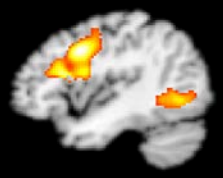
功能性磁振造影
Functional MRI
在語言與閱讀研究的應用



郭文瑞

陽明大學神經科學研究所

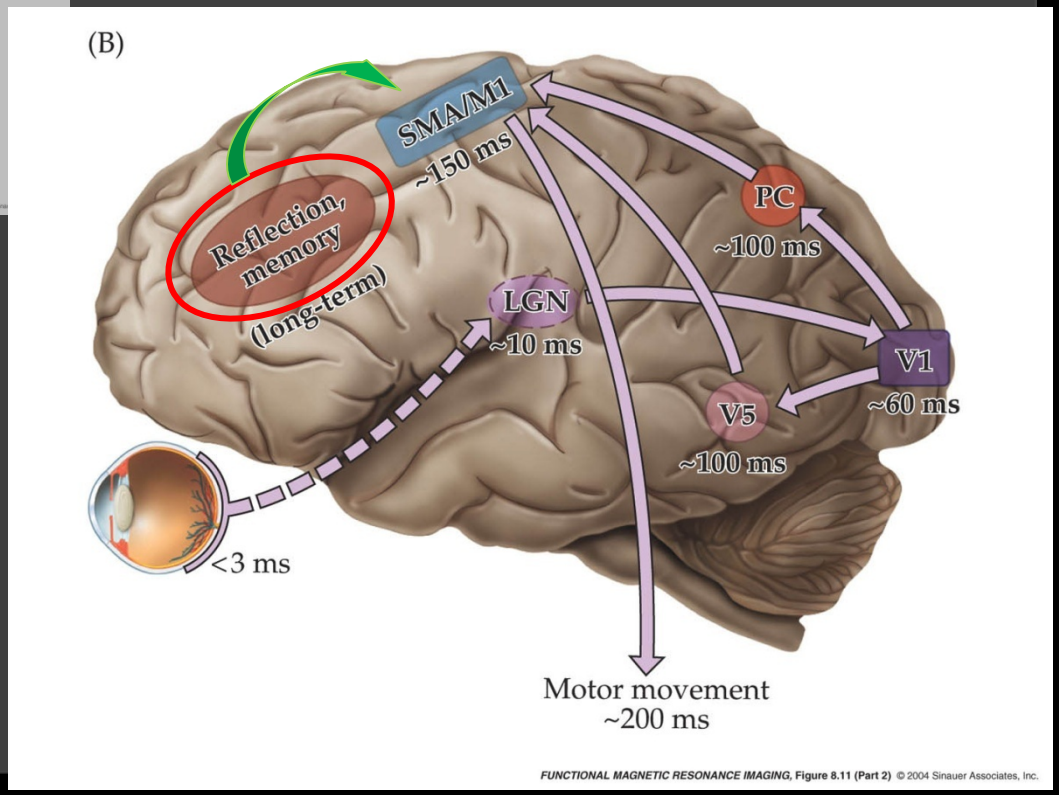
陽明大學腦科學研究中心

每個腦區都有其獨特的功能？

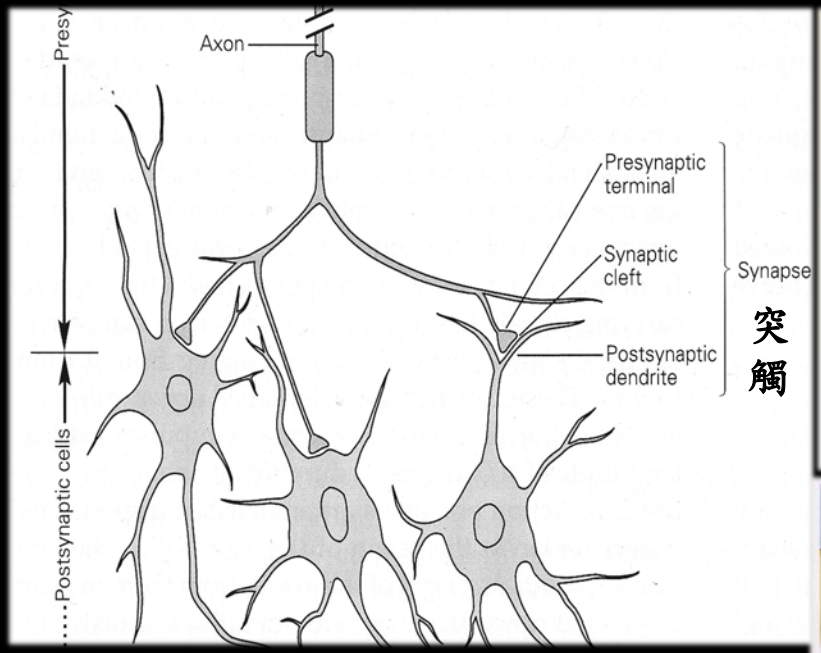
Paul Broca (1824-1880)

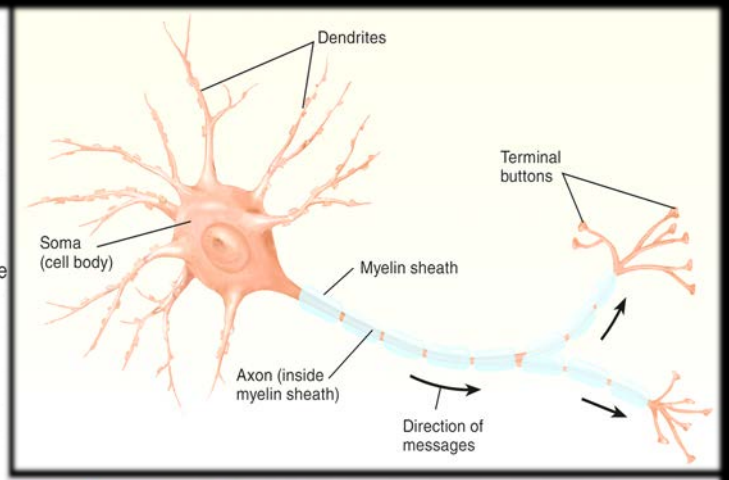
如何*啟動*和*觀察*腦神經系統運作?

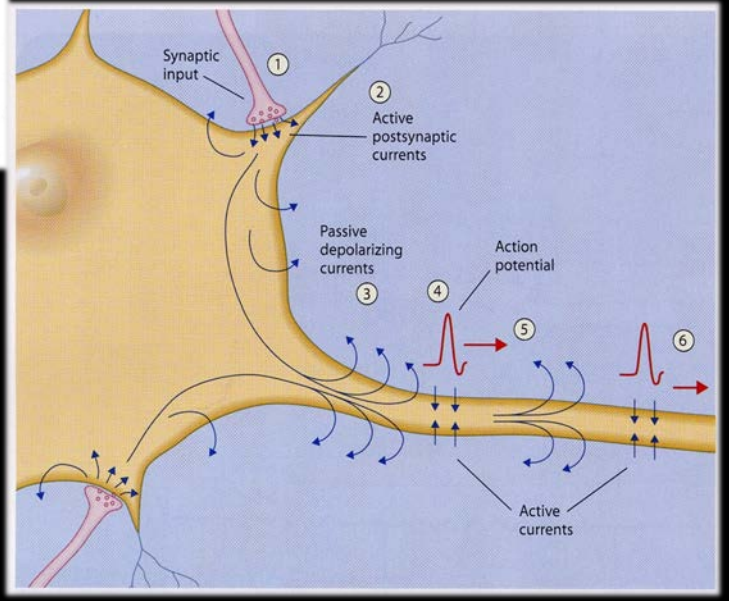
- *外在* 刺激所啟動, 例如視覺
- *內在* 運作所啟動, 例如記憶

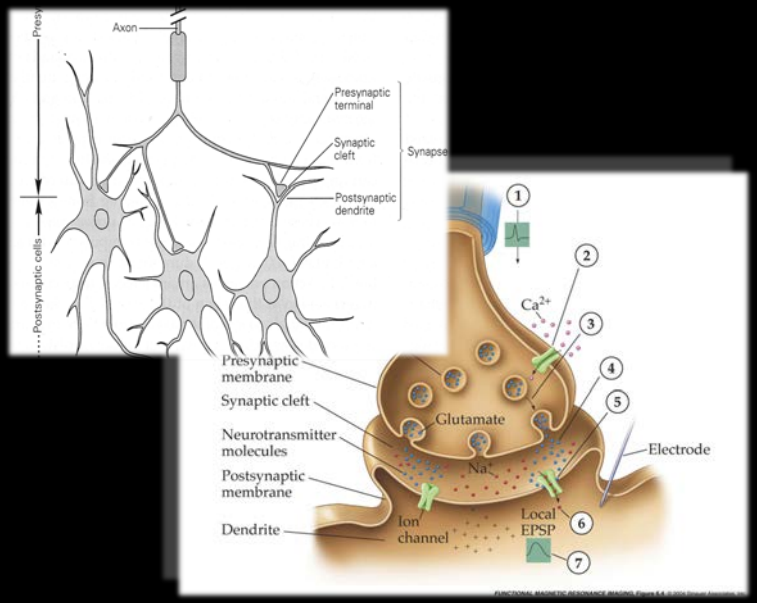


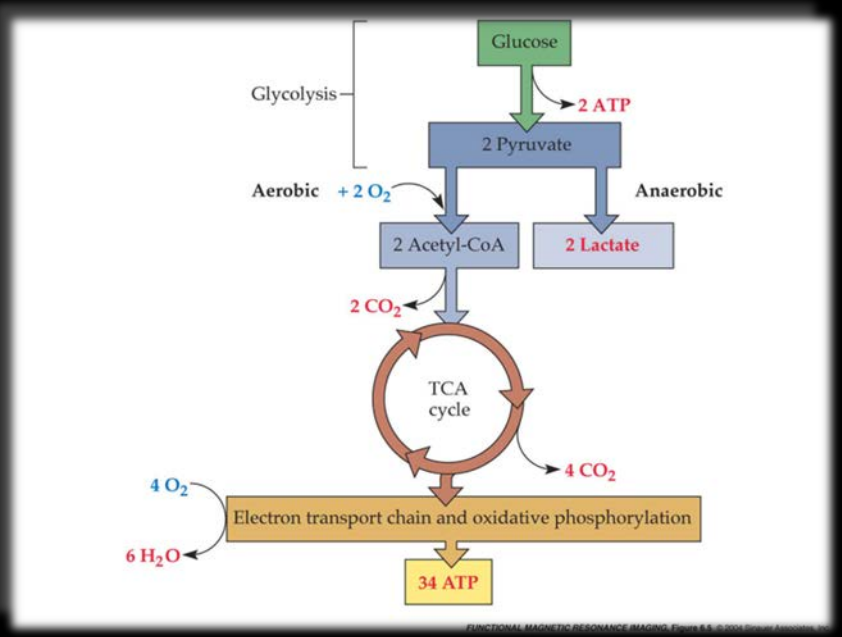
大腦神經元的訊息傳遞與溝通

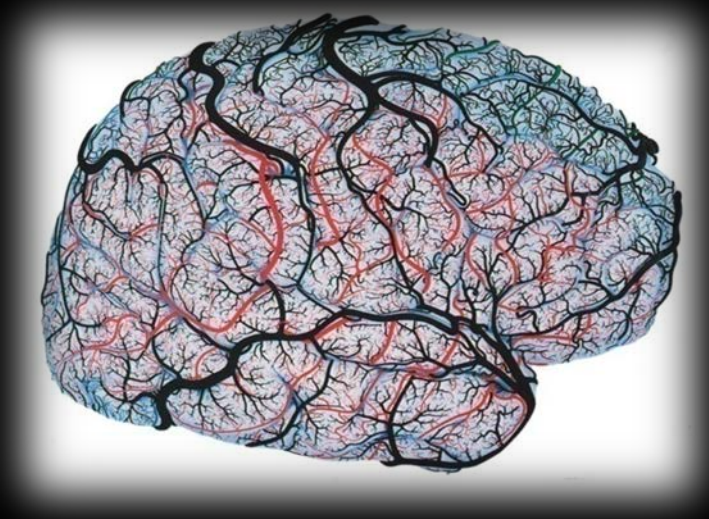


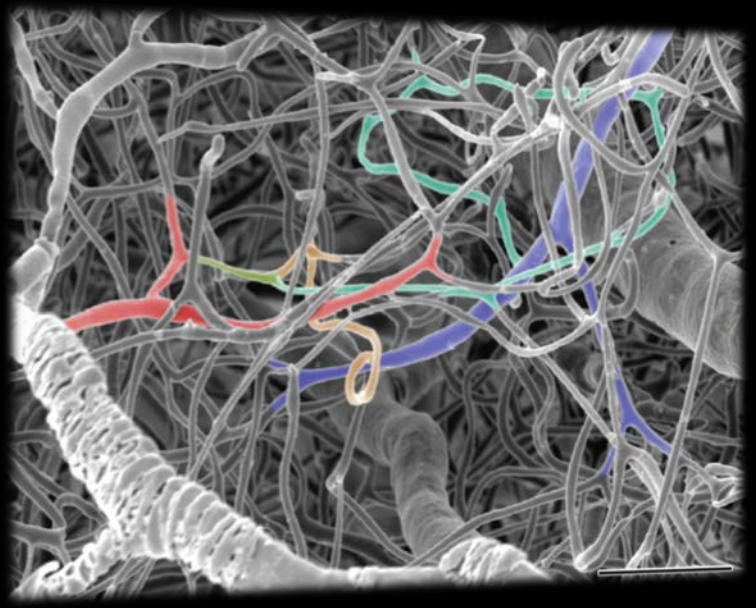




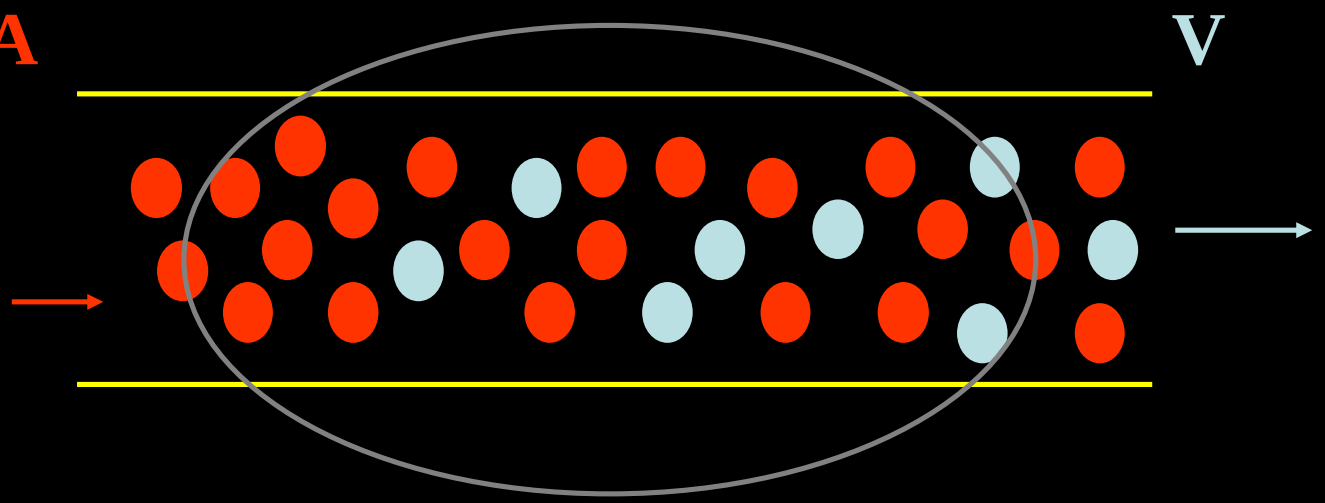

Axon
Presynaptic terminal
Synaptic cleft
Synapse
Postsynaptic dendrite
Presynaptic cells
Postsynaptic cells
Presynaptic membrane
Synaptic cleft
Neurotransmitter molecules
Postsynaptic membrane
Dendrite
Glutamate
Ion channel
Ca^{2+}
Na^+
Local EPSP
Electrode
1
2
3
4
5
6
7


Glucose
Glycolysis
2 ATP
2 Pyruvate
Aerobic
+ 2 O_2
Anaerobic
2 Acetyl-CoA
2 Lactate
2 CO_2
TCA cycle
4 CO_2
4 O_2
Electron transport chain and oxidative phosphorylation
6 H_2O
34 ATP

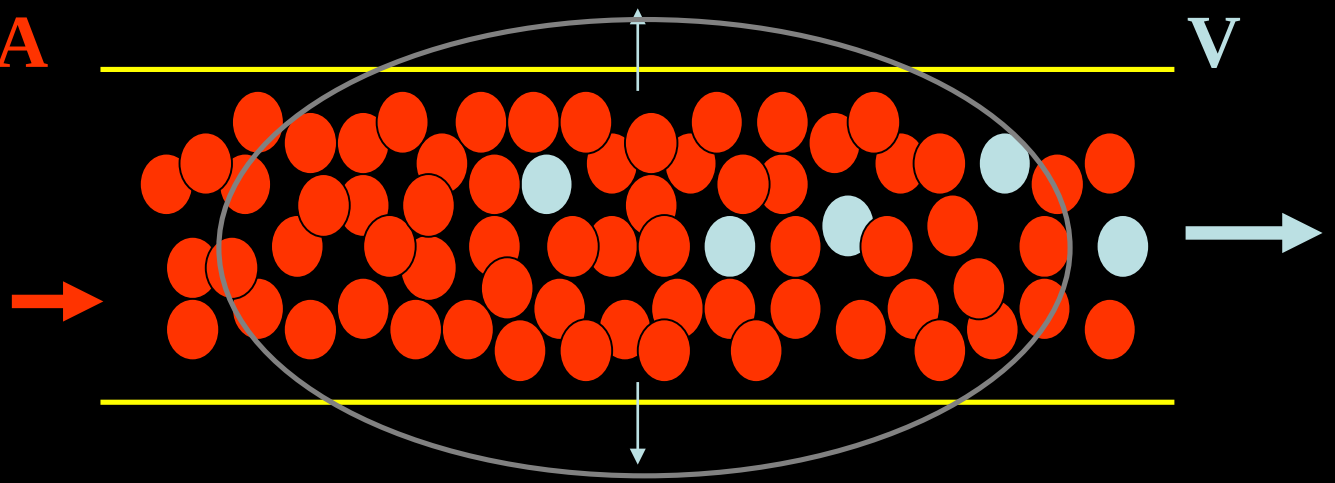




休息狀態



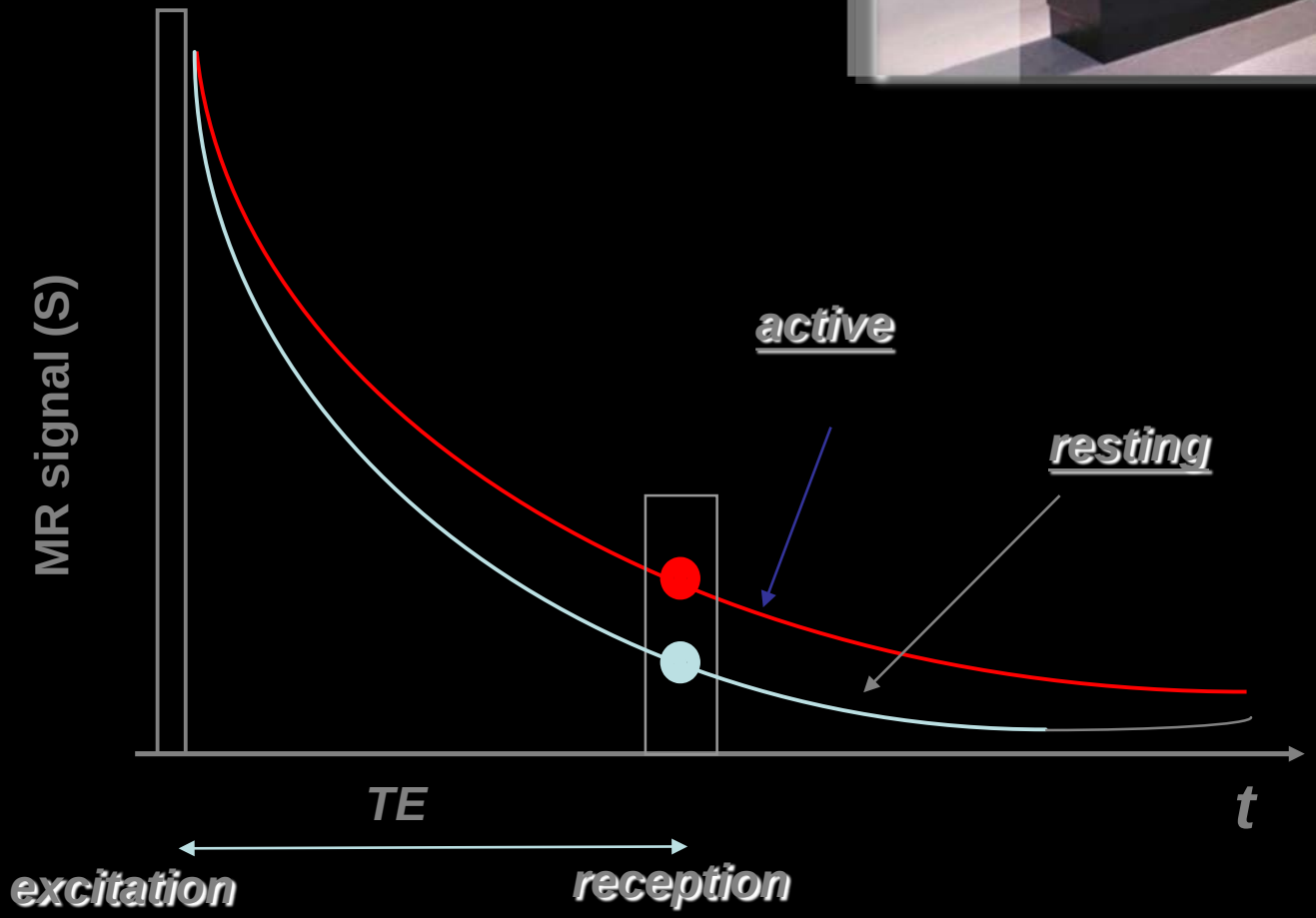
工作狀態

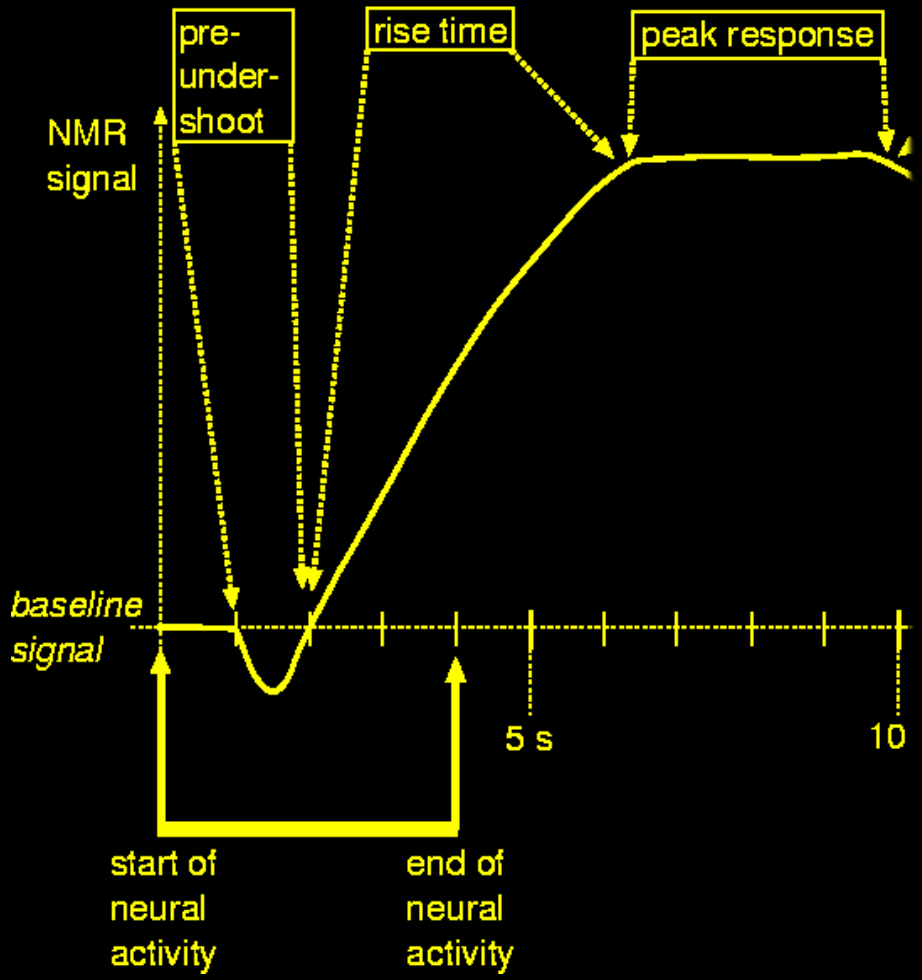


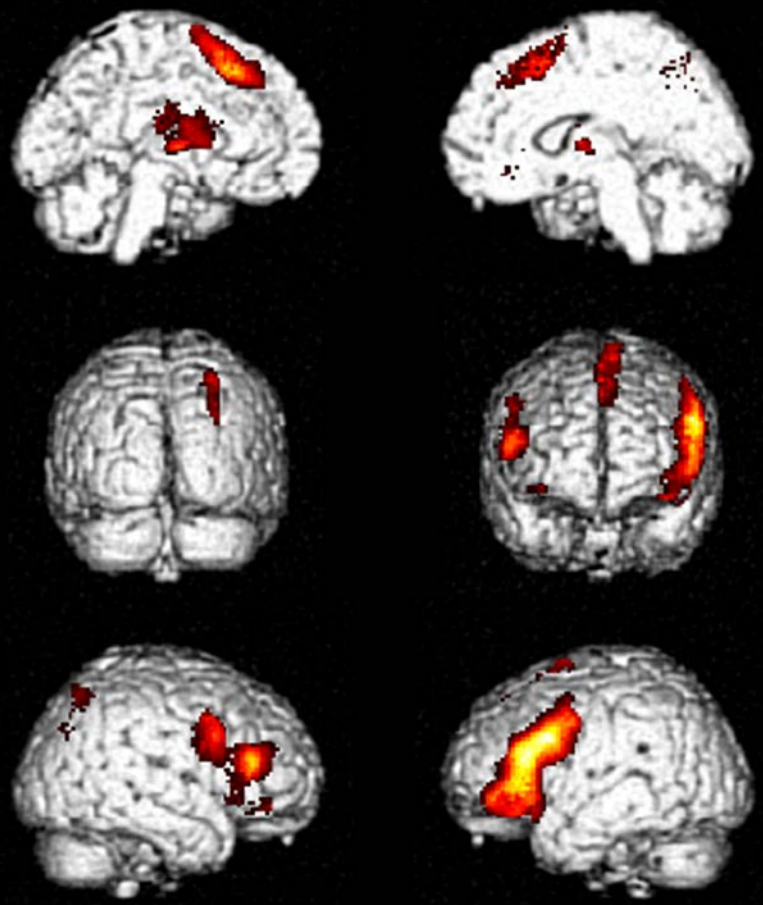
Oxy-hemoglobin

Deoxy-hemoglobin

T_2^* effect in fMRI

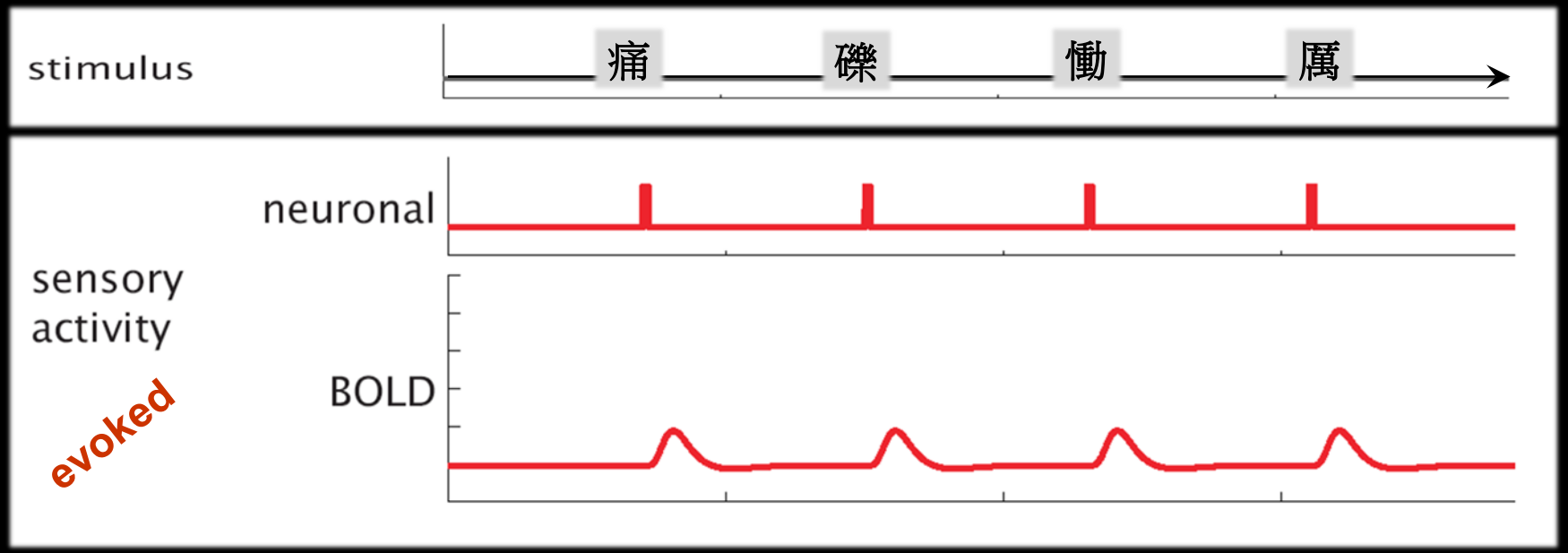




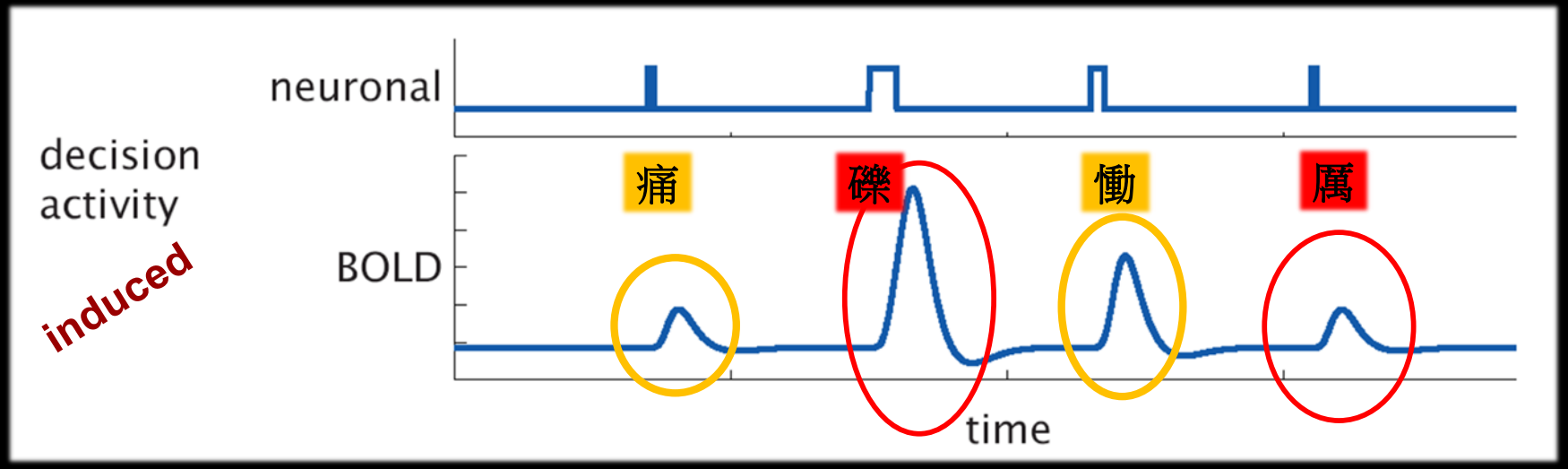


Hemodynamic Response Function (HRF)

(Blood-Oxygenation-Level-Dependent, BOLD)



However, ….



MRI scanning

跨文化認知神經科學研究

Cross-cultural Cognitive Neuroscience Research

-- Specificity & Universality --

以認知神經科學取向

探討中文字處理之神經生物基礎

郭文瑞

陽明大學神經科學研究所

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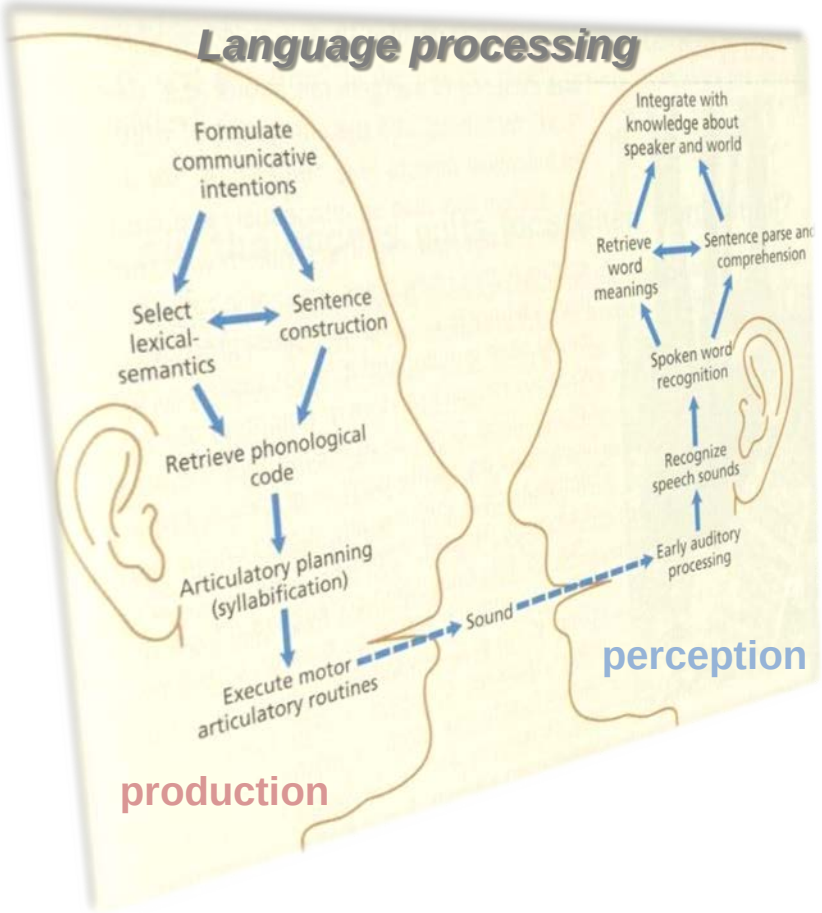
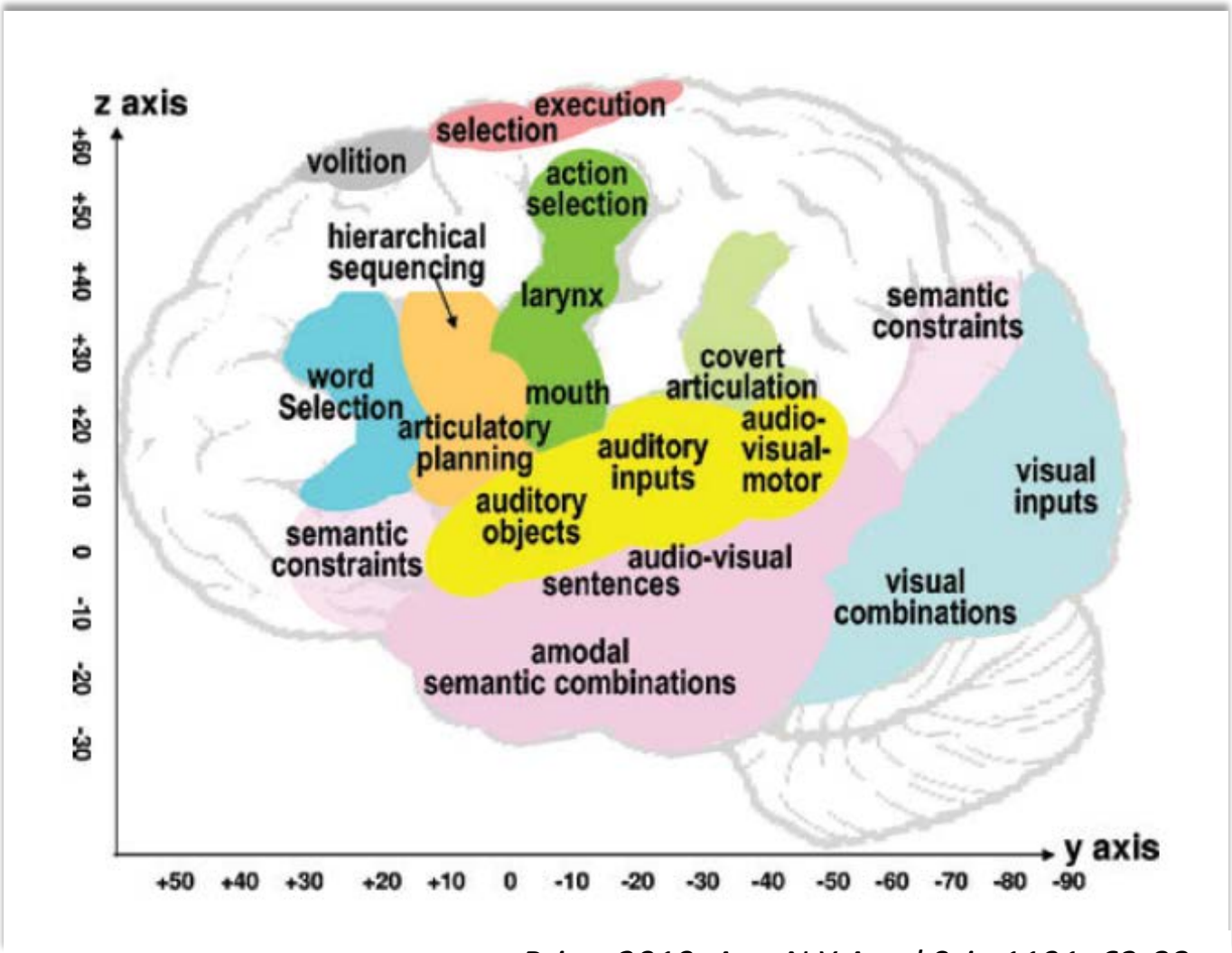
Cross-cultural Cognitive Neuroscience Research

-- Specificity & Universality --

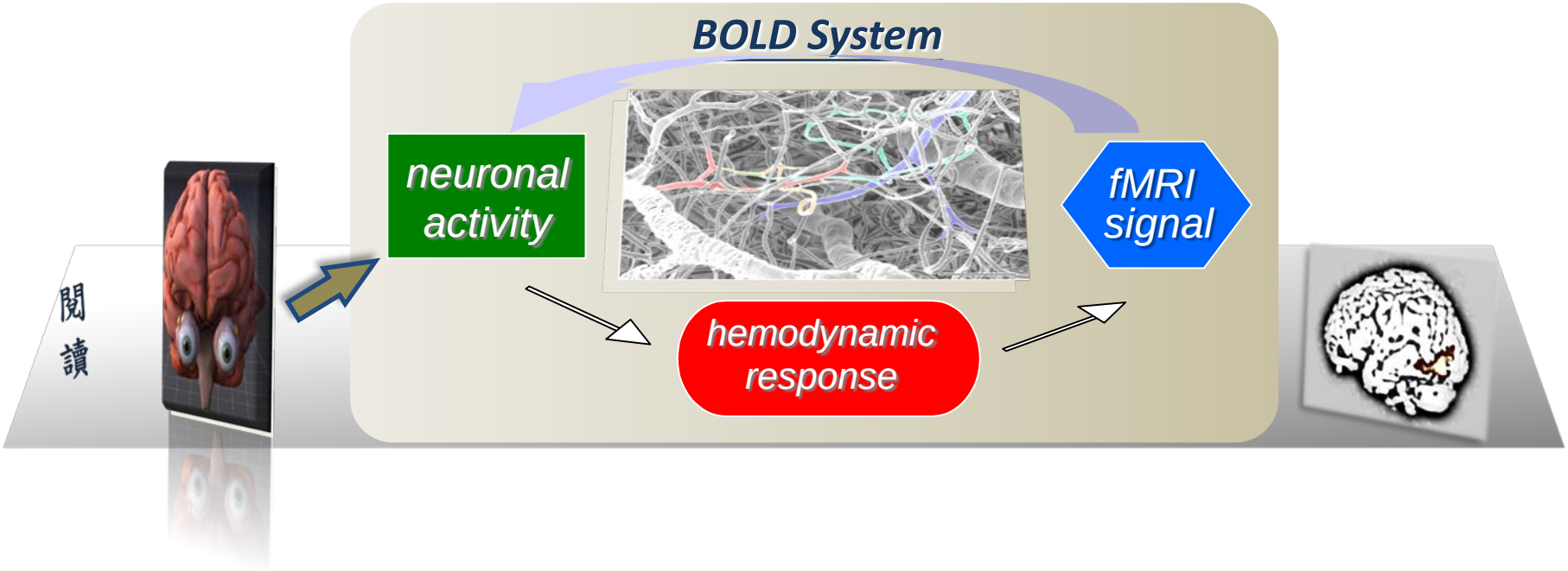


The anatomy of language (& *reading*)



Price, 2010. Ann N Y Acad Sci., 1191: 62-88.

Functional MRI is a neuroimaging technique/procedure to depict neural correlates of psychological processes of interest by detecting the changes of blood oxygenation level in the brain. By using fMRI, we are able to look for neural underpinnings of reading.



For Chinese, a word can be comprised of
one character, (e.g., *神, god*),
two characters, (e.g., *神經, nerve*),
or more, (e.g., *神經元, neuron*).

In modern Chinese, more than 80% of words are disyllabic compounds (雙音節). Compound words consist of characters that can be mapped onto their own syllables and morphemes.

Question:
What is the neurocognitive mechanism of compounding process ?

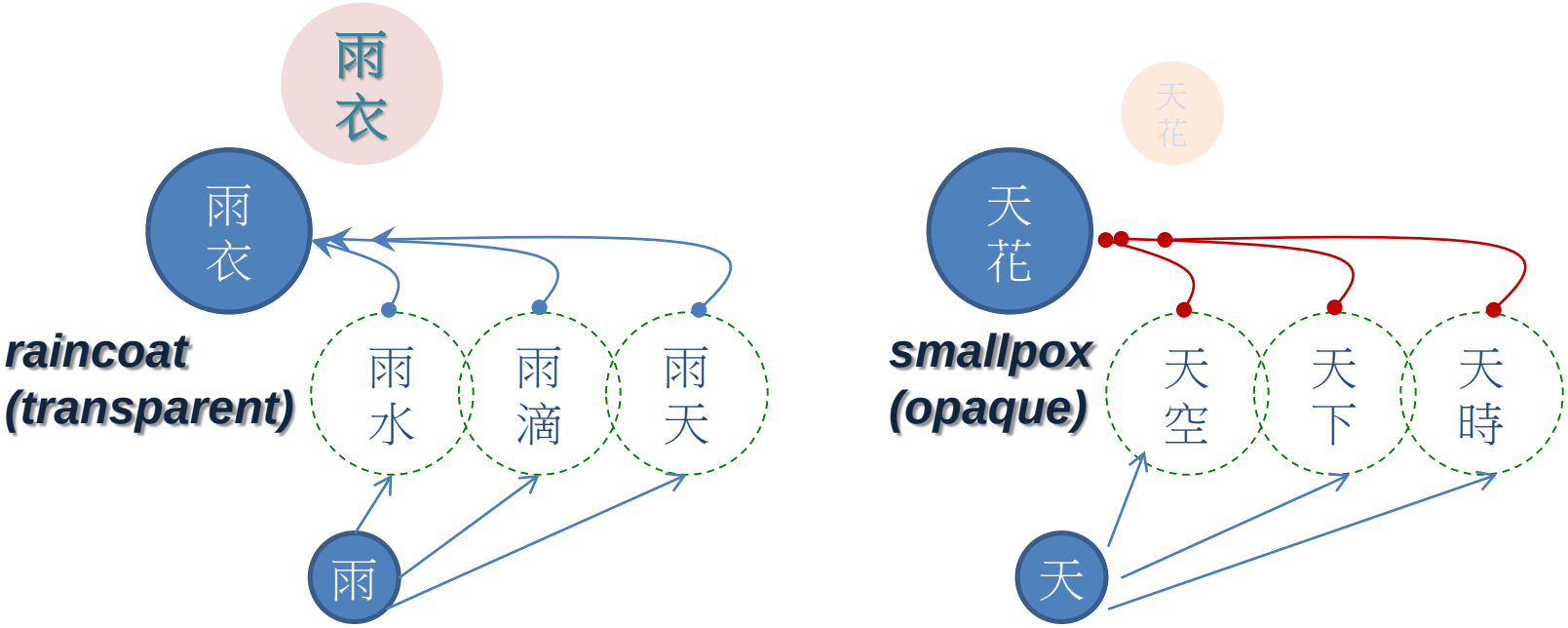
For a Chinese compound,

- it can come either from a big or small family which shares one of the two constituent characters (sharing the first one has more impact).
- it can be semantically transparent or opaque to its constituent characters.

花園、花店、花草、
花束、花茶、花蕊、
花瓣、花蜜、花生…

騎士、騎樓…

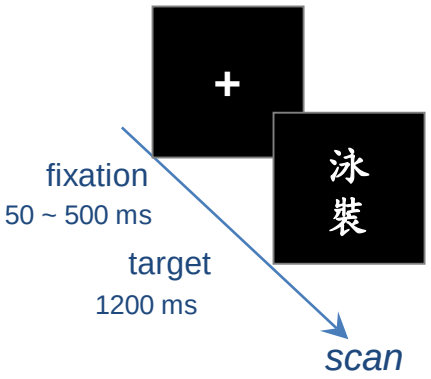
The model


雨衣
雨衣
raincoat
(transparent)
雨水
雨滴
雨天
雨
天花
天花
smallpox
(opaque)
天空
天下
天時
天

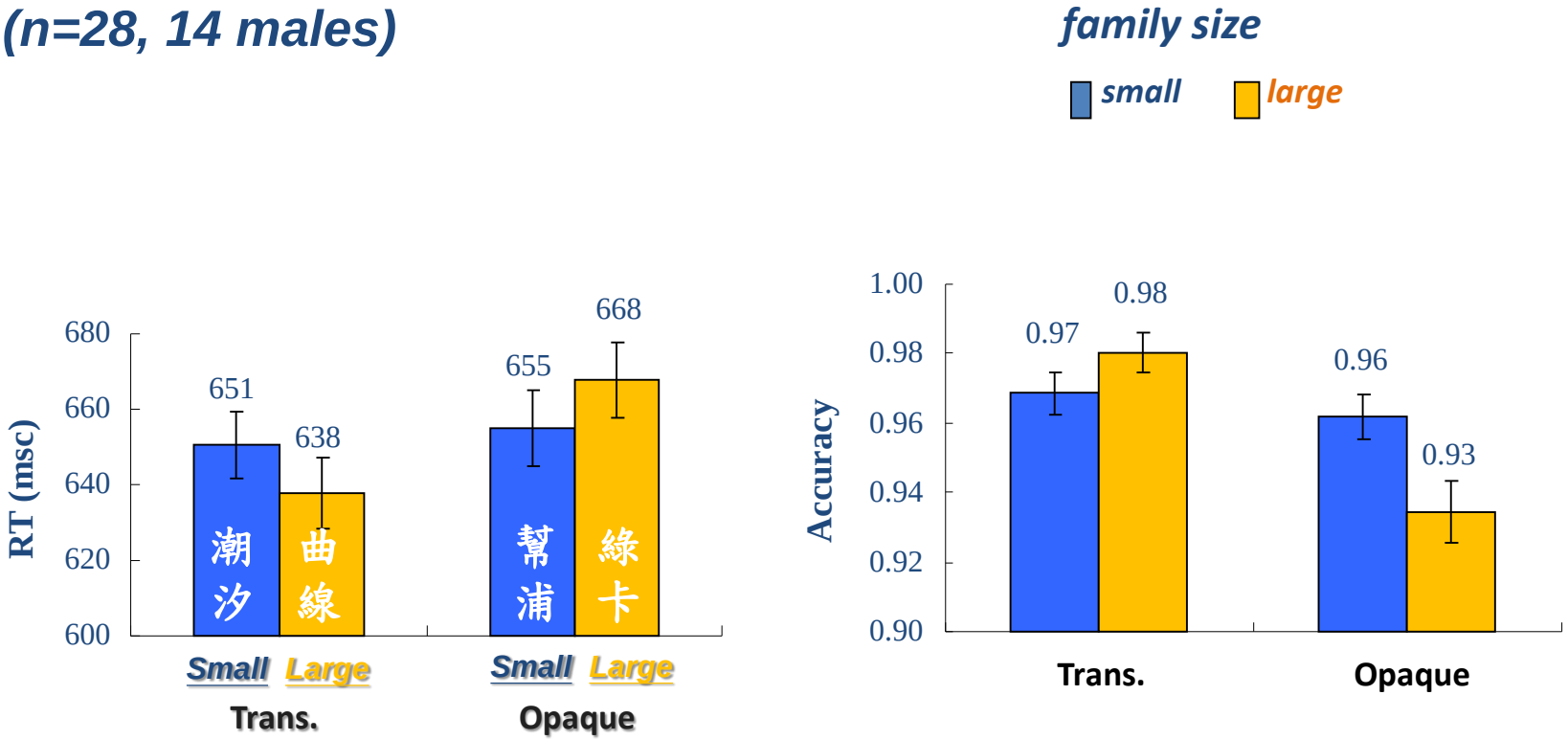
Study II: Processing of Chinese two-character compounds in the brain

- *3T event-related fMRI paradigm*
- ***28** college students volunteered for subjects*
- ***lexical decision task, reaction time and accuracy** were recoded.*
- *semantic transparency and family size for IV, word frequency balanced.*

***transparent words** (n=60)*	(S) 愚笨、潮汐、爬山、炊具 …. (L) 閃躲、鋼盔、曲線、皮箱 ….
***opaque words** (n=60)*	(S) 蜘蛛、杜鵑、幫浦、摸魚 …. (L) 姑娘、綠卡、天花、把風 ….



Behavioral data
(n=28, 14 males)

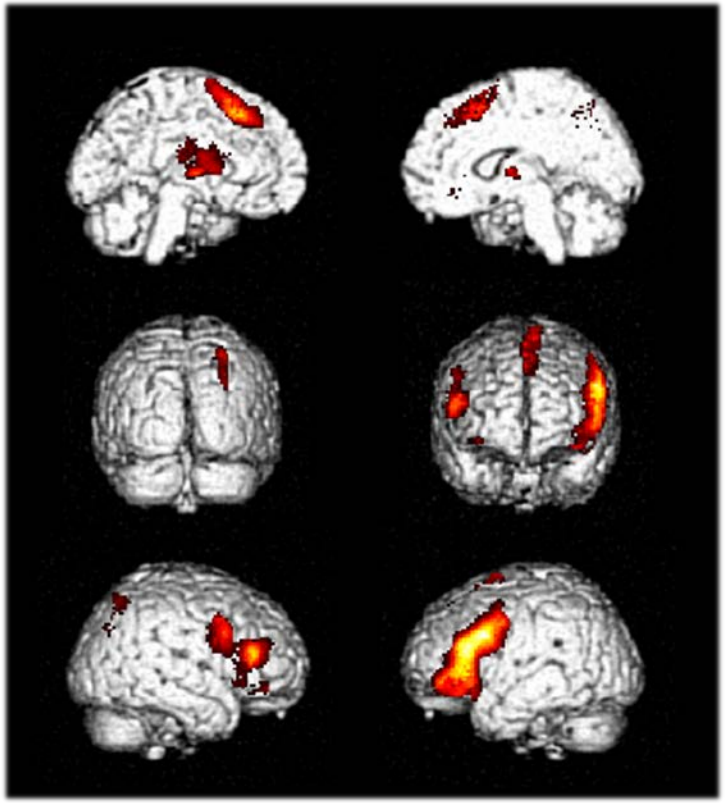


- ✓ ***Main effect of semantic transparency was significant.***
  - ➔ *RT transparent < RT opaque*
- ✓ ***Interaction was significant.***

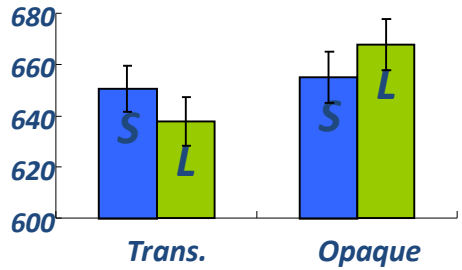
Brain data
(n=28, 14 males)

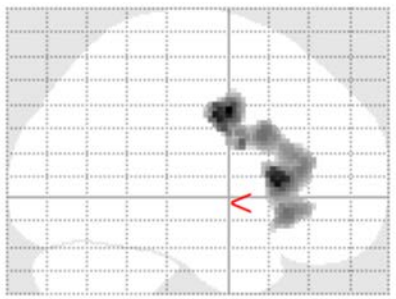
Main effects of semantic transparency

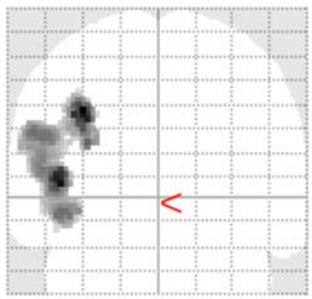
*[revealed by the contrast of **opaque-vs.-trans**]*



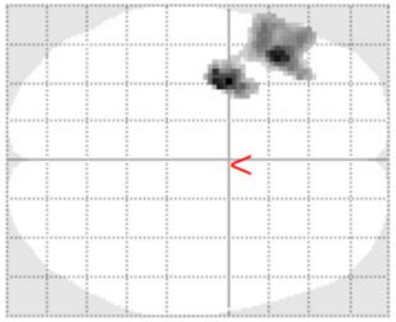
Interaction of semantic transparency and family size (1/2)

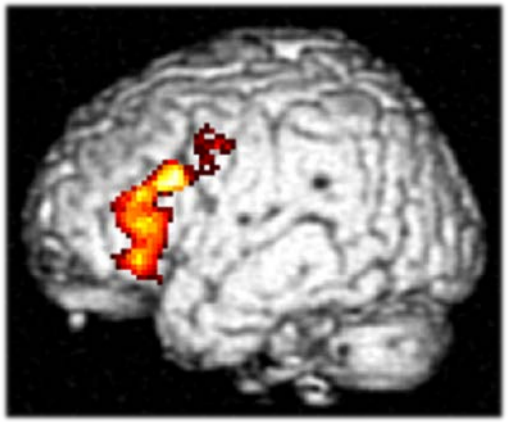


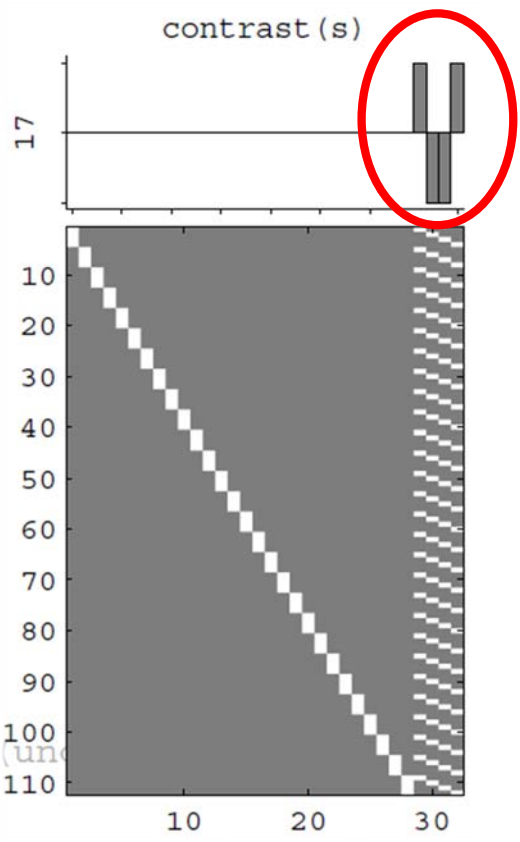




SPM(z)







In conclusion,

- a lexical control mechanism for the compounding process was suggested
- the neural substrate to host this mechanism was located in the inferior frontal gyrus (IFG)