Cognitive Neuroscience of Language: 11: Brain areas for spoken and written wordforms

Richard Shillcock

Reading

Tettamanti, M., Buccino, G., Saccuman, M. C., Gallese, V., Danna, M., Scifo, P., Fazio, F., Rizzolatti, G., Cappa, S. F.,& Perani, D. (2005). Listening to action-related sentences activates fronto-parietal motor circuits. *Journal of Cognitive Neuroscience, 17*, 273–281.

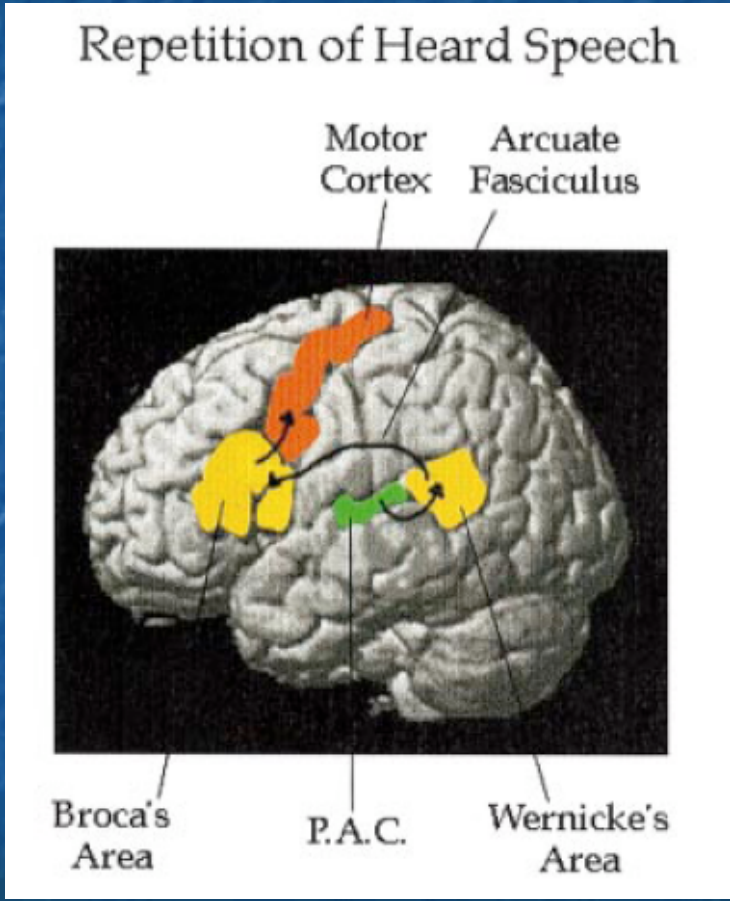
Price, C. (2000). The anatomy of language: contributions from functional neuroimaging. *Journal of Anatomy, 197*, 335–399.

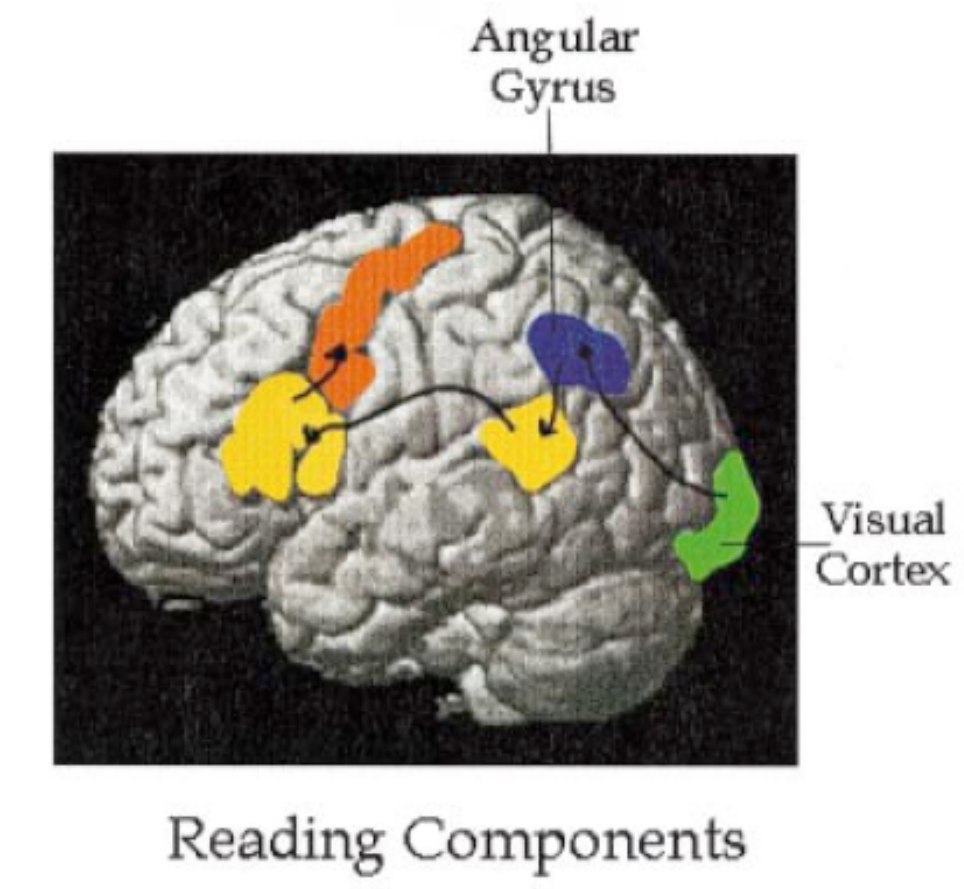
Goals

Understand the more central processing and representation of spoken wordforms, with particular reference to "embodiment"

Reading aloud and repetition

Lichtheim, 1885; Dejerine, 1891

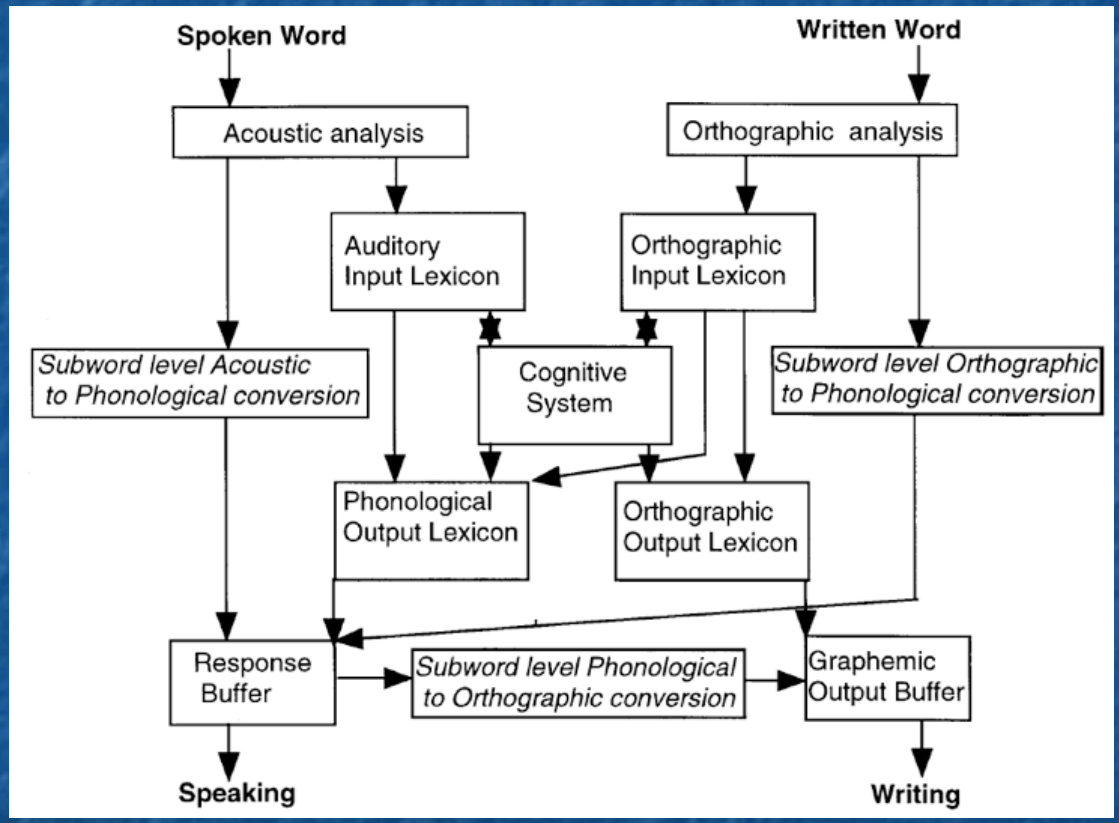




Alexia with agraphia: deficit in the left angular gyrus, linked with memories of visual wordforms

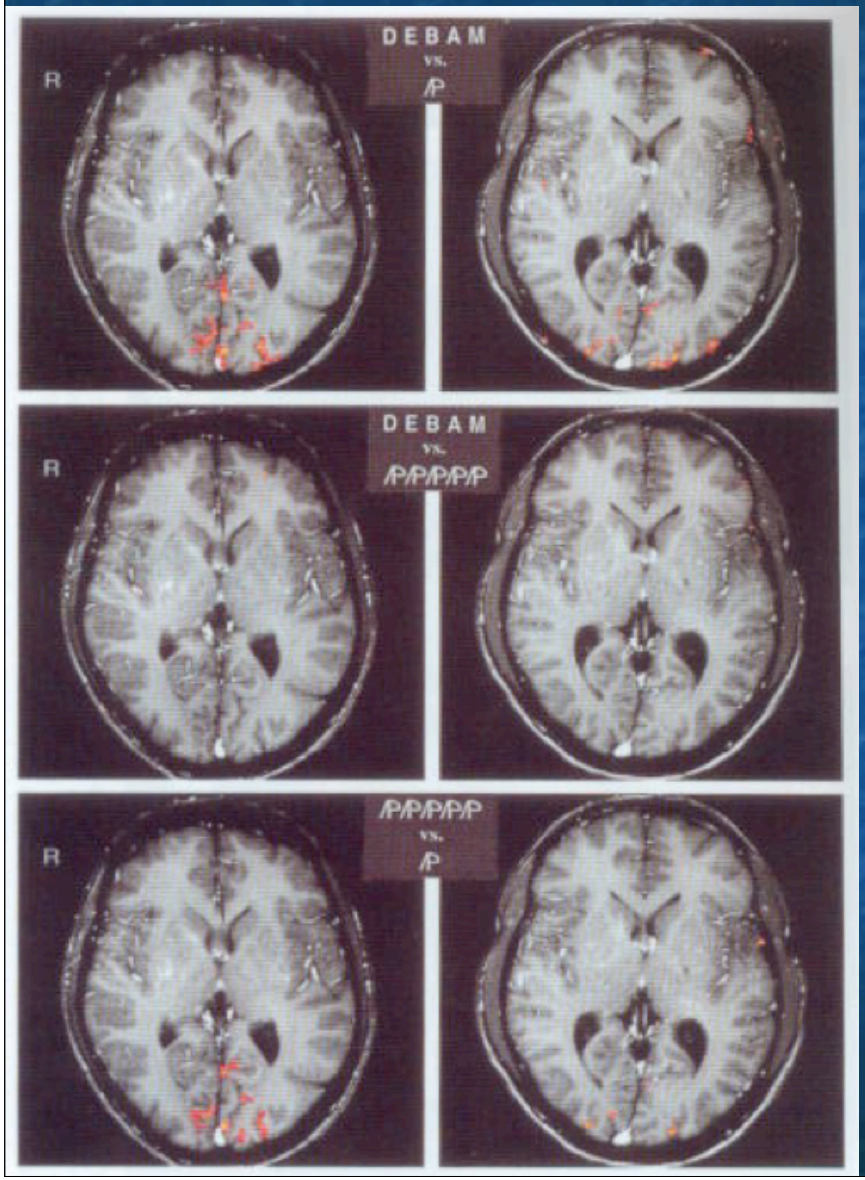
Cognitive model

Patterson & Shewell, 1987



What sort of mapping is possible between such a functional model and brain anatomy?

Specific brain areas activated

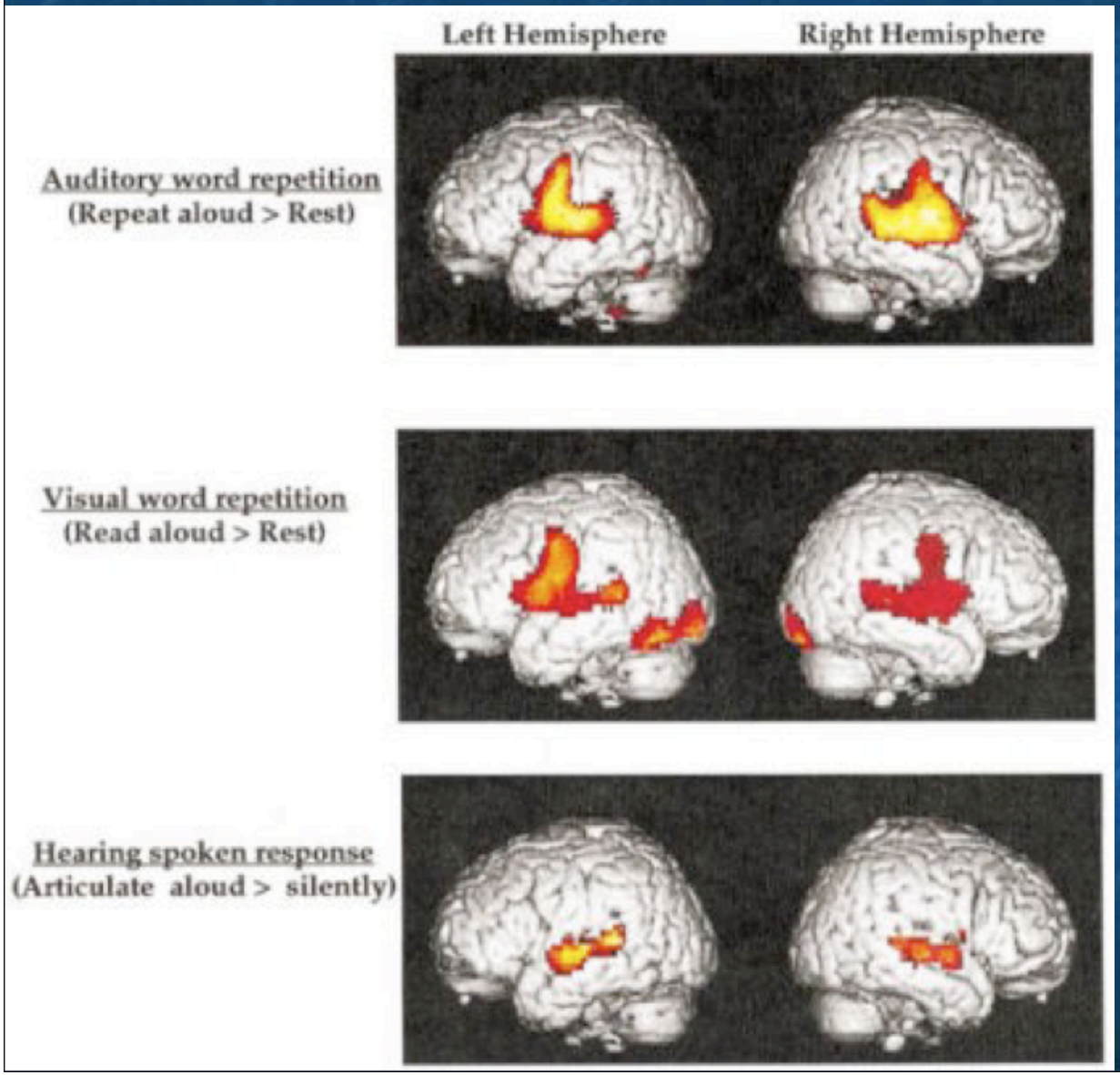


Indefrey *et al.* (1997)

Early orthographic processing

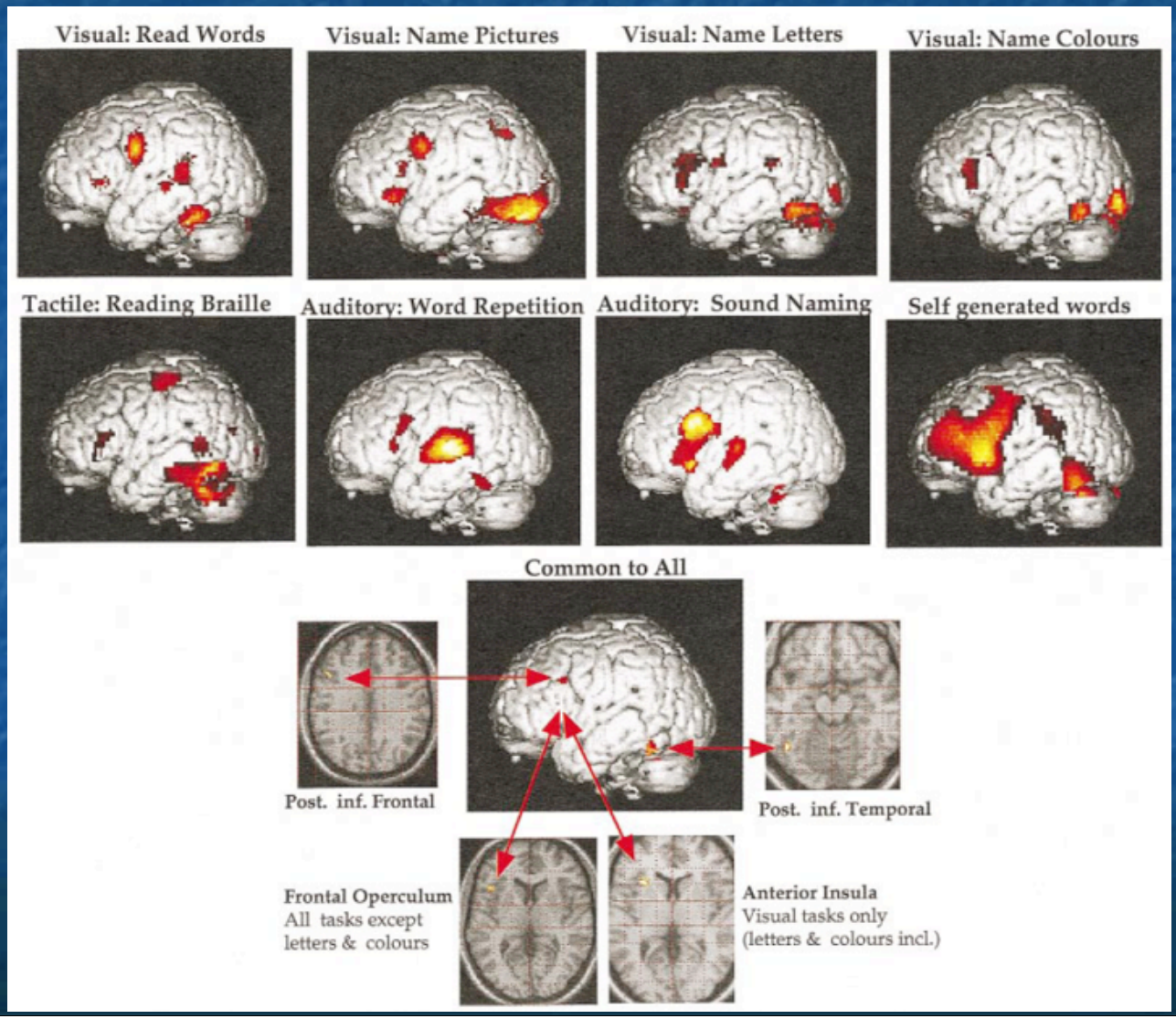
Specific brain areas activated

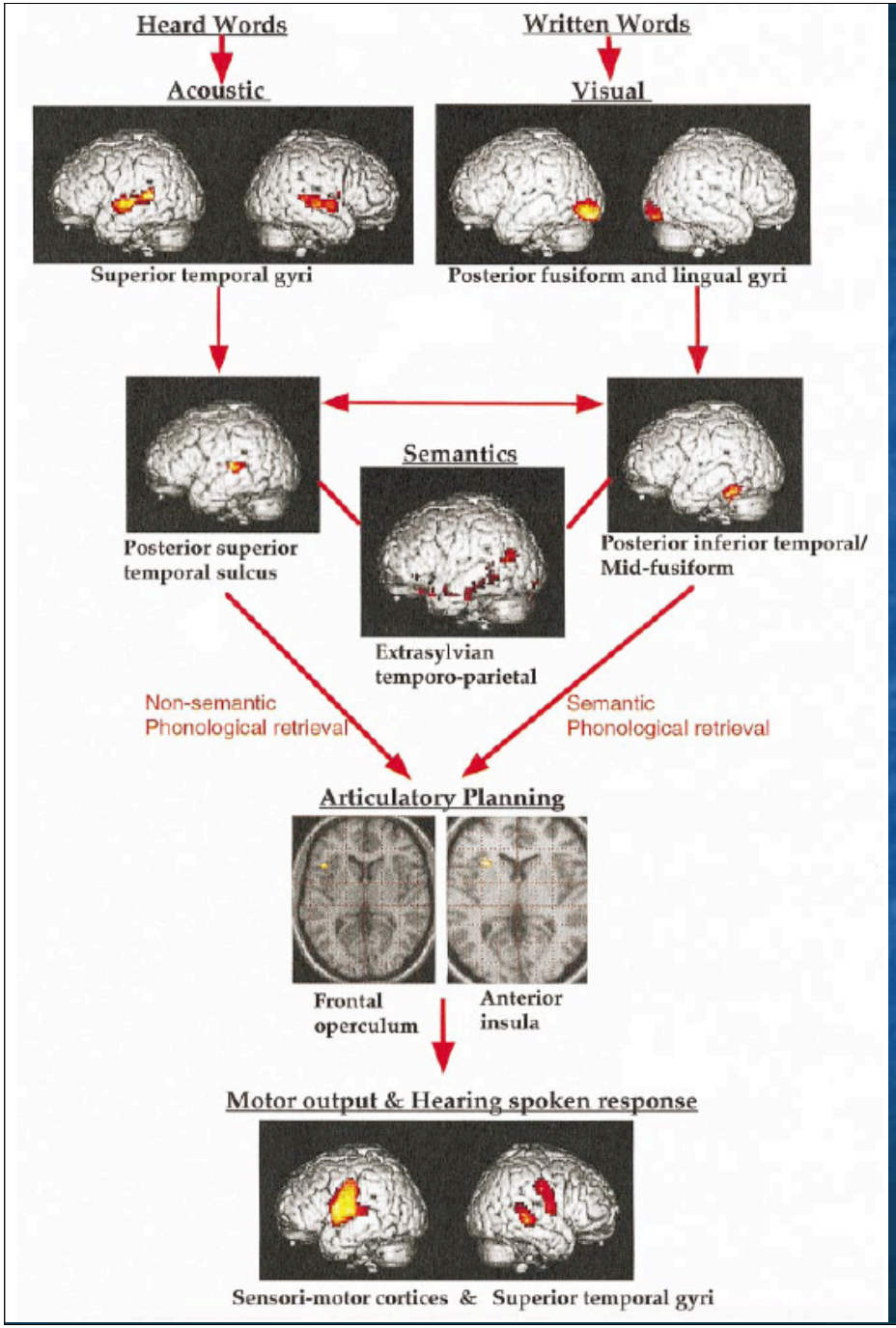
Price (2000)



Phonological retrieval

Price (2000)

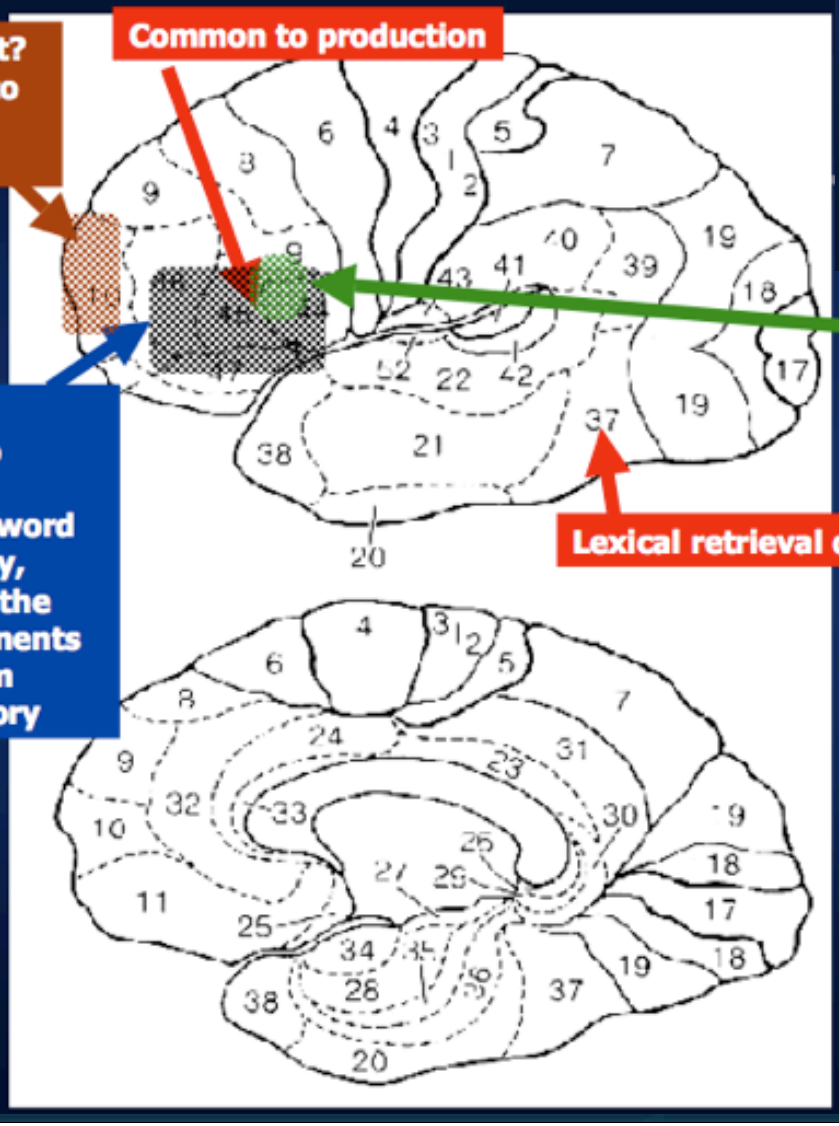




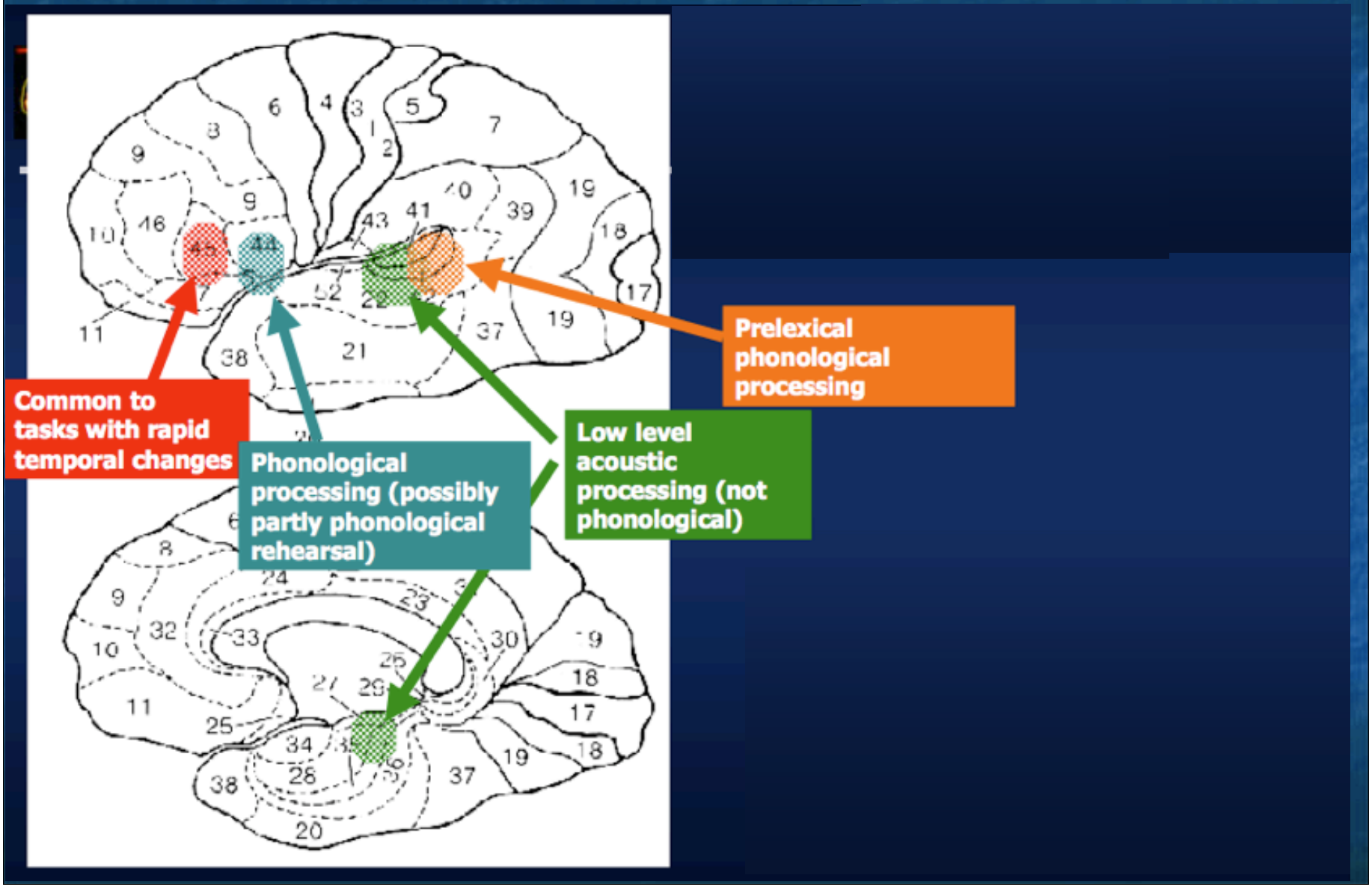
Anatomical/ functional model

Price *et al.* (2000)

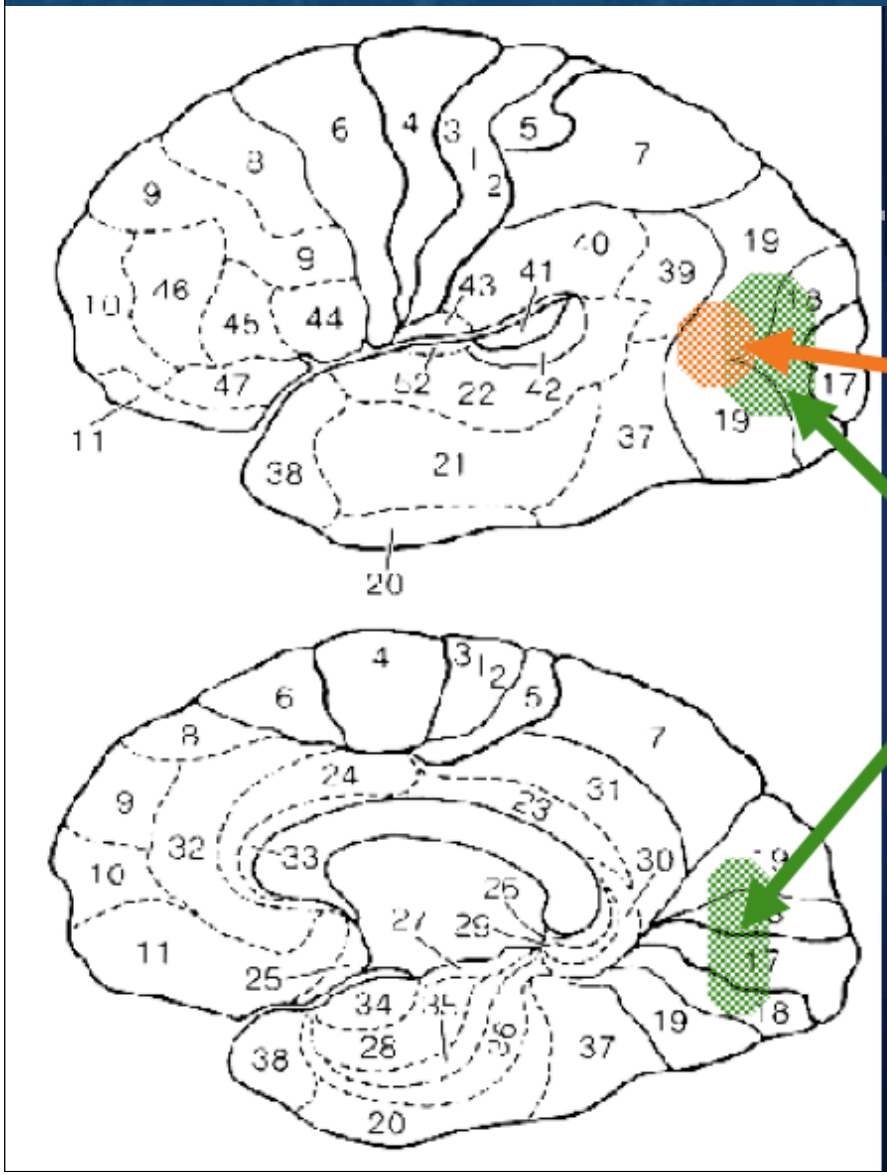
Word production



Spoken word comprehension



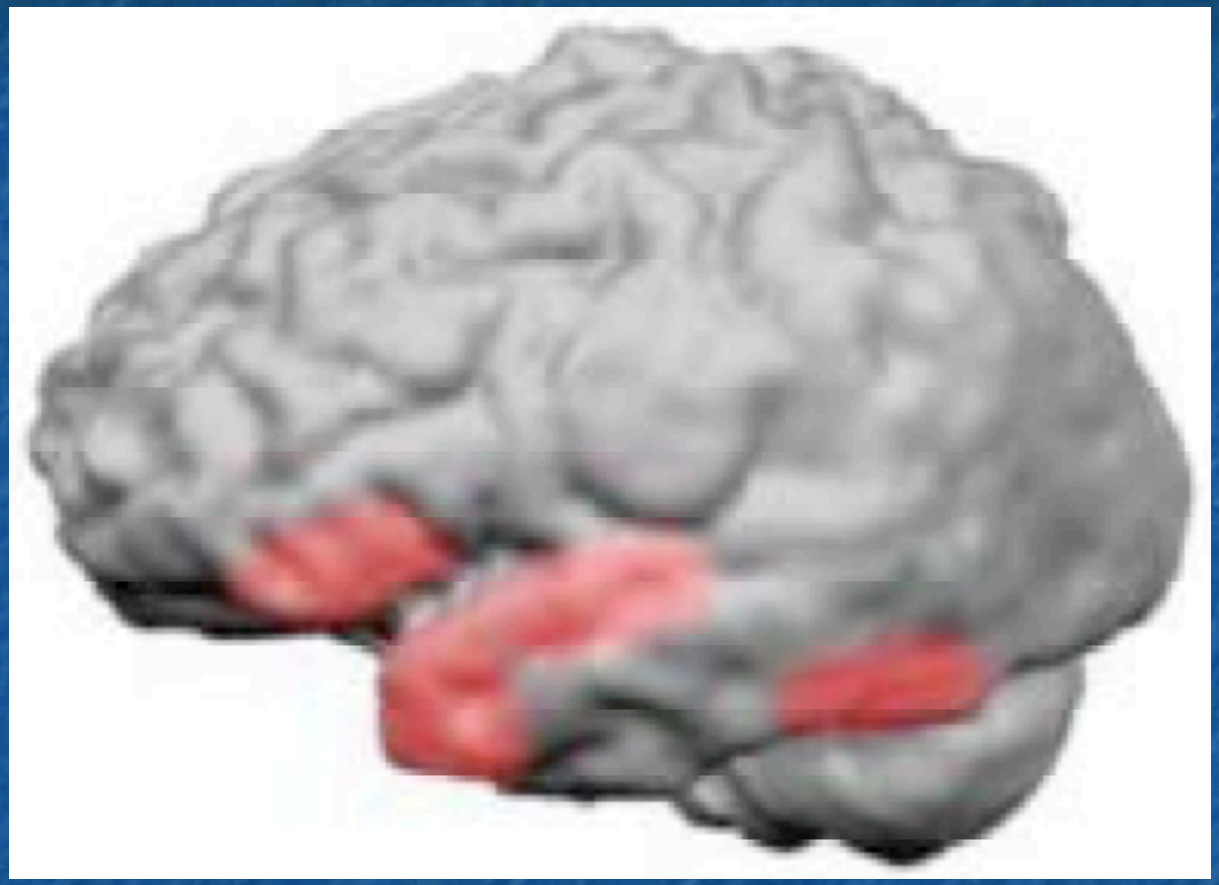
(Part of) printed word processing



Word form (contested)

Early visual processing (word vs false font)

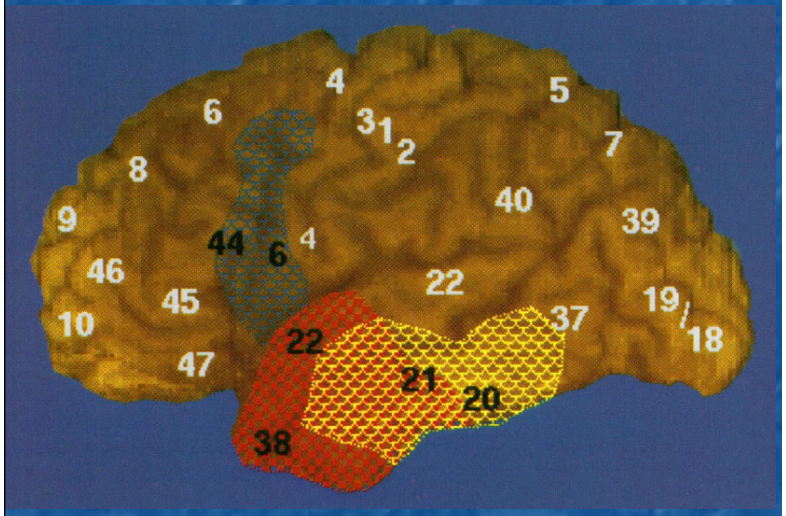
Semantic processing



Temporal lobe: upper and anterior TL – integration of meaning within a sentence; lower TL semantic interpretation of words

Implicating "non-linguistic" areas

Damasio & Tranel (1993)

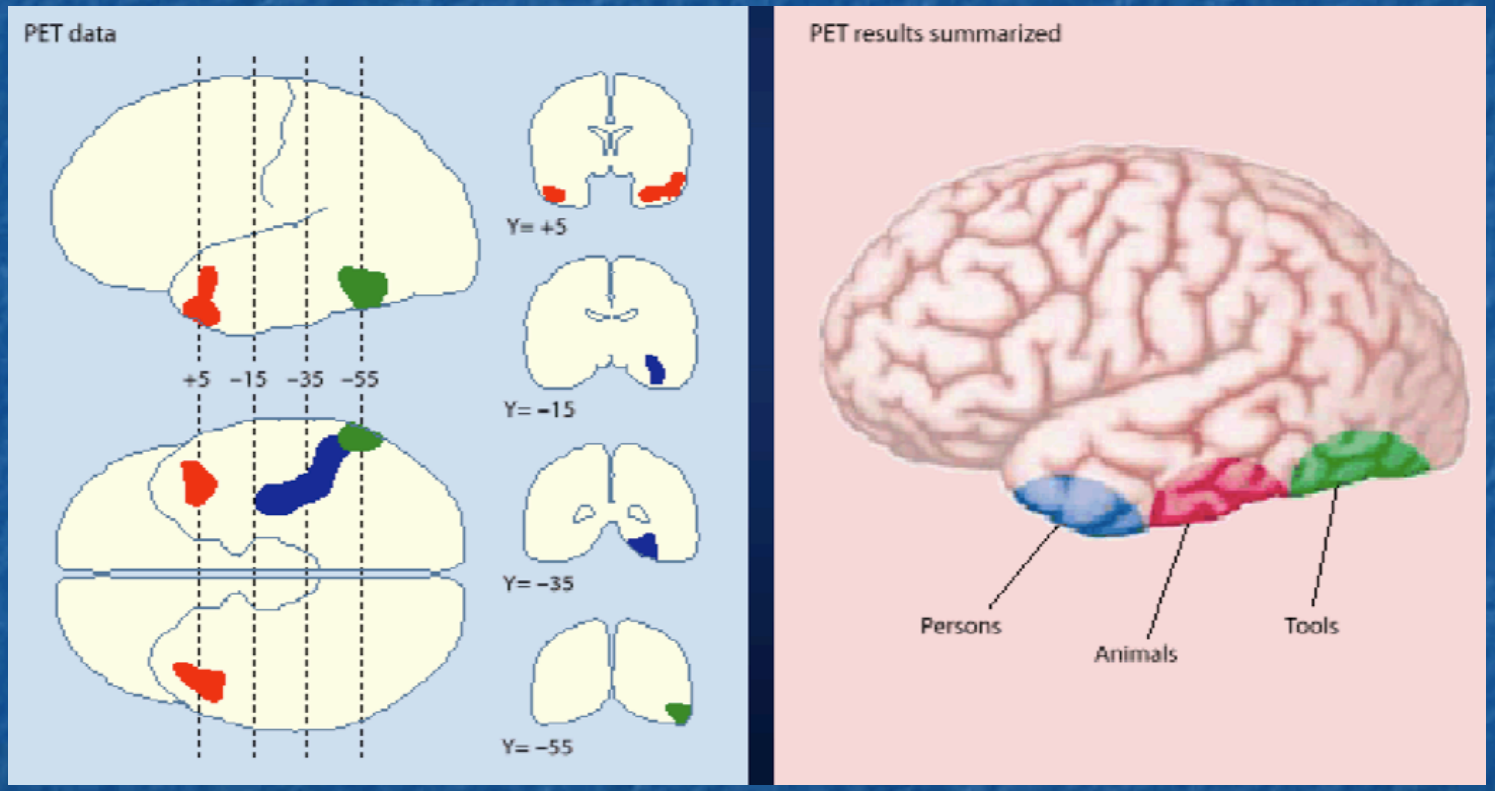


Patient	Stimulus	Response
Boswell	Duck	Bird . . .
	Penguin	Bird
	Pineapple	Possibly vegetable
	Zebra	Horse
AN-1033	Ostrich	Bird that sticks head in sand
	Raccoon	Animal . . . washes its food
	Zebra	Horse-like animal with black and white stripes
	Pumpkin	Melon . . . use it on Halloween
KJ-1360	Cutting	Going . . . scissoring
	Sailing	Sailboating
	Conducting	Band director
	Digging	Getting ready to move dirt

Red/yellow *vs.* blue indicate areas involved in a double dissociation between producing nouns and verbs

Implicating "non-linguistic" areas

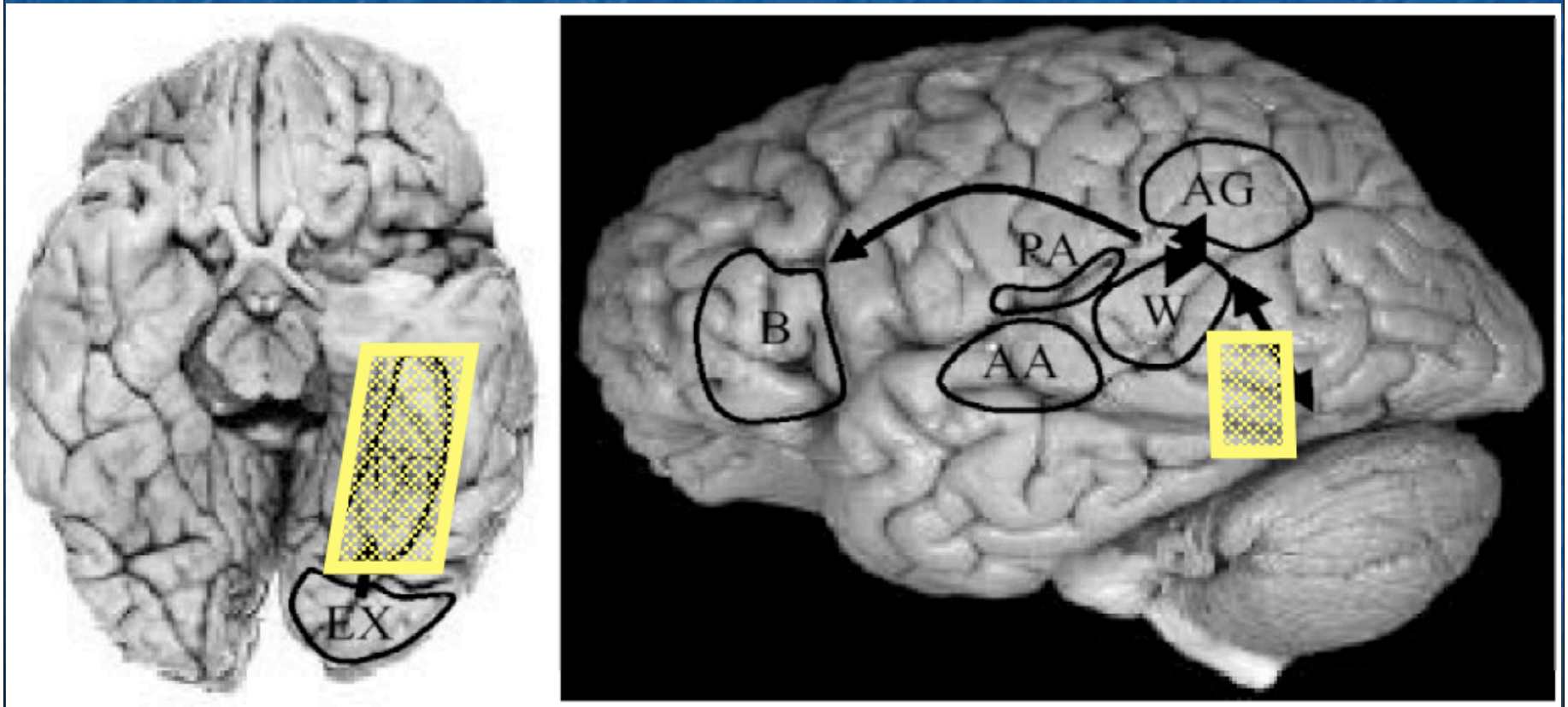
Damasio *et al.* (1996)



PET data implicating different areas of the temporal lobe in semantic processing

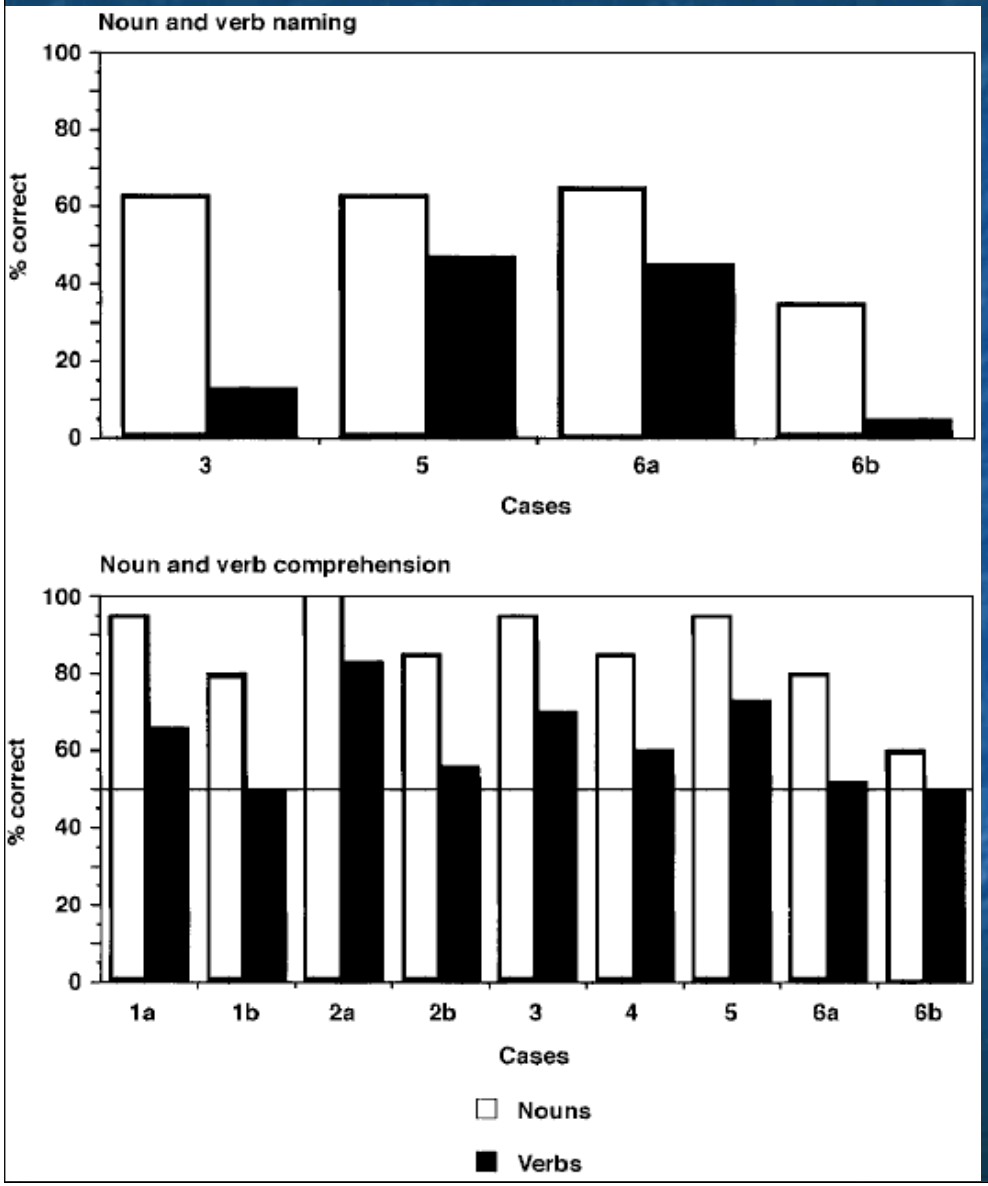
"Visual Word-Form Area"

Cohen *et al.* (2005);
Price & Devlin (2003); Price *et al.* (2003)



Posterior region of the left mid-fusiform gyrus

Implicating "non-linguistic" areas

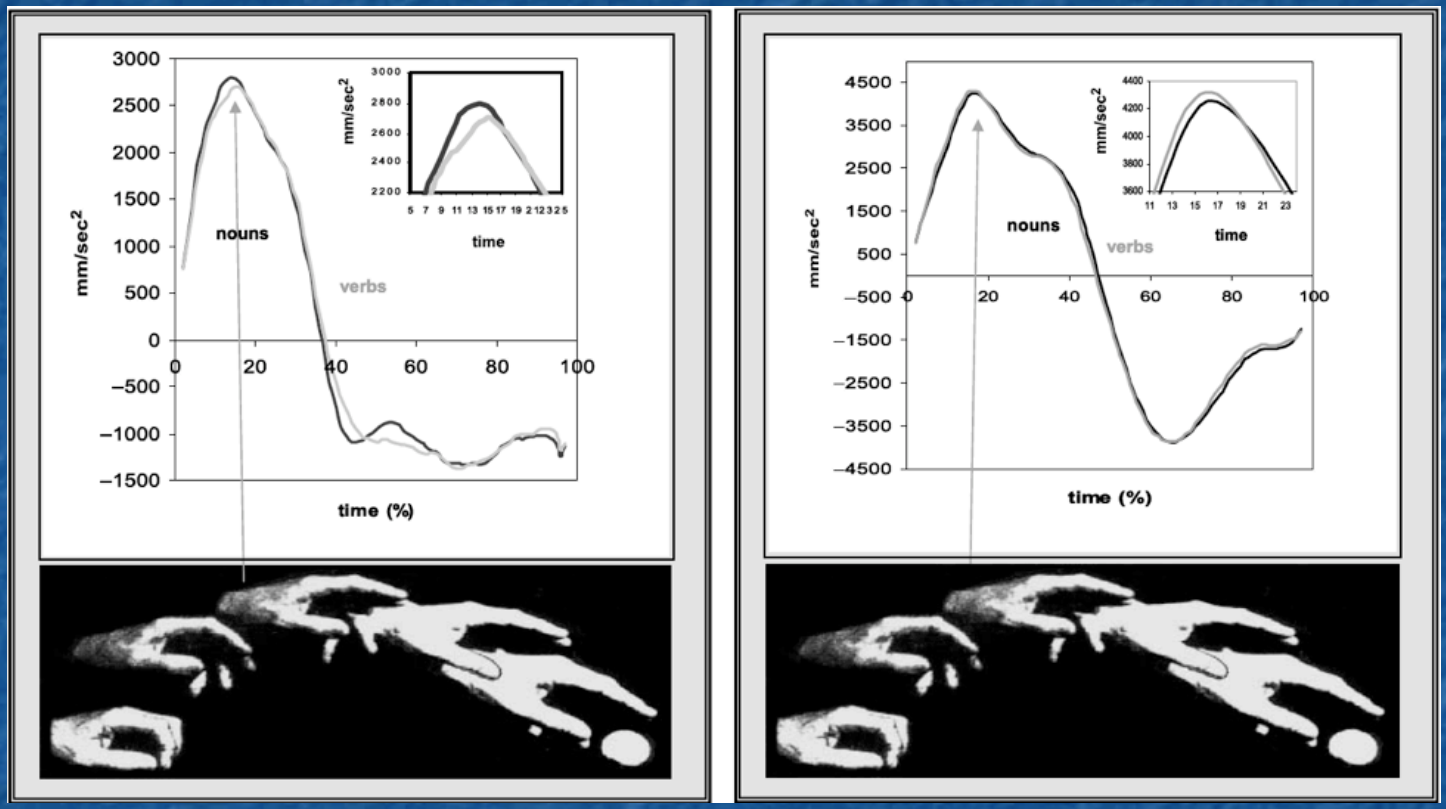


Bak *et al.*, 2001

Motor Neurone Disease disproportionately impairs verb processing

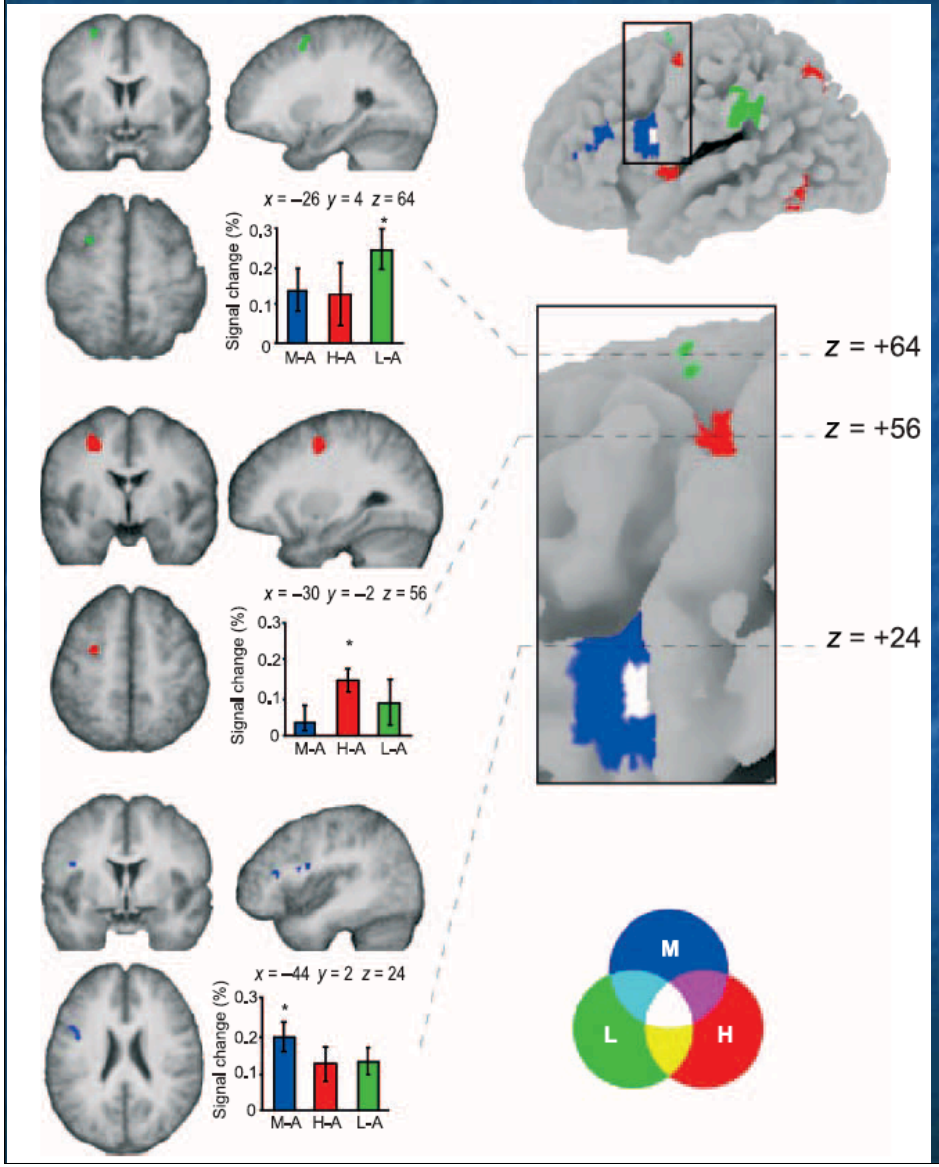
Implicating "non-linguistic" areas

Boulenger *et al.*, 2006



Reaching and grasping is hindered (160–80 msec) by a verb presented simultaneously, primed (550–80 msec) by prior presentation

Implicating "non-linguistic" areas



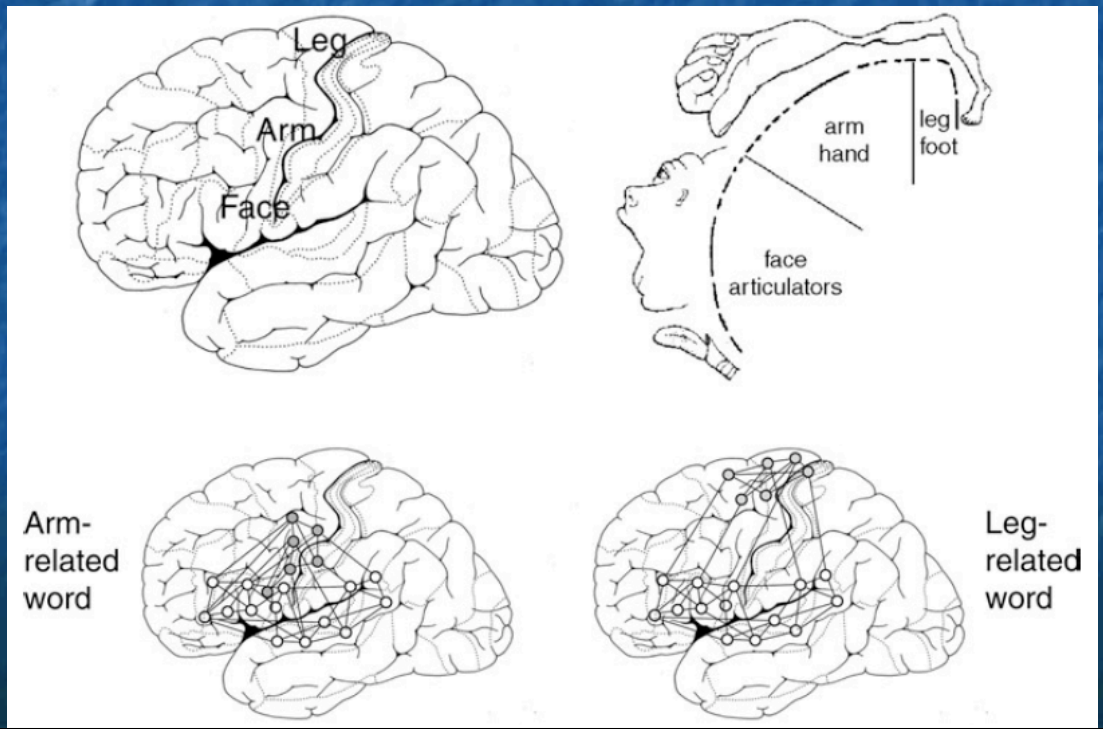
Tettamanti *et al.* (2005)

Sentences with mouth/hand/leg verbs cause somatotopic activation in the left hemisphere

A Hebbian perspective

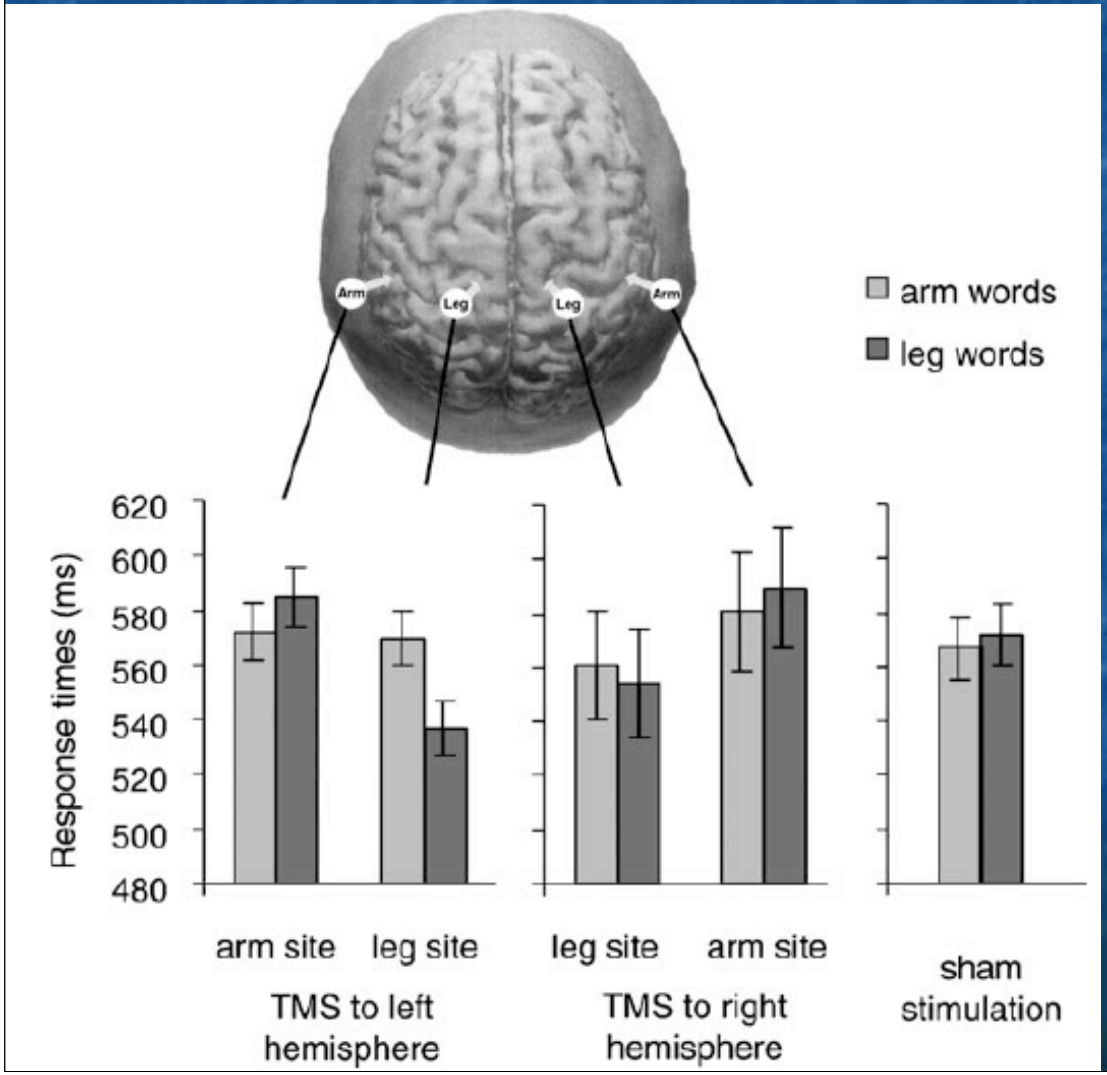
Pulvermüller, 1996, 1999, 2001, 2005

Hebbian learning: concurrent activation of two areas strengthens the connections between them. Hearing nouns, seeing objects; hearing verbs, seeing actions



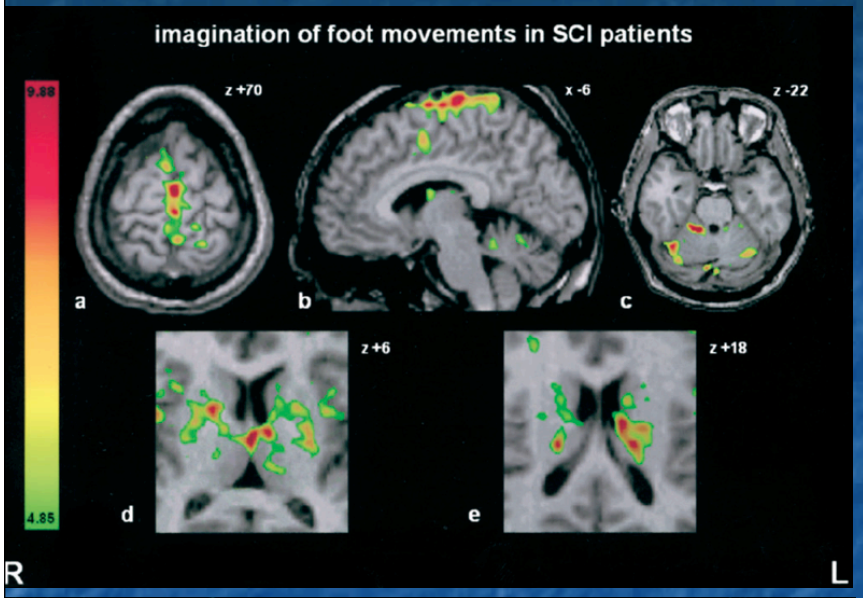
A Hebbian perspective

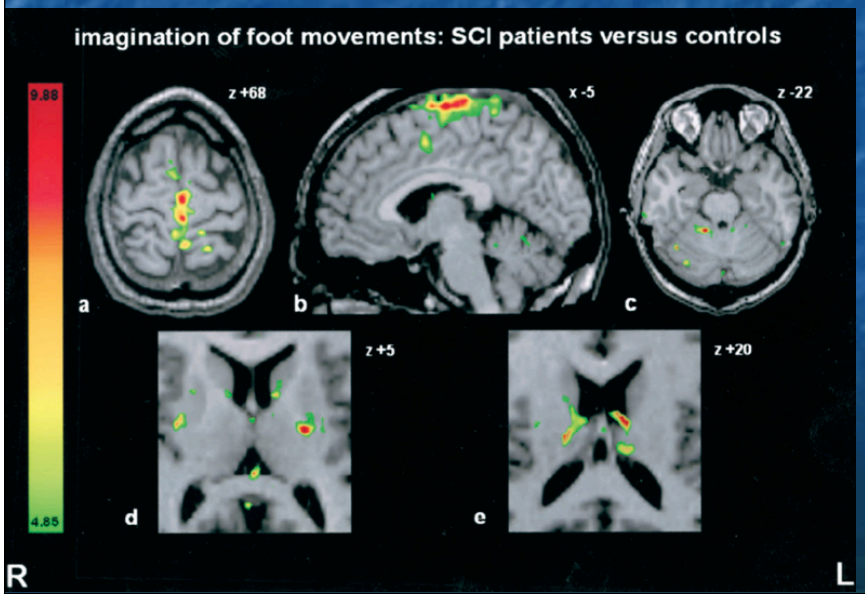
Pulvermüller *et al.* (2005)



TMS shows that action words differentially affect RH motor cortex

A simulation perspective



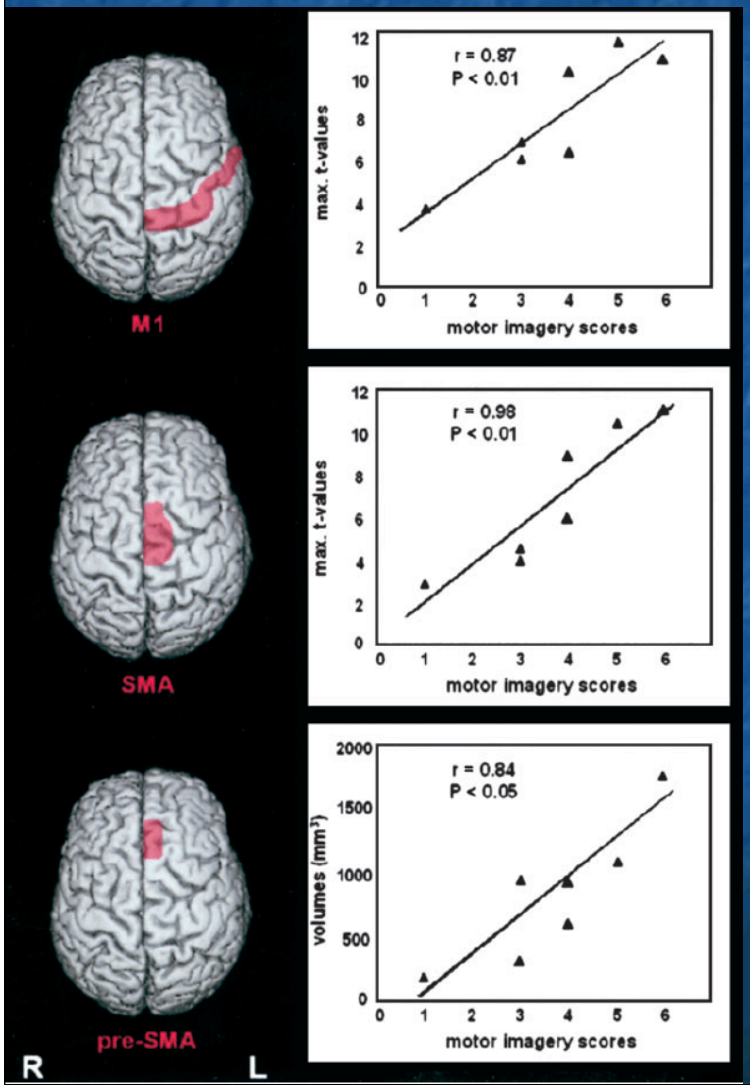


Alkhadi *et al.* (2005)

Mental imagery causes stronger cortical motor activity in spinal column injury patients than in controls (in whom suppression happens)

A simulation perspective

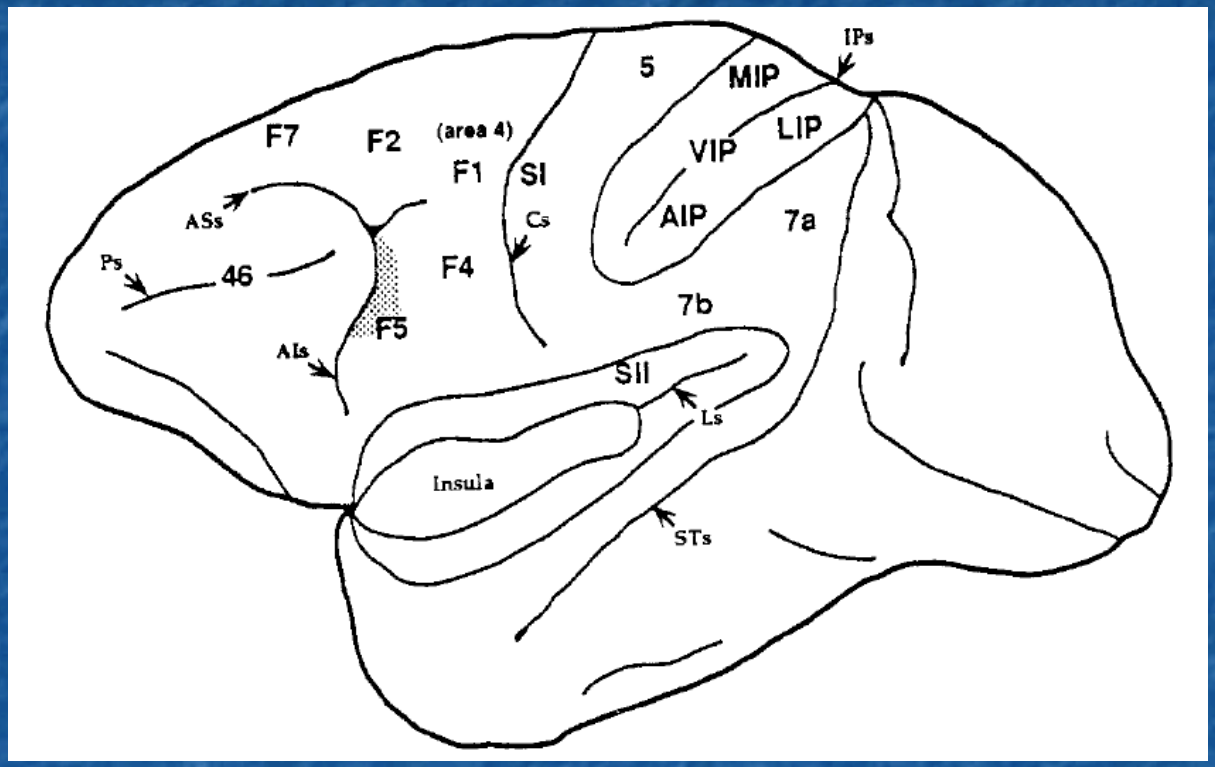
Alkhadi *et al.* (2005)



Vividness of mental imagery correlates with strength of cortical motor activity in spinal column injury patients

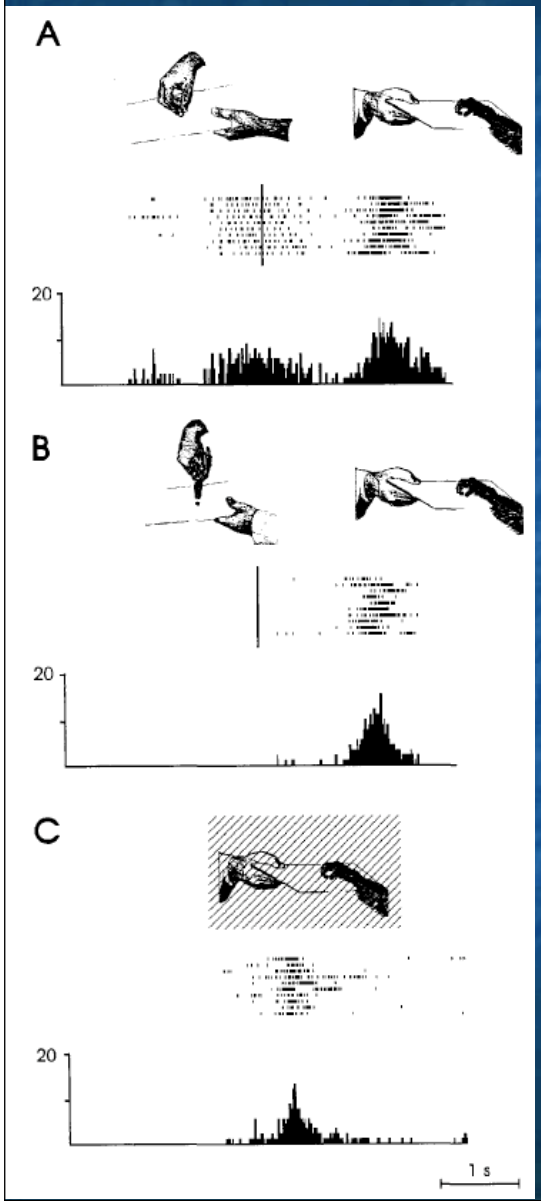
A simulation perspective

Rizzolatti *et al.* (1996)



Action mirror neurons: Area F5 in the macaque, a homolog of Broca's Area; AIP and F5 and F1 are concerned with seeing and grasping

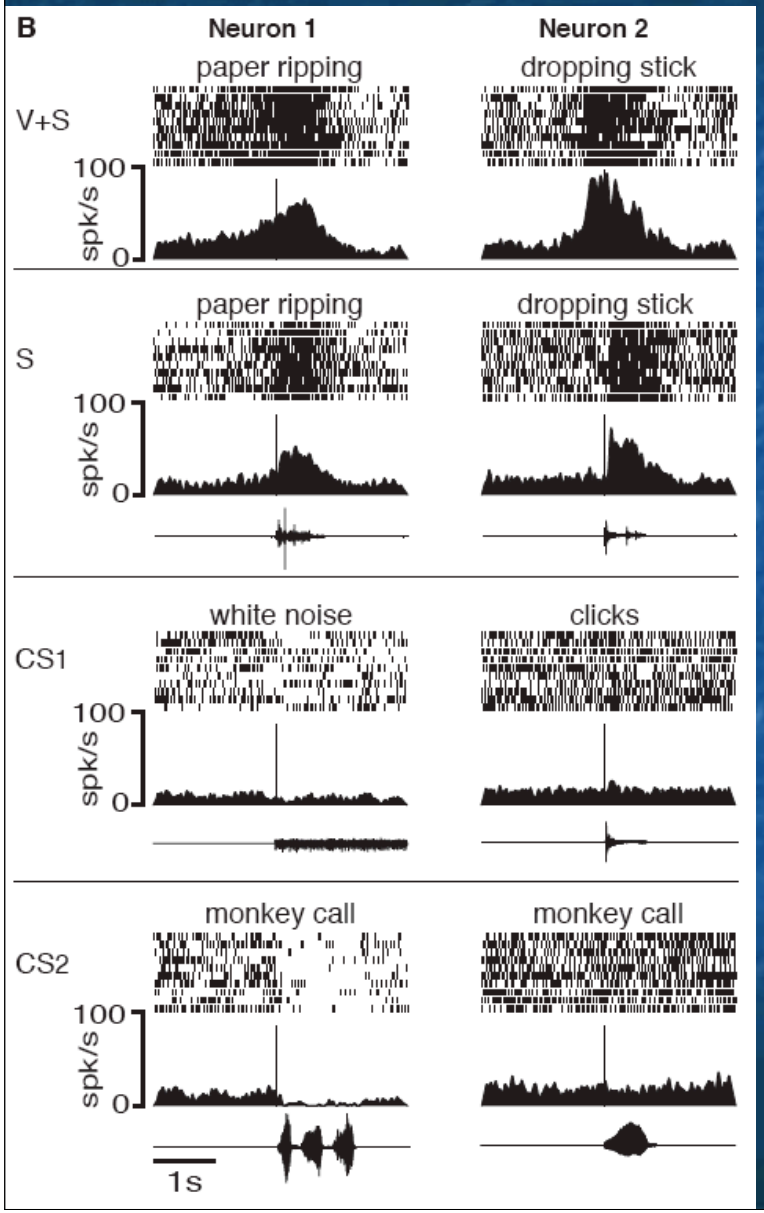
A simulation perspective



Rizzolatti *et al.* (1996)

Single-cell recording, showing a cell that responds when the monkey grasps and/or sees another grasp

A simulation perspective



Kohler *et al.* (2002)

Audio-visual mirror neurons in F5 of macaques are activated by the performance, sound and the sight of a particular action

A simulation perspective

Ferrari *et al.* (2003)

35% of mouth neurons in F5 discharge when a mouth action is observed. 85% concern eating, 15% involve communication (lip smacking, lip protrusion). The monkeys are not actually imitating. Eating is a shared basis for communication in grooming.

Conclusions

Data on the instantiation of words in the brain supports the "embodied" view of cognition – representations are only important if they're doing something

There are strong indications regarding the evolution of language, and the role of B44 and its homolog