美麗心視界：心智與大腦的交會

阮啟弘

中央大學

認知神經科學研究所

腦科學　是非題

- 頭大, 表示聰明?
- 一般人只用了大腦的十分之一?
- 多用左手寫字, 可幫助你變聰明?
- 一般人很少使用右腦, 所以要開發右腦?
- 過了十歲, 大腦就不會再產生新細胞？
- 多閱讀, 可以幫助你變聰明？

大綱

- 為什麼我們要研究認知神經科學
- 認知神經科學的起源
- “人身難得”→演化、基因、遺傳與腦中的地圖
- 美麗心視界→視覺、注意力與眼球運動
- 認知神經科學的運用
  - Neurosocieties：the rise and impact of the new brain sciences; Neuroprosthetics-Brain-Computer-interface; Neuroeconomy; Neuroethics
- 分享一點點的求學經驗

為什麼我們要研究認知神經科學?

神經或精神疾病：
造成百分之30 的工作時數喪失

成本約為:
發展中國家國民所得的4%～5%

精神分裂症:
全球約有兩千五百萬人口

自殺:
每年有一百萬人口

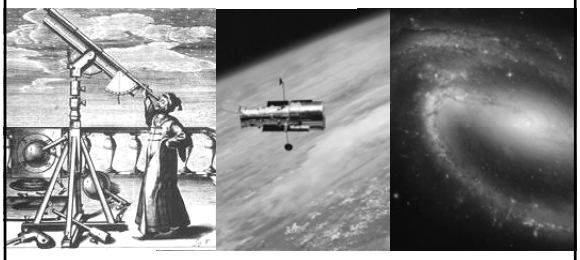
憂鬱:
全球約有一億五千萬人口

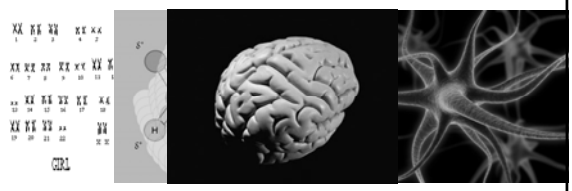
暴力犯罪：
一百六十萬人被害

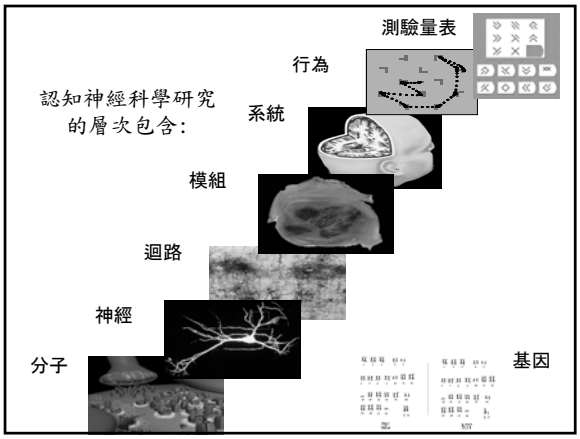
注意力與執行控制功能的缺損
常見於心理疾病

- 注意力不足/過動症
- 精神分裂症
- 雙極性情感疾患/躁鬱症
- 重鬱症/單極性憂鬱疾患
- 行爲障礙症
- 邊緣性人格疾患

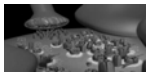
認知神經科學的起源





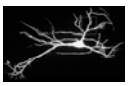


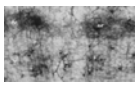
*認知神經科學*的研究目的在於-了解心智歷程(例如理解我現在在說什麼)在腦中是如何發生的。



在神經細胞中的分子不會聽得懂我在說什麼。

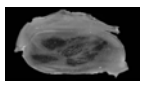
單一神經元不會懂，十個神經元也不會懂。.



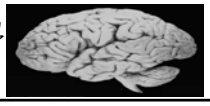


一千個神經元(= 10^3)？

一百萬(= 10^6)？



我們需要10^{12} 個神經元才會懂，因為人類需要整個大腦的分工合作才能了解這些東西，而10^{12}正是大腦擁有的神經元數量！

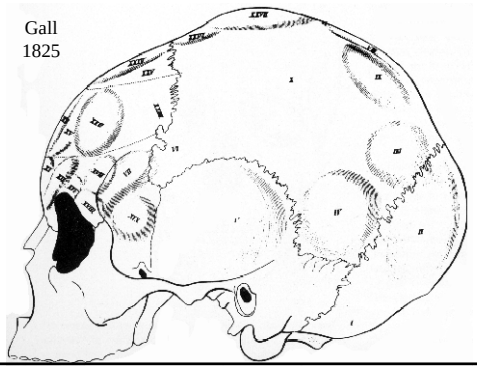


Aristotle's Arguments for the Heart Against the Brain as the Centre of Mind (384-322 B.C.)

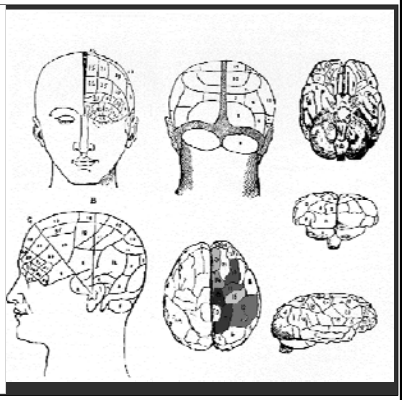
Heart	Brain
1. Heart is centrally placed	1. Brain is peripheral, to cool the blood
2. All animals have a heart	2. Invertebrates have sensations but no brain
3. Heart provides blood, needed for sensation	3. Brain is bloodless, without sensation
4. Heart is warm, like higher life	4. Brain is cold
5. Heart connects with all senses and muscles, via blood vessels	5. Brain is not connected with the sense organs
6. Heart is essential for life	6. Brain is not essential
7. Heart forms first	7. Brain forms later
8. Heart is sensitive to touch	8. Brain is insensitive to touch
9. Heart is affected by emotion	9. Brain is emotionally neutral
10. Man's heart is hottest, fitting his superior intelligence	10. Man's brain is largest in order to cool the hot blood.

Gall的顱相學 (Phrenology)

Gall
1825



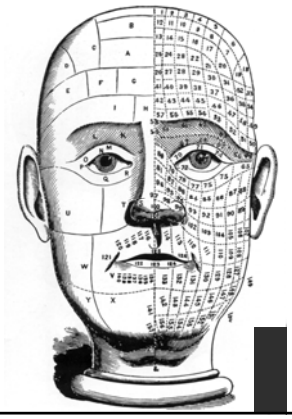
1. Reproductive Instinct
2. The love of one's offspring
3. Affection and friendship
4. Self-defence and courage
5. Destructiveness
6. Cunning
7. Acquisitiveness
8. Pride
9. Vanity
10. Forethought
11. Memory for facts and things
12. Sense of place
13. Memory for people
14. Memory for words
15. Language
16. Sense of colour
17. Sense of sounds and music
18. Sense of numbers
19. Architectural sense
20. Wisdom
21. Sense of metaphysics
22. Satire and wit
23. Poetic talent
24. Kindness
25. Mimicry
26. Religious sentiment
27. Firmness of purpose



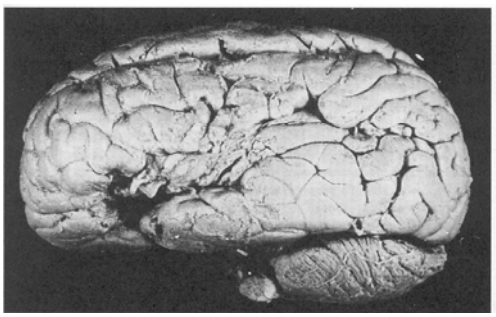
Lavery的電子顱相儀
(1907)

Lavery在1907年設計顱相儀，以取得科學上對測量頭部隆起的可信度。英國顱相學會直到1967年才漸漸式微。

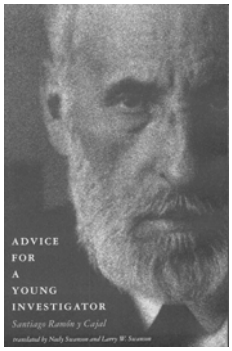
Redfield
1866

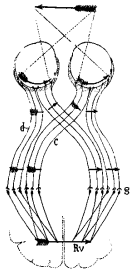


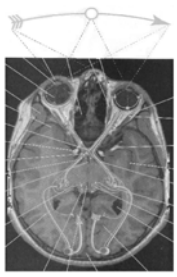
Paul Broca, 1861 : Tan's brain



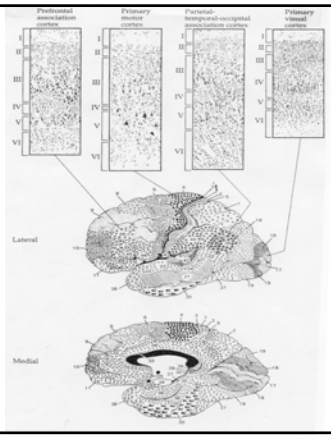
現代神經科學之父：
Santiago Ramon j Cajal
(1852-1934)

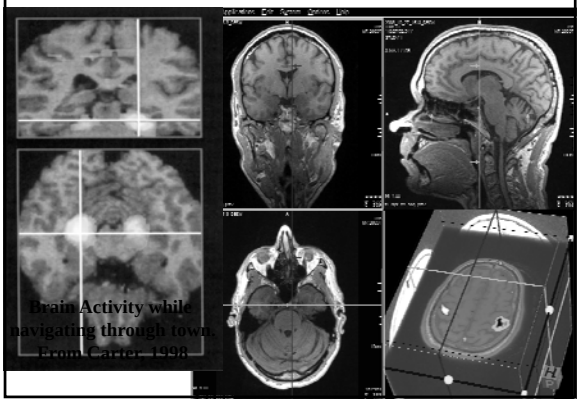






Brodmann
1908





Brain Activity while navigating through town. From Maguire, 1998

中研院腦磁波實驗室成立於2004年12月

EEG Recording System and Magnetic Shielded Room in ICN, NCU

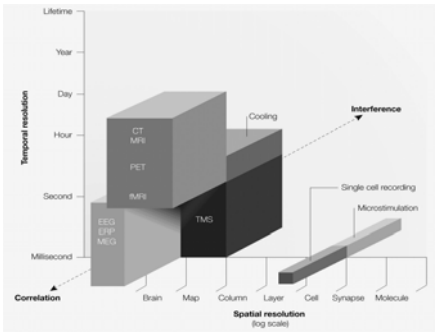
The EEG recording system coupled with the electrode cap contains 64 channels to record electrical activities over the

The experimenter, sitting outside the magnetic shielded room, monitors the participant's brain wave.

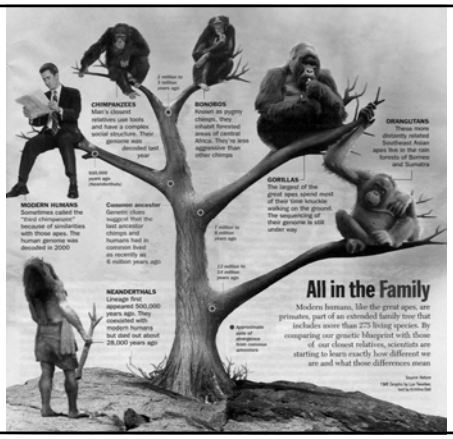
The participant engages in experimental tasks inside the magnetic shielded room while their brain waves are recorded.

跨顱磁刺激Transcranial Magnetic Stimulation (TMS) setup in ICN, NCU

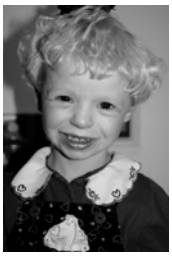
TMS與其他神經科學研究儀器之比較
(Walsh & Cowey, 2000)

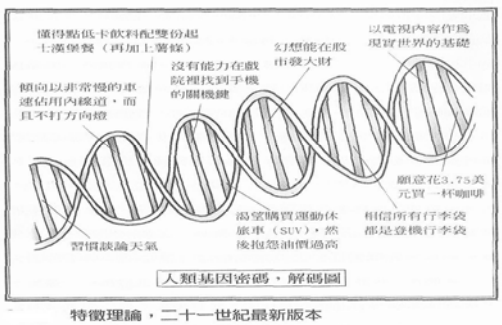


“人身難得”→演化、基因、遺傳與腦中的地圖

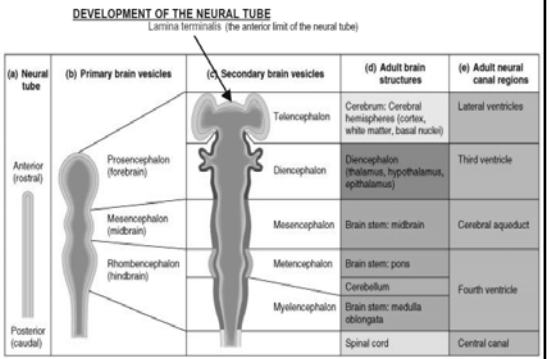


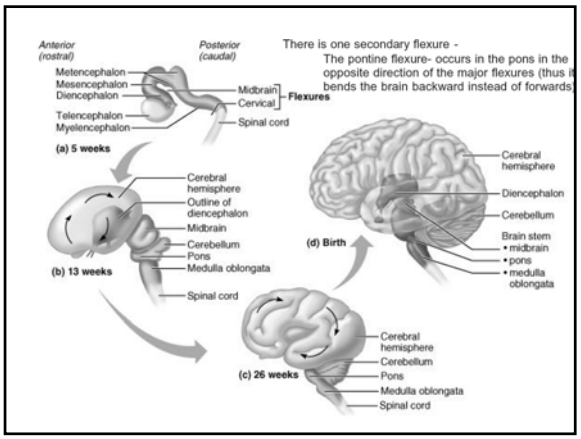

唐氏症


威廉氏症

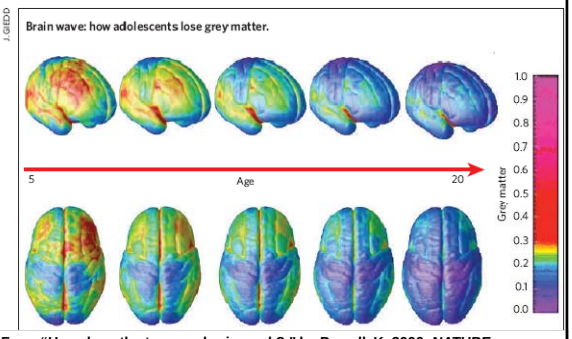


特徵理論，二十一世紀最新版本
資料來源：Matt Davies and Tribune Media Services

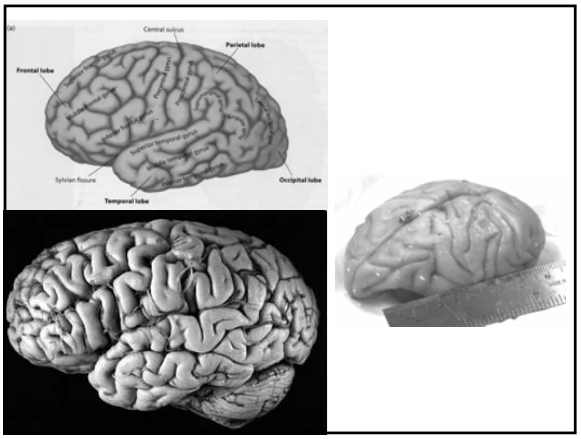


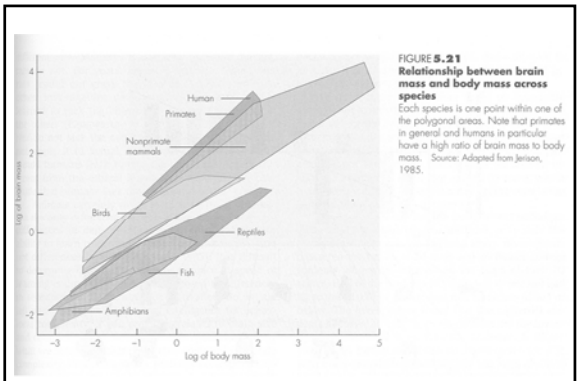


青少年額葉灰質減少的情形

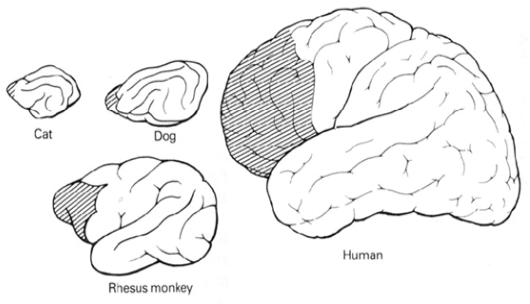


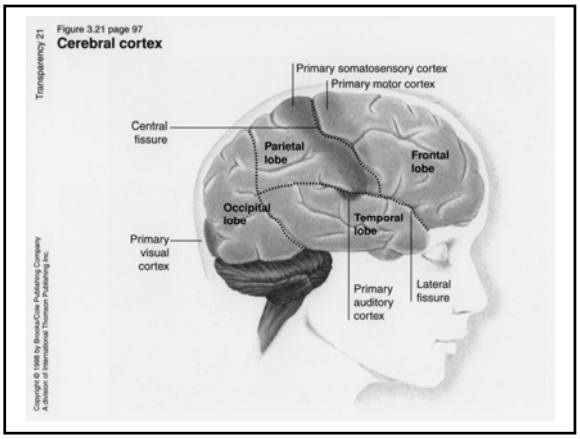
From "How does the teenage brain work?," by Powell, K. 2006, ***NATURE*, *442(24)*,865-867.**

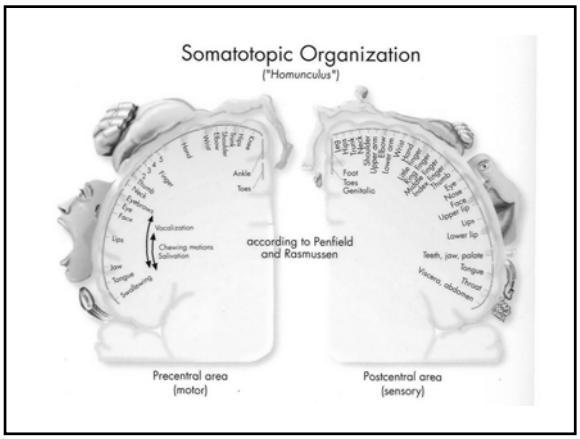


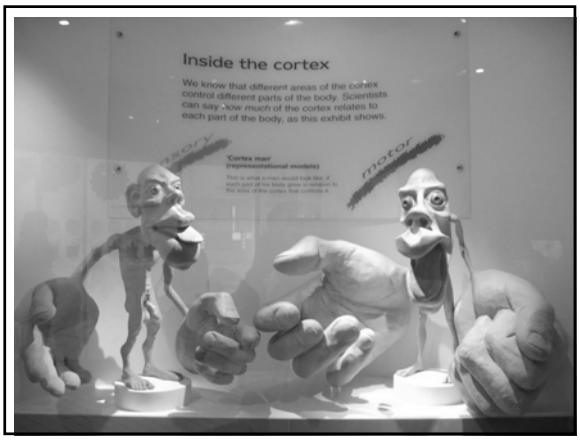


不同物種的大腦皮質

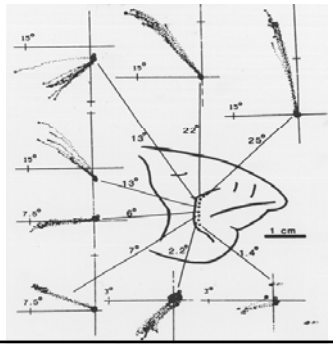




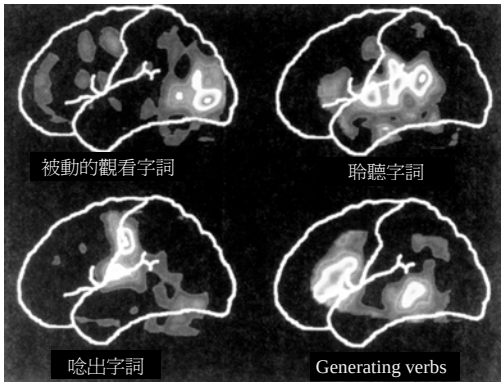




在FEF給予微刺激:
在FEF上有系統的在不同部位給予刺激,
可引發不同振幅(amplitudes)的跳視(saccades)過程。



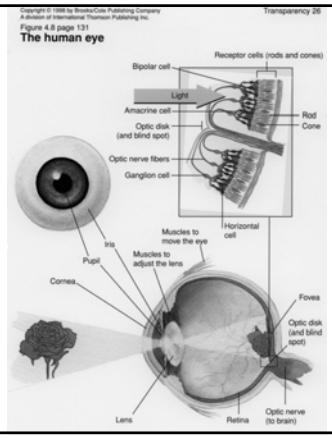
Posner & Raichle, 1994



美麗心視界:視覺、注意力、眼球運動與衝動行為控制

你的注意力有多好?

(Rensink et al, 1997; O'Regan et al, 1999)



複眼很漂亮，但有比較好?

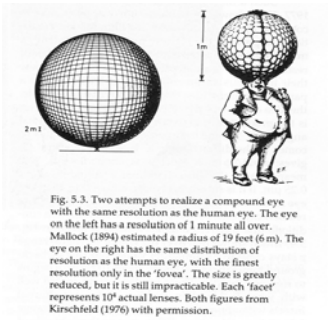
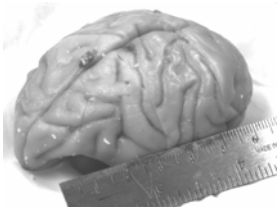
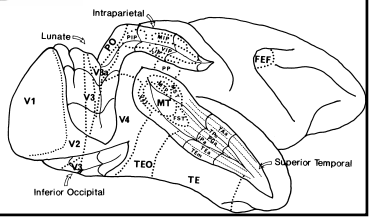


Fig. 5.3. Two attempts to realize a compound eye with the same resolution as the human eye. The eye on the left has a resolution of 1 minute all over. Mallock (1894) estimated a radius of 19 feet (6 m). The eye on the right has the same distribution of resolution as the human eye, with the finest resolution only in the 'fovea'. The size is greatly reduced, but it is still impracticable. Each 'facet' represents 10^4 actual lenses. Both figures from Kirschfeld (1976) with permission.

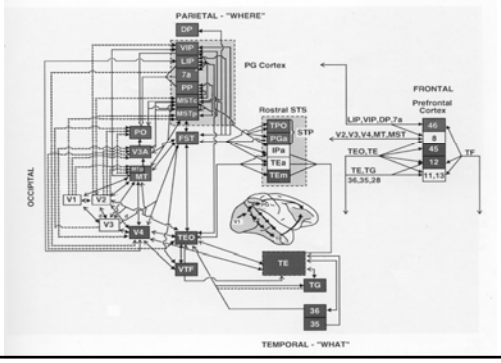


獼猴全腦約只有65公釐的大小，卻具有超過30個視覺區域



獼猴的背側及腹側神經路徑

(Ungerleider and Mishkin 1982)



皮質性色盲 (Achromatopsia)

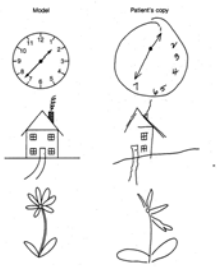
cortical color blindness

Akinetopsia **皮質性動作盲**

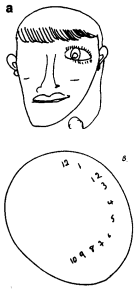
(cortical motion blindness)

忽略症患者的圖畫

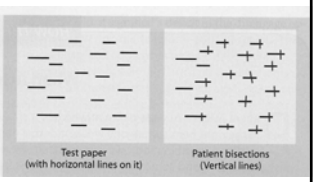
複製:



自發性繪畫:



視覺忽略症（Visual Neglect）



How fast can your brain be?

王建民: 150 km/1hr

球從投出到打擊者的時間只有450ms。(18.4 m)

一般人: 75 km/1hr

仍然只需要900ms(不到一秒)的時間就可到達打擊者的位置。

但是，人類執行一次眼動需要超過200ms的時間。

所以，我們的大 腦是如何幫助打擊者在沒有眼動的情形下去擊中球？

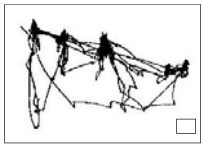
- 你知道你每天有超過100,000次的眼動嗎？
- 每次的眼動都是一個做決定的歷程，儘管你很少意識到。
- 一次眼動只需要花費250毫秒，然而對於認知神經科學家而言，250毫秒仍然是一段很長的時間。

我的研究主要在闡明：視覺注意力與眼動過程是如何短時間內在大腦中相互影響。

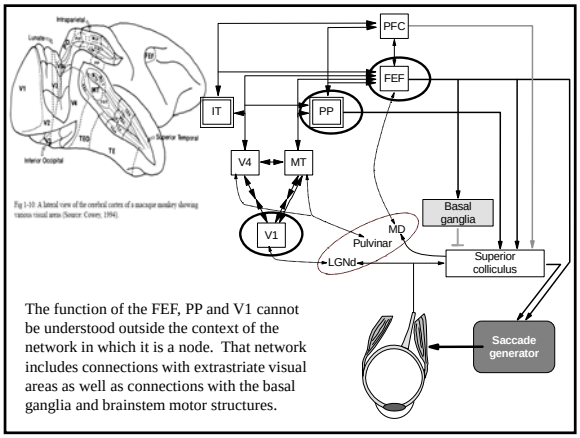
Gaze is guided by knowledge as well as vision

Remember the location of the objects in the room.

Remember the ages of the people in the room

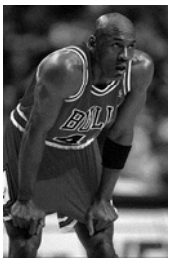


Yarbus, A. L. 1967 *Eye Movements and Vision*. New York: Plenum Press.



The function of the FEF, PP and V1 cannot be understood outside the context of the network in which it is a node. That network includes connections with extrastriate visual areas as well as connections with the basal ganglia and brainstem motor structures.

What is a choice? What is a decision?



"I feel that way right now. Ask me in two or three months and I may change. I don't think I will. I'm pretty sure that's my decision."
— Michael Jordan on his retirement from professional basketball. Associated Press, 17 July 1998.

叫色作業 (Stroop effects)

好　　綠

朋　　黃

友　　紅

Flank Effects

A ----> 舉右手

B ----> 不舉手

C ----> 舉左手

A　　B　　C

看中間字母做舉手反應

A C A A C A

動物同樣也使用執行控制能力調整行為！

認知神經科學的運用

認知神經科學的應用

Neurosocieties：the rise and impact of the new brain sciences.

Neuroprosthetics: Brain-Computer-interface

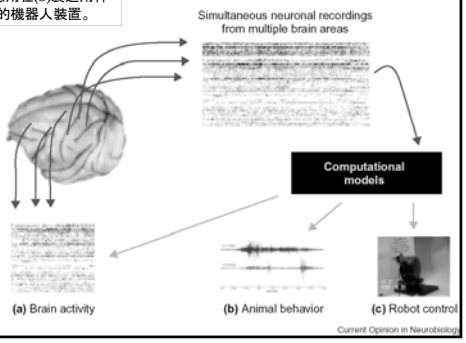
Neuroeconomy.

Neuroethics.

Brain based education.

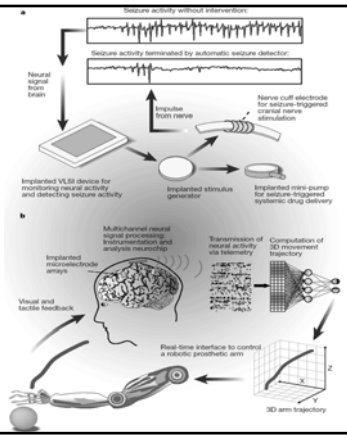
即時的神經生理學:同時記錄大腦各個區域的生理訊號提供給電腦的運算模型, 可產生(1)各個腦區連結的活化情形及(2)動作行為的即時預測。此種方法可應用在(3)製造用神經生理訊號控制的機器人裝置。

Miguel Nicolelis, Duke University

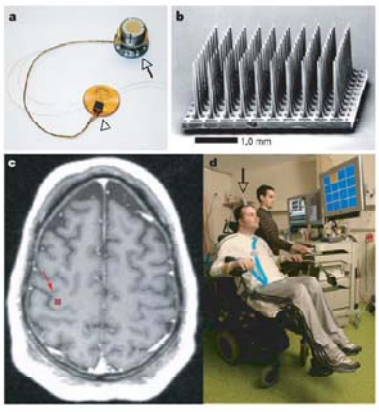


Real-time

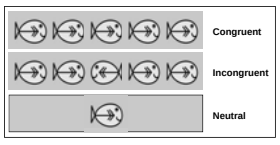
神經生理學



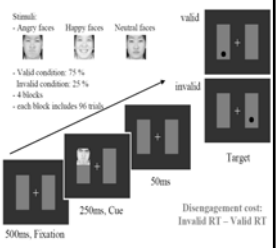
將思想轉換成行動



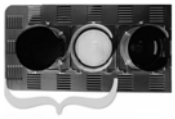
學童視覺注意力的增進及教育學習



注意力控制與衝動暴力行為的關係

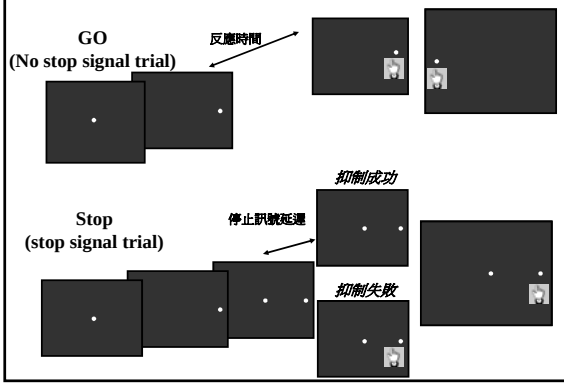


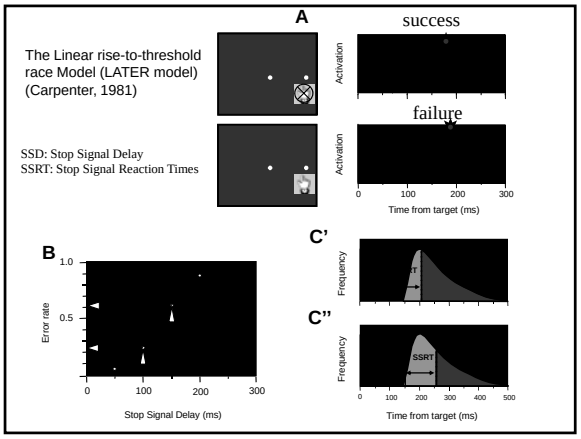
注意力控制與日常行為的關係



兩難區 (The dilemma zone)

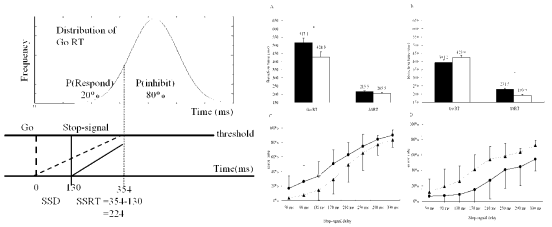
使用停止信號作業(stop signal task)研究衝動控制行為





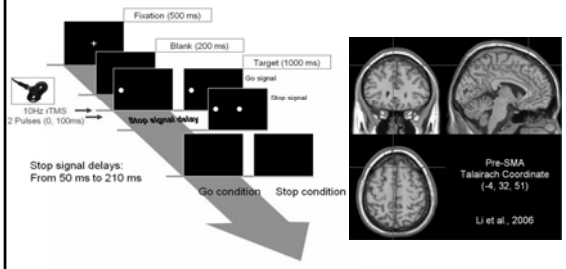
衝動暴力犯在時間壓力下會導致抑制控制功能的缺損

衝動暴力型的犯罪行爲常被歸咎於行爲控制的問題，這類的行爲可能是較強烈的前優勢反應的結果，或是抑制控制的失敗。我們使用停止信號作業分離這兩種歷程，用以檢驗衝動暴力犯是否具有抑制控制能力上的缺損。



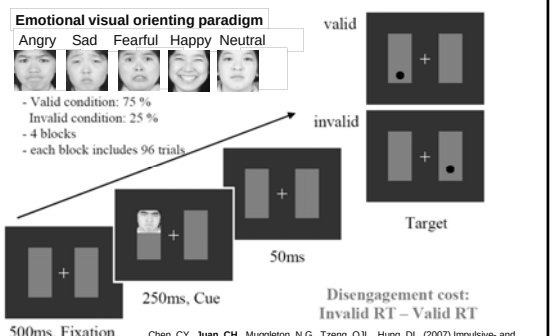
Chen, C-Y, Muggleton N. G., **Juan C-H**, Tzeng, O. J-L & **Hung, D. L**. (2008). Time pressure leads to inhibitory control deficits in impulsive violent offenders. (*Behavioural Brain Research*, ***corresponding author***)

TMS over pre-supplementary area to probe the neural mechanism of inhibitory control



Chen, CY. Muggleton, NG. Tzeng, OJL. Hung, DL and **Juan CH**. (*Neuroimage*, 2009)

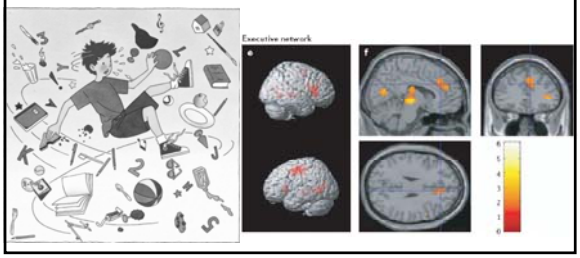
衝動型與預謀型暴力犯在負向臉部情緒的注意力抽離上，有不同模式的的結果



Chen, CY., **Juan, CH**., Muggleton, N.G., Tzeng, OJL., Hung, DL. (2007) Impulsive- and premeditated- violent offenders display different patterns of attentional disengagement from negative facial expressions. *Cognitive Neuroscience Society Annual Meeting*, New York, USA, May.

注意力訓練與教育

功能性核磁共振（MRI）研究顯示：ADHD男孩的前額葉皮質及基底核都較正常男孩來得小。這些區域在4~6歲時有急劇的發展。



分享一點點的求學經驗

Why should I choose Cognitive Neuroscience as my career?

- It is very challenging and rewarding.
- It is very helpful for understanding yourself and others.
- It will be very influential to your and others' life.
- It will be very important to the education and health systems.

More simply, it is great fun!

If I were still at your age, I would do…..

- Backgrounds:

BBC website for science; BBC radio 4; Podcast

Neuroscience for kids

Brain mapping: www.loni.ucla.edu: Arthur Toga

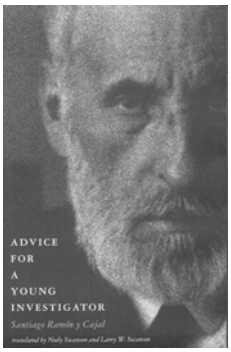
Google: www.google.com

- Tools:

English; Programming: C (or any), Matlab

life long lasting sports

Most importantly: An open mind

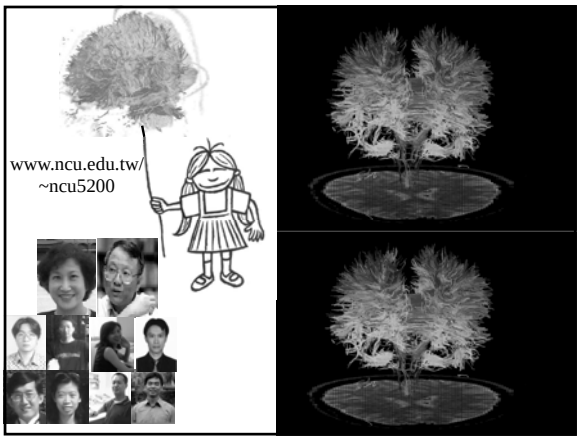


As long as our brain is a mystery, the universe, the reflection of the structure of the brain will also be a mystery.

Santiago Ramon j Cajal

Watson & Crick, 1953
"The proposed structure for DNA may help to solve one of the fundamental biological problems: the molecular basis for genetic replication."

Francis Crick, 1998
"The overwhelming question in neurobiology today is the relation between the mind and the brain."



Many thanks for your *ATTENTION!*