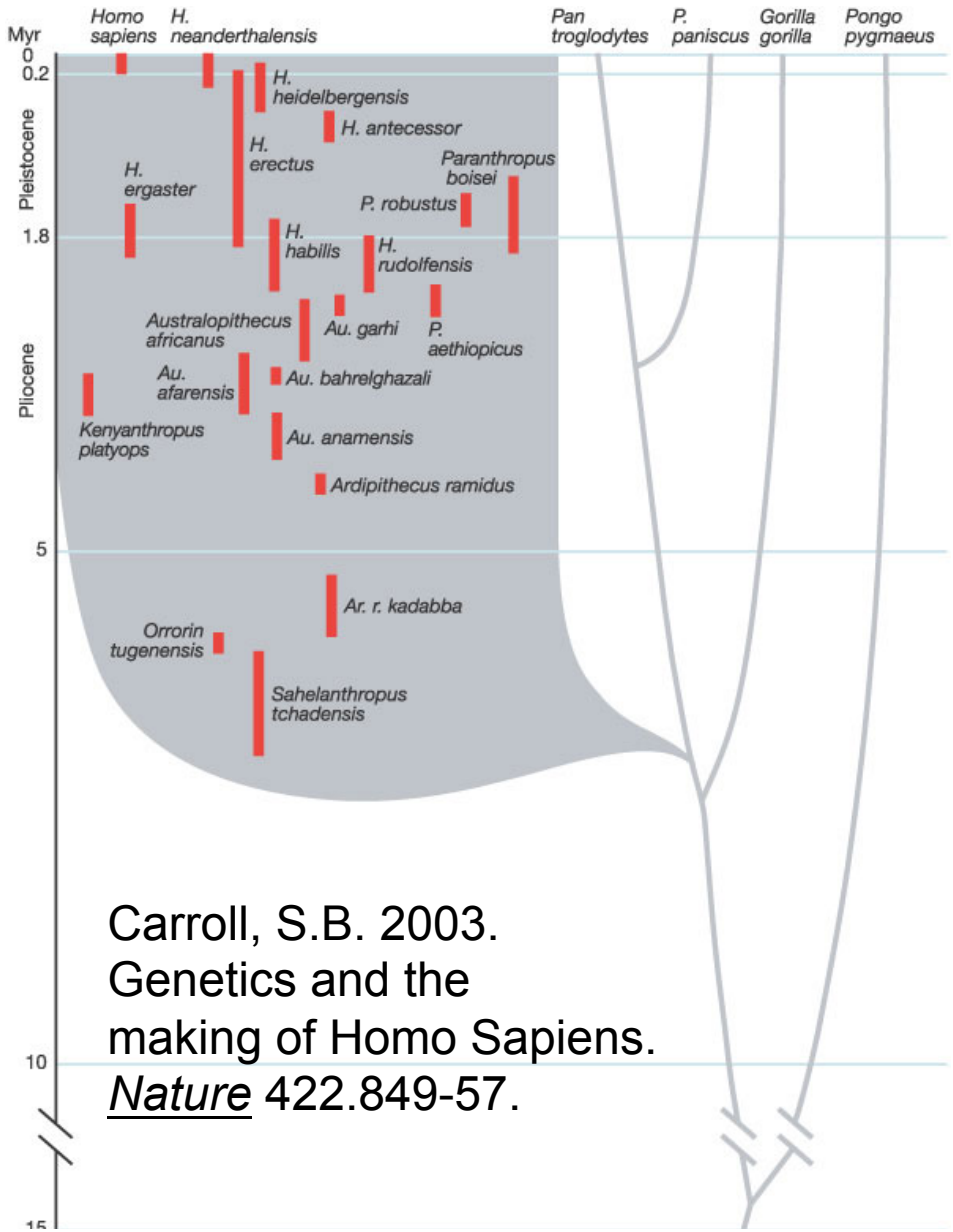
Language is a mental instrument for representing the world, unique to our species, whose evolutionary trajectory began with erect posture, over 3 million years ago. The trajectory accelerated sharply as our social and physical environments became increasingly diverse and complex. It is the single most defining feature of our humanity.

Language builds upon and integrates many biological and social behaviors, especially respiration, mastication, remembering, reasoning, and socializing. Language is a complex system with several interacting subsystems, such as phonology, grammar, lexicon, each constantly adapting & self-organizing to changes in our lives.

Research on language must draw from many bodies of knowledge, especially linguistics, cognitive neuroscience, genetics, anthropology, and computer science, as this lecture will illustrate.

Paul Gauguin, 1897.

D'où venons nous?
que sommes nous? où allons nous?



Carroll, S.B. 2003. Genetics and the making of Homo Sapiens. *Nature* 422.849-57.

Homo Sapiens

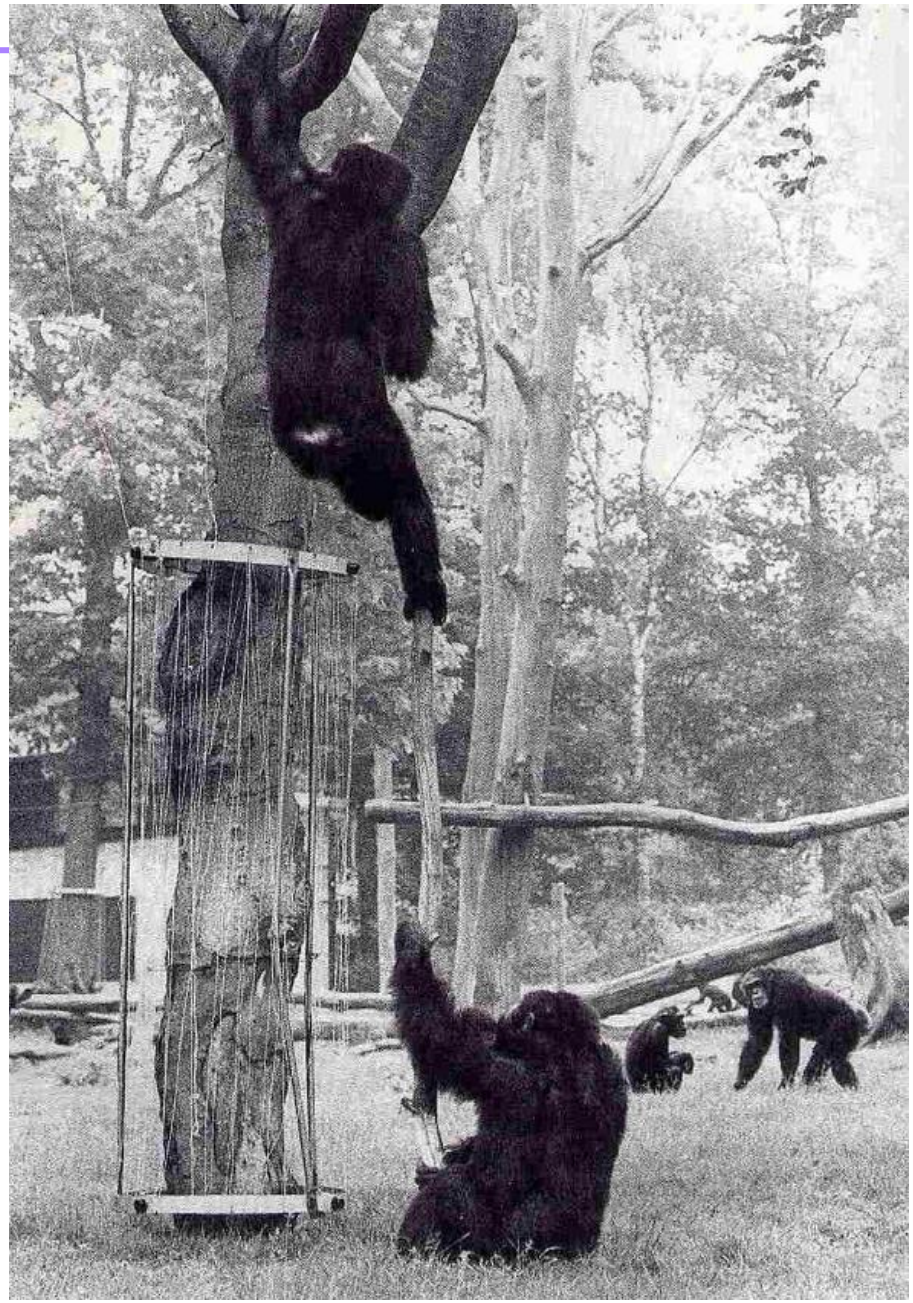
Homo

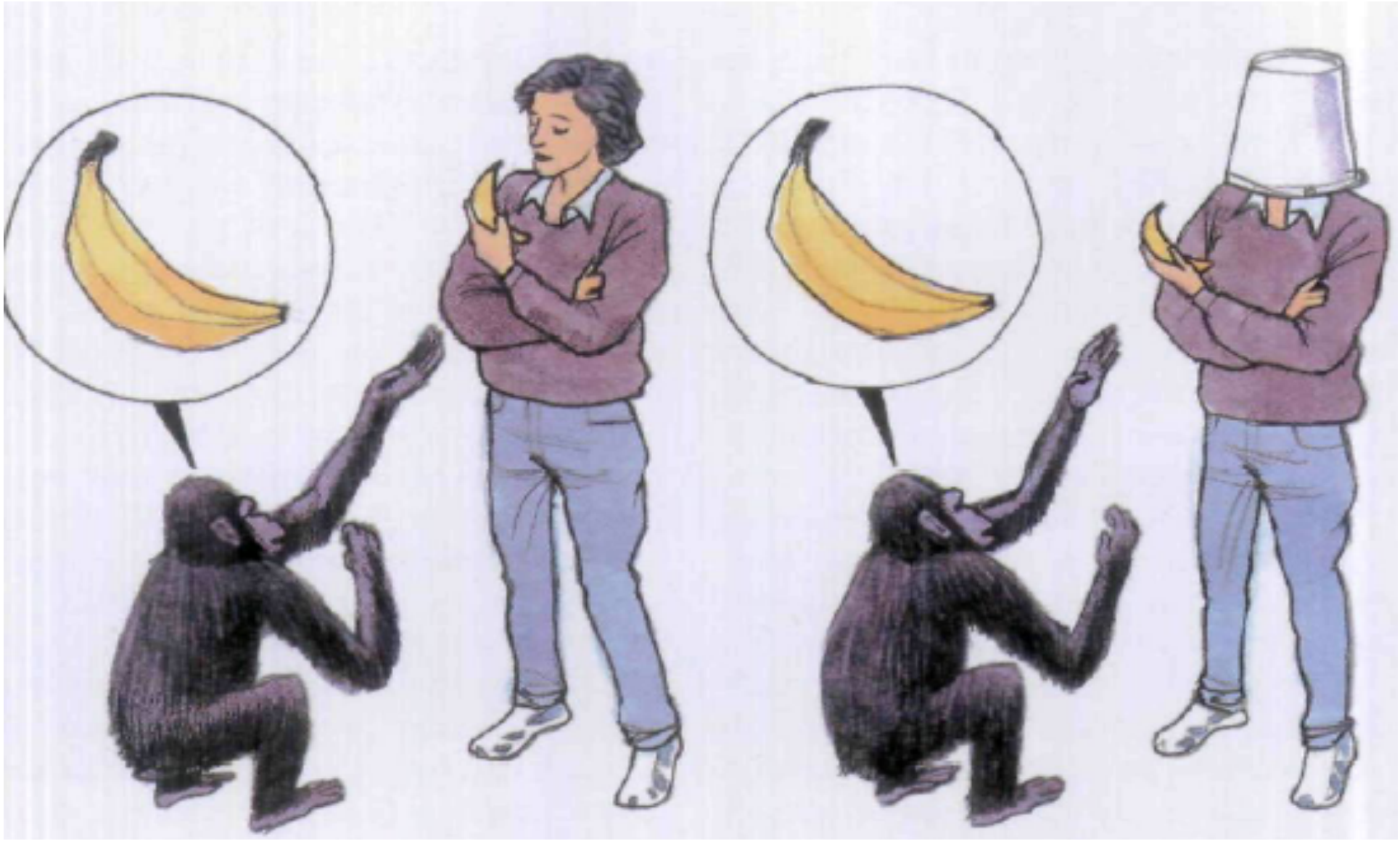
Australopithecus

primate

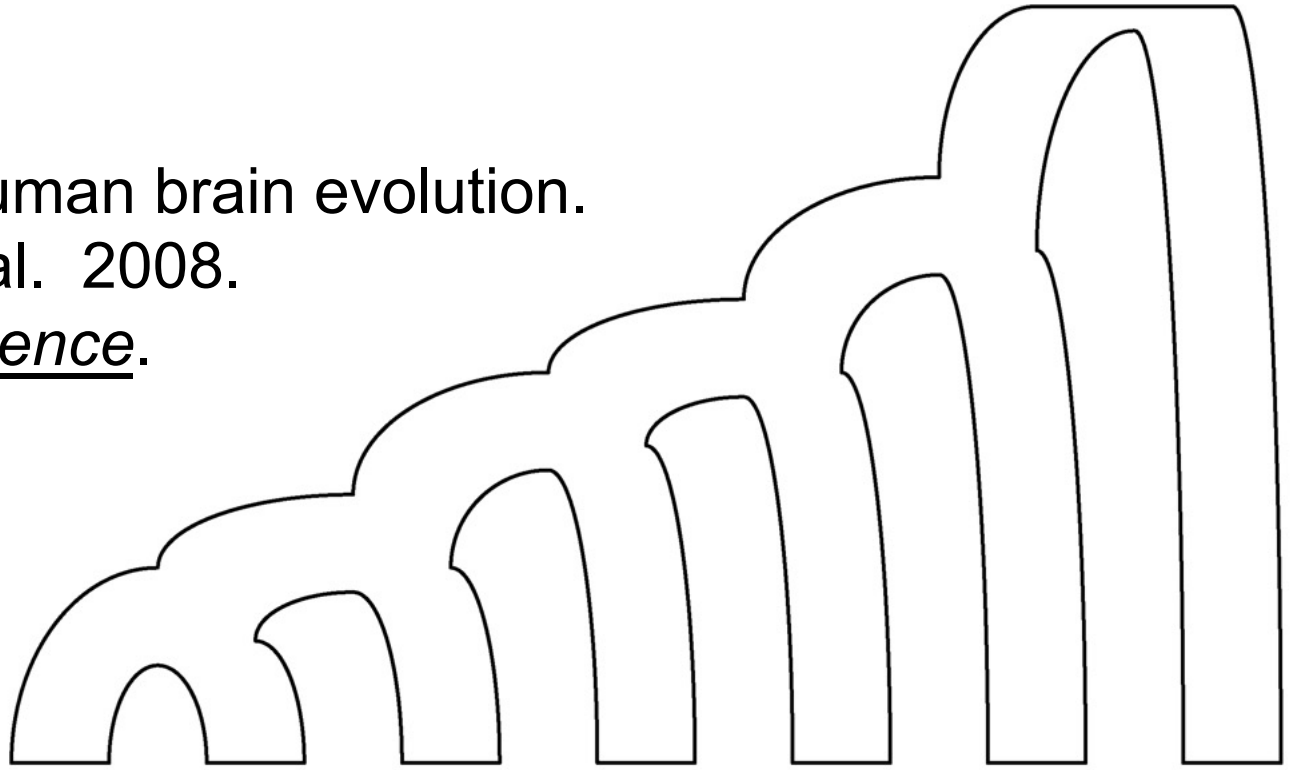
mammal

Povinelli & Vonk. 2003.



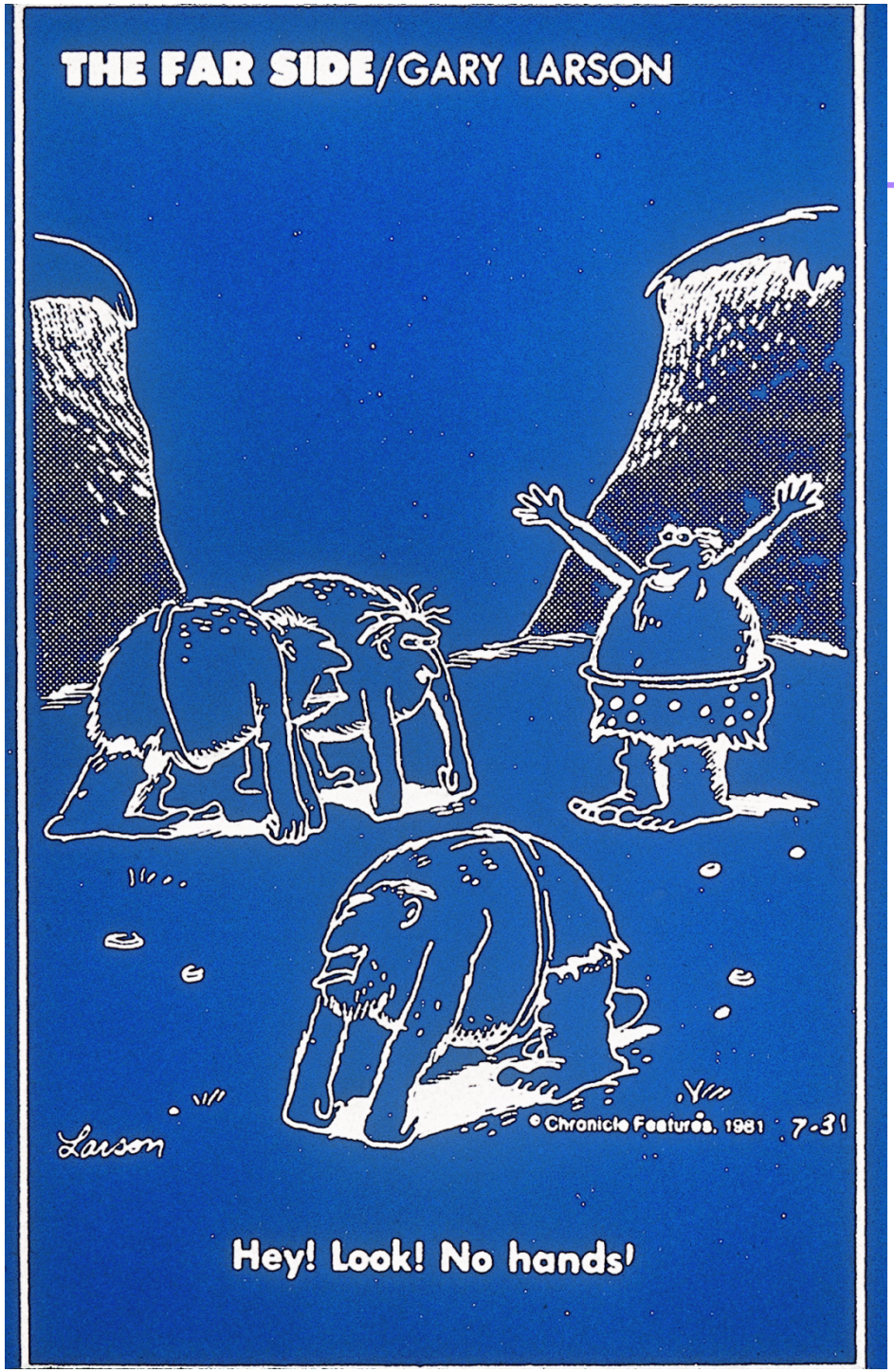


Genetic basis of human brain evolution.
Vallander, Eric, et al. 2008.
Trends in Neuroscience.



	Human	Chimpanzee	Gorilla	Orangutan	Gibbon	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	4–123

TRENDS in Neurosciences



When Australopithcine stood up 3+ Mys ago, it set into motion a series of events that led to cultural evolution, language, and modern civilization.

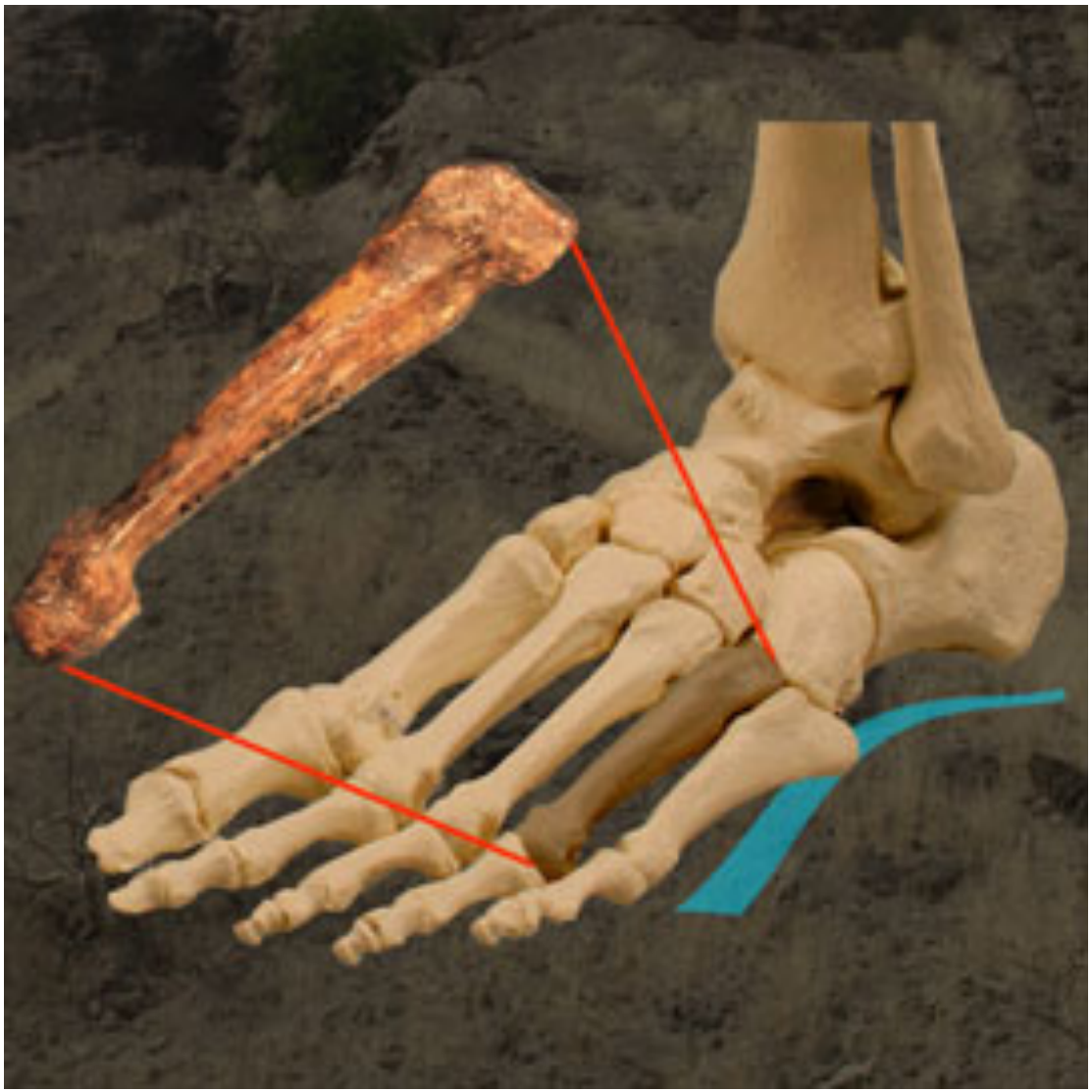
E.Lorenz 1972 *Predictability: Does the Flap of a Butterfly's Wings in Brazil set off a Tornado in Texas?*

Johanson, D. &
B. Edgar. 1996.
From Lucy to Language.
Simon & Schuster.

Footprints in Laetoli from 3,500,000 b.p.

Carol V. Ward, et al. ***Science*** *Feb.11, 2011*.

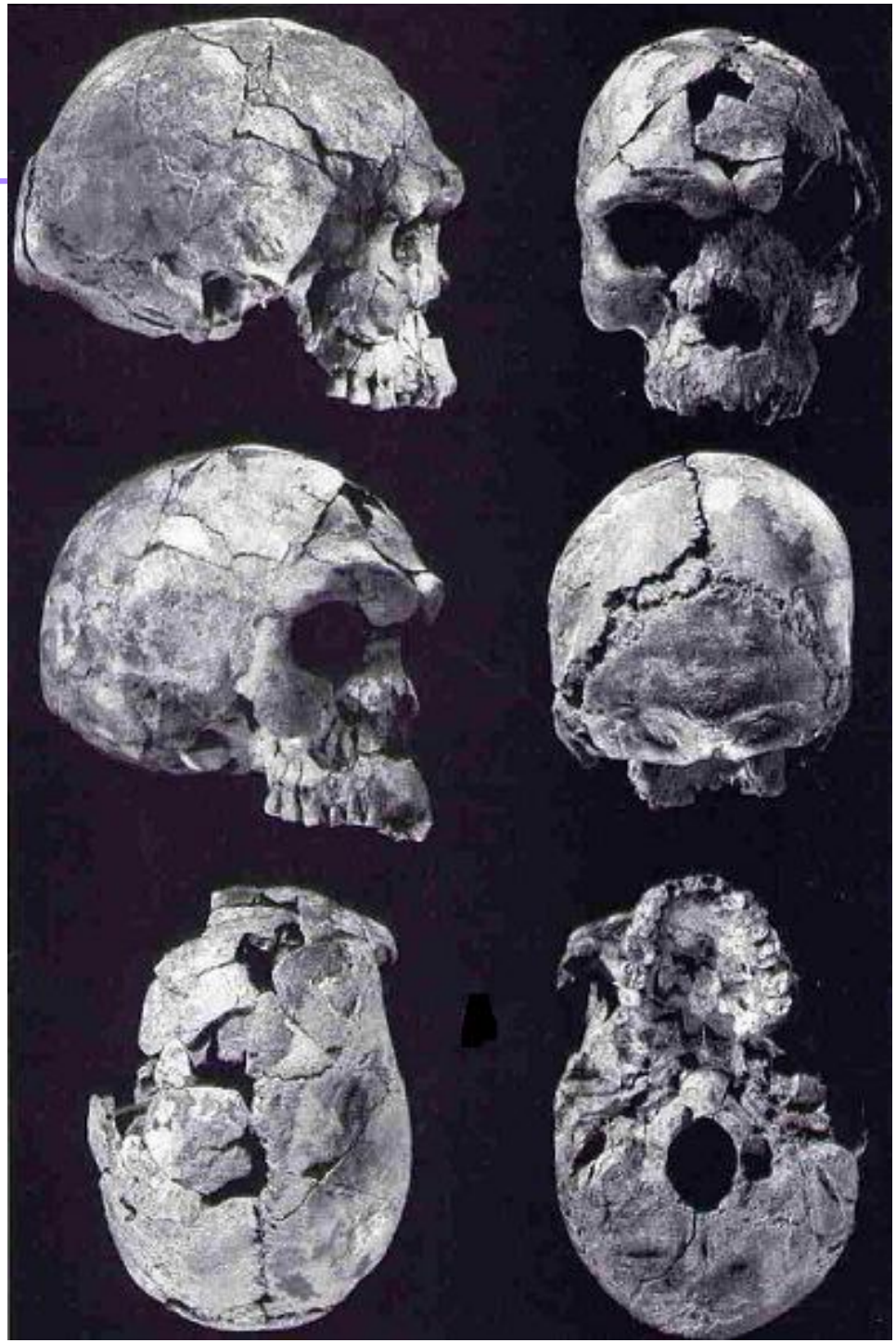
Complete Fourth Metatarsal & Arches in the Foot of *Australopithecus afarensis*



。Early Homo in China。

北京猿人 400,000 BP

大荔人 200,000 BP　陝西

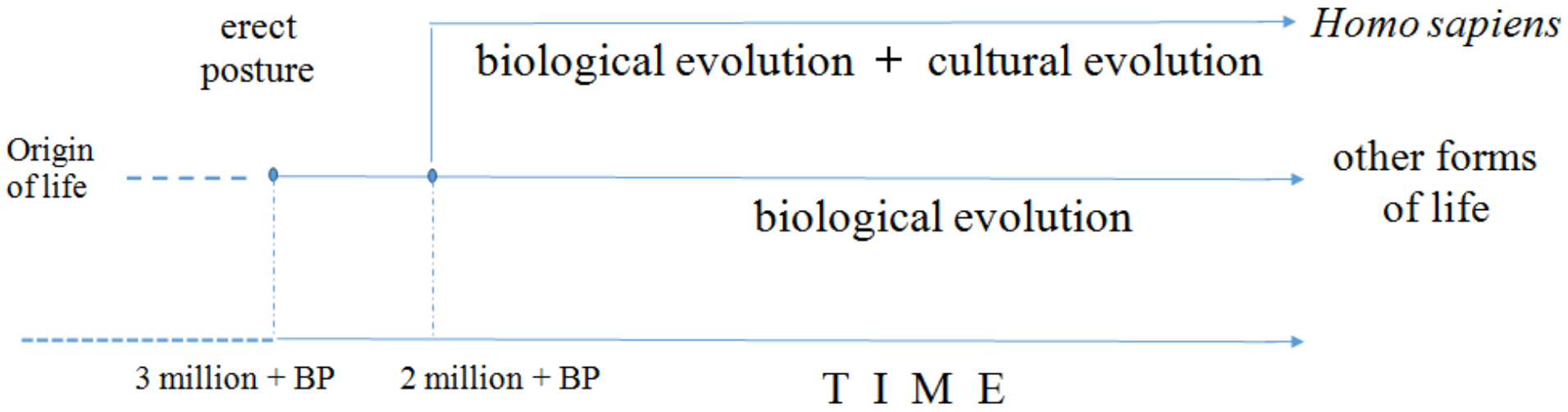


Adult cranium from Herto, ca.160,000 BP.
Tim White et al, 2003.
Nature June 12, p.743.

Lordkipanidze,D. et al. 2013.

A Complete Skull from Dmanisi, Georgia, and the Evolutionary Biology of Early Homo.

Science 342.326-31.


erect
posture
Homo sapiens
biological evolution + cultural evolution
Origin
of life
other forms
of life
biological evolution
3 million + BP
2 million + BP
T I M E

"The limits of my language are the limits of my world."

Ludwig Wittgenstein

"The 'real world' is to a large extent unconsciously built up on the language habits of the group."

Edward Sapir, 1929.
The status of linguistics as a science.
Language **5.207-214**

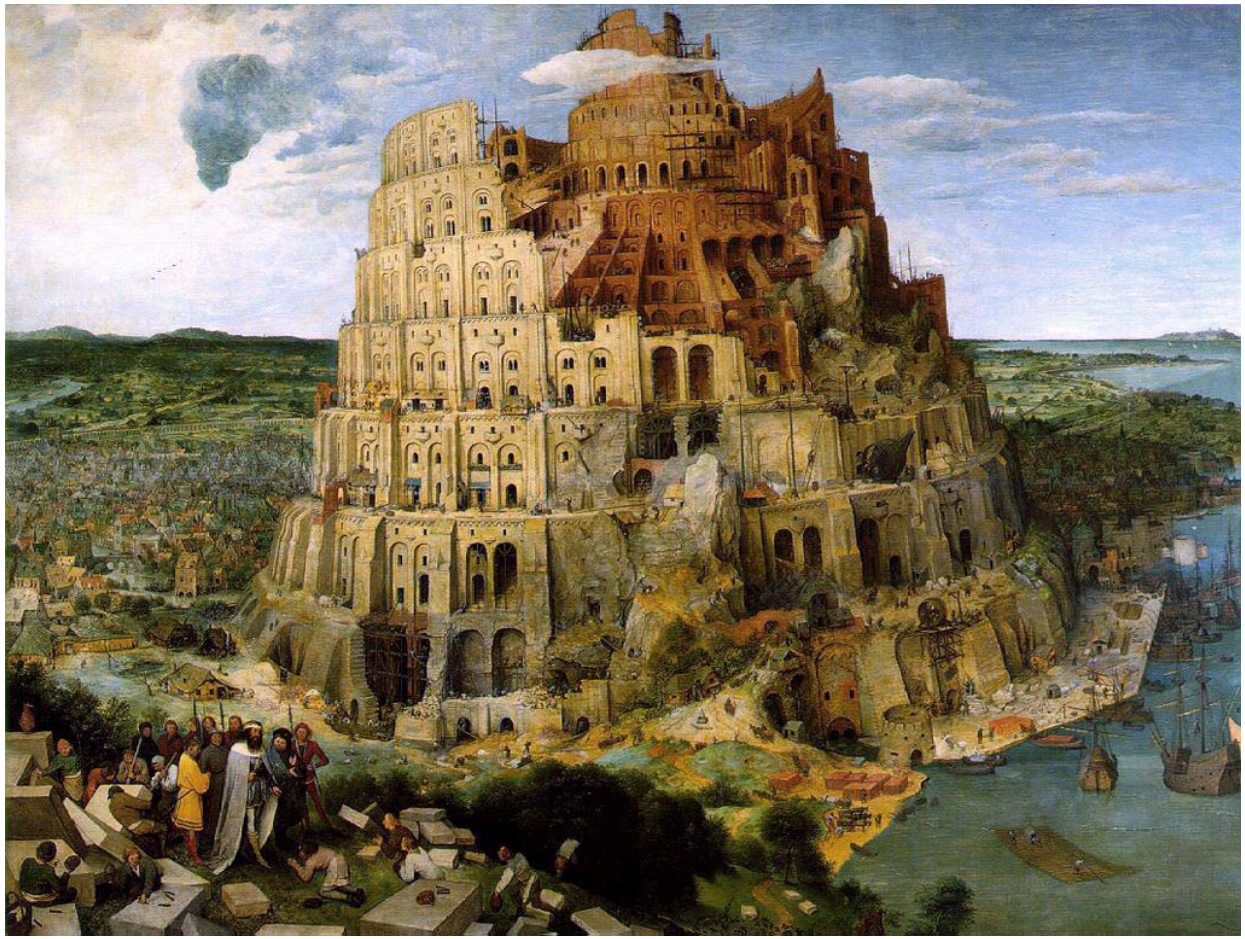
- “We mold our ‘reality’ with our words and our sentences in the same way as we mold it with our vision and our hearing. And the versatility of human **language** also makes it a unique tool for the development of the imagination.”

  Francois Jacob, Nobel Prize 1965.

Language Diversity:
an early account

Tower of Babel
圣经故事：
古人建筑巴贝儿塔

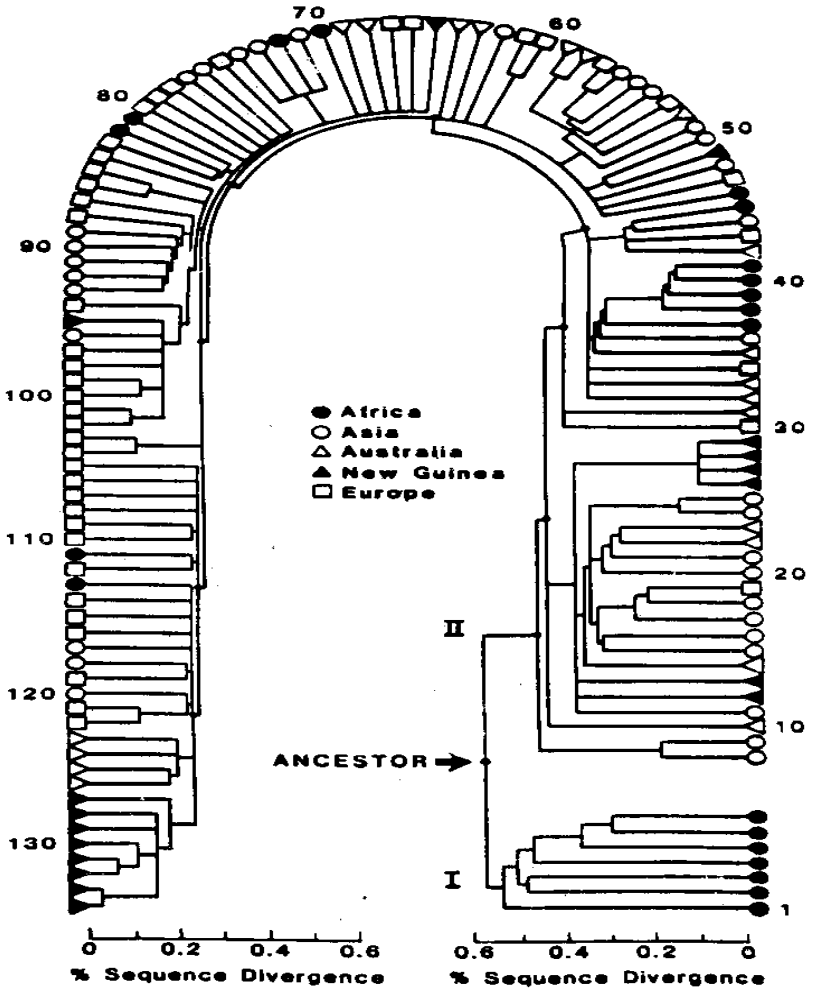
Painting by
Pieter Bruegel
1525-69



Genesis 11:7 "Go to, let us go down, and there confound their language, that they may not understand one another's speech."

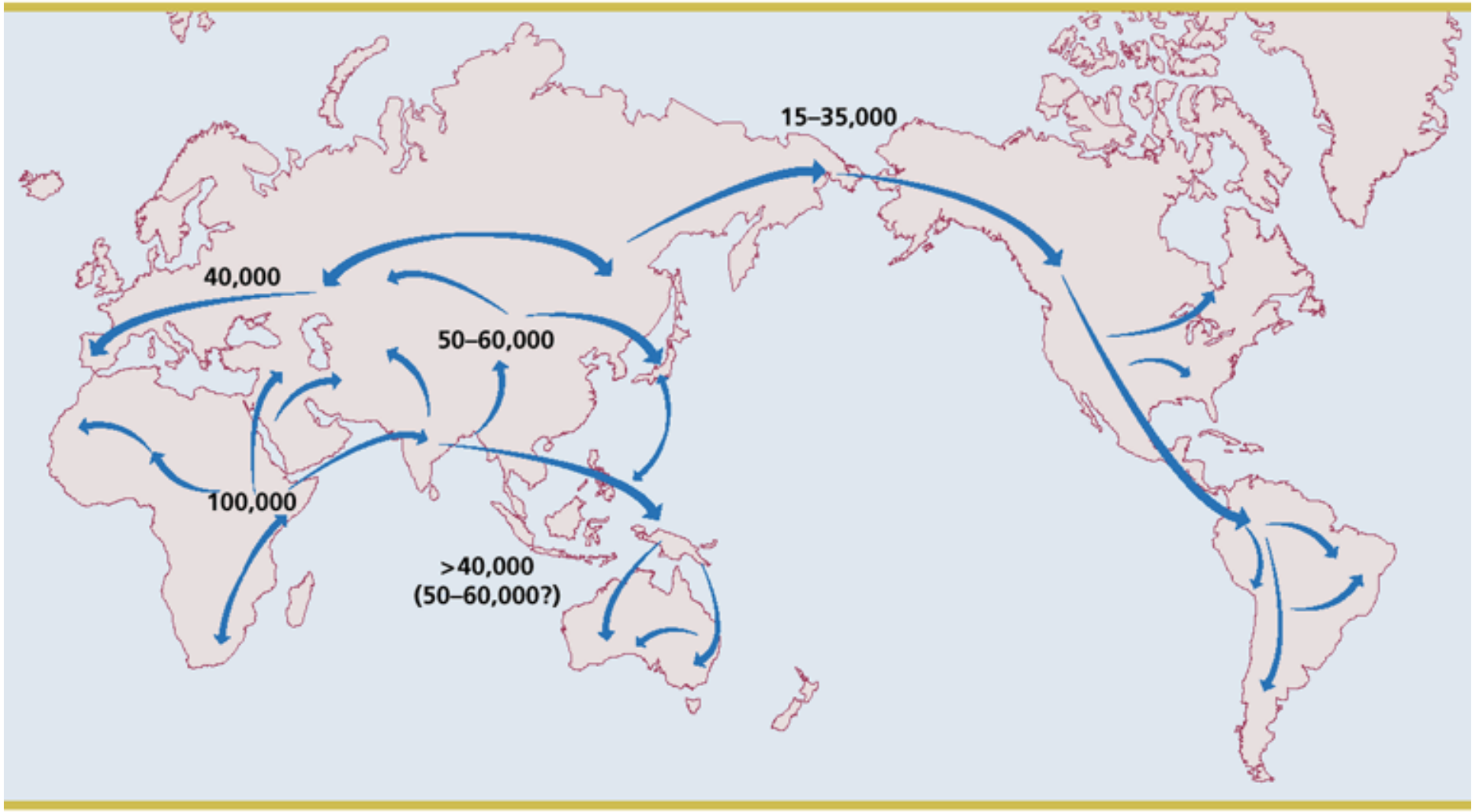
“Mitochondrial Eve” and The Out of Africa Hypothesis

Cann, R., Stoneking, M., and Wilson, A. (1987). Mitochondrial DNA and human evolution. Nature 325.31-36.



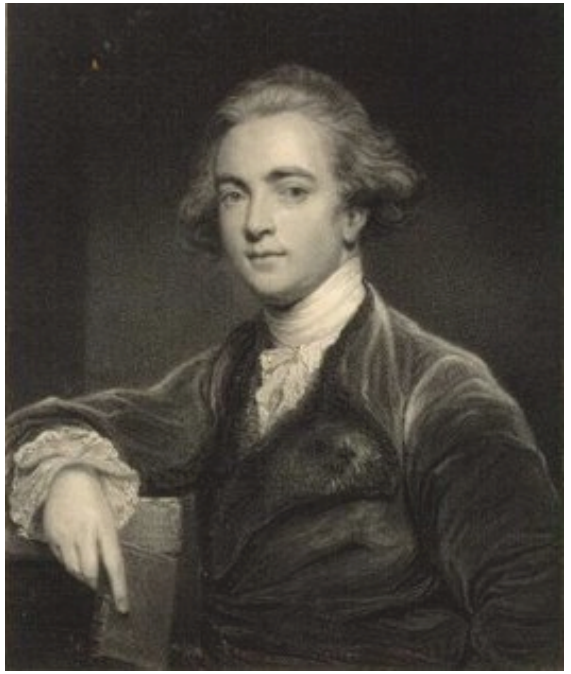
all of African descent

L.L.Cavalli-Sforza & M.W.Feldman. The application of molecular genetic approaches to the study of human evolution. *Nature Genetics Suppl.* 33.266-75, 2003.



Early Comparative Linguistics

- "*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.*"



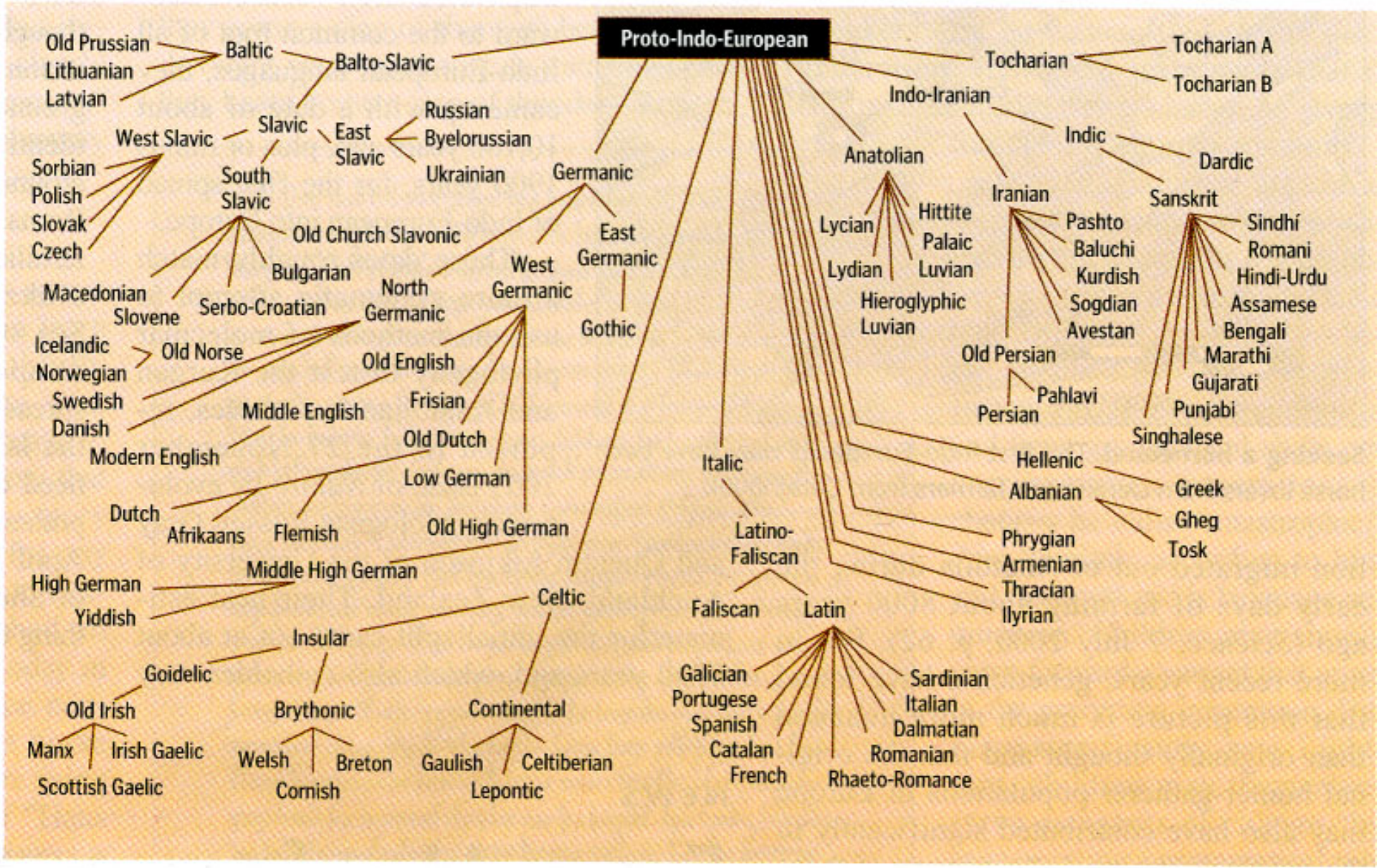
(William Jones, 1786)

Words for integers in some Indo-European languages. *from C.Renfrew 1989.*

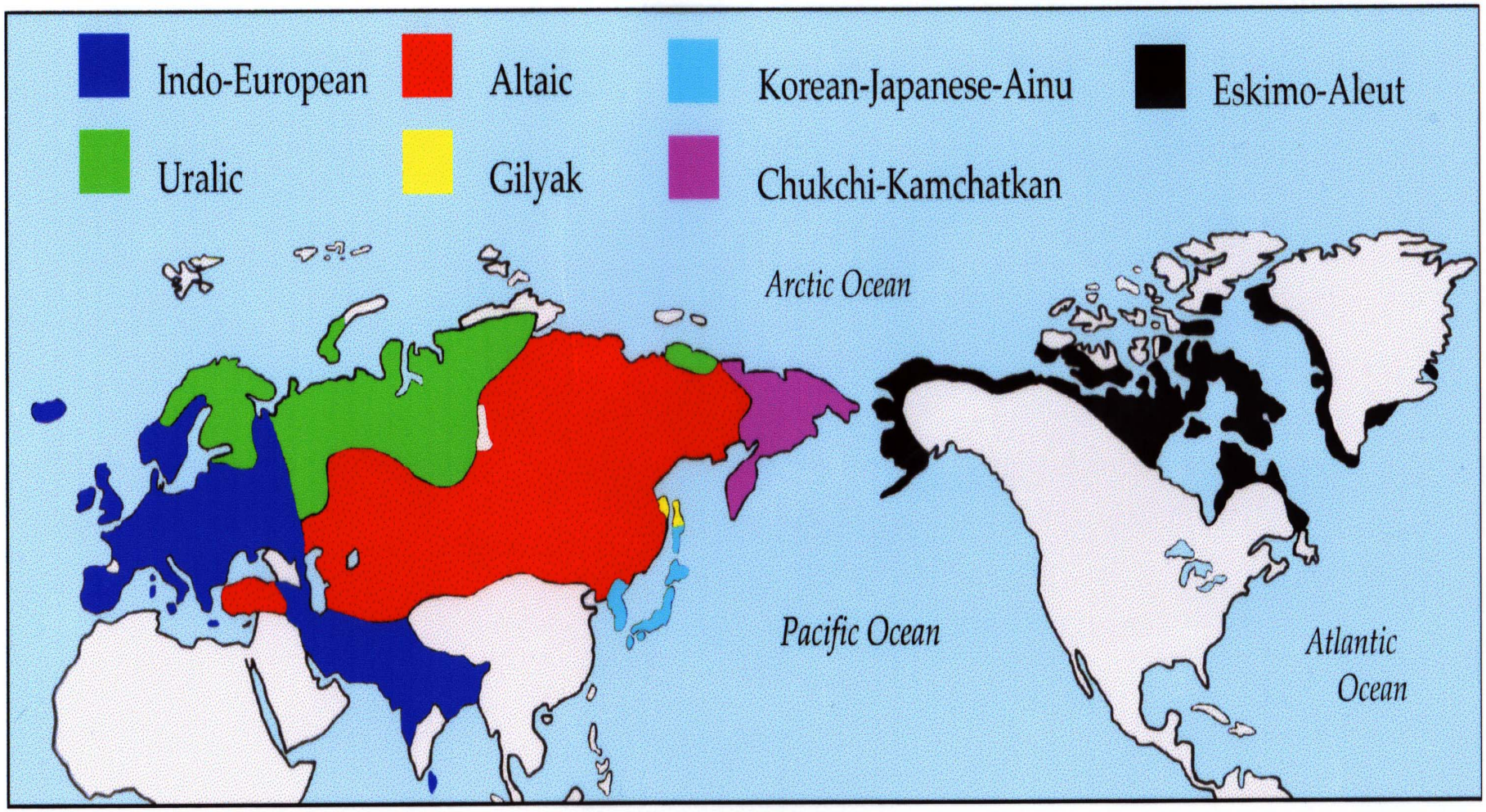
ENGLISH	GOTHIC	LATIN	GREEK	SANSKRIT	JAPANESE
ONE	AINS	UNUS	HEIS	EKAS	HITOTSU
TWO	TWAI	DUO	DUŌ	DVĀ	FUTATSU
THREE	THREIS	TRS	TREIS	TRAYAS	MITTSU
FOUR	FIDWOR	QUATTUOR	TETTARES	CATVĀRAS	YOTTSU
FIVE	FIMF	QUINQUE	PENTE	PANCA	ITSUTSU
SIX	SAIHS	SEX	HEKS	ṢAṬ	MUTTSU
SEVEN	SIBUN	SEPTEM	HEPTA	SAPTA	NANATSU
EIGHT	AHTAU	OCTO	OKTŌ	AṢṬĀ	YATSU
NINE	NIUN	NOVEM	ENNEA	NAVA	KOKONOTSU
TEN	TAIHUN	DECEM	DEKA	DAŚA	TO

Integers in Chinese dialects.

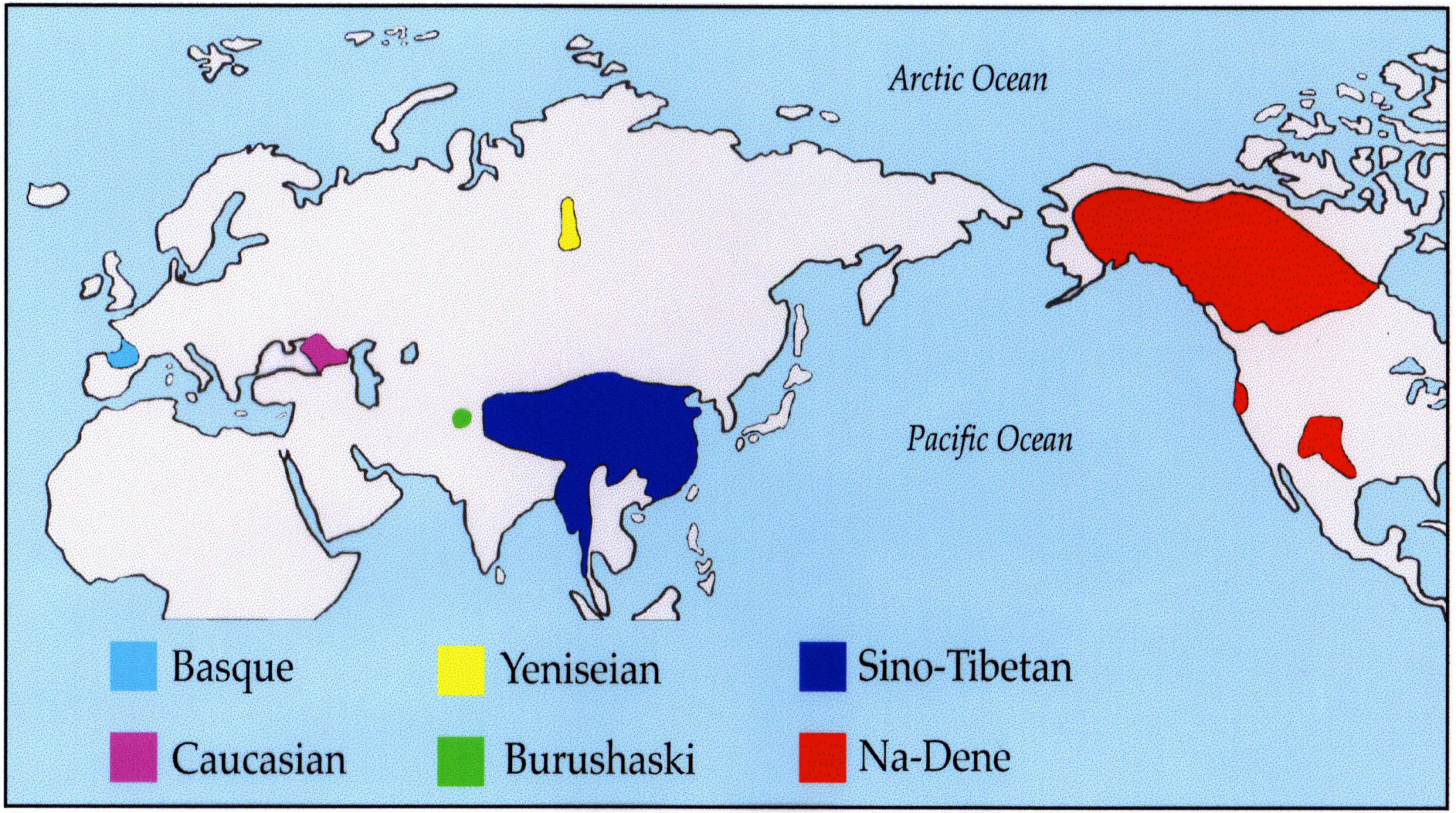
	PTH	HKC	SH	TMn	Jpn
1	Iu yi	IVu jat	IVu yi?	IVu tsit	ichi
2	III er	IIIv ji	IIIv ni	IIIv li	ni
3	Iu san	Iu saam	Iu se	Iu sã	san
4	III si	IIIu sei	IIIu si	IIIu si	shi
5	II wu	IIv m	IIv ng	IIIv go	go
6	III liu	IVv luk	IVv lu?	IVv lak	roku
10	Iv shi	IVv sap	IVv ze?	IVv tsap	ju



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



The Eurasiatic Family



The Dene-Caucasian Family

Verb Morphology in Italian

Language Engineering Laboratory

camminare = to walk

Present indicative	1ps	cammin.o	1pp	cammin.iamo
	2ps	cammin.i	2pp	cammin.ate
	3ps	cammin.a	3pp	cammin.ano
Future	1ps	camminerò	1pp	cammineremo
	2ps	camminerai	2pp	camminerete
	3ps	camminerà	3pp	cammineranno

Gender & number in nouns.

	masc.	*fem.*
sing.	ragazz-**o**	ragazz-**a**
plur,	ragazz-**i**	ragazz-**e**

Italian

У м е н я е с т ь

Russian

о д н а к н и г - а		*sing. 单数*
т р и к н и г - и		*dual 双数*
п я т ь к н и г -		*plural 多数*

Class 1 noun:

Mtu mzuri mmoja yule ameanguka.

Person good one that fell down.

Watu wazuri wawili wale wameanguka.

Class 4 noun:

Kikapu kizuri kimoja kile kimeanguka.

Basket good one that fell down

Vikapu vizuri viwili vile vimeanguka.

马骑人一个来了。

来了一个骑马的人。

饭吃人个有哩。

有一个吃饭的人。

意西微萨阿错. 2010. 交际压力度与混合语形成机制--以倒话为例. *研究之乐II:庆祝王士元先生七十五寿辰学术论文集*, 潘悟云 & 沈钟伟 编, 376-88. 上海教育出版社.

Husmann, L.E. & W.S-Y. Wang. 1991.
Ethnolinguistic notes on the Dungan. *Sino-Platonic Papers* 27.71-84.

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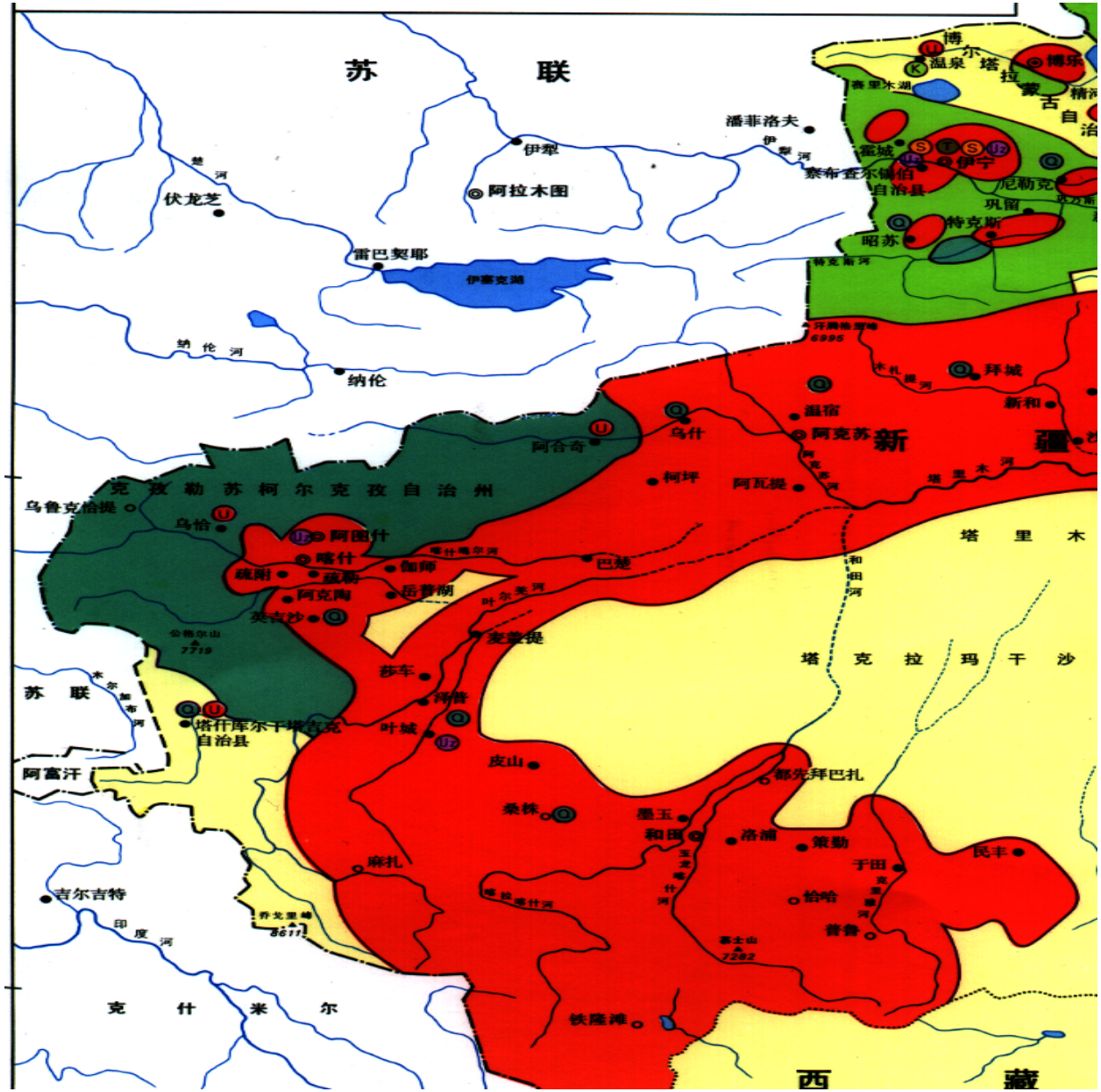


Frunze (Bishkek)

Kyrgystan,USSR.

1990

东干语课本

Husmann, L.E. & W.S-Y. Wang. 1991. Ethnolinguistic notes on the Dungan. Sino Platonic Papers 27.71-84.

Лёнгэ ляншу.

Лёнгэ ляншу зэ фулинни зудилэ. Мынмынди чўлэлигэ щүн. Йигэ подичи шонли фу, чёнхали. Ди эргэ мэ дунтан. Мэ форли, та пахали, жуончын сыжынли.

Щүн до гынчян вынтуэ, та чи ду бу чўли. Щүн ба тади лян вынлихар, дончын сыдёли, зугуэли.

Щүн зудё, нэгэ да фушон халэ, щётуэли: «Щүн ги ни зэ эрдуэшон чёчёр фэ сали?» Ди эргэ хуэйдади: «Щүн фэсы, ю бу хо жынни, таму до зуэнанчўр, ба ляншуму лёха, пони».

(Л. Н. Толстой).

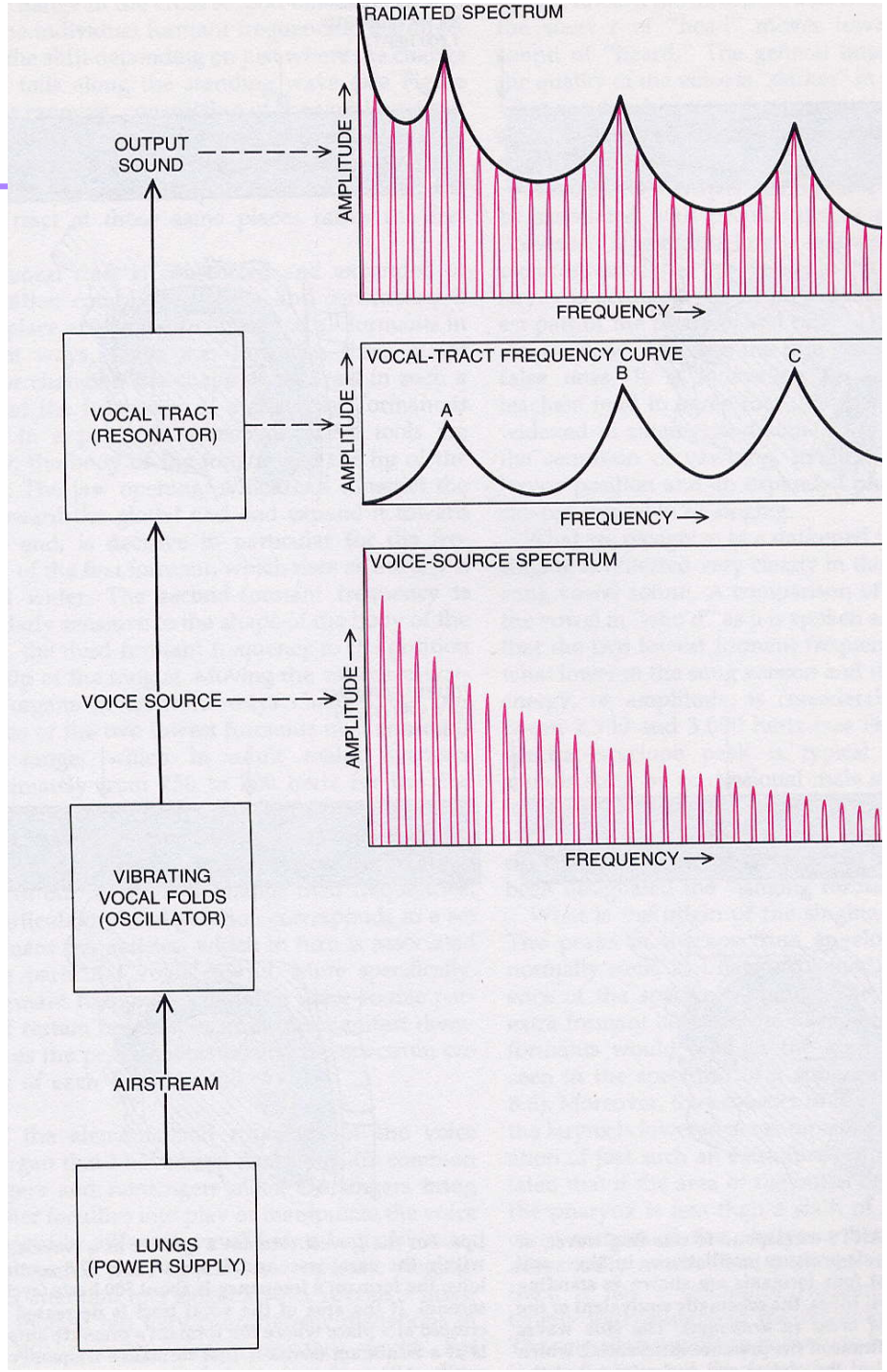
(.wav)

Нян жян, эр лён.

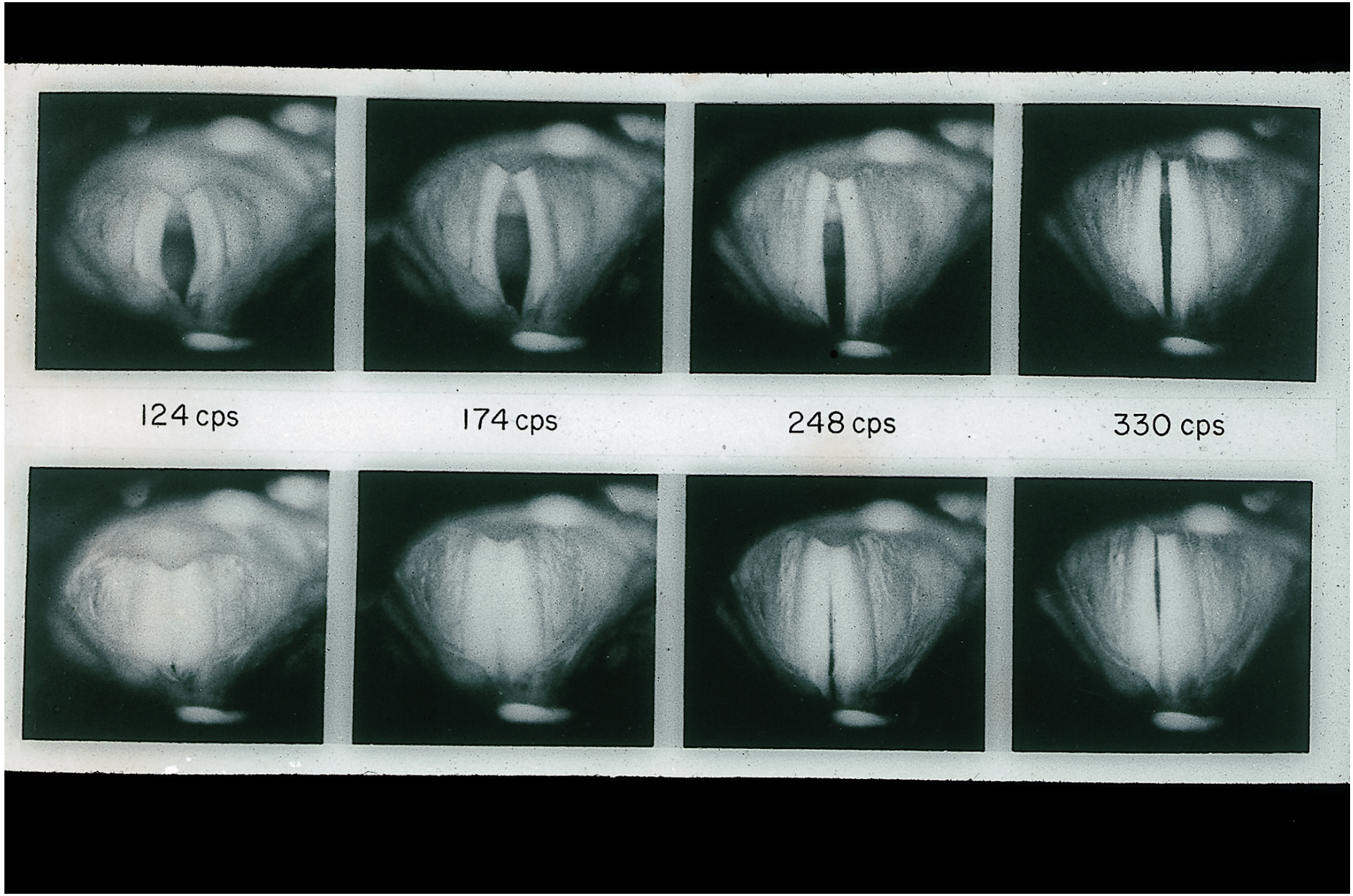
Сангэ южуанжя зудо савэнили. Жужу-виви мэю фужы-цомё. Ячё-ловади йинщён ду бу жян. Гуонсы

The Emergence of Language: Development and Evolution.

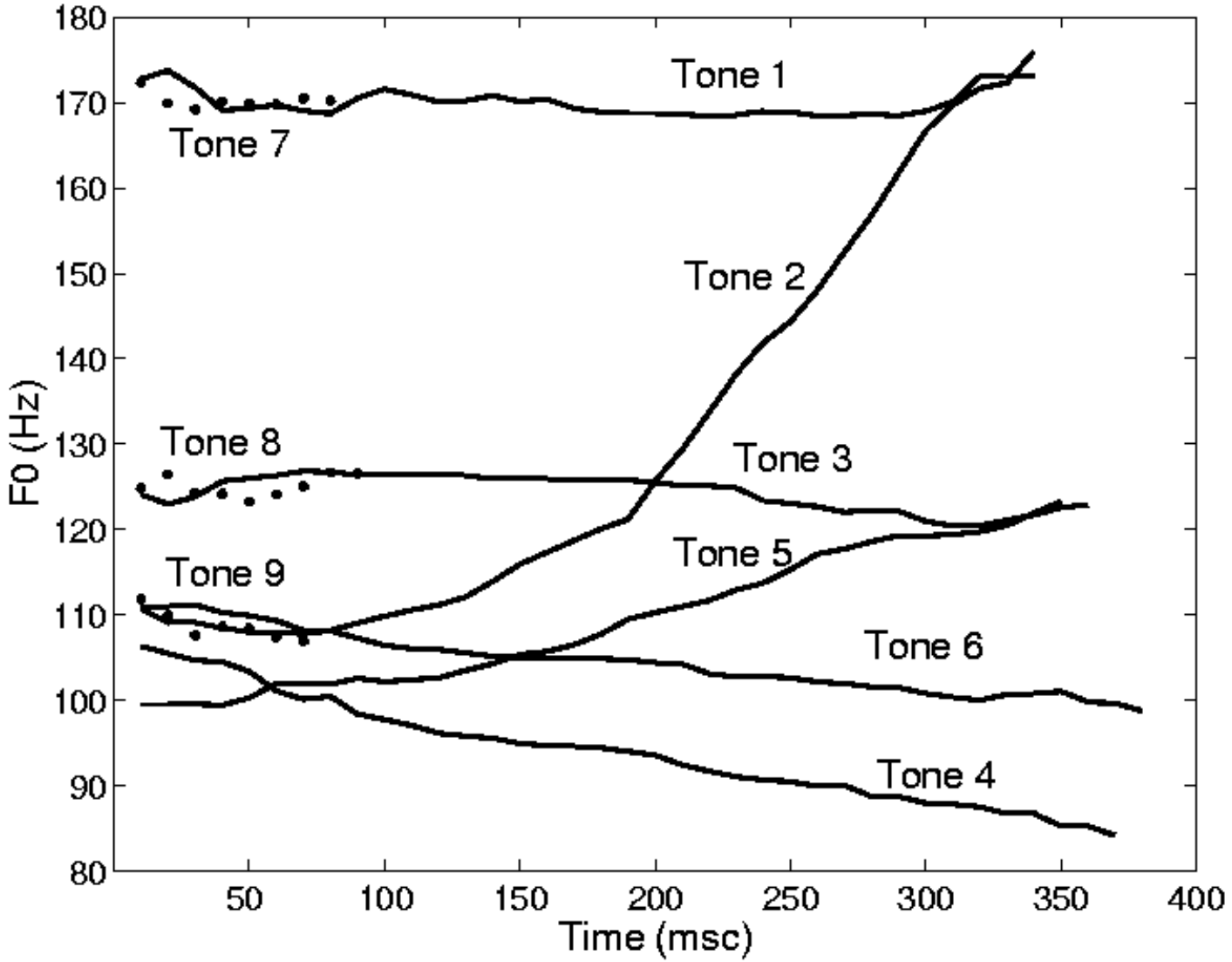
W.S-Y.Wang, ed. p.107.



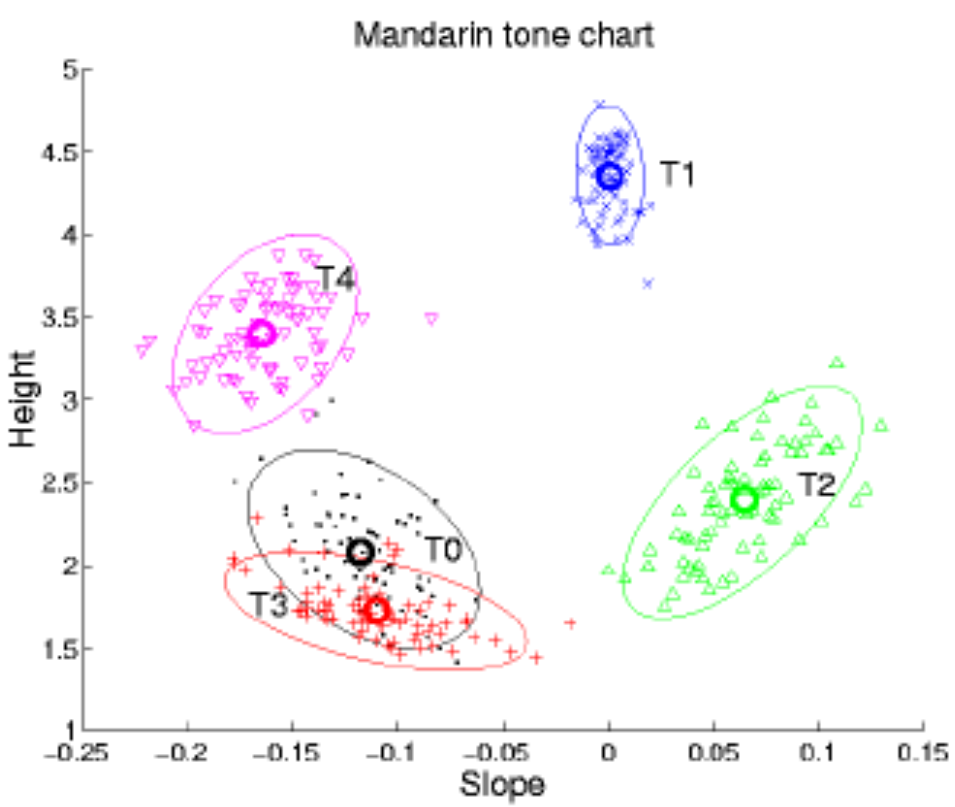
Vibration of vocal folds

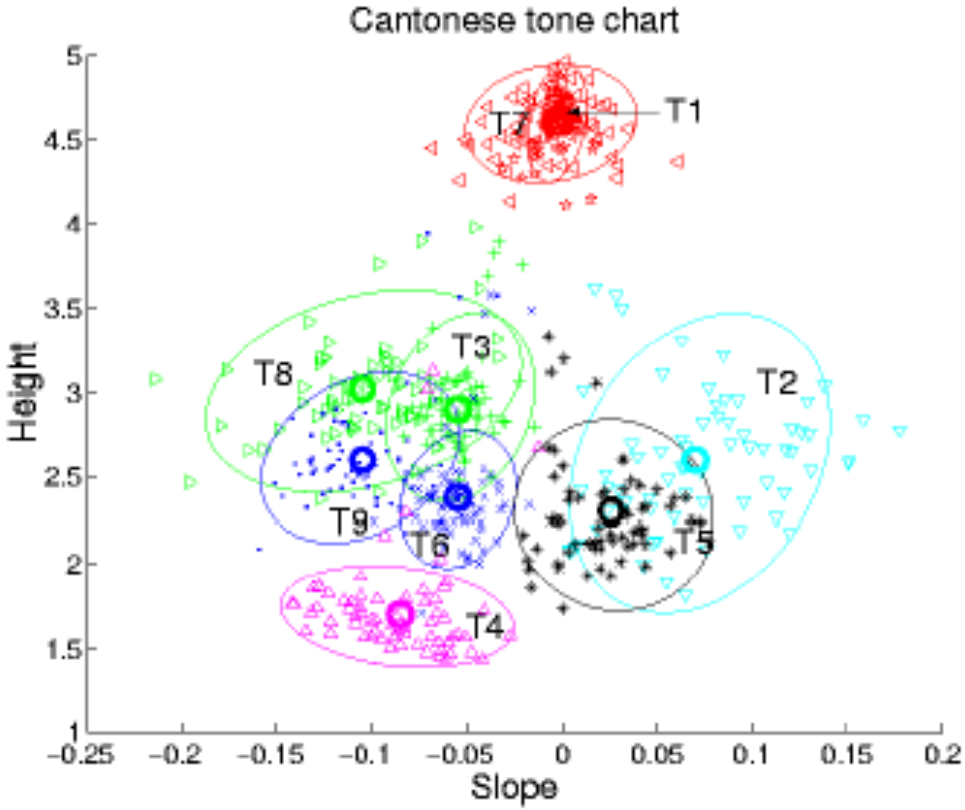


平	上	去	入
詩	史	試	識 錫
時	市	事	食



F_0 contours of lexical tones of Cantonese uttered by a male speaker. The solid lines are for long tones on unchecked syllables, while the dotted lines are for short tones on checked syllables. (Without duration normalization)


Mandarin tone chart
Height
Slope
T1
T4
T2
T0
T3
5
4.5
4
3.5
3
2.5
2
1.5
1
−0.25
−0.2
−0.15
−0.1
−0.05
0
0.05
0.1
0.15


Cantonese tone chart
Height
Slope
T1
T7
T3
T8
T2
T9
T6
T5
T4
5
4.5
4
3.5
3
2.5
2
1.5
1
−0.25
−0.2
−0.15
−0.1
−0.05
0
0.05
0.1
0.15
0.2

赵元任，语言问题。1980：149

施氏食狮史

石室诗士施氏，嗜狮，誓食十狮。氏时时适市视狮。十时，适十狮适市。是时，适施氏适市。氏视是十狮，恃矢势，使是十狮逝世。氏拾是十狮尸，适石室。石室湿，氏使侍拭石室。石室拭，氏始试食十狮尸。食时，始识是十狮尸，实十石狮尸。试释是事。

赵元任，语言问题。1980：149

施氏食狮史

石室诗士施氏，嗜狮，誓食十狮。氏时时适市视狮。十时，适十狮适市。是时，适施氏适市。氏视是十狮，恃矢势，使是十狮逝世。氏拾是十狮尸，适石室。石室湿，氏使侍拭石室。石室拭，氏始试食十狮尸。食时，始识是十狮尸，实十石狮尸。试释是事。

SciAm.Feb.09

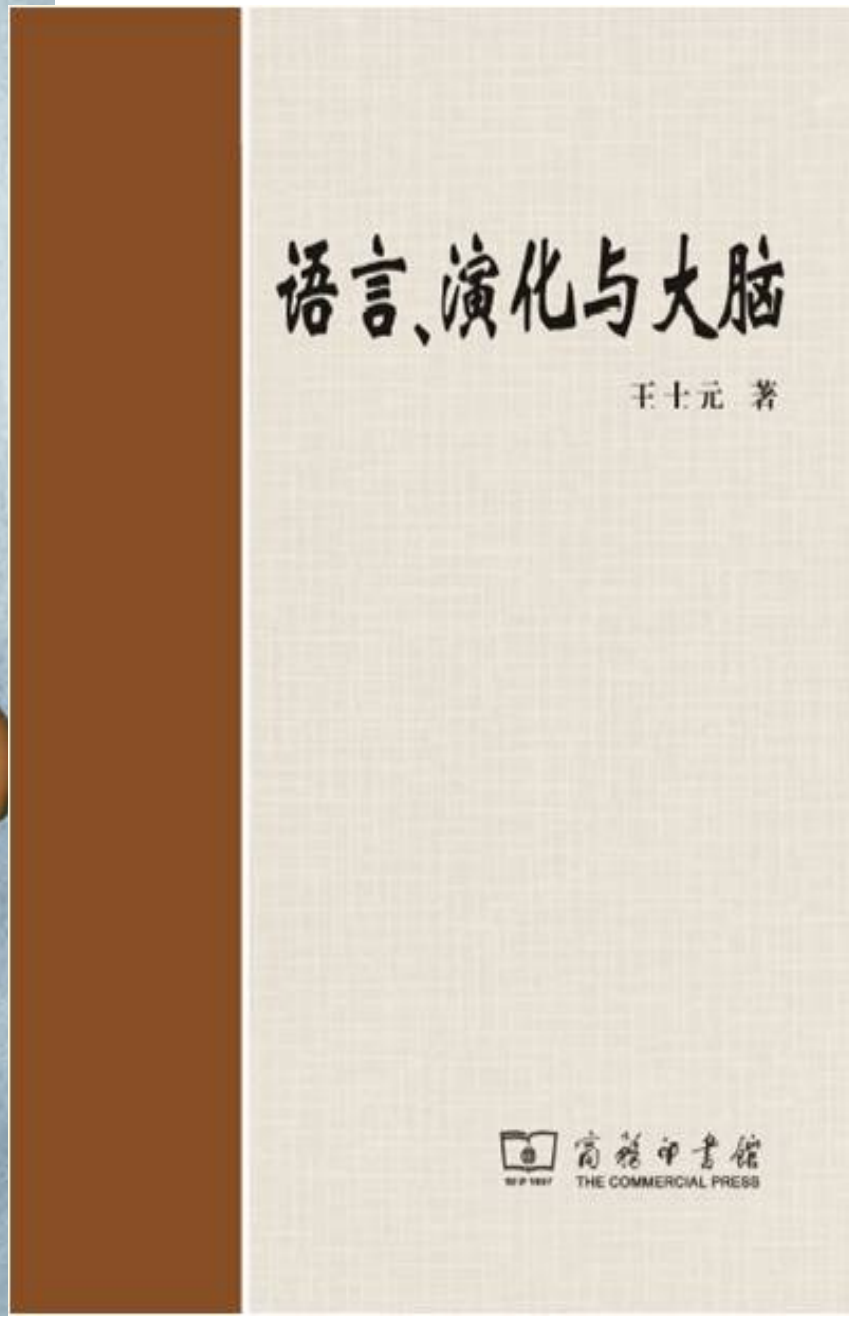
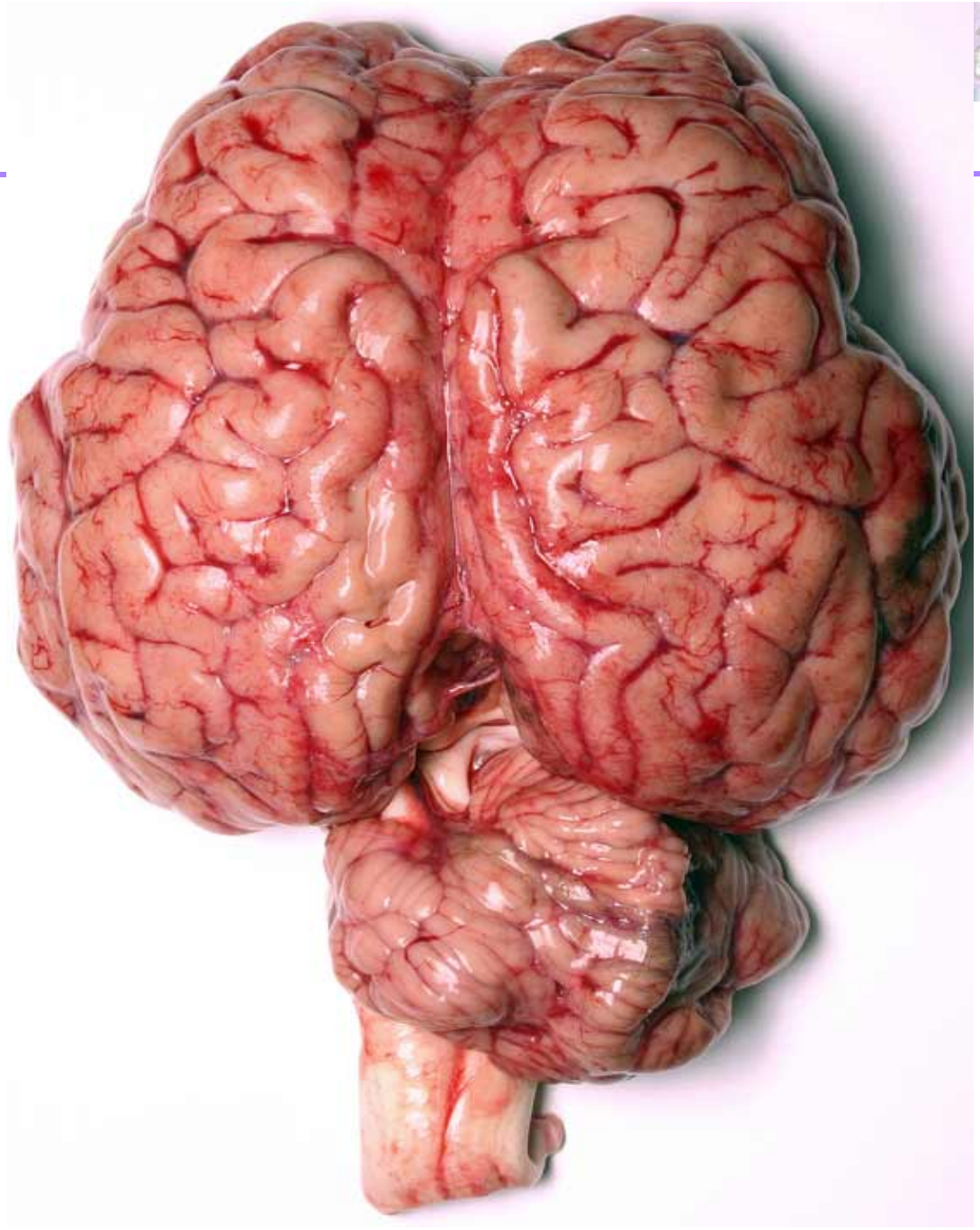


FIGURE 3–1

The exposed surface of the human cerebral cortex, drawn by the great anatomist Andreas Vesalius (1514–1564). He is generally considered to be the founder of modern anatomy, and his De Fabrica Humanis Corpora *set a new standard for medical art.*



The most complex matter in the known universe

Three pioneers in studies of

Language & Brain

Paul Pierre Broca
(1824-1880)

Carl Wernicke
(1848-1904)

Jules Dejerine
(1849-1917)

Dick, F. et al. 2001. Language Deficits, Localization, and Grammar: Evidence for a Distributive Model of Language Breakdown in Aphasic Patients and Neurologically Intact Individuals. *Psychological Review* 108.759-88.

Broca's aphasia:

"Alright. . . . Uh ... stroke and uh ... I . . . huh tawanna guy . . . h ... h ... hot tub and.... And the ... two days when uh . . . Hos . . . uh ... huh hospital and uh . . . amet... am ... ambulance."

Wernicke's aphasia:

"It just suddenly had a feffort and all the feffort had gone with it. It even stepped my horn. They took them from earth you know. They make my favorite nine to severed and now I'm a been habed by the uh stam of fortment of my annulment which is now forever."

1887. Discovery of pure alexia, *alexia sine agraphia.*

Oscar C., a retired businessman who had no problem recognizing people and objects, but who had suddenly become unable to read. Here is the first description of Oscar C.'s situation, included in Dejerine's report:

"Asked to read an eye chart, C is unable to name any letter. However, he claims to see them perfectly. He instinctively sketches the form of the letters with his hand, but he is nevertheless unable to say any of their names. … He compares the A to an easel, the Z to a serpent, and the P to a buckle.
His incapacity to express himself frightens him.
He thinks he has 'gone mad,' since he is well aware that the signs he cannot name are letters."

Broca, Paul. 1824-80.

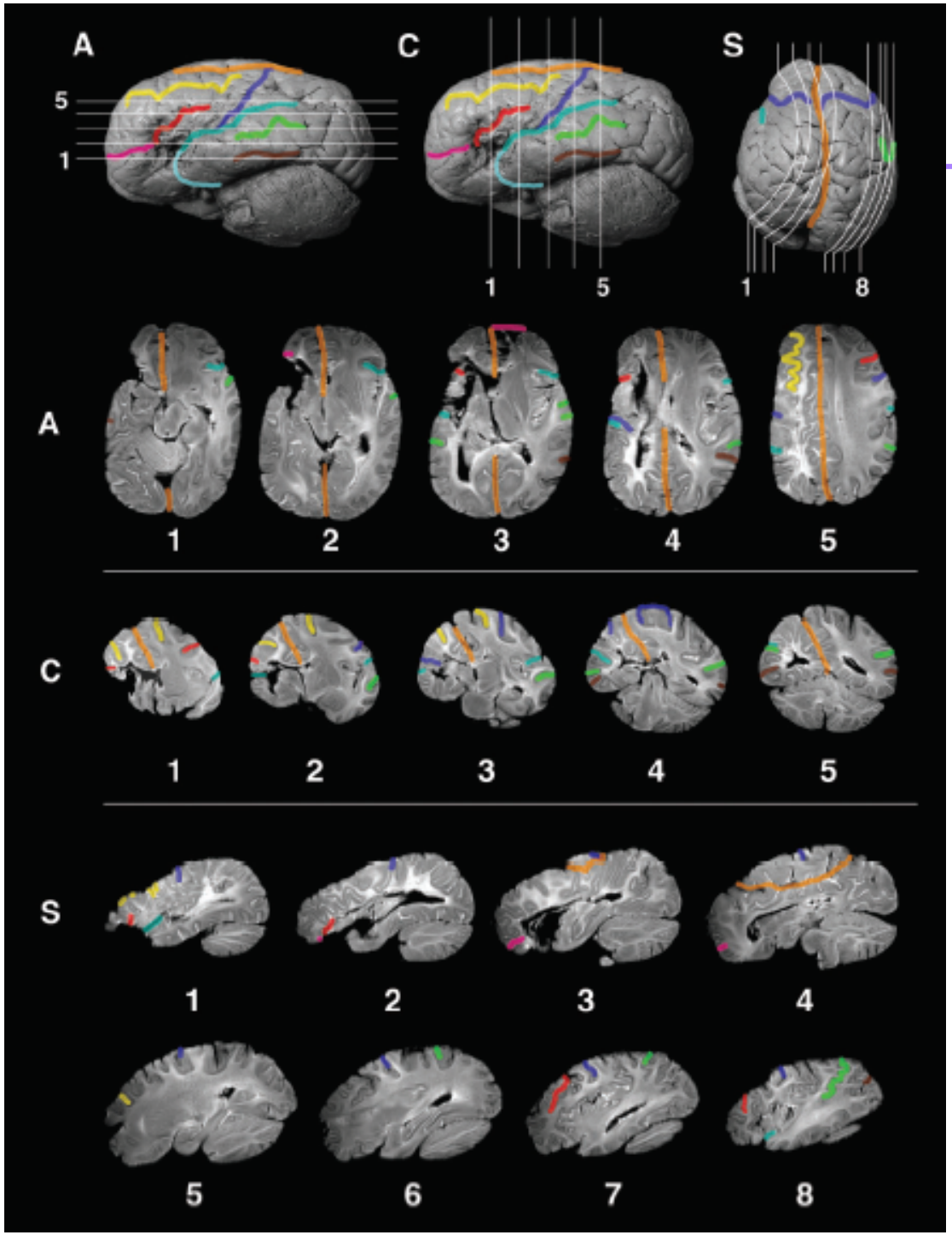
Nouvelle observation d'aphémie produite par une lésion de la moitié postérieure des deuxième et troisième circonvolution frontales gauches. *Bulletin de la Société Anatomique 36. 398-407 (1861).*

"The integrity of the third frontal convolution (and perhaps of the second) seems indispensable to the exercise of the faculty of articulate language ... I found that in my second patient the lesion occupied exactly the same seat as with the first - immediately behind the middle third, opposite the insula and precisely on the same side."

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.

A

B

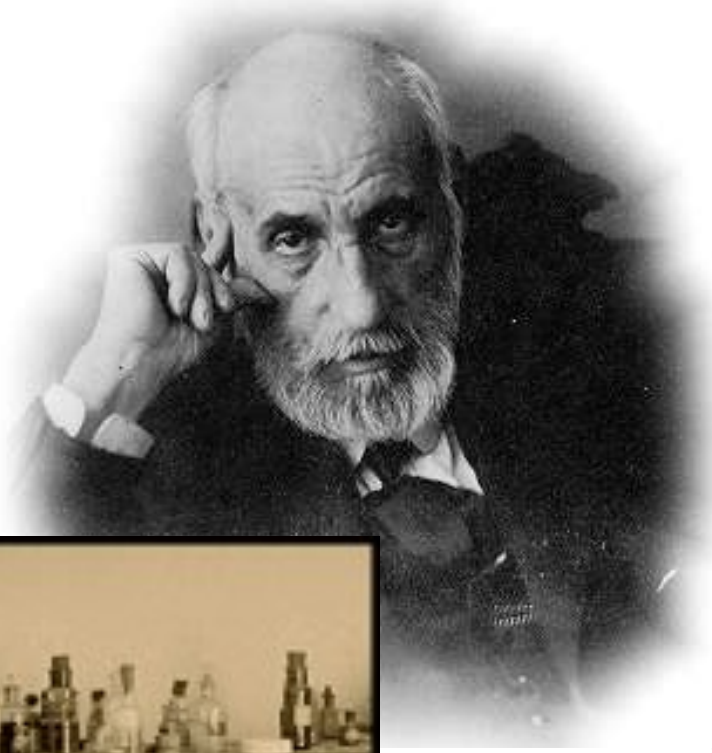


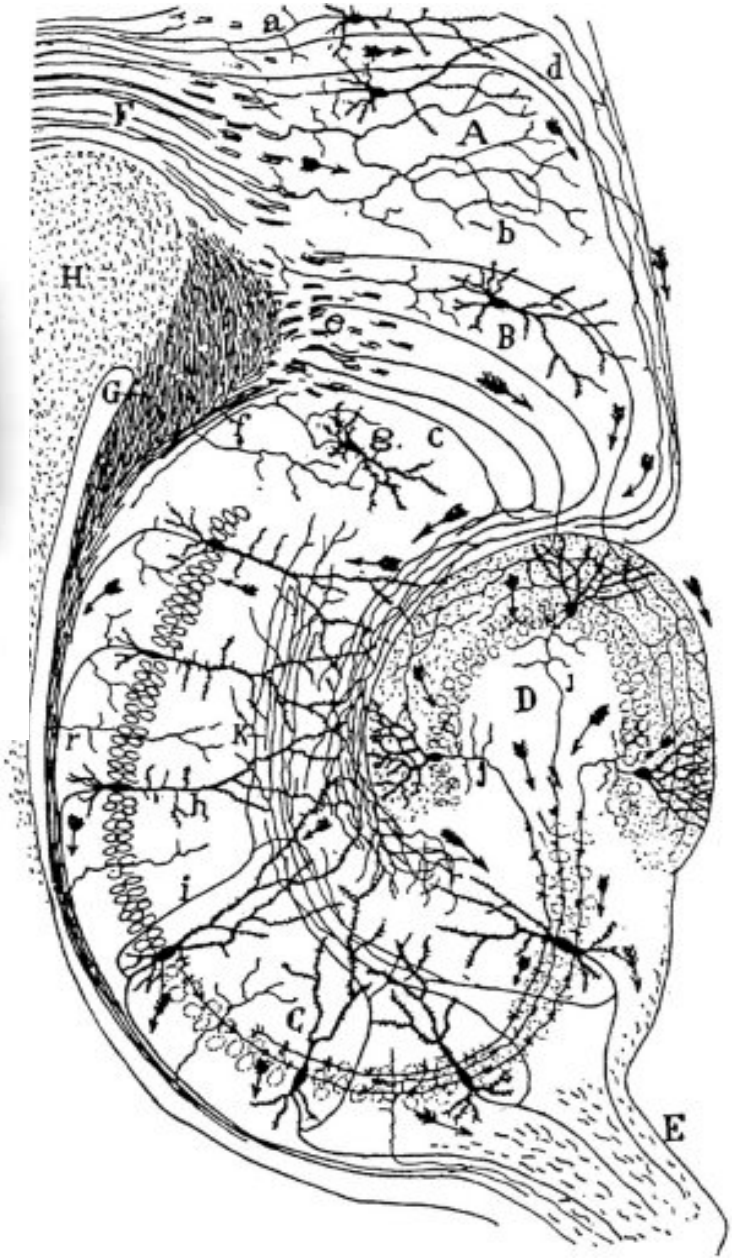
Dronkers, N. et al. 2007.
Paul Broca's historic cases: high resolution MR imaging of the brains of Leborgne and Lelong.
Fig.4. ***Brain*** 130.1432-41.

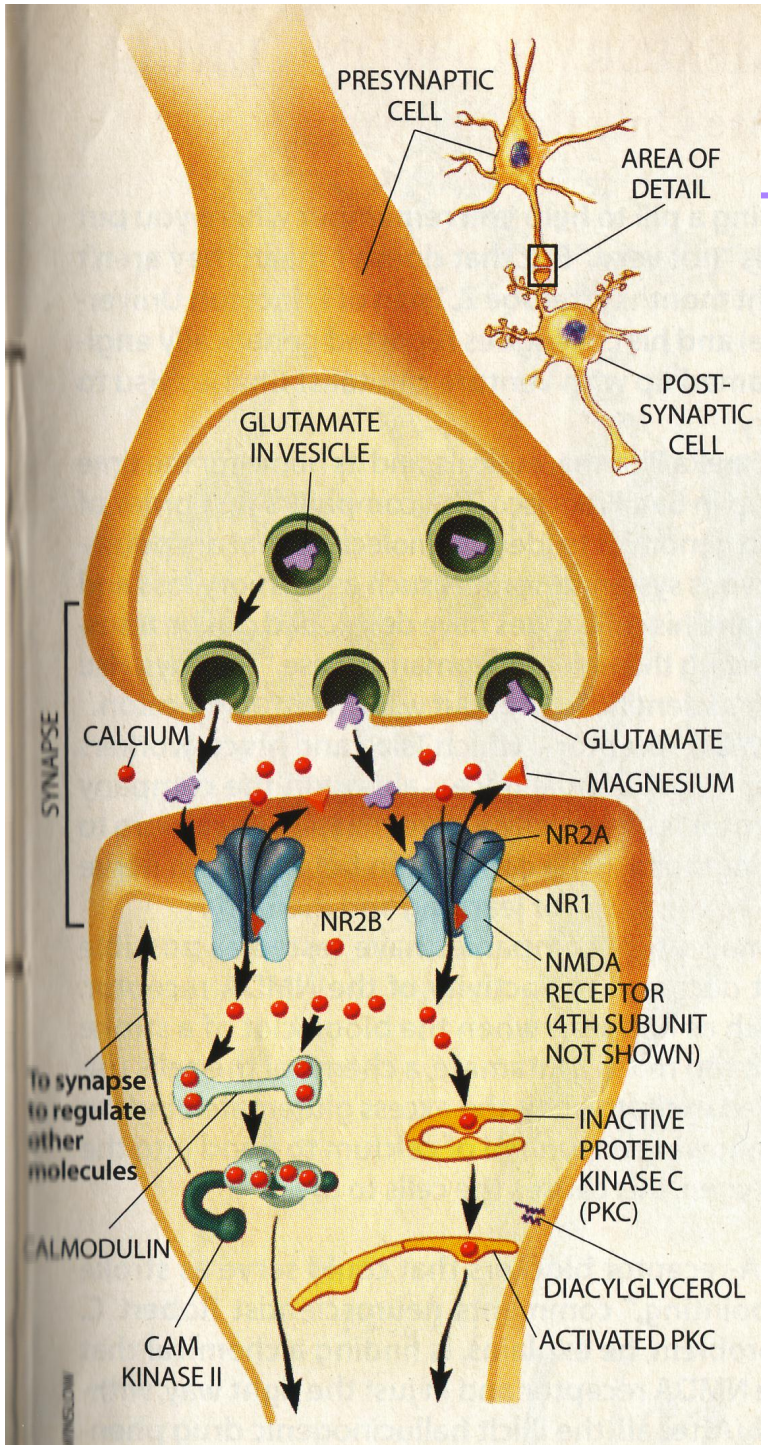
"Sagittal, axial and coronal slices through the brain reveal lesions in the left inferior frontal gyrus, deep inferior parietal lobe and anterior superior temporal lobe. In addition, there is extensive subcortical involvement including the claustrum, putamen, globus pallidus, head of the caudate nucleus 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-parieta periventricular white matter.
The medial subcallosal fasciculus is also affected." *p.1436.*

R.S.Cajal

1852-1934







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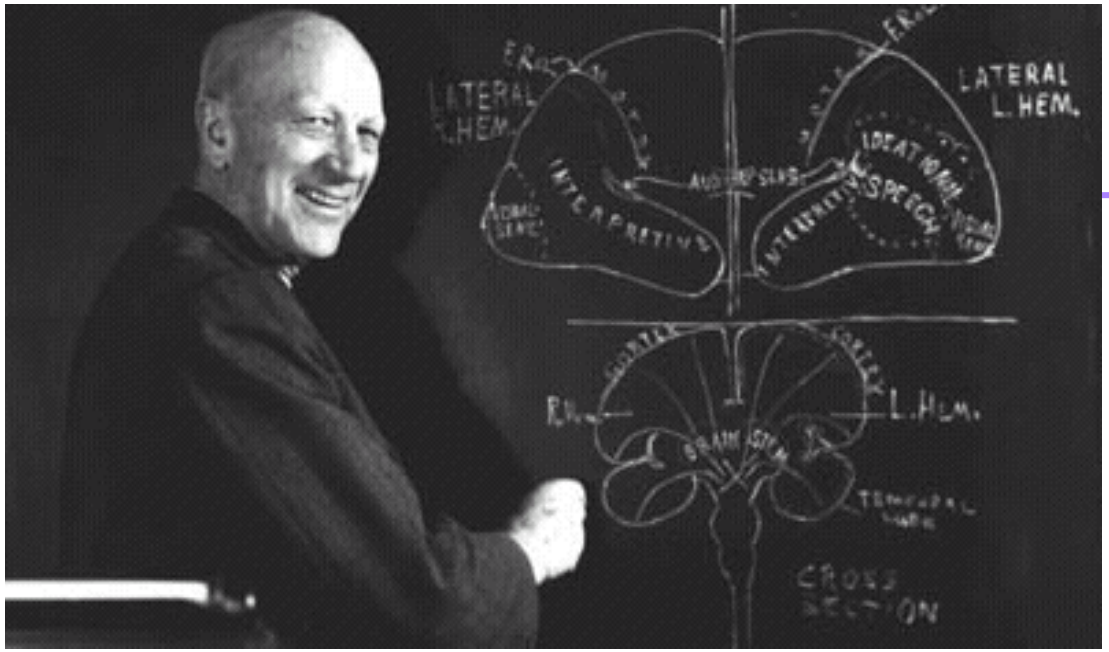

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Penfield, Wilder. 1965. Conditioning the uncommitted cortex for language learning. ***Brain*** 88.787-98.

Penfield, W. & L. Roberts. 1959. *Speech and Brain Mechanisms*. Princeton Univ. Press.

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

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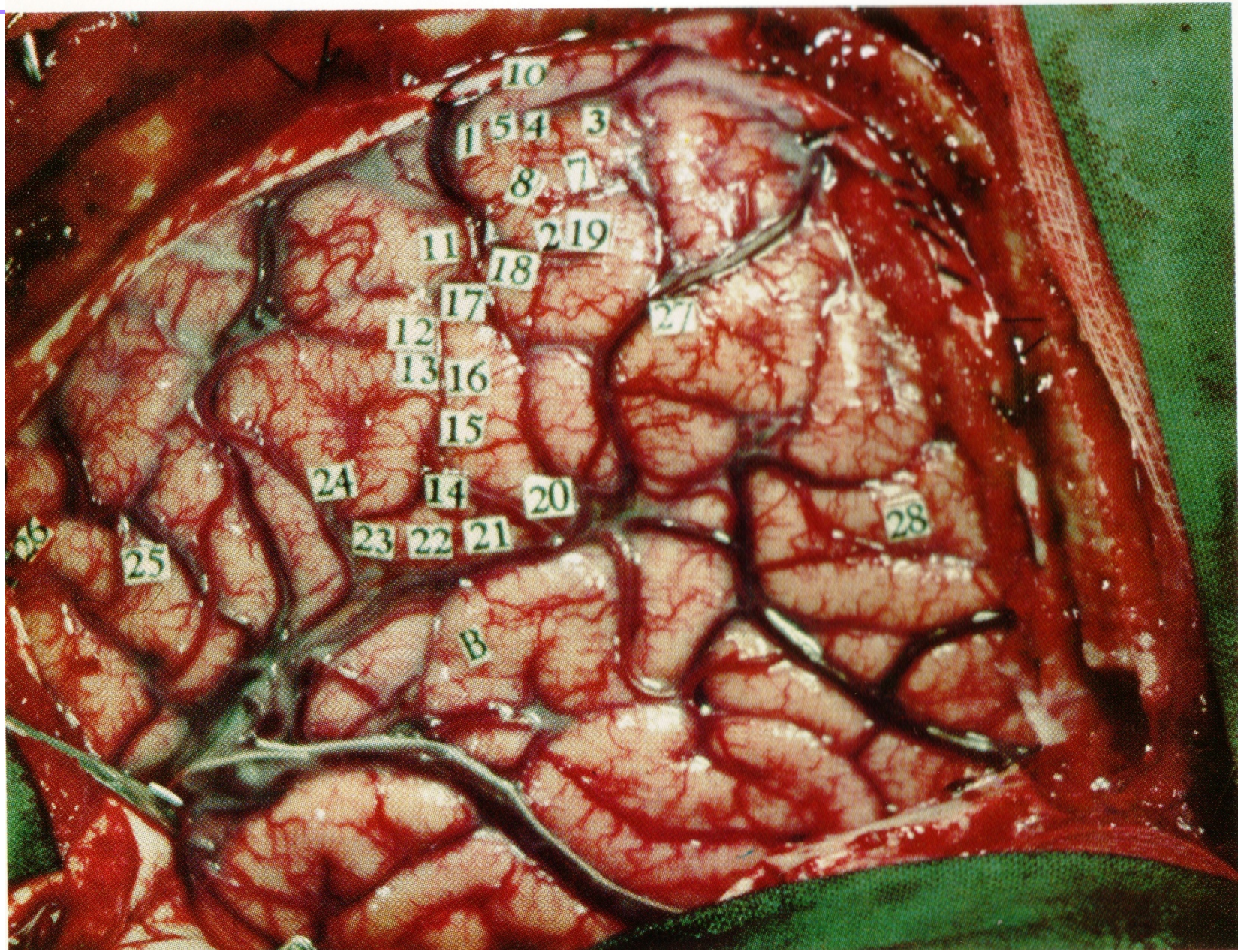
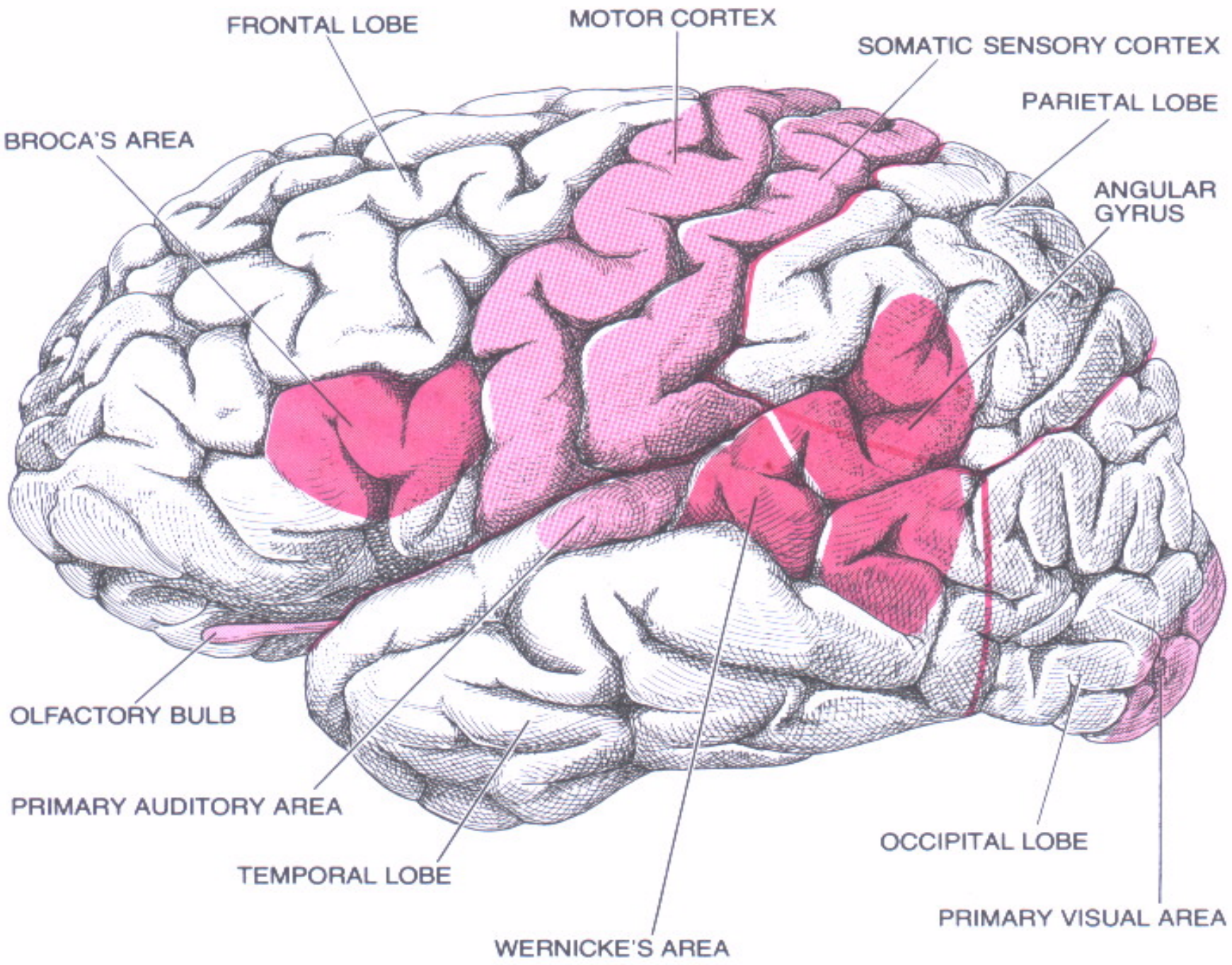
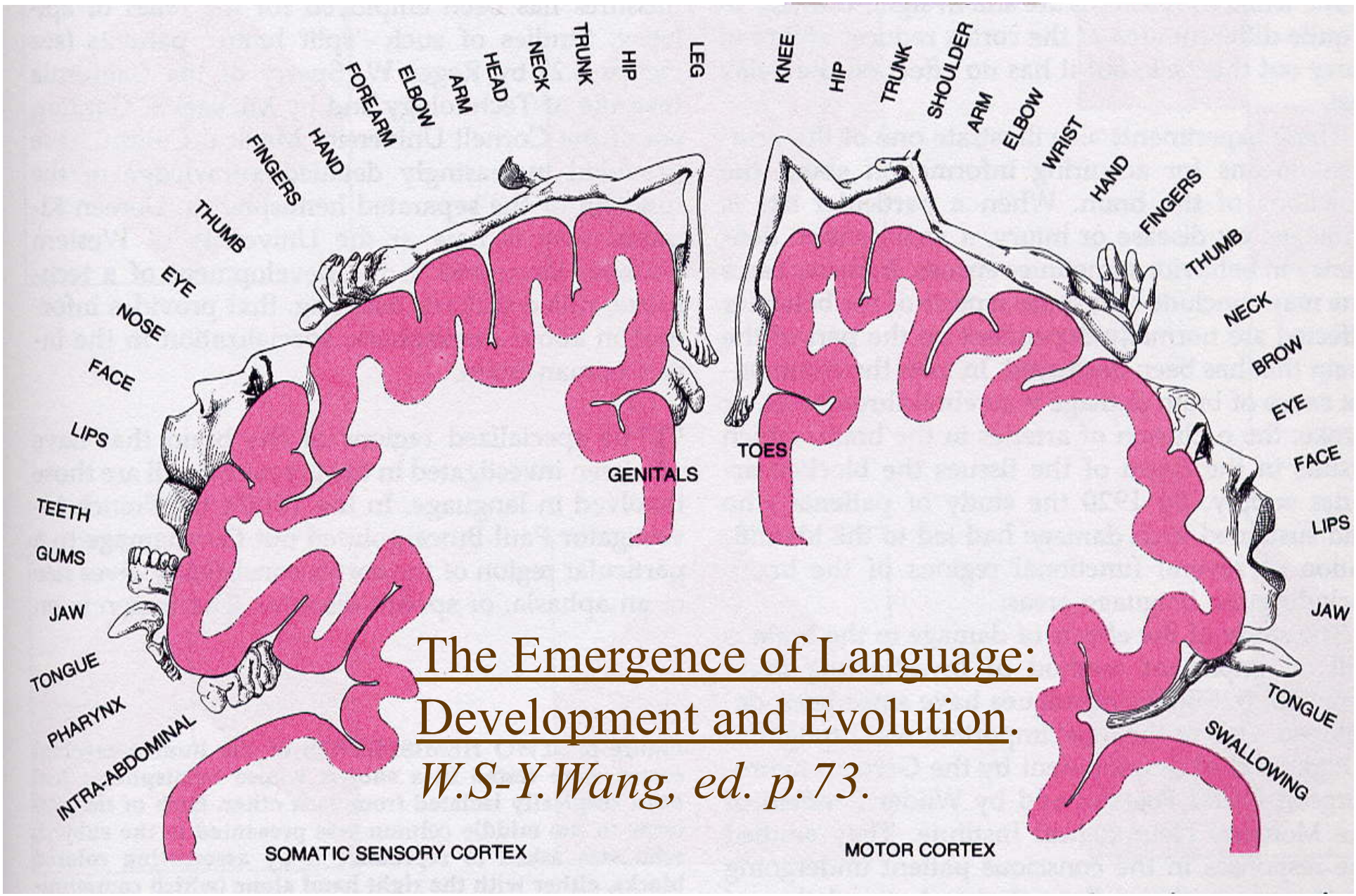



FRONTAL LOBE
MOTOR CORTEX
SOMATIC SENSORY CORTEX
PARIETAL LOBE
BROCA'S AREA
ANGULAR GYRUS
OLFACTORY BULB
PRIMARY AUDITORY AREA
TEMPORAL LOBE
WERNICKE'S AREA
OCCIPITAL LOBE
PRIMARY VISUAL AREA



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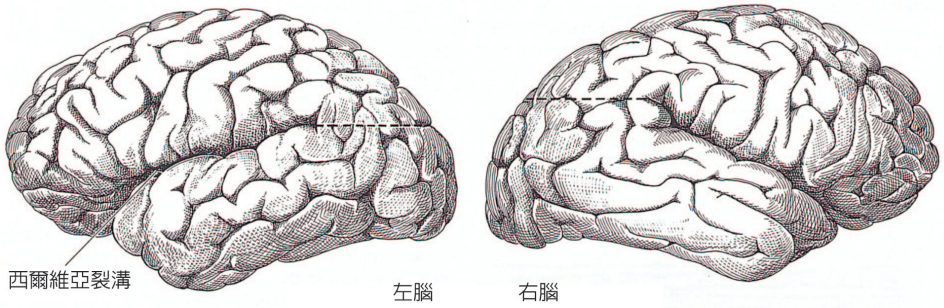
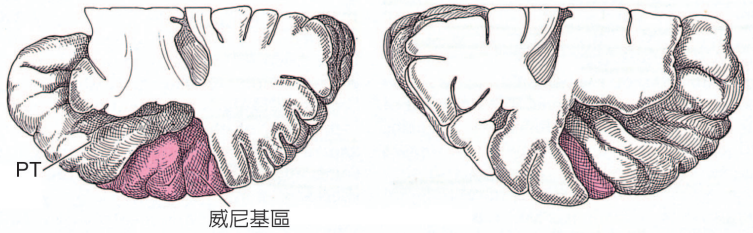
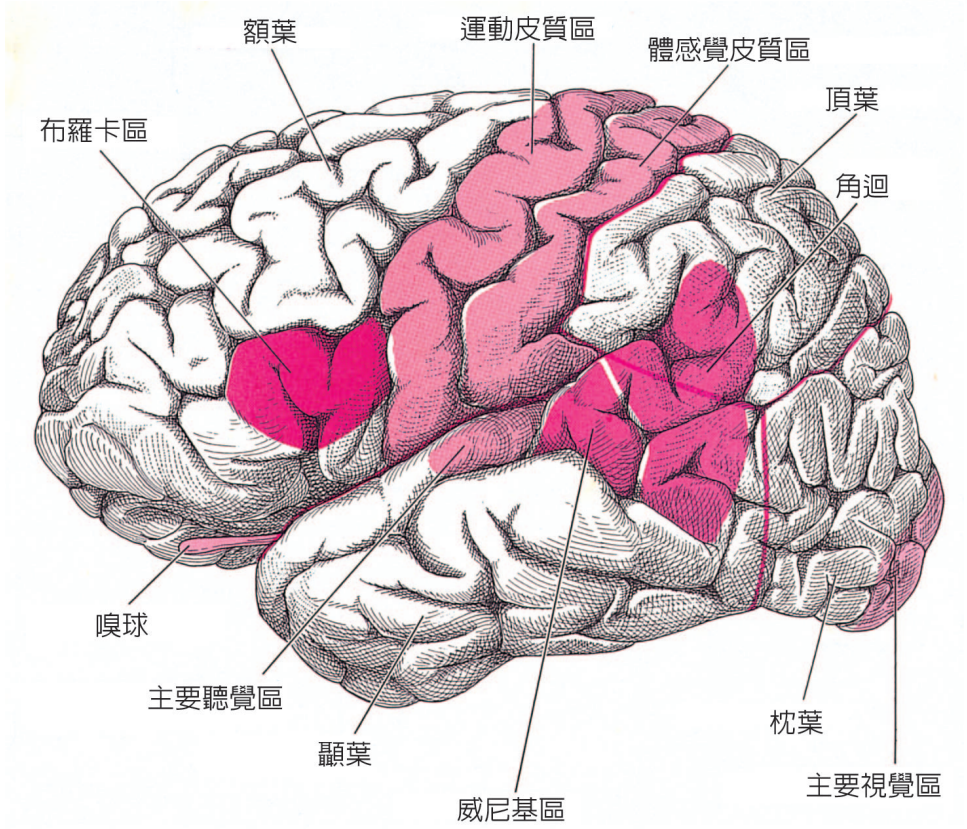
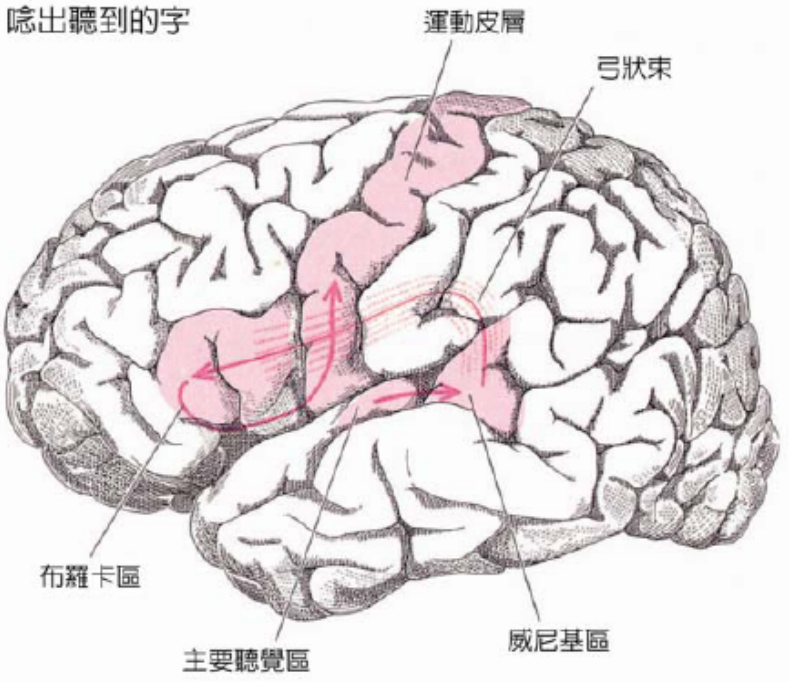
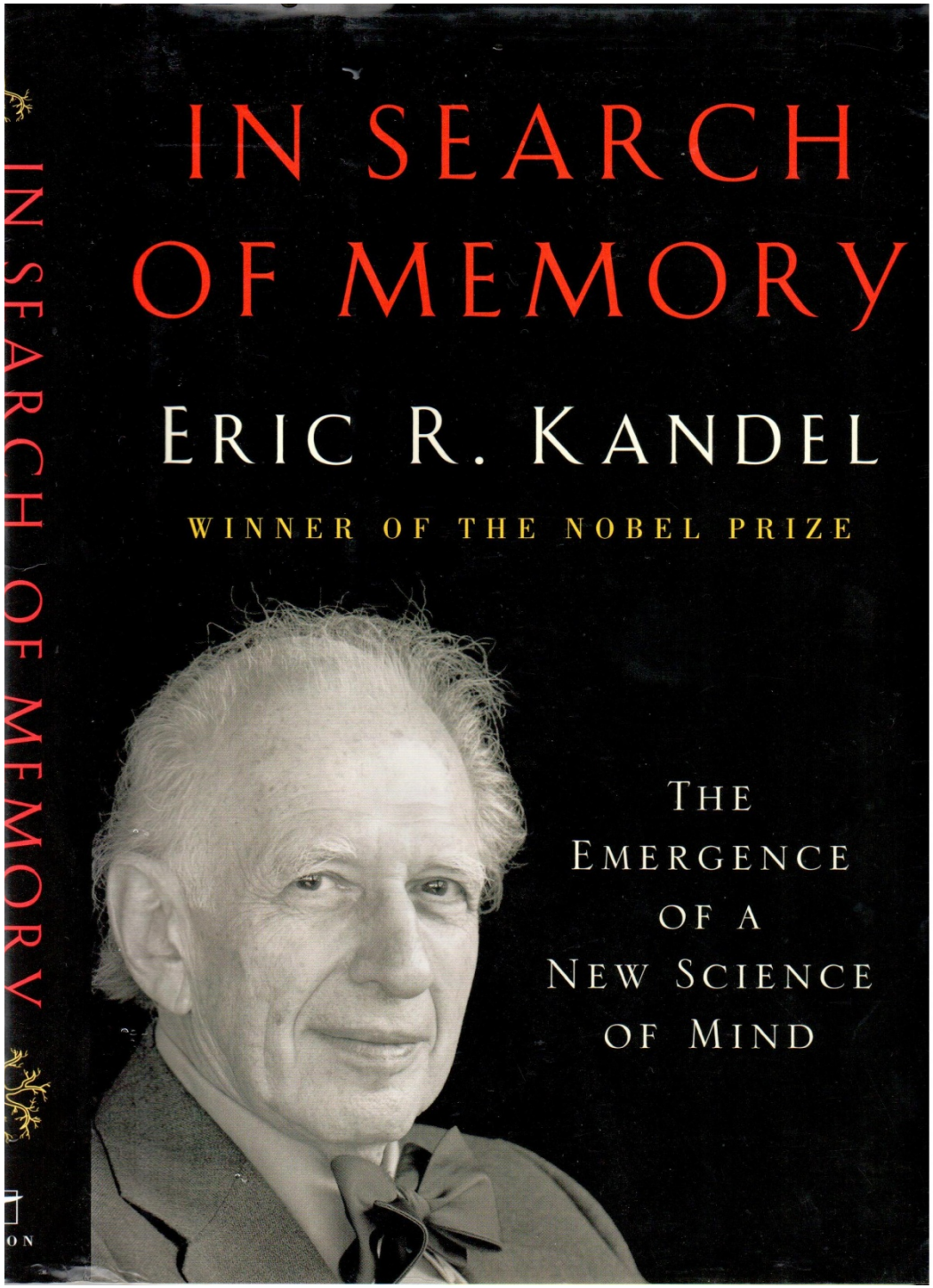

西爾維亞裂溝
左腦
右腦


PT
威尼基區

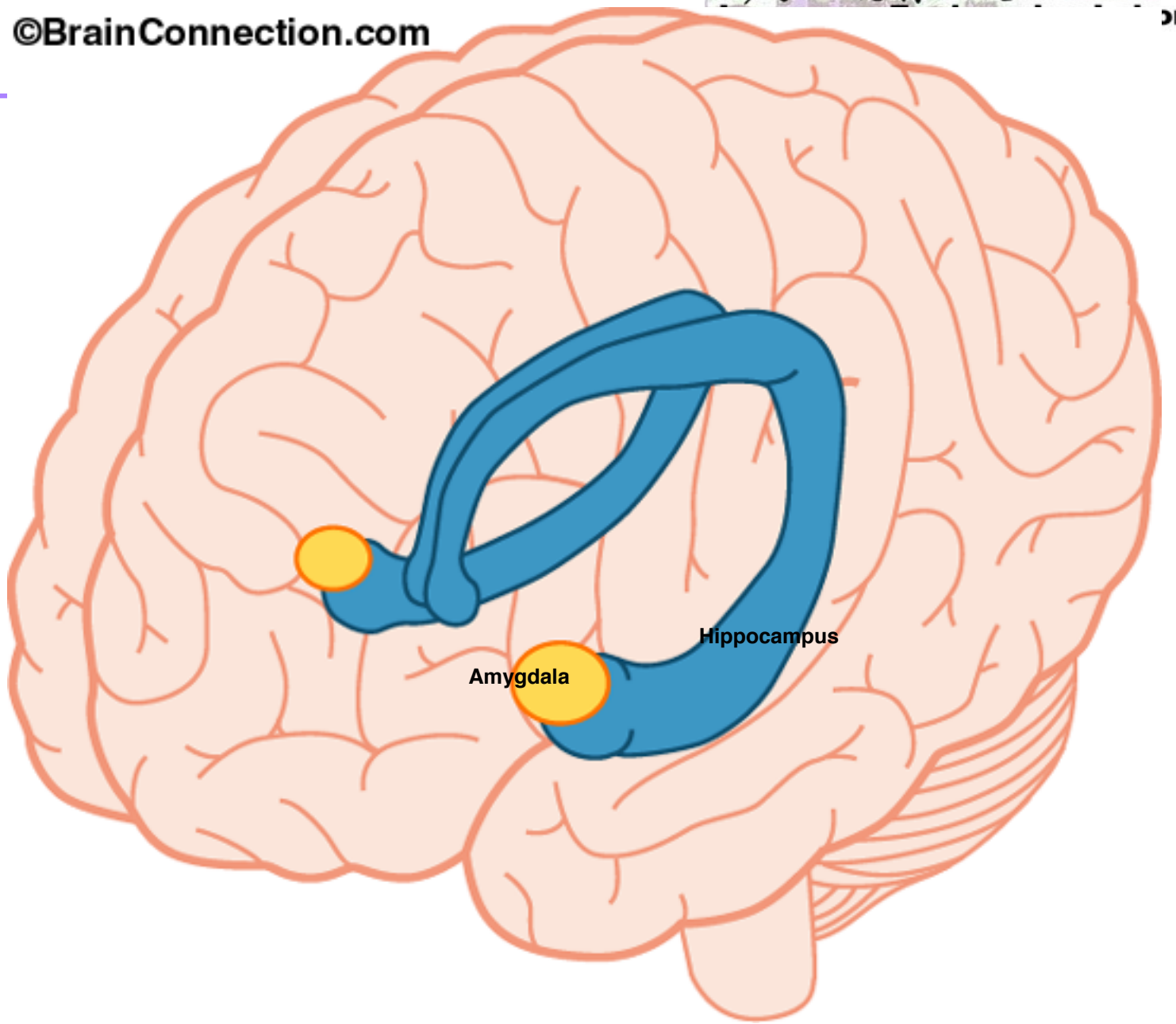

額葉
運動皮質區
體感覺皮質區
頂葉
布羅卡區
角迴
嗅球
主要聽覺區
顳葉
威尼基區
枕葉
主要視覺區

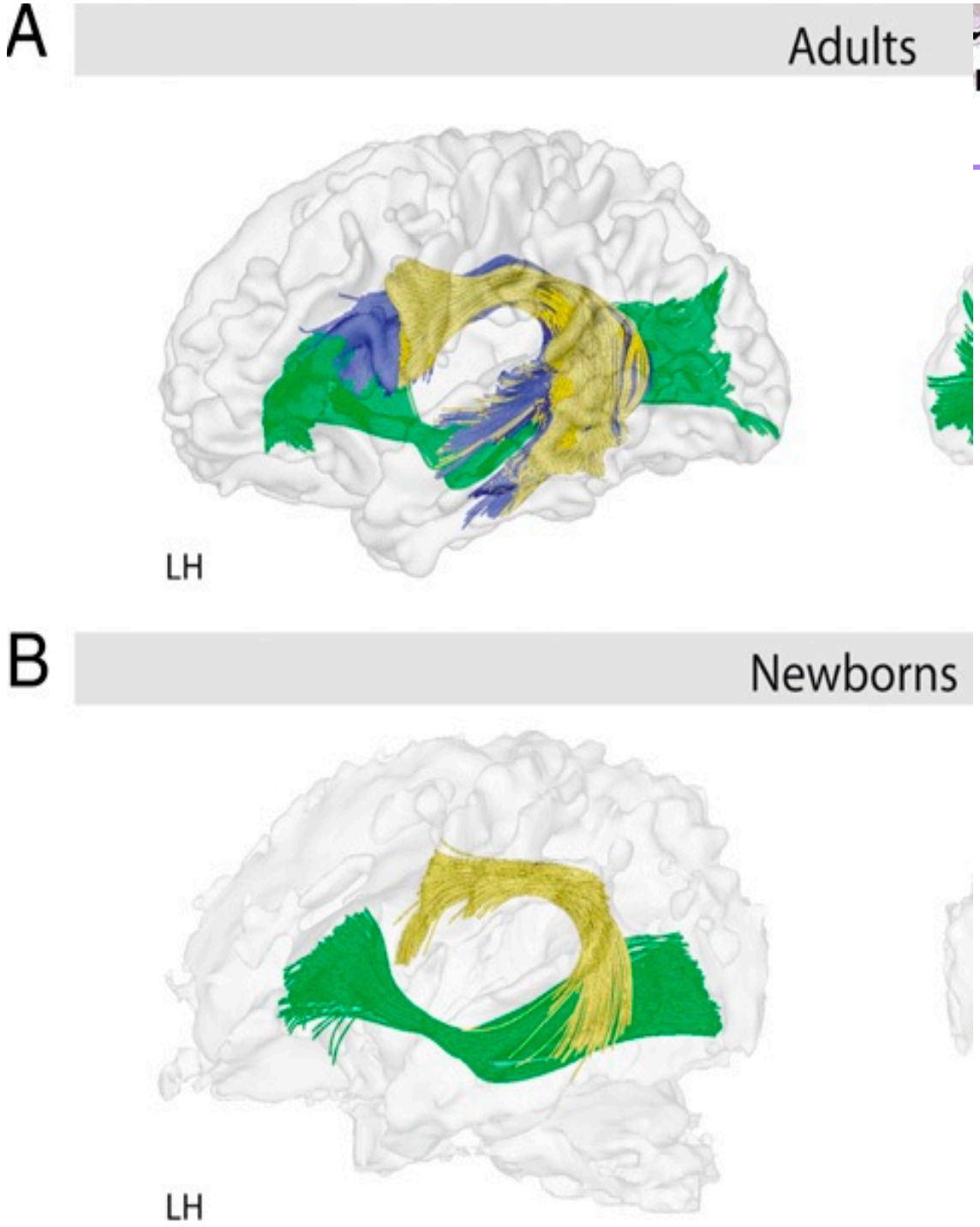

唸出聽到的字
運動皮層
弓狀束
布羅卡區
主要聽覺區
威尼基區



"… recounts Eric Kandel's bold life at the frontier of brain science, where his molecular biological approach has revolutionized human understanding of how information received by our senses becomes hard-wired."

J.D.Watson, Nobel Laureate, 1962.


©BrainConnection.com
Hippocampus
Amygdala



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Vol 466|1 July 2010 nature

OPINION

Most people are not WEIRD

To understand human psychology, behavioural scientists must stop doing most of their experiments on Westerners, argue **Joseph Henrich**, **Steven J. Heine** and **Ara Norenzayan**.

Much research on human behaviour and psychology assumes that everyone shares most fundamental cognitive and affective processes, and that findings from one population apply across the board. A growing body of evidence suggests that this is not the case.

decides how much of a fixed amount to offer a second player, who can then accept or reject this proposal. If the second player rejects it, neither player gets anything. Participants from industrialized societies tend to divide the money equally, and reject low offers. People from non-industrialized societies behave

affect the way that experienced investors make decisions about the stock market[6].

We offer four suggestions to help put theories of human behaviour and psychology on a firmer empirical footing. First, editors and reviewers should push researchers to support any generalizations with evidence. Second,

Western, **E**ducated,
Industrialized, **R**ich, **D**emocratic.

Toward a more balanced view of humanity from the perspective of Greater China, we can contribute to future research in two important ways. We must achieve a fuller understanding of the linguistic diversity in our part of the world, especially in the non-urban regions,. We must pay special attention to features not commonly found in European languages and cultures. These include the lexical use of tones, a rich system of classifiers, a relatively simple morphology, and writing in thousands of sinograms.

Currently, disciplinary boundaries are often too rigid, transdisciplinary research is scarce, and it is difficult to make connections among bodies of knowledge. We must break down such boundaries, and effectively connect the first-hand data collected from the field with the experimental results obtained in the laboratory for the light such combined views can shed on the nature of our species as a whole.

Investigating ‘where we come from’, ‘what we are’, and ‘where we are going’ , the questions posted by Gauguin, as a unique species in this known universe is a grand challenge that our Joint Center has committed to do. We hope that many young people will be excited by these questions and join us in this fundamental quest.

谢谢!

Thank you!

3Q!