

The Neural Substrates Underlying Word Generation:

A bilingual functional-imaging study

Denise Klein et al. (1995) –Psychology(92)

Big Question:

- (1) Whether there is a common cortical substrate within which all languages operate
- (2) Whether multiple languages may be represented by different, yet overlapping, cerebral regions within the language-dominant hemisphere
- (3) Whether cerebral representation of a second language differs fundamentally from that of the first

Preliminary Study: Similar brain regions supported word repetition in L1 and L2 except for vicinity of the left putamen.

Question: linguistic representation in the brain by investigating areas activated by higher-level cognitive tasks than word repetition.

Subjects: 12 native speakers of English who are proficient in French. All acquired French after age of 5.

Method: PET – a technique used for visualizing the local changes in cerebral blood flow (CBF) and metabolism

Tasks:

English: repeat cues

Find synonym of cue

Find rhyme of cue

Translate cue into French

French: repeat cue

Find synonym of cue

Translate cue into French

Results:

PET Results

1) In all condition, regardless L1 or L2,

- ✓ Left inferior frontal cortex
 - ✓ Left posterior dorsolateral cortex
 - ✓ Left inferotemporal cortex
 - ✓ Left parietal cortex
- were activated

What this suggests?

Left inferior frontal cortex (and dorsolateral prefrontal cortex, areas 46 and 9) are not activated by semantic processing alone.

How to interpret this?

Left inferior frontal cortex: related to lexical search and access

Dorsolateral prefrontal cortex: working memory

Why no activation of superior temporal cortex?

This is due to the fact that the semantic system in superior temporal regions both in the repetition task and in the generation tasks

But there was activation of left inferotemporal cortex during the tasks requiring word generation → **But why does this matter?**

Reciprocal Relationship between left prefrontal cortex and both Sylvian-insular cortices

Left prefrontal cortex: active when generating

Both Sylvian-insular cortices: active when repeating heard words but inactive when generating

Conclusion:

- ✓ L1 processing appears to hold for L2 processing as well irrespective of success in word generation or latency to respond.
- ✓ The activation in the putamen when subjects perform L1-L2 translation but not the inverse.
→ Contribution of the left basal ganglia in articulation in the precise timing of motor

District Cortical Areas Associated with Native and Second Languages

Karl H.S. Kim et al. Nature v. 388, 1997

Question: How multiple languages are represented in a human brain (and possibly, how much age matters in the representation of languages.)

Method: fMRI

Finding: Differential representation in Broca's area among early and late bilinguals but no difference in representation in Wernicke's area among the subjects.

Subjects: 6 subjects who are early bilinguals. (exposed to two lgs during the infancy.)

6 subjects who are late bilinguals (exposed to a 2nd lg in early adulthood: 11.2 yr)

Tasks: Subjects were instructed to use silent, internal speech to describe events that occurred during a specified period of the previous day. (morning, afternoon, or night)

Results:

Broca's area (area 44, 46):

- ✓ Late bilinguals: 2nd languages are spatially separated from native languages.
- ✓ Early bilinguals: Overlapping areas of activation.

Wernicke's area (area 22):

No representational differences in L1 and L2 between the early and late bilinguals.

What does this suggest?

Anatomical separation of centers of languages in Broca's area varies with time of acquisition →

Age of acquisition is a significant factor in organization of Broca's area.

Anatomical Variability in the Cortical Representation of First and Second Language

Dehaene et al. NeuroReport 8, 1997

Question: Are different brain areas recruited for learning and processing L1 and L2?

Specific question: Assessing inter-subject variability in the cortical representation of language comprehension processes in L1 and L2.

Subjects: 8 right-handed male French speakers aged bet. 21 and 25. Initial exposure to English was 7.

Task: Listening to 6 fragments of stories: 3 in French and 3 in English.

Control: Japanese speech played backward.

Method: whole-brain 3-Tesla echo-planar fMRI

Results:

Listening to L1 showed considerable consistency in the activated areas. → Left superior temporal sulcus (STS), superior and middle temporal gyri, temporal pole and left angular gyrus.

Listening to L2 showed greater inter-subject variability. → Some subjects showed only right-hemispheric activations in L2 in temporal areas and other subjects showed activity in the left superior temporal sulcus in L2 but with greater activity in L1 with occasional differences in exact topography.

Less left temporal activity shown in L2

: A significant interaction between hemisphere and language was found.

Average active volume in the	left STS and	right STS
L1 Listening:	1378 mm ³	456 mm ³
L2 Listening:	666 mm ³	327 mm ³

Compact organization of L1 → Seven subjects showed discrete foci of activation in the left or right

Discussion

- ✓ Reliably activated temporal network for L1 comprehension was not consistently activated in L2 comprehension.
- ✓ Comparison with Kim et al (1997)
 - Kim et al (1997) found a “similar” distinction between subregions for L1 and L2 within the same general anatomical area. However, frontal or temporal regions?
- ✓ Implication on lateralization in the second language acquisition research
 - Lateralization of activity to the left temporal lobe is reduced in L2
 - Individual subjects show greater variability for lateralization of L2 than of L1.