

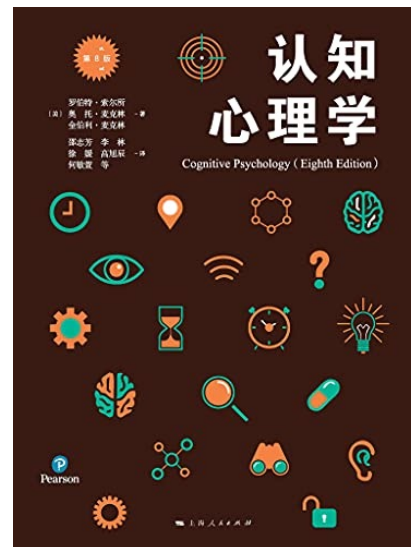
# Individual differences in cognition

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2024年1月8日

## 参考书籍

- R. L. Solso, O. H. MacLin, M. K. MacLin, Cognitive Psychology. Pearson Education, 2008 (教材)



## 第12章

# Cognition across the Lifespan

# 重点

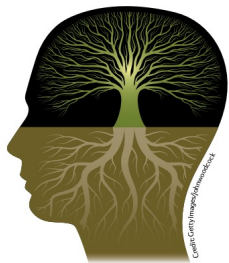
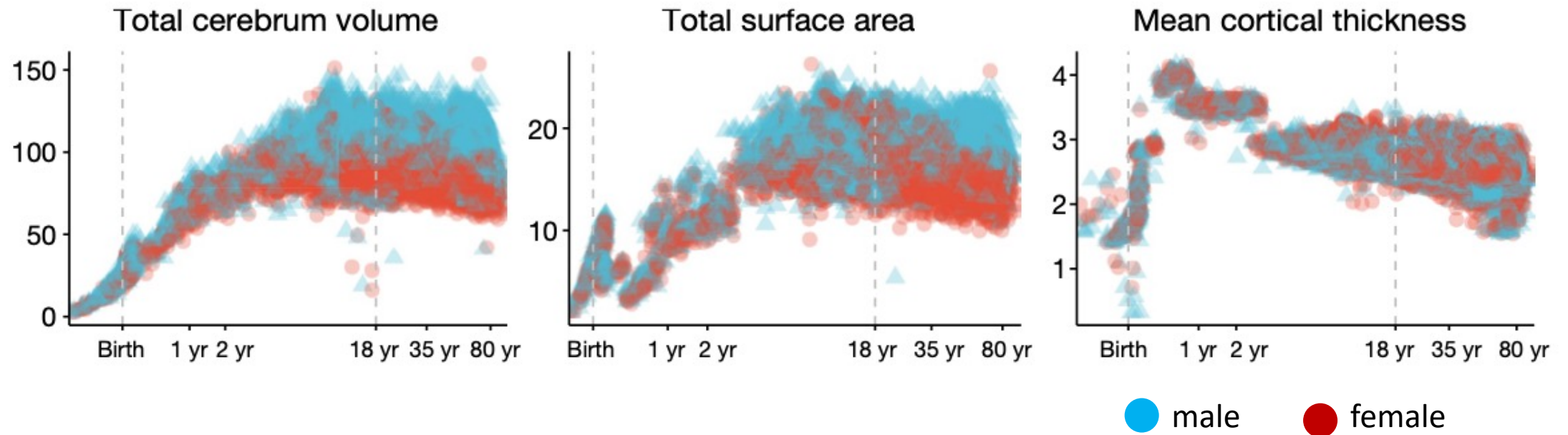
## Individual differences

- Two different types of individual differences in cognition
  - Cognitive development across lifetime, including special populations
  - Inter-person variability at a certain age.
- Two aspects of individual differences in cognition
  - Cognitive performance
    - Cognitive abilities (intelligence)
    - 执行认知任务的能力
  - Cognitive style
    - 个体用于处理认知任务的特有方式

# Development of the brain and cognitive abilities

Aging（老齡化）

# Brain development across lifetime



- More than 100 primary studies.
- 101,457 human participants.
- 123,984 MRI scans.
- Between 115 days post-conception to 100 years of age.

# Should pilots older than 60 get retired?

- Gerontology (老年学)
  - The scientific study of old age, the process of aging, and the particular problems of old people.
  - Aging and dying are natural aspects of the human experience.
  - Dying is quite adaptive. A shorter life span (one that **extends beyond reproduction and childrearing**) frees up resources required for reproduction.
- Geriatrics (老年病学)
  - The study of **diseases** due to aging.

Boeing 727 simulator.



Early 1990s, Otto MacLin.

# 重点

## Explicit vs. implicit memory in aging

### • Implicit memory test

- Word-stem completion task (词干补全任务):  
Subjects see three letters on the computer screen and to give the first word that came to mind that started with those three letters.

del\_\_\_\_\_

delight (*studied*), delete (*unstudied*, baseline)

- If subjects give more answers from the 'studied' list, they exhibit implicit memory.

### • Explicit memory test

- Word list memory task
- Subjects studied a list of words, and later recalled the words from the list.

*Summary of Mixed Models Evaluating the Effects of Age, Time, and Their Interaction on Composite Explicit and Implicit Memory Measures (Controlling for Sex and Education)*

Test measure and model term	Parameter estimate (SE)	p
Explicit memory		
Age	-0.032 (0.006)	< .01
Time	-0.049 (0.019)	.01
Age × Time	-0.006 (0.002)	.02
Implicit memory		
Age	0.004 (0.013)	.77
Time	0.009 (0.056)	.88
Age × Time	0.002 (0.007)	.73

- Subjects' performance on explicit memory declined with aging, but their performance on implicit memory did not change with aging.

# Memory function in normal aging

- Memory types that do not decline with aging
  - Semantic memory
  - Procedural/implicit memory
- Memory types that decline with aging
  - Episodic memory (explicit)
- Mixed results
  - Short-term memory (may depend on the studied materials)

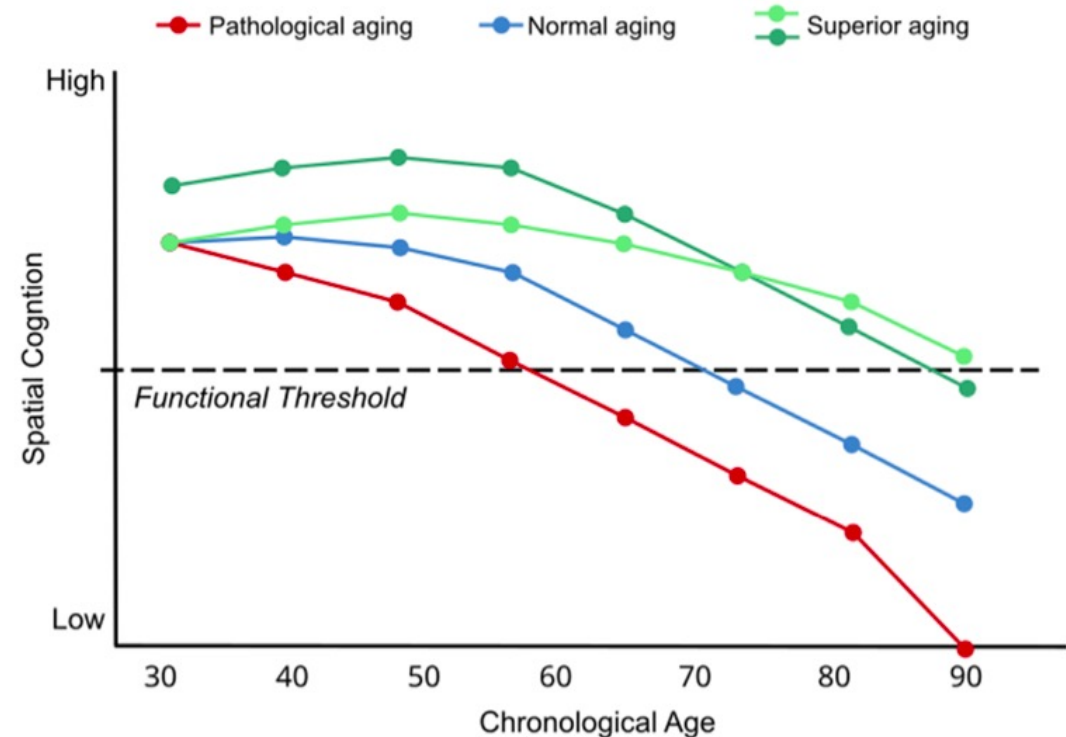
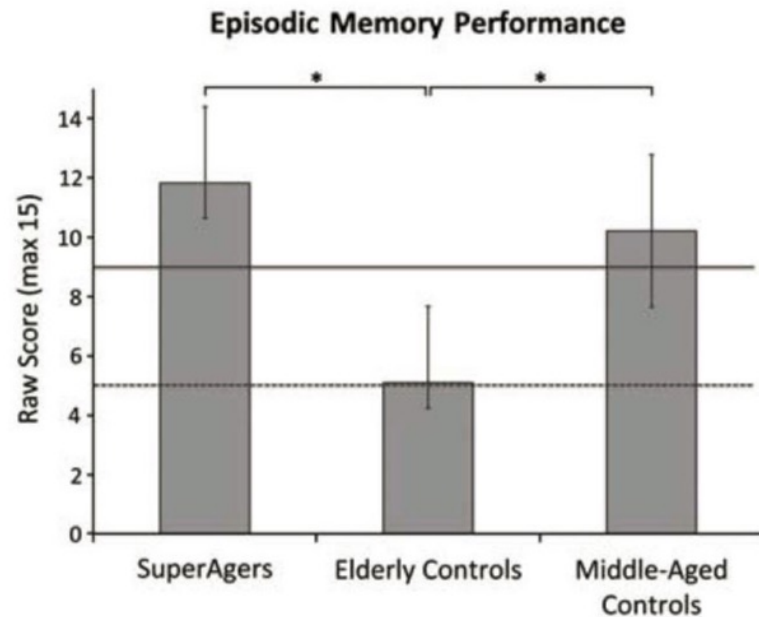


# 重点

## Cognitive SuperAgers

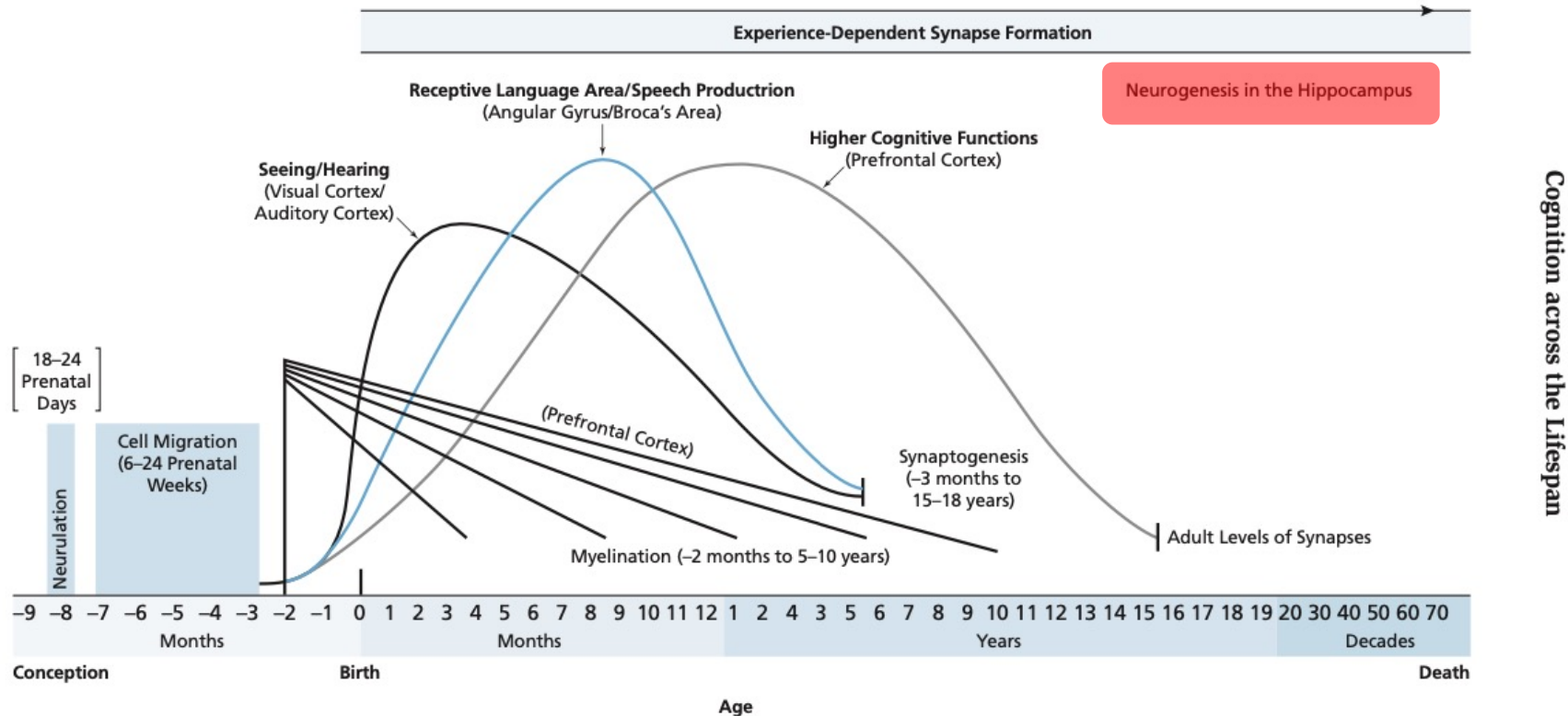


- SuperAgers are defined as people in **advanced age (above 80)** whose **episodic memory** performance is comparable to that of cohorts **2–3 decades younger** (Rogalski et al., 2013)



# Brain development across lifetime

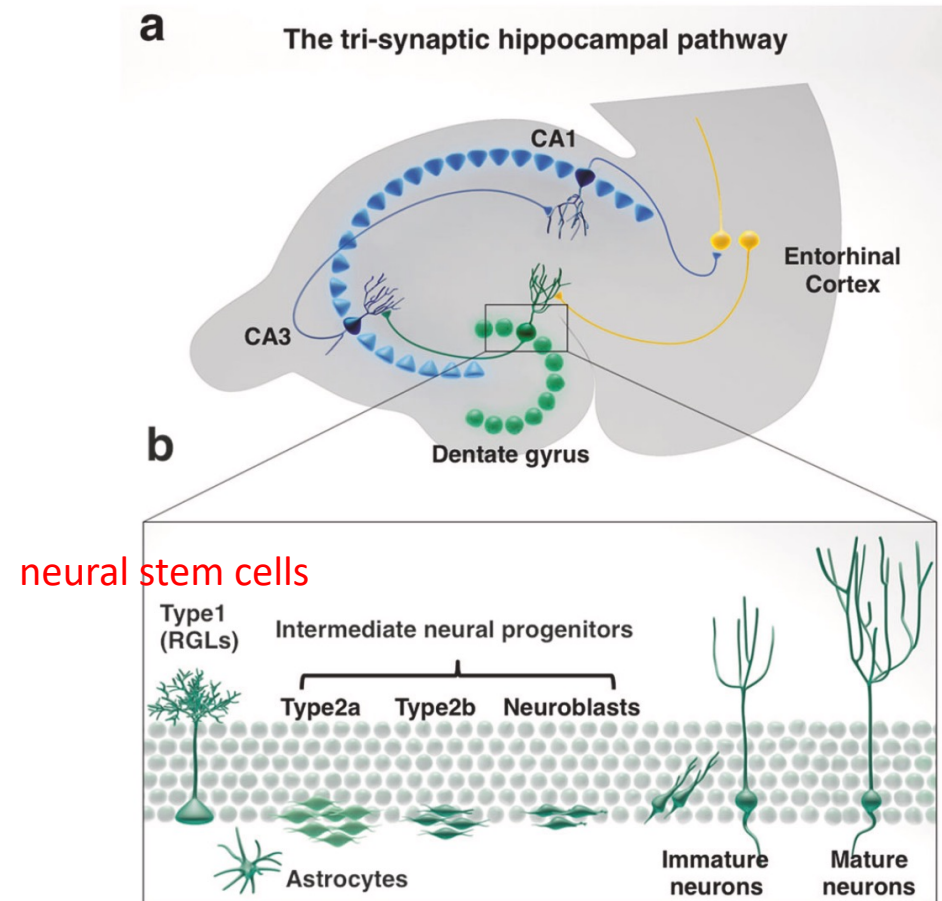
The developmental course of human brain development.



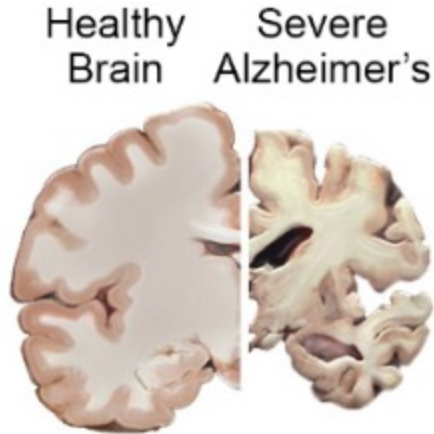
- Neurogenesis in hippocampus never declines.
- Sensitive periods.
- Brain development is lifelong.

# Adult neurogenesis in hippocampus

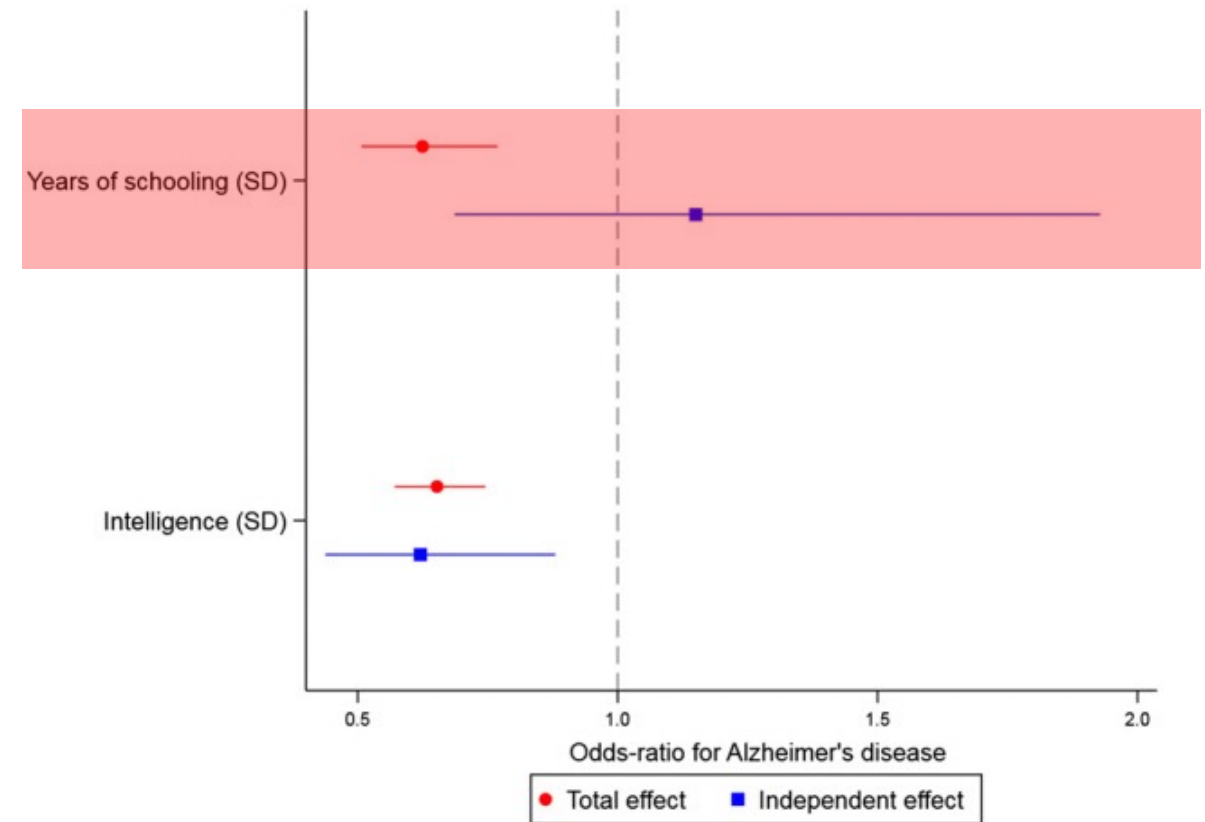
- Adult neurogenesis is the formation of **functional, mature neurons** from **neural stem cells** in specific brain regions in adults. In these regions, new neurons are generated **throughout life** and integrated into established neuronal circuits.
- Adult hippocampal neurogenesis has been implicated in cognitive processes under normal physiological conditions, such as **learning, memory, pattern separation**, and **cognitive flexibility**.
- Dysregulation of adult **hippocampal neurogenesis** may be associated with cognitive decline in neurological disorders and psychological symptoms in psychiatric disorders.



# Education reduces odds of Alzheimer's disease



- 17,008 AD cases and 37,154 controls from the International Genomics of Alzheimer's Project (IGAP) consortium.
- With each 3.6 year increase in years of schooling, odds of AD were, on average, 37% lower.
- Physical exercise, rich social network also have positive effects → cognitive reserve (认知储备).





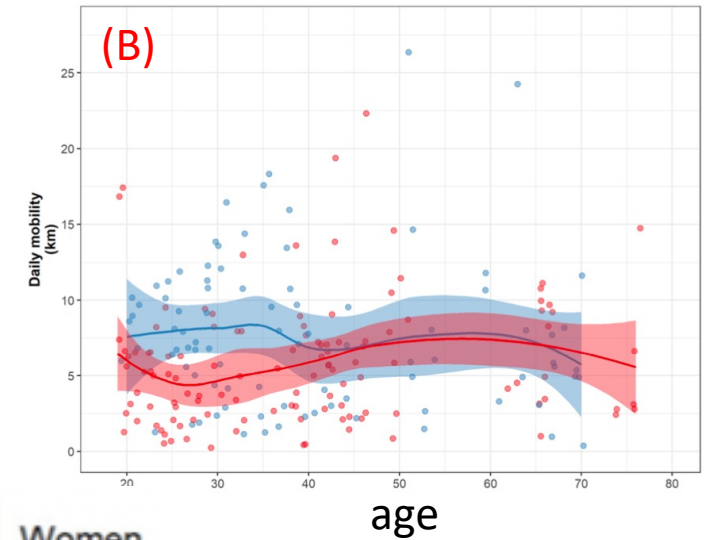
# Physical mobility helps spatial navigation abilities

## Tsimané

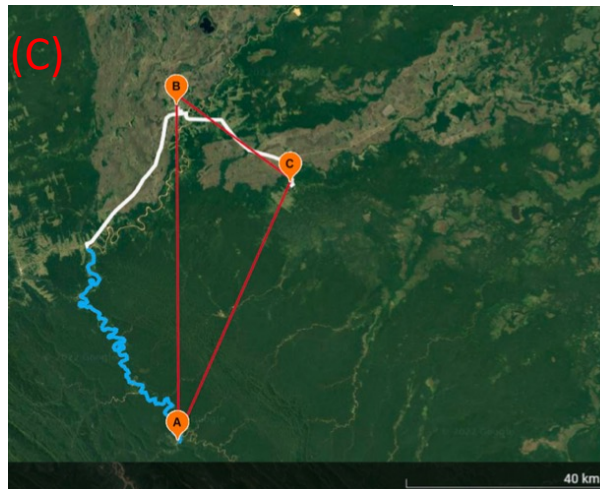
(A) a Bolivian people who live in the Amazon River Basin and depend heavily on horticulture, hunting, fishing, and foraging for their livelihood.



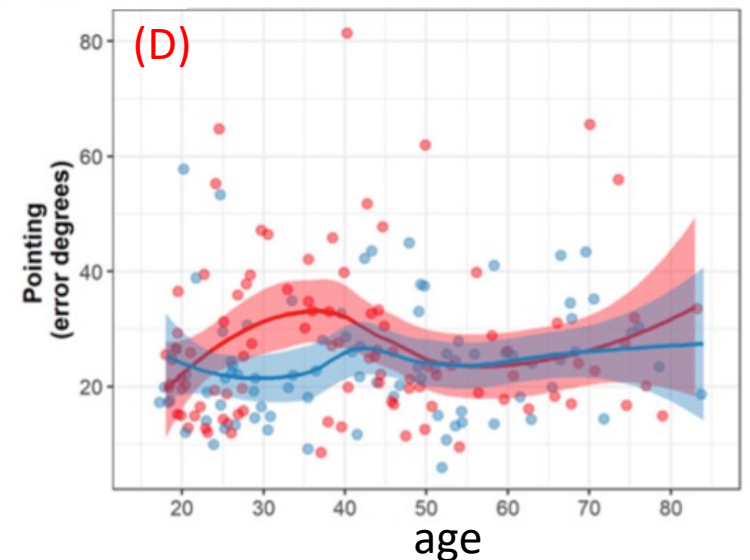
(B) Daily mobility remains high through old ages.



(C) Pointing task: standing at A, point to B. (in a very large complex environment)

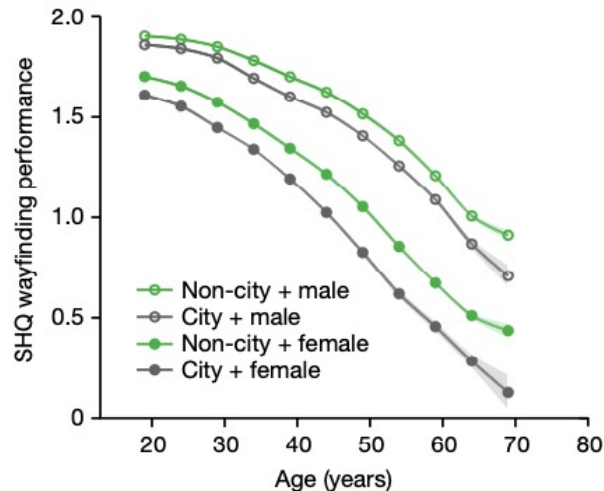


(D) Pointing performance remained relatively stable into old ages.

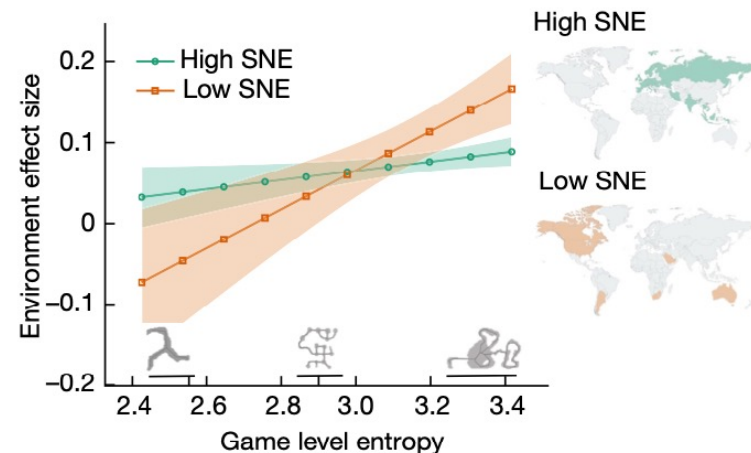
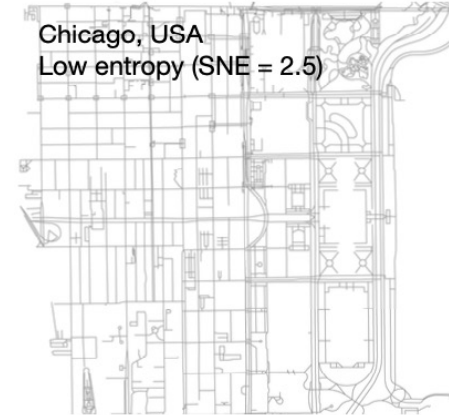
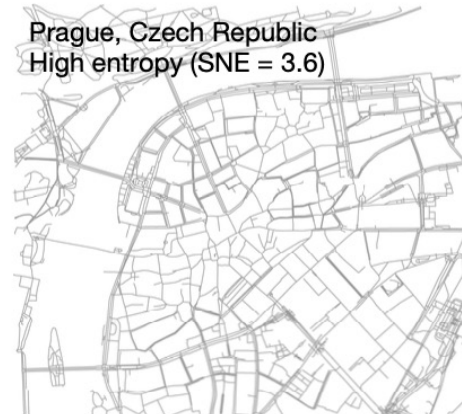


# Entropy (熵) of city street networks linked to future spatial navigation ability

Sea Hero Quest (SHQ) 手机App游戏



- People growing up in cities performed worse.



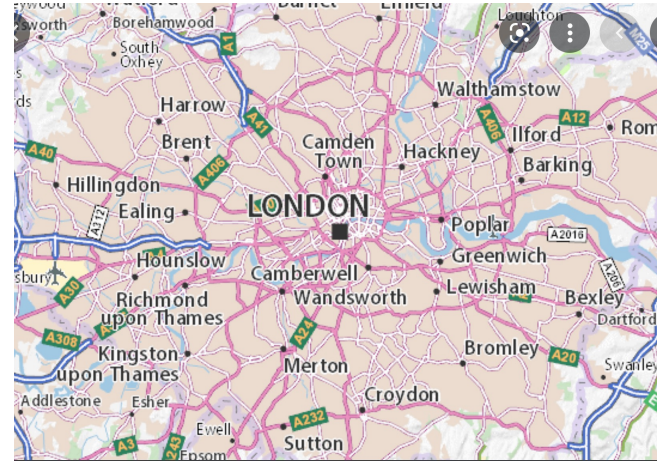
- People growing up in low-entropy cities performed better in low-entropy environments and worse in high-entropy environments, relative to those growing up in high-entropy cities.

Coutrot, 2022. Nature.



# Engaging in challenging spatial navigation increases hippocampal volume.

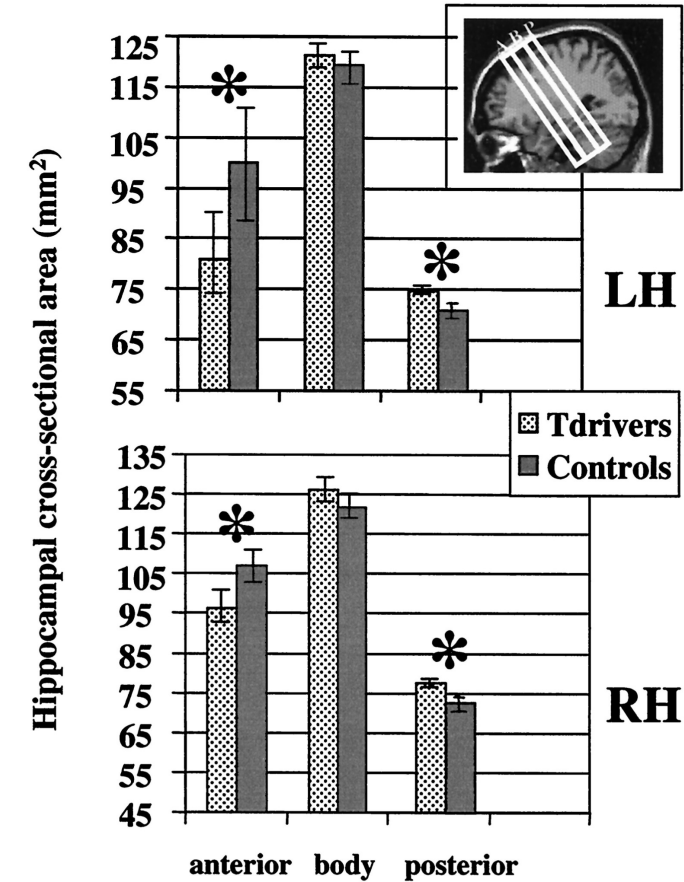
Map of London



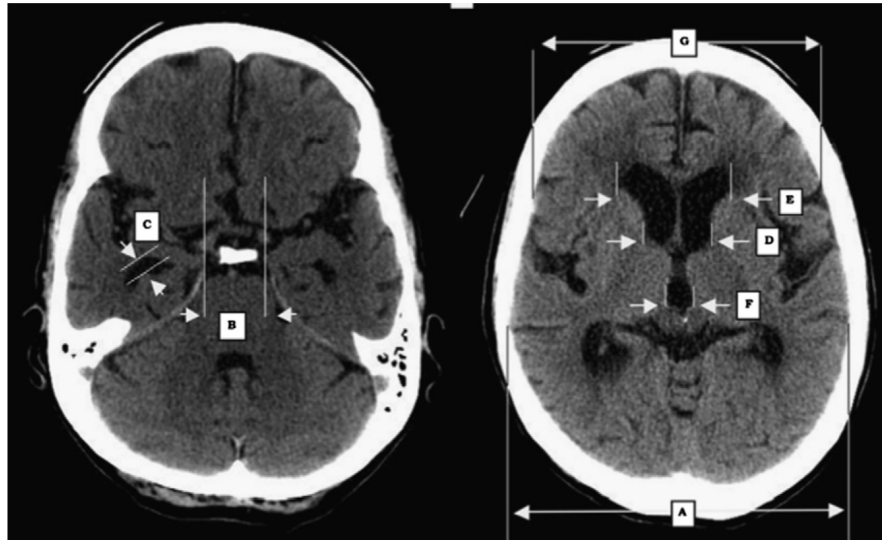
taxi driver



bus driver (control)



# Bilingualism protects against Alzheimer's disease



Maximal transversal intracranial width (A)  
Suprasellar cistern (B)  
Temporal horn diameter (C)  
Minimal intercaudate distance (D)

Maximal frontal horn width (E)  
Maximal width of the third ventricle (F)  
Maximal width of the frontal skull (G)

Suprasellar cistern ratio (B/A), temporal horn ratio (C/A), bicaudate ratio (D/A), Huckman's number (D D E), third ventricle ratio (F/A) and Evans ratio (E/G).

**Table 2 – Brain ratios and scores of monolingual and bilingual patients.**

	Monolingual (n = 20)		Bilingual (n = 20)	
	Mean	SD	Mean	SD
Bicaudate ratio	.17	.03	.18	.05
Huckman's number	60.01	7.82	64.30	12.18
Evans ratio	.36	.05	.35	.07
Suprasellar cistern ratio	.20	.02	.20	.02
Temporal horn ratio	.03***	.01	.05***	.02
Third ventricle ratio	.06**	.02	.07**	.01
Radial width of the temporal horn (rWTH) <sup>a</sup>				
Left	4.16***	1.09	7.23***	3.21
Right	4.04*	1.56	6.48*	3.64
Largest	4.69***	1.31	7.87***	3.53

\* $p < .05$ .

\*\* $p < .01$ .

\*\*\* $p \leq .001$ .

<sup>a</sup> n = 19/group.

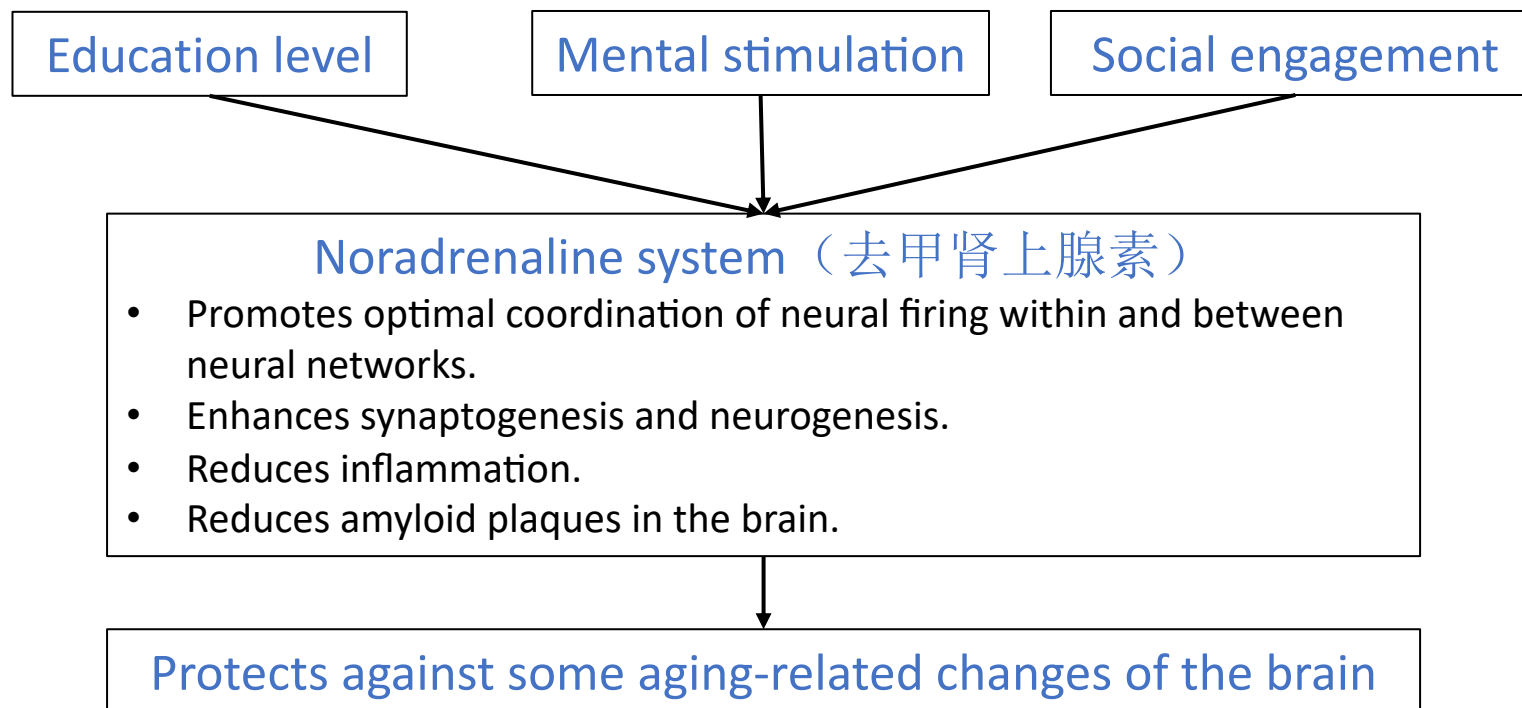
- The bilingual brains are more diseased than monolingual brains at the point of AD diagnosis.



# 重点

## Cognitive researve hypothesis (认知储备假说)

- Cognitive reserve is the thinking capacity and adaptation of the mechanisms that protect and maintain optimal cognition in functioning across multiple contexts and in the face of multiple pathologies and stressors.



*Ian H. Robertson and Paul M. Dockree. Chapter 10, Aging and Attention.*

# Should pilots older than 60 get retired?

- Procedural vs. explicit memory
  - The main factor leading to poor performance was the amount of flying time the pilots had logged recently. **practice makes perfect**, and continued practice maintains the skill.
- Cognitive reserve
  - “Senility” does not have to be the norm for older adults. **Keeping mentally, socially, and physically active** maintains a healthy cognitive system.

Boeing 727 simulator.



Early 1990s, Otto MacLin.

# 总结

## 重点

- 重点概念
  - 认知储备(cognitive reserve)
  - 超级年老者(superAgers)