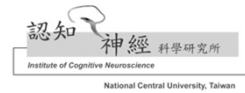


FMRI在動作控制研究的應用

張智宏副教授 中央大學認知神經科學研究所



FMRI實驗設計

12/27/2014

2

Experimental Designs

- The organization of an experiment to allow effective testing of the research hypothesis.
- Well-designed experiments
 - Test specific hypothesis
 - Can ruled out your hypothesis
 - Minimize costs

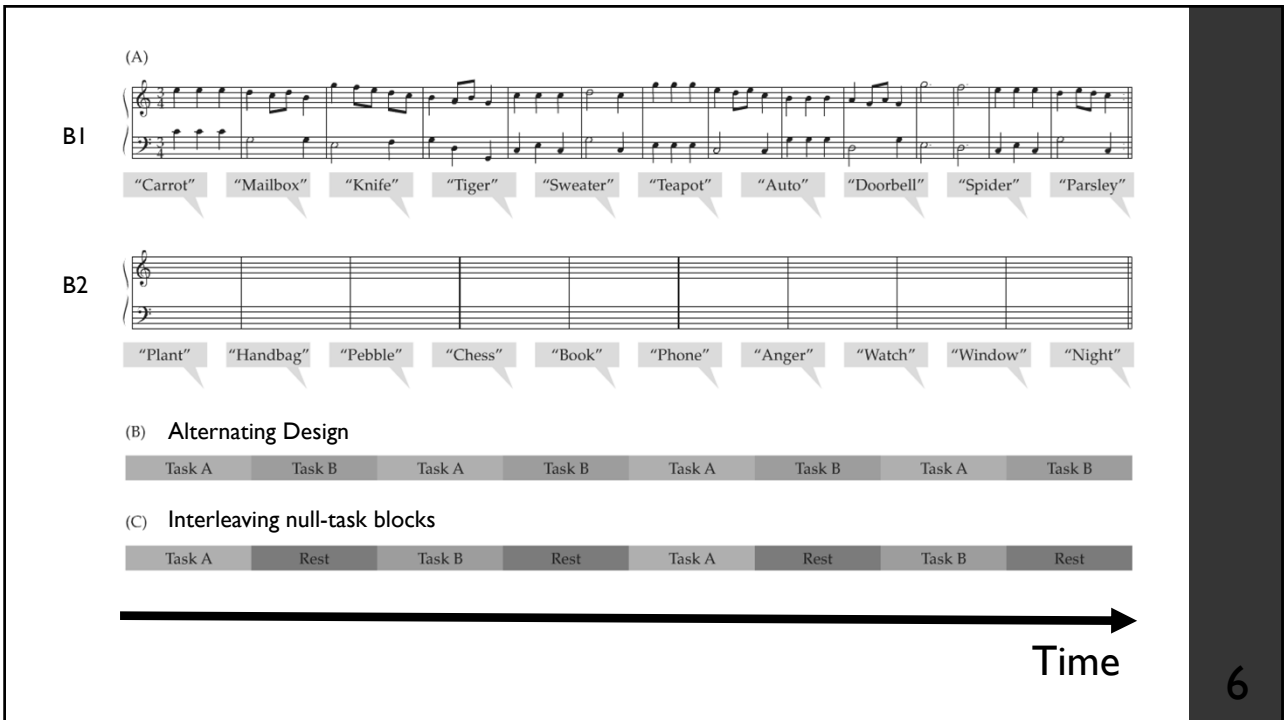
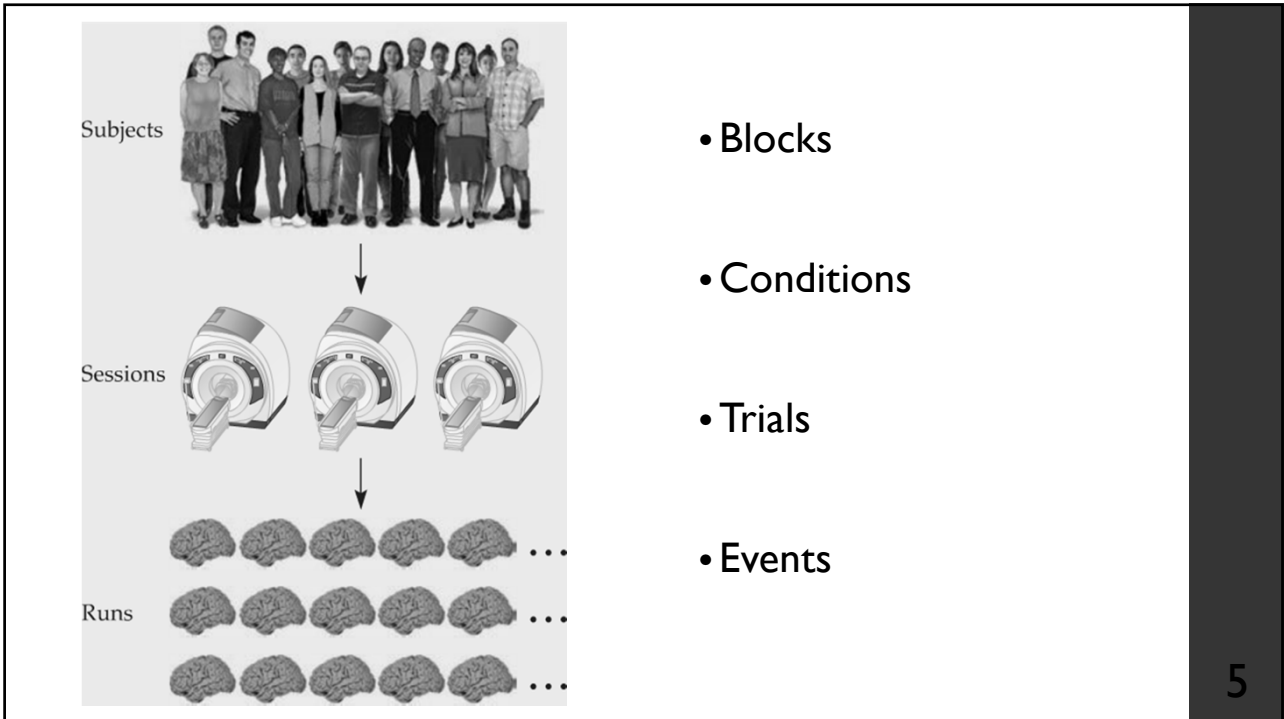
3

Experimental vs. Control Conditions

(A)



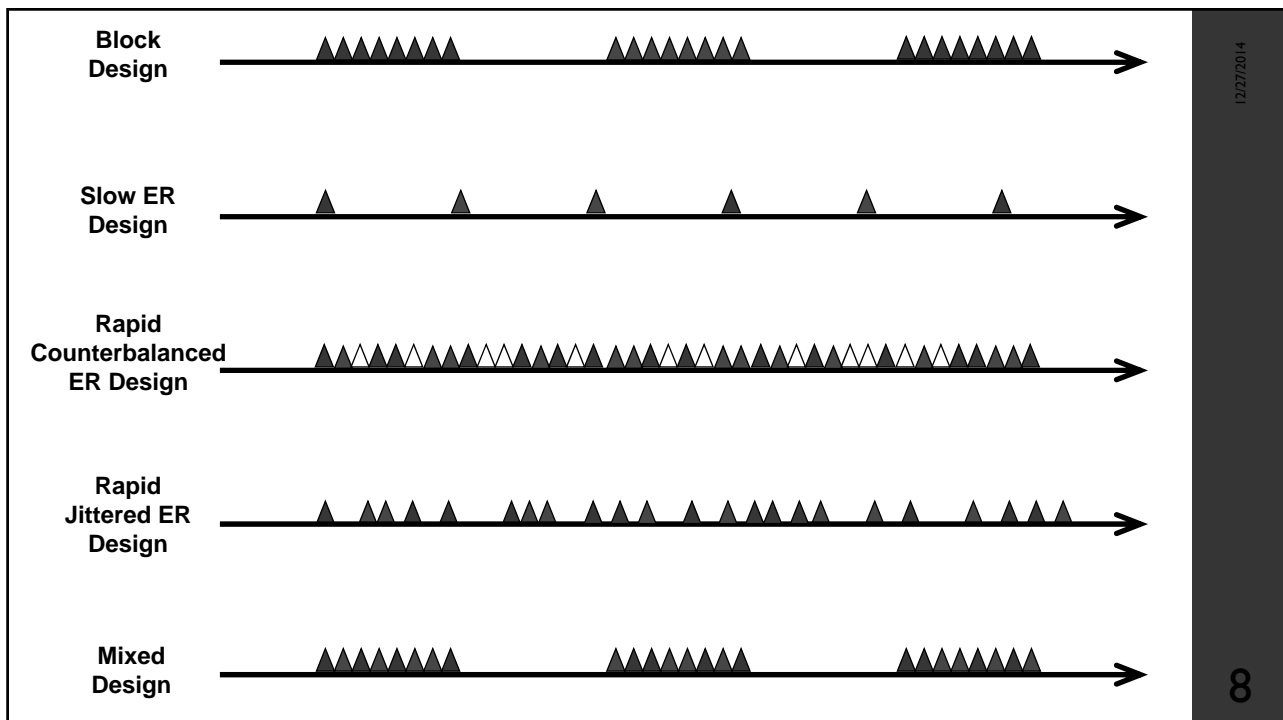
4



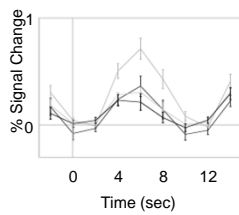
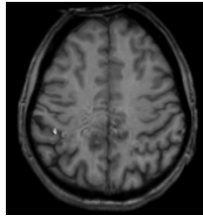
FMRI Experimental Designs

- Blocked designs
- Event-related designs
- Mixed designs

7



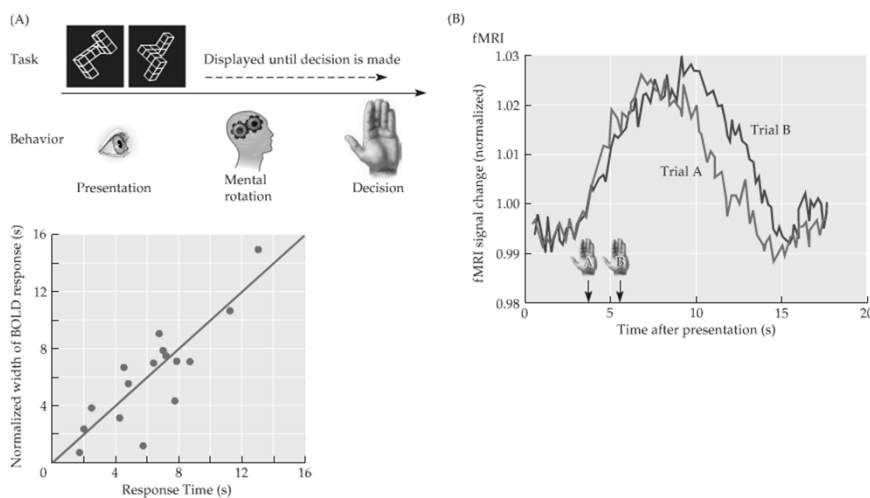
Detection vs. Estimation



- Detection: determination of whether activity of a given voxel (or region) changes in response to the experimental manipulation
- “which voxel?”
- Estimation: measurement of the time course within an active voxel in response to the experimental manipulation
- “How does signal change in a voxel?”

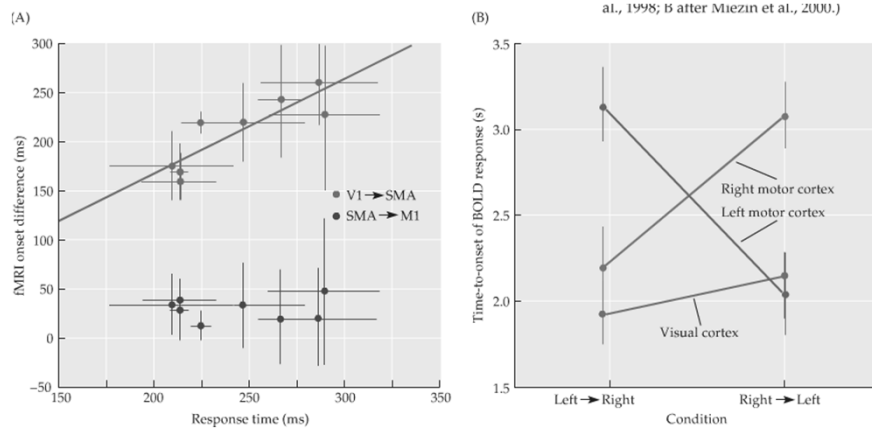
Definitions modified from: Huettel, Song & McCarthy, 2004, *Functional Magnetic Resonance Imaging*

Reaction Time & BOLD



After Menon & Kim (1999); data from Richter et al. (1997)

Relative Timing of BOLD across Brain Regions



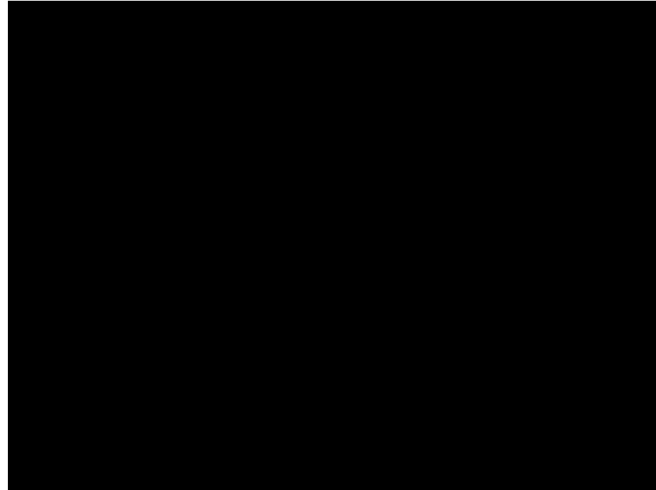
A) Menon et al. (1998); B) Miezín et al. (2000)

動作控制研究議題

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競技疊杯



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疊杯包含哪些動作控制成份？

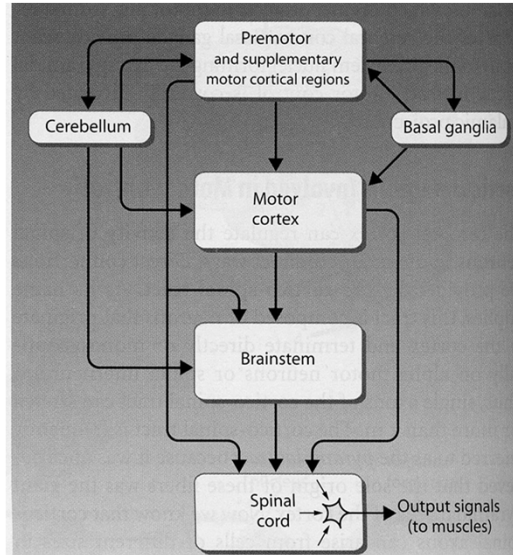
- **What?**
 - 大小、重量、硬度、表面特性
- **Where?**
 - 杯子的位置、擺設方式
- **How?**
 - 抓取杯子和移動杯子的最佳姿勢
 - 移動杯子的順序



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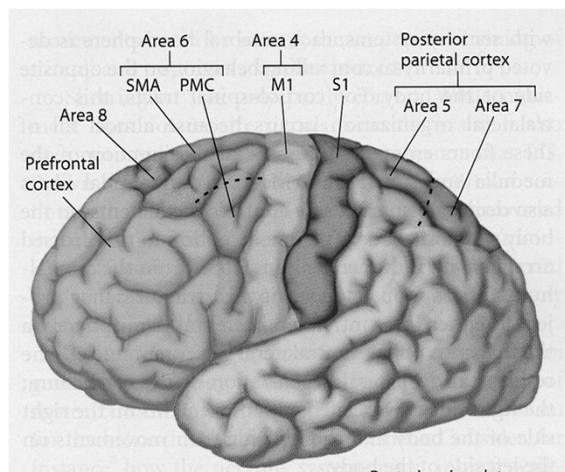
腦中的動作控制階層 (Motor hierarchy)



2014/12/27

Cognitive Psychology

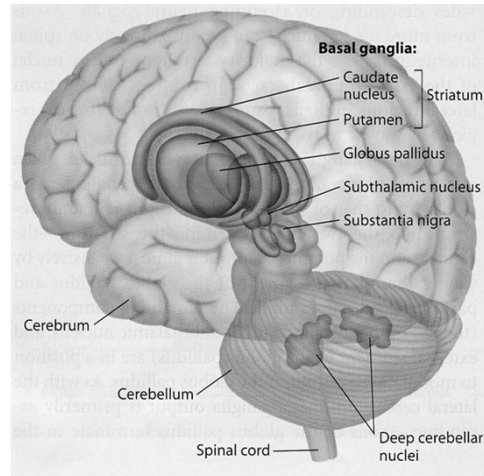
Cortical Motor Areas



2014/12/27

Cognitive Psychology

Subcortical Motor Areas



2014/12/27

Cognitive Psychology

核心理論議題

- 動作控制系統如何解決以下課題？
 - 自由度
 - 序列與時間
 - 知覺動作整合
 - 學習

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自由度問題

Issues of Degree of Freedom

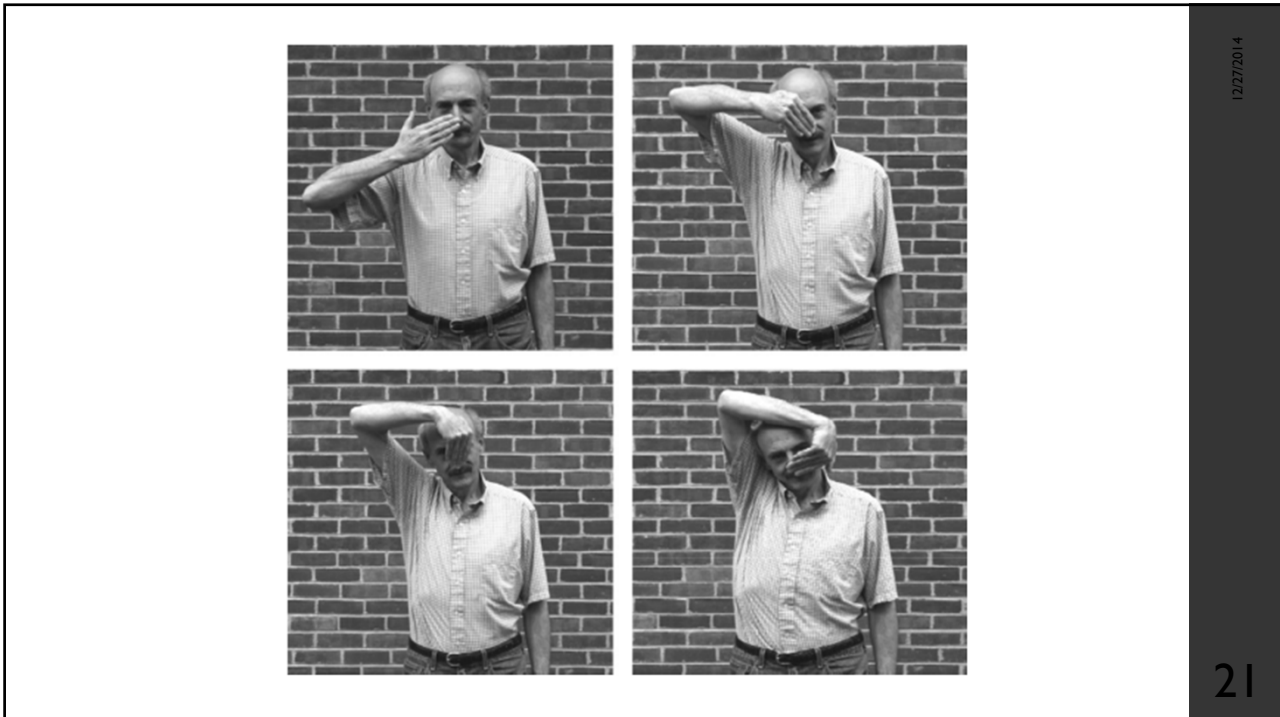
19

別多想，請立刻....

- 碰你的鼻子



20



動作控制中的自由度問題

- 如何從為數眾多的可能成份組合中，選擇出最終被執行的動作

以「手指碰鼻尖」為例...

- 鼻尖位置：x, y, z
- 空間自由度
 - 肩膀、手肘、手腕
- 時間自由度
 - 上述部位形成特定姿勢的時間點
- 力自由度
 - 形成每一組成姿勢的肌肉力量

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動作序列與時間問題

Sequencing and Timing

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咖啡加糖



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序列動作控制之性別差異

Behavior

Manual Sequence Box
(Kimura, 1977)

Chipman & Hampson (In press)

Patients

Apraxia Incidence (%)

Anterior Posterior

Anterior Posterior

Modified from Kimura (1999). Sex and Cognition.


The complex block contains four main visual elements. At the top left, under the heading 'Behavior', is a photograph of a 'Manual Sequence Box' (Kimura, 1977), which consists of three vertical panels with levers. To its right is a sequence of eight small images showing a woman performing a series of hand movements, with a small black square above each image. Below this sequence is the citation 'Chipman & Hampson (In press)'. At the bottom, under the heading 'Patients', are two brain diagrams. The left diagram is labeled with a female symbol (♀) and shows a bar chart for 'Apraxia Incidence (%)' with a high bar for the 'Anterior' region and a low bar for the 'Posterior' region. The right diagram is labeled with a male symbol (♂) and shows a bar chart with a low bar for the 'Anterior' region and a high bar for the 'Posterior' region. The citation 'Modified from Kimura (1999). Sex and Cognition.' is at the bottom.

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實驗設計

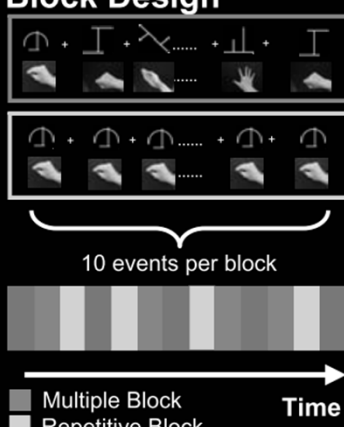
Participants
10 females and 10 males; all are right-handed, native English speakers.

Task



Performed with the right hand; all participants were highly practiced before the experiment.

Block Design



10 events per block

Multiple Block
Repetitive Block
Fixation Block

Time

Chang, E. C., Hampson, E., Valyear, K. F., & Goodale, M.A. (2006).

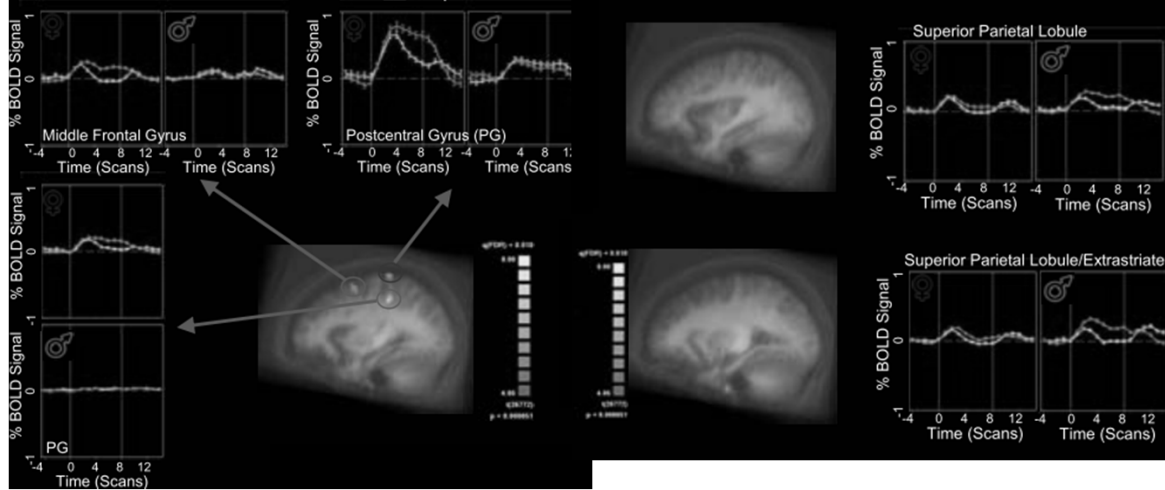
27

Manual Praxis

Female > Male

Multiple
Repetitive

Male > Female



Chang, E. C., Hampson, E., Valyear, K. F., & Goodale, M.A. (2006).

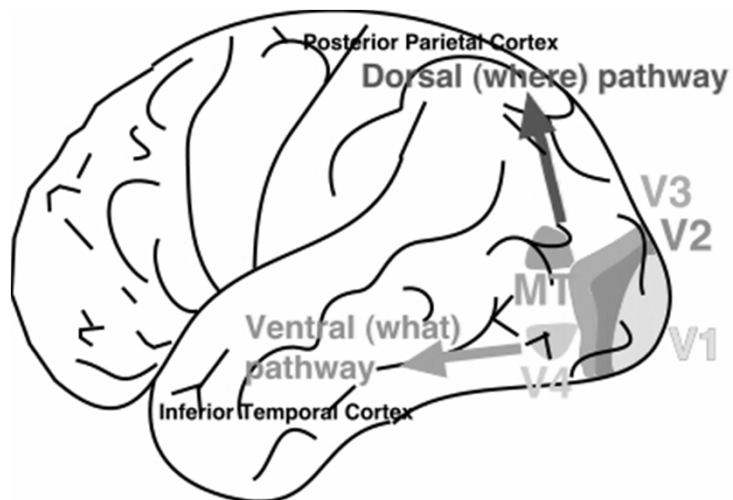
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知覺與動作整合問題

Perception-action integration

29

人類視覺神經系統



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背側 vs. 腹側通路受損

- **Optic Ataxia**

- Caused by damage to posterior parietal cortex
- Incapable of reach-for-grasp objects, but can name them and describe their functions

- **Visual form agnosia**

- Failure to identify familiar objects
 - But can recognize them by touching
- Normal in verbal memory and intelligence

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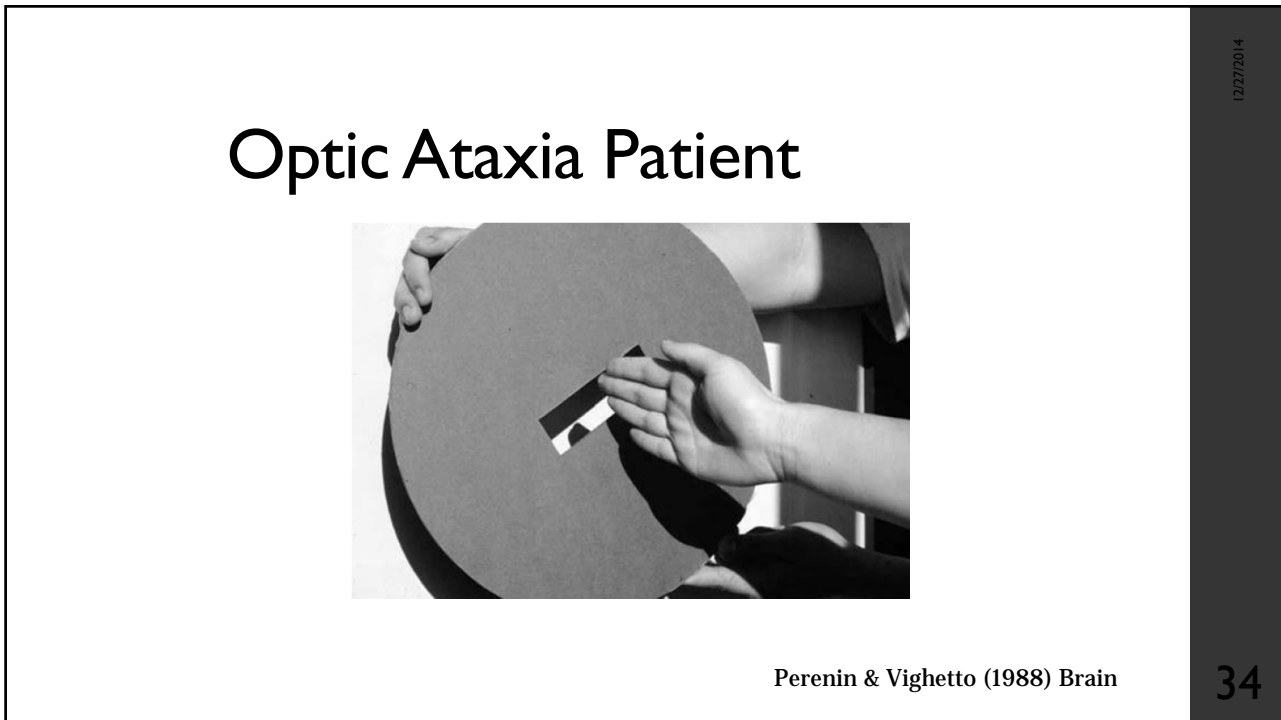
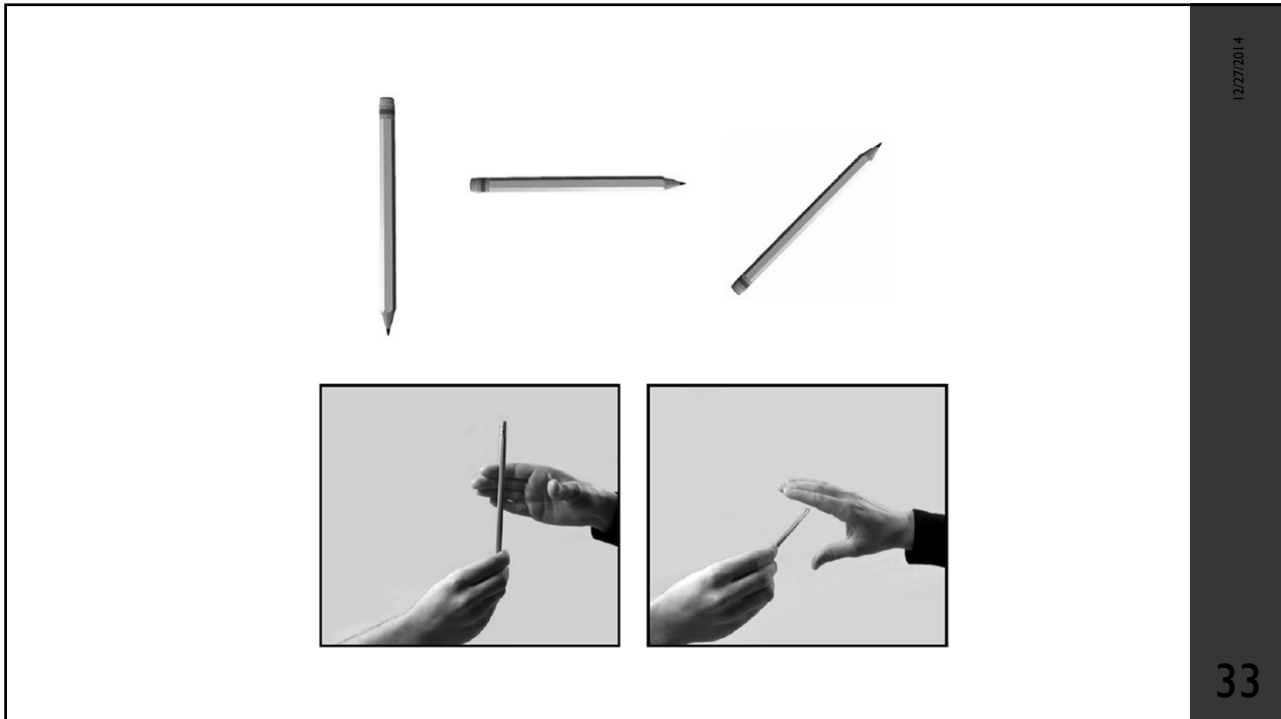
“It’s made out of metal –is it aluminium? It’s got red plastic on it.

“Is it some sort of kitchen utensil?”

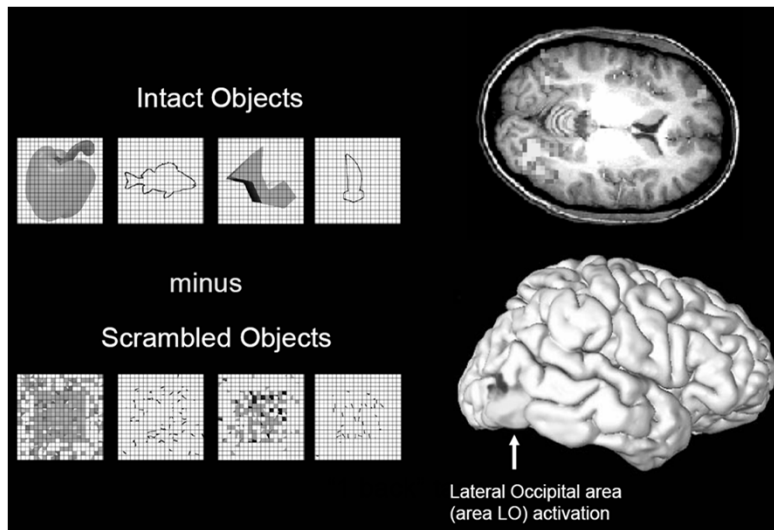
Humphrey, Goodale, Jakobson, & Servos (1994). *Perception*

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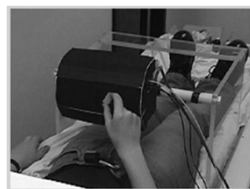
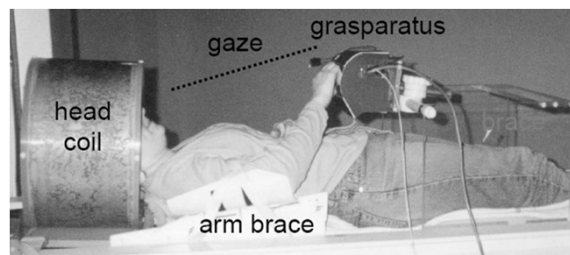
物體辨識腦造影研究



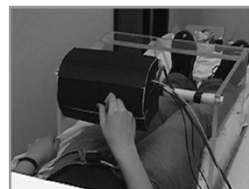
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伸手抓物腦造影研究



Grasping



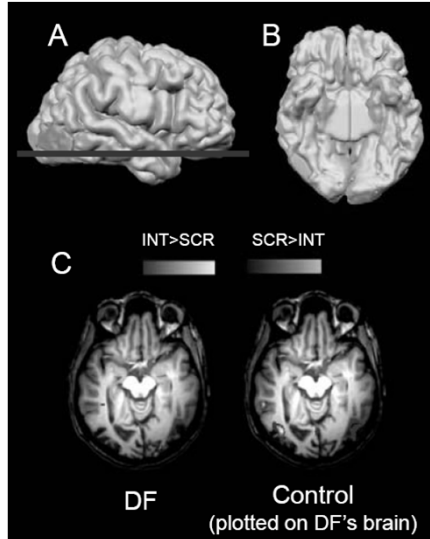
Reaching

Culham, Danckert, DeSouza, Gati, Menon & Goodale (2003). Experimental Brain Research

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病人DF與正常人的物體辨識腦活動

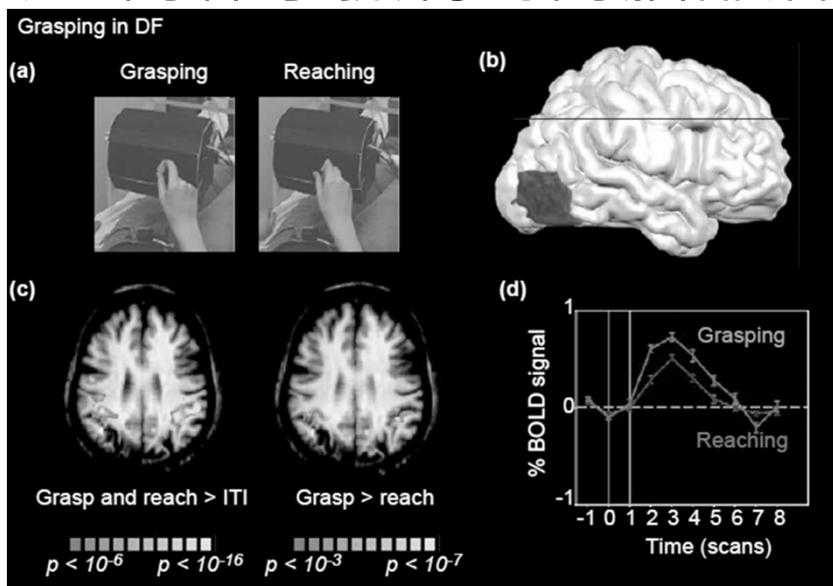


Culham, Danckert, DeSouza, Gati, Menon & Goodale (2003). Experimental Brain Research

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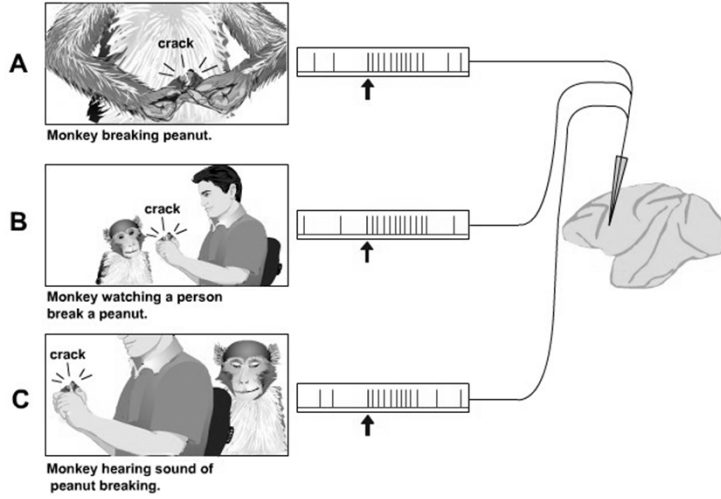
病人DF的伸手抓物時的腦部活動



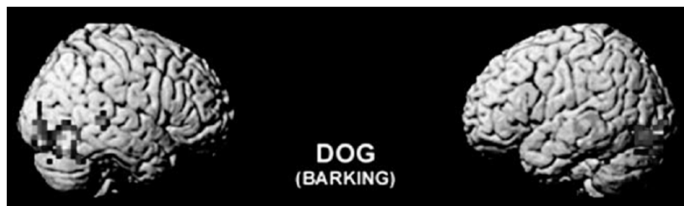
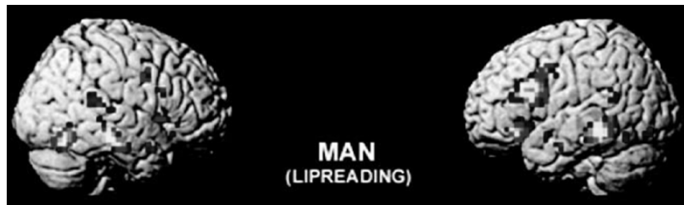
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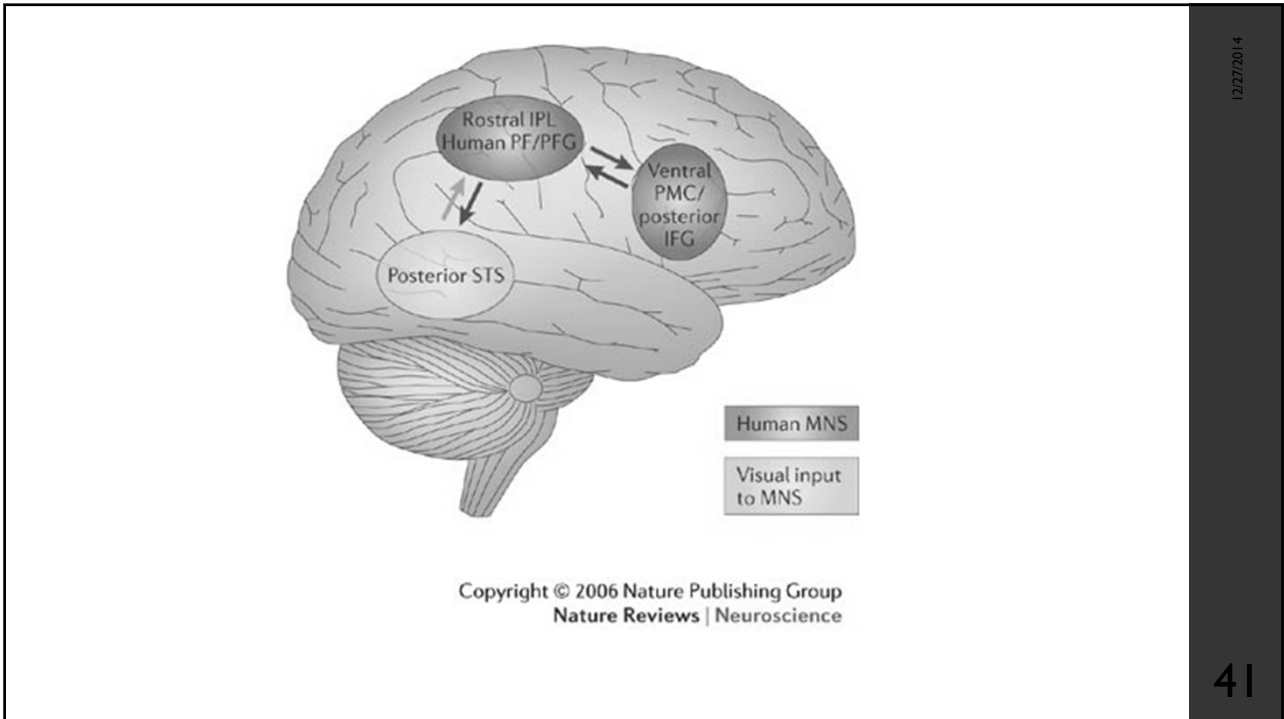
鏡像神經元(Mirror Neurons)



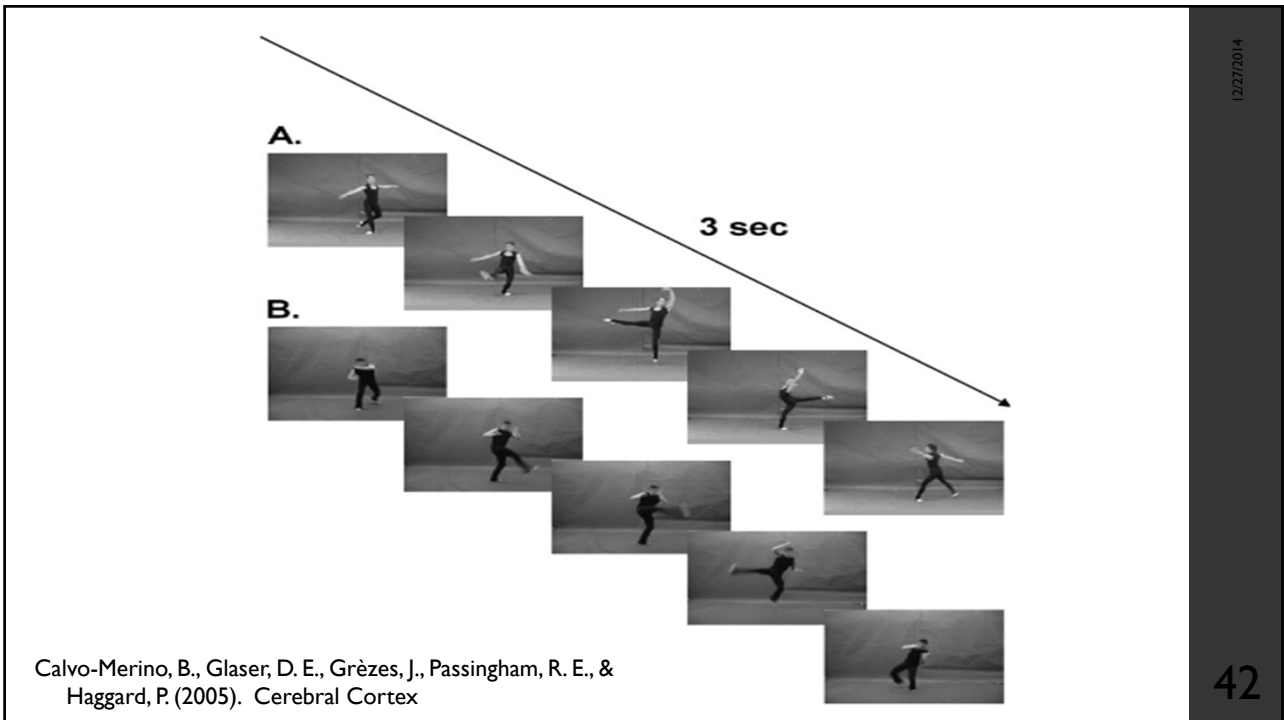
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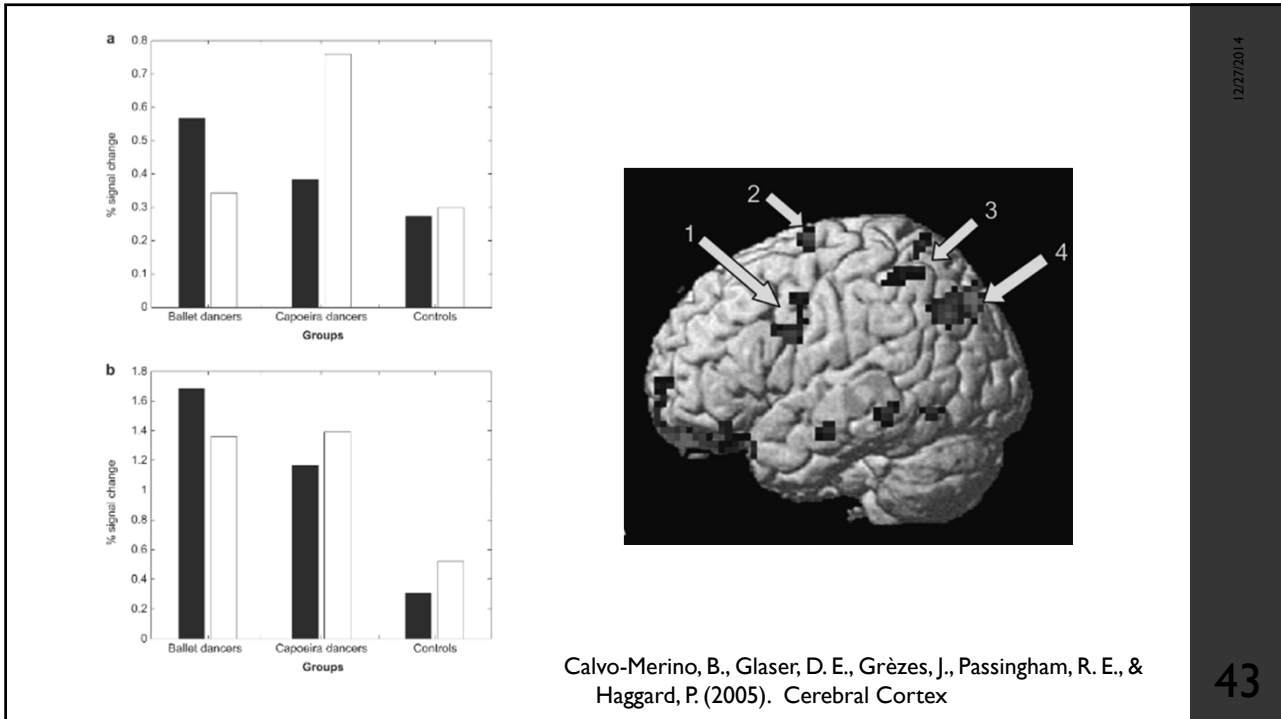


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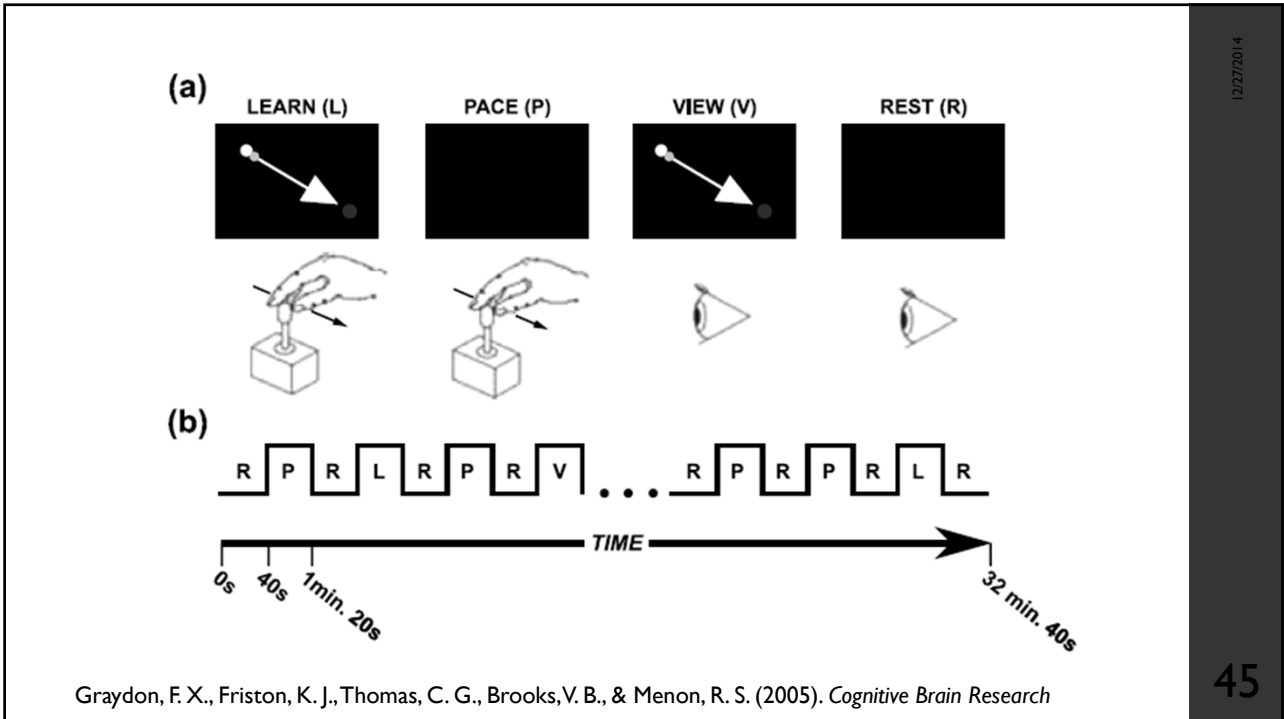
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Calvo-Merino, B., Glaser, D. E., Grèzes, J., Passingham, R. E., & Haggard, P. (2005). Cerebral Cortex

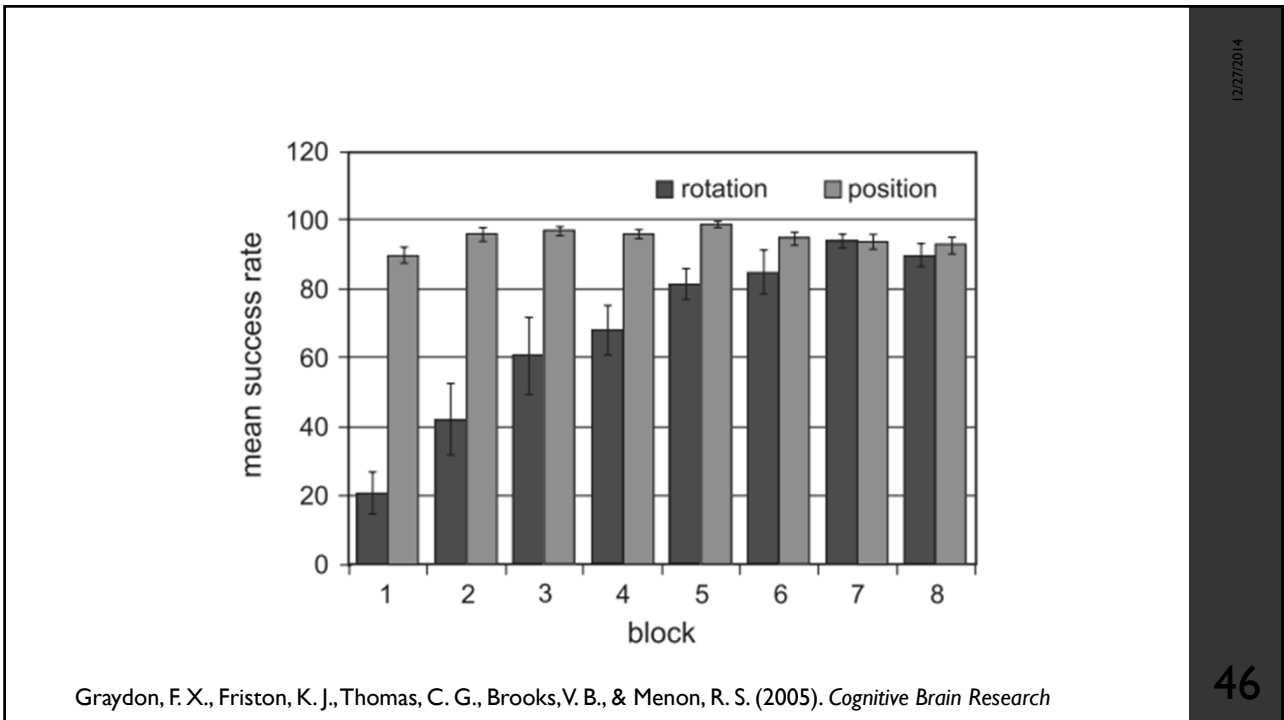


動作技能學習

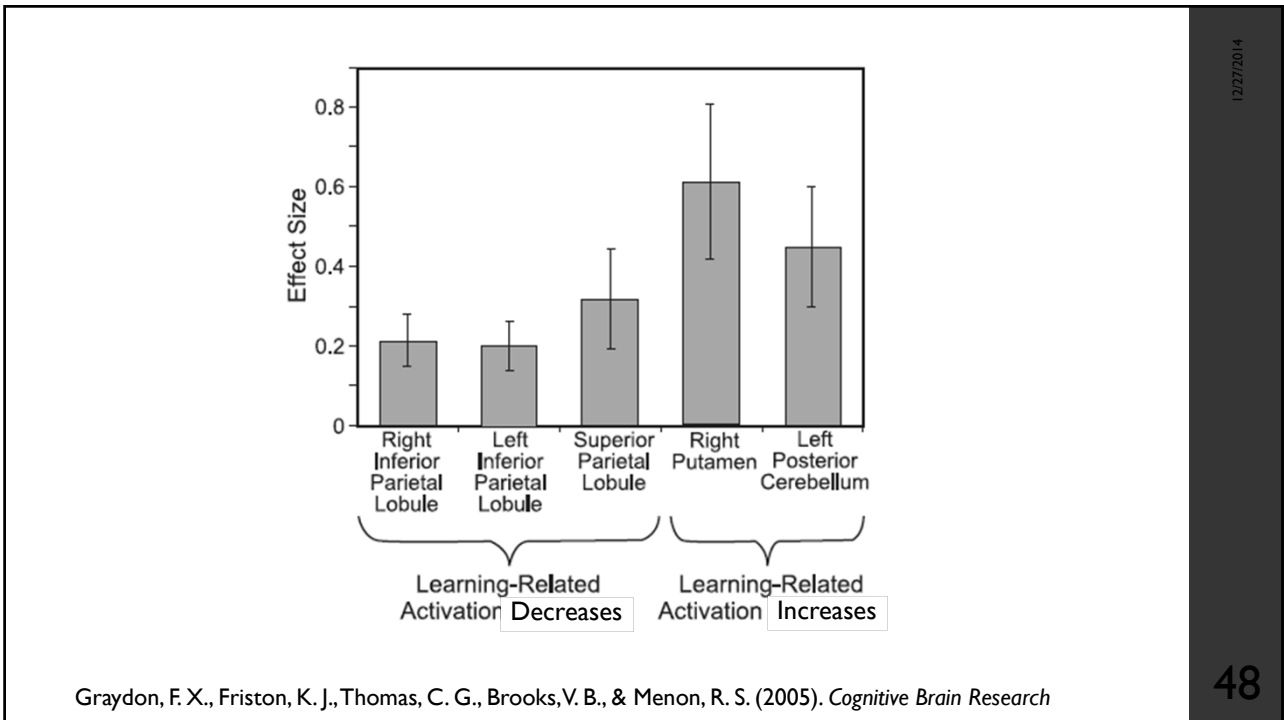
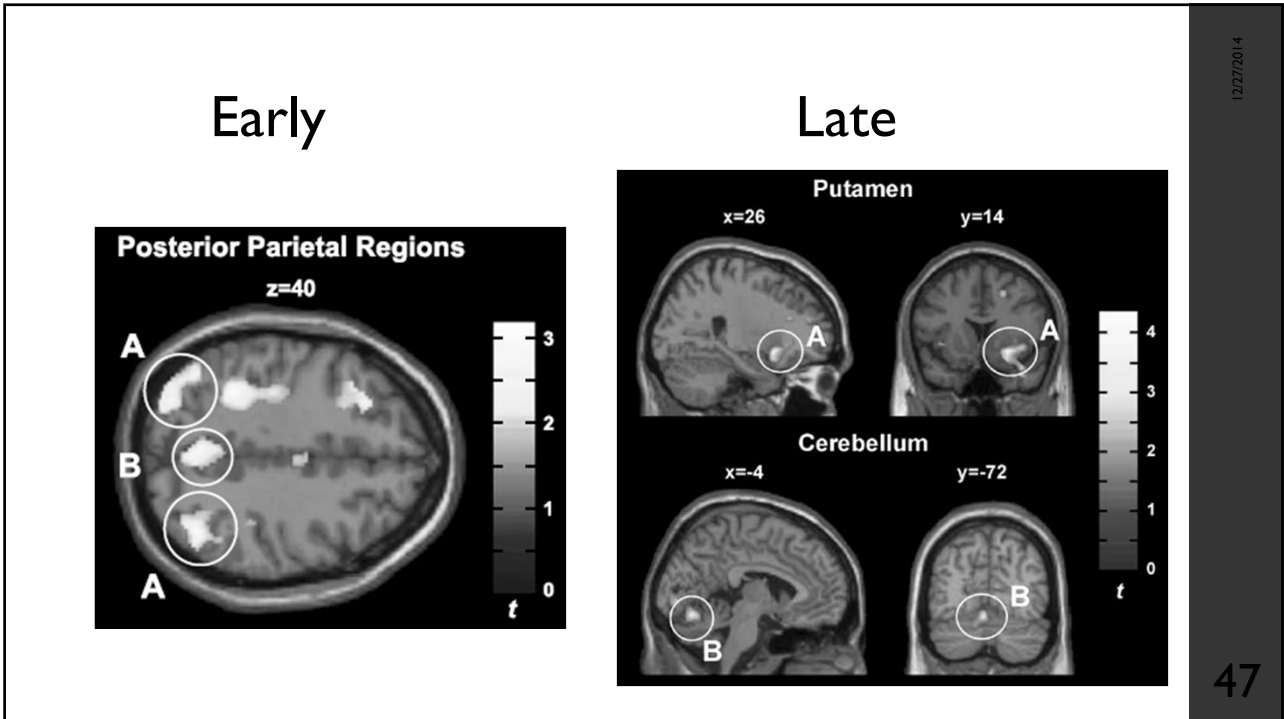
Motor skill learning



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Graydon, F. X., Friston, K. J., Thomas, C. G., Brooks, V. B., & Menon, R. S. (2005). *Cognitive Brain Research*

語誤

- 一句講也不會話
- Spoonerism
 - The queer old dean
 - You hissed all my mystery lectures

具有序列特性意味著...

- 存在動作計畫安排各成份動作順序
 - 證據
 - 動作錯誤有規則性
 - 連串動作在第 n 步驟尚未完成時 $n+1$ 步驟已經展開