

Ojemann, G. (1991). 'Cortical Organization of Language'. The Journal of Neuroscience, 11 (8), pp. 2281-2287.

The model that Ojemann proposes:

- left-lateralized, localized frontal and temporoparietal areas
(i.e. the classical model)
BUT with substantial individual variance within those classical areas
- neurons widely dispersed in cortex
- parallel activation of entire system
- based largely on his own intraoperative electrical stimulation data
(which is the focus of this summary)

"COMPARTMENTALIZATION IN SEPARATE SYSTEMS"

Dissociations evidenced in electrical stimulation of cortical sites:

- (both frontally and temporoparietally)
- between the languages of multilinguals (object naming)
- between object naming and reading in 77% of 111 sites tested
in 55 monolinguals
- among object naming, sentence reading, verbal working memory, orofacial movement mimicry, and phoneme identification in 57% of 91 sites tested
in 14 monolinguals

Dissociations evidenced in microelectrode recording:

- (from areas where electrical stimulation has no effect)
- between languages (object naming) in six "neuronal populations" recorded
from left temporal cortex in four bilingual subjects
- among object naming, reading, and verbal working memory in 67% of the
"neuronal populations" recorded from in left anterior temporal lobe

Speech production sites found both frontally and temporoparietally:

- essential sites for naming and reading adjacent to speech productions sites
- essential sites for verbal working memory adjacent to sites for naming and reading

Characteristics of essential sites for naming (studied in most detail):

- localized to small cortical surface areas of 1-2 square centimeters
- in 2/3 of 117 subjects tested, two or more such areas separated by non-language cortex; in 24% of 117 subjects, three or more
- usually one area in inferior frontal gyrus (= Broca's area) and one or more in temporoparietal cortex (= Wernicke's area)
- usually have sharp boundaries
- total surface area of naming sites only 2.5 square cm or less in 50% of 117 subjects, and exceeding 6 square cm in only 16% of 117 subjects [Penfield and Roberts' (1959) finding of 8+ square cm per subject likely due to pooling data from subjects with essential sites in different locations]
- preferentially localized in crown of gyri, rarely buried entirely in sulci

Conclusions:

"...the system for a particular language includes both essential areas and widely dispersed neurons, dispersed even to the nondominant hemisphere." (p. 2282, righthand column, first paragraph)

- human association cortex has a modular organization, evidenced by at least partly separate systems for:
 - naming in general
 - naming different categories of objects in particular
 - reading in general
 - "the syntactic aspect of language"
 - and different languages

[the evidence for separate systems for
speech production and perception is less clear;
see p. 2282, bottom half of righthand column]

"VARIANCE"

There is variance in gross anatomy across individual brains
(e.g. posterior portion of Sylvian fissure)

As for lateralization, WADA (sodium amobarbital) tests indicate that:

91% of the population has language lateralized to the LEFT hemisphere
5% of the population has BILATERAL representation of language
4% of the population has language lateralized to the RIGHT hemisphere
Excluding subjects who are left-handed because of left-hemisphere damage,
there is NO correlation between handedness and language lateralization

Also much individual variation in the location of essential language areas:

- NO frontal sites for naming in 15% of 90 subjects:
ONLY frontal sites in 17% of 90 subjects
- essential sites for naming show surprisingly little overlap across subjects
frontally, there is substantial overlap only in Broca's area (79% of 82)
and in motor and premotor regions
elsewhere, and particularly in temporoparietal areas, there is never
overlap in more than 1/3 of subjects tested

➡ This suggests that Broca's and Wernicke's areas are not large, uniform areas of language representation across individuals, but merely provide the boundaries within which essential sites (for naming and reading) are likely to be found

Correlations with gender and verbal IQ:

- women more likely to have only frontal naming sites
among low verbal IQ subjects, women less likely to have parietal sites
than men (presumably for naming again?)
less posterior language representation in women also in lesion studies
- High verbal IQ: naming in middle temporal gyrus, reading in superior
Low verbal IQ: reading in middle temporal gyrus, naming in superior

No correlation with age or development:

children 4-10 show about the same amount of individual variation as adults