The Role of the Lateral Premotor Cortex in Conditional and Imitated Praxis

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Summary

- Study designed to test the hypothesis that the lateral premotor cortex has a specific role in conditional selection of actions on the basis of abstract cues
- PET study compared local cerebral blood flow during an abstract conditional task to blood flow during imitation
- The abstract conditional task was very well learnt before scanning
- There was no detectable activation of premotor cortex during the imitation or abstract condtional task
- It is possible that the role of premotor cortex is specific to the early phase of motor conditional learning

Introduction - 1

- The role of the lateral premotor cortex (LPMC) in man is still not clear.
- LPMC may be important when action selection is conditional on abstract cues from the environment.
  - Monkeys with LPMC lesions are unable to relearn a task which requires them to select one of two movements on a lever depending on a nearby colour cue [1]
  - Patients with focal LPMC strokes may be unable to learn to associate abstract stimuli with motor acts [2]

Introduction - 2

- In less abstract tasks, LPMC lesions do not impair relearning
  - LPMC lesioned monkeys can relearn to select one of two actions on a lever according to a colour cue if the cue is on the lever itself (rather than nearby) [3]
- Apraxic patients also have difficulty with abstract conditional motor tasks
  - Many patients with apraxia cannot mime a gesture to command, but find imitation and tool use easier [4]
- This study is designed to test the hypothesis that abstract conditional tasks activate premotor cortex more than less abstract tasks such as imitation

Task

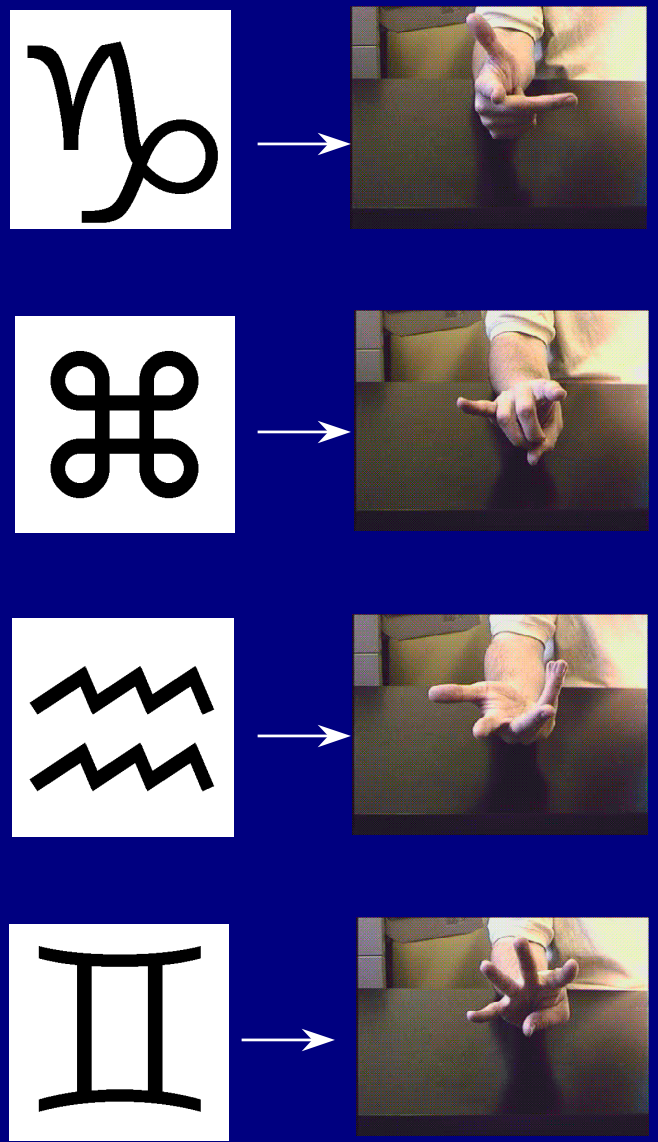
Subjects learnt two related tasks: Imitation (I) and Abstract Conditional (AC) (see next panel).

Each task involved the cued right-handed performance of four hand gestures which were unfamiliar to our (English) subjects, but differed in the cue that signalled which action to perform.

In the AC task, subjects saw a ready signal, followed by one of four abstract cues which signalled which gesture to perform (right). They then saw a video of the gesture, which they ignored. This cycle repeated every 12 seconds.

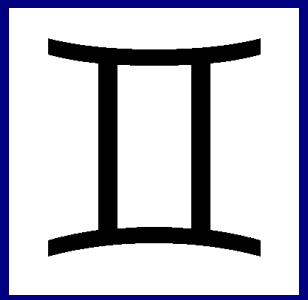
In the I task, subjects saw a ready signal, a video of one of the gestures, which they imitated, then the associated abstract stimulus, which they ignored, again repeated every 12 seconds.

Stimuli



Abstract Conditional

Ready → Stimulus signals correct gesture → (Performance by subject) → Ignored video → Ready →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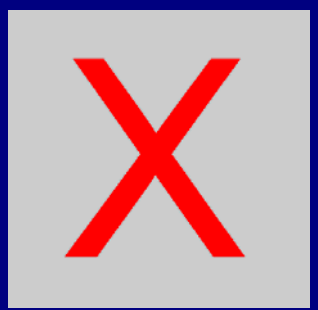
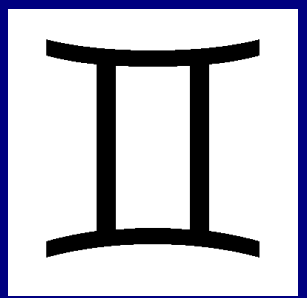
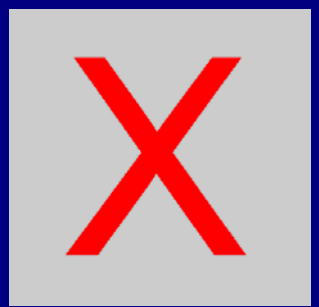
Imitation

Ready → Video to imitate → (Performance by subject) → Ignored Stimulus → Ready →



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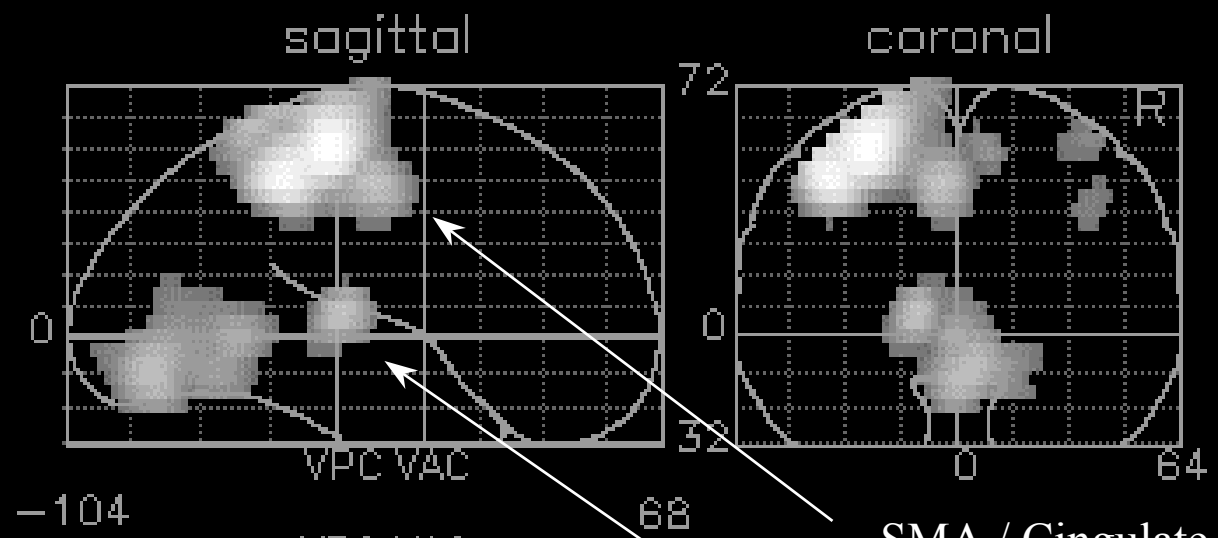
Subjects and Methods

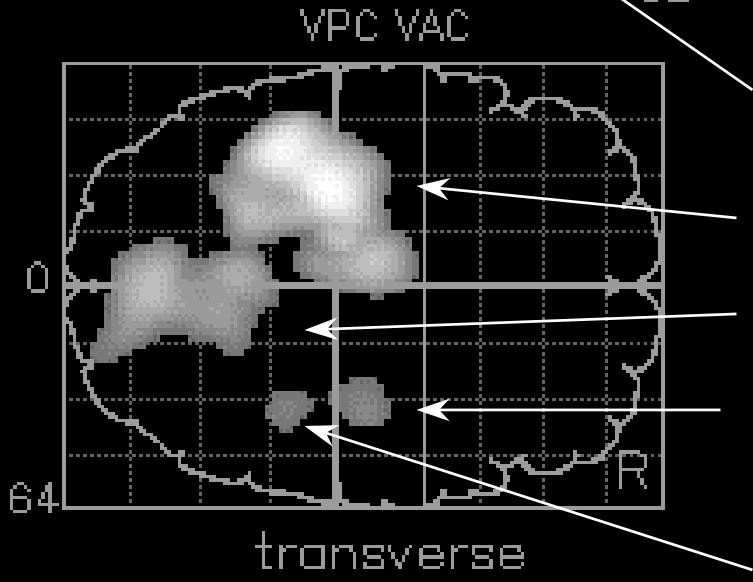
- 9 normal right handed volunteers
  - aged 37-57 (4 male, 5 female).
- Study protocol
  - 90 minutes training before scanning (45 minutes per task)
  - Scans were 5 I, 5 AC, 2 rest, random order
    - Rest was same visual input, but without performance.
  - bolus injection of O^{15} H_20 in a CTI 953B PET scanner
- Analysis
  - Scans realigned with SPM96, normalised to the Talairach template with SPM95, smoothed to 16mm. Statistical analysis used standard (default) settings in SPM96.
  - All SPMs thresholded to $p<0.001$ uncorrected

Results - Overview

- All subjects learned stimulus/gesture association
  - No errors during scanning
- Activation of SMA but not LPMC during AC and I compared to rest
  - No differences in LPMC at any threshold
- Very little difference between AC and I
  - No area surviving correction for multiple comparisons
- Lack of LPMC activation compared to rest was unlikely to be due to LPMC activation during rest scans
  - Comparison of rest scans in this study with those of another study with eyes closed found trend for SMA activation in this study, but not for premotor cortex

Results: Imitation vs Rest





SMA / Cingulate 24

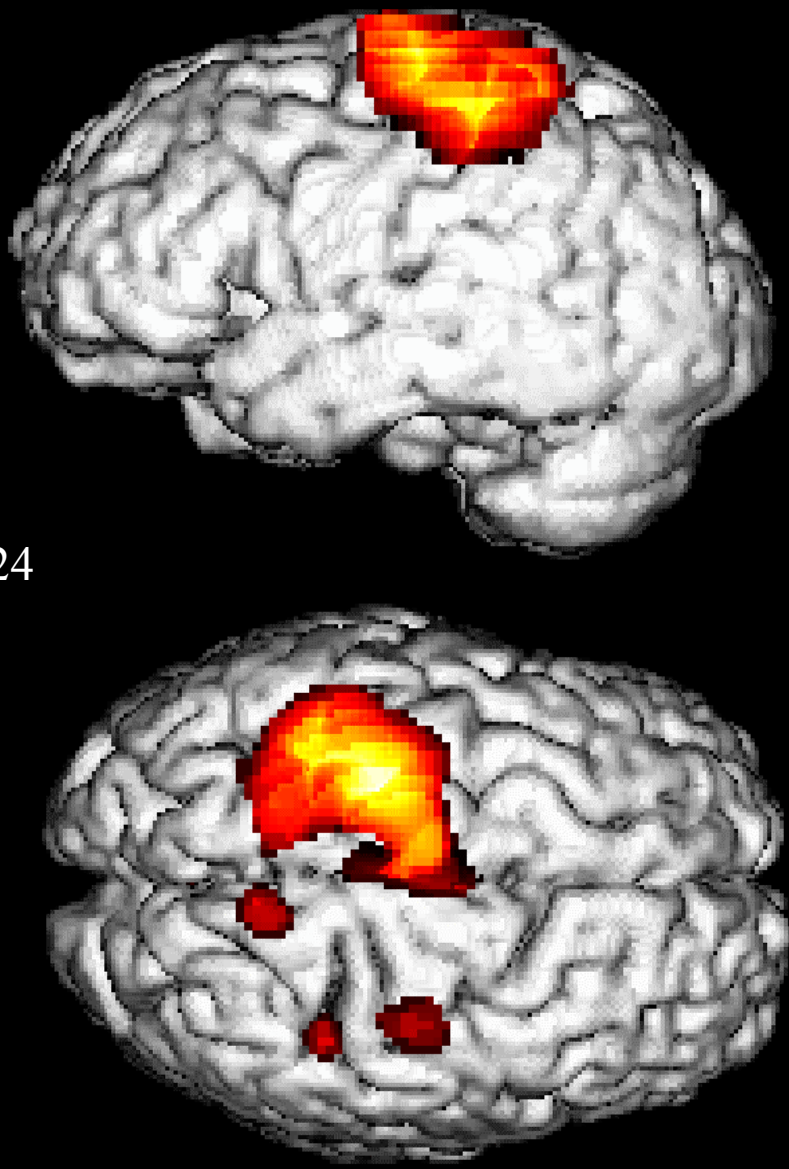
L Thalamus

L M1, S1, 5, 40, (7)

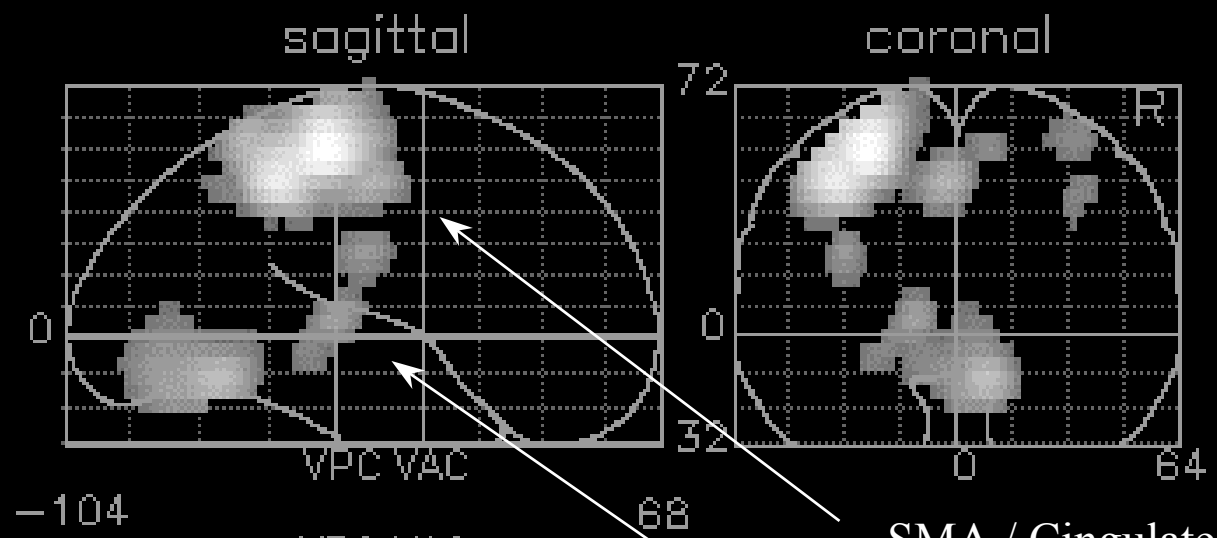
Visual 18

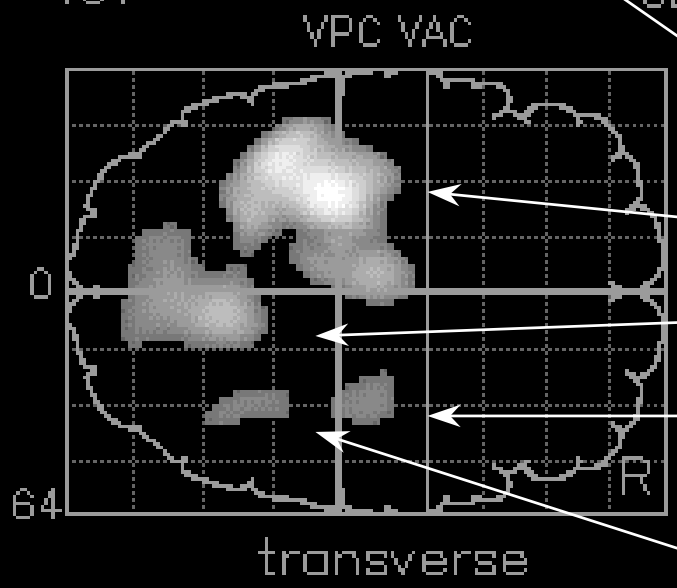
R M1

R S1 / 40



Results: Conditional vs Rest





SMA / Cingulate 24

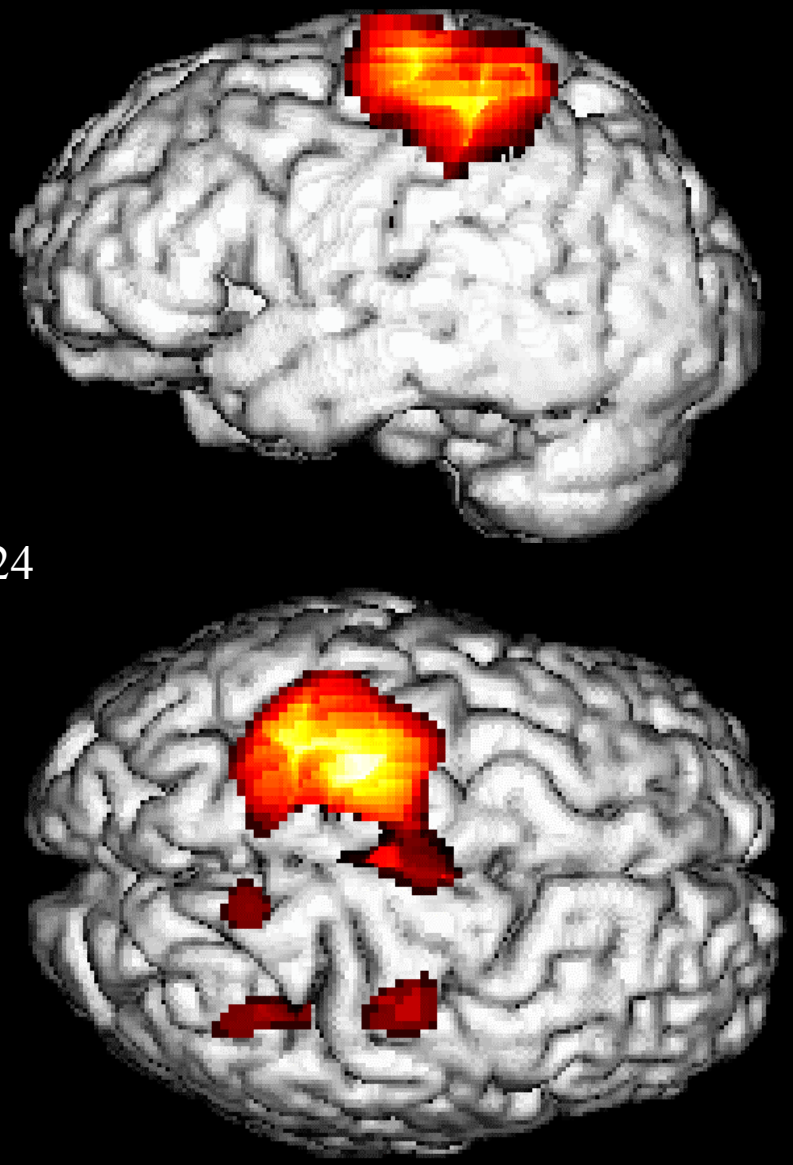
L Thalamus

L M1, S1, 5, 40, (7)

Visual 18

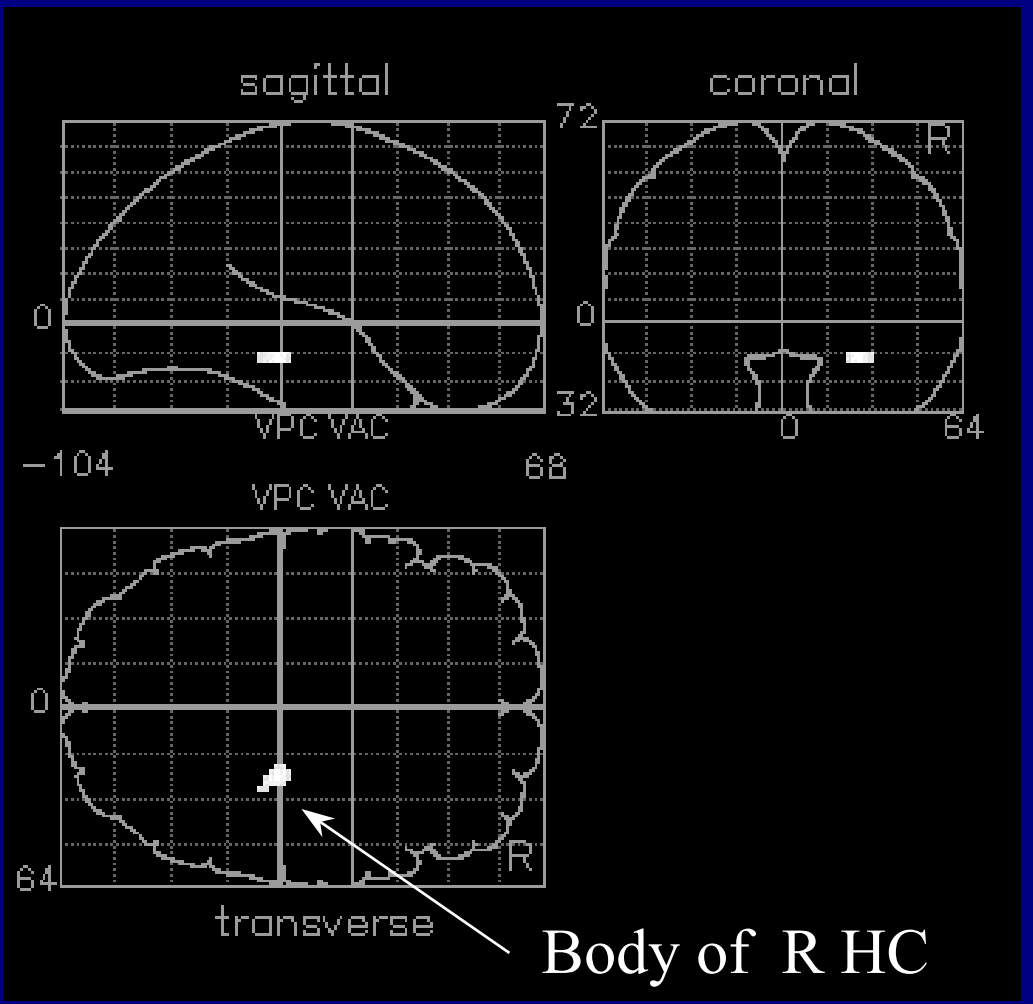
R M1

R 40 / ?7

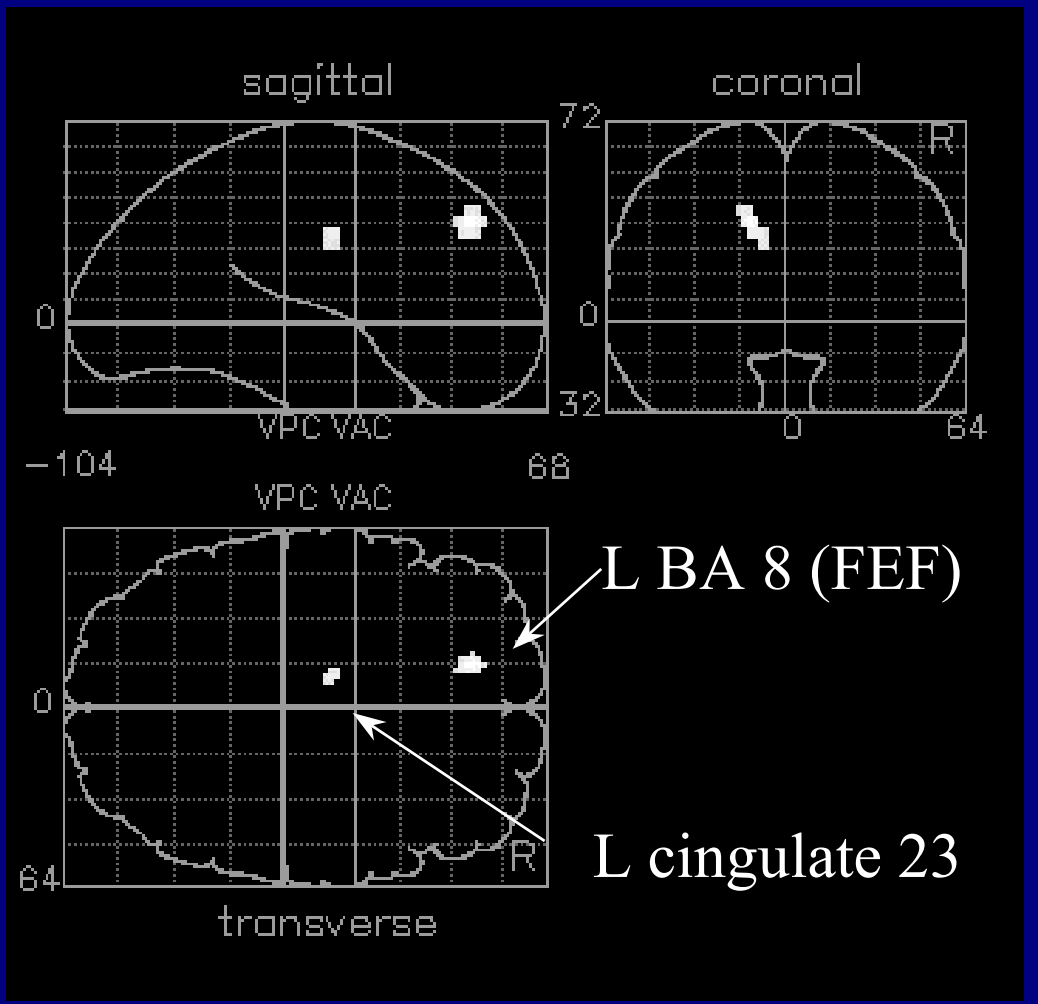


Results: Conditional vs Imitation

AC minus I



I minus AC



Conclusions

- No support for hypothesis that LPMC is involved in abstract conditional action selection
- No activation of LPMC by performance of complex hand gestures in either task
- Marked activation of thalamus, SMA / cingulate in both tasks
- LPMC may be involved in selection tasks early in learning, but not when task is well learnt, regardless of the mode of action selection

References

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2) Passingham, R. E. (1986) **Cues for movement in monkeys (Macaca mulatta) with lesions in premotor cortex**, *Behav Neurosci* 100, 695-703

3) Halsband, U. and Freund, H. J. (1990) **Premotor cortex and conditional motor learning in man**, *Brain* 113, 207-22

4) De Renzi, E., Faglioni, P. and Sorgato, P. (1982) **Modality-specific and supramodal mechanisms of apraxia**, *Brain* 105, 301-312