Language area

Localization

The cortical localization of language varies in different individuals, particularly in patients with intracranial lesions where the atypical distribution of the language cortex is particularly common [1].

The ability to locate the language cortex is the key towards surgery in the dominant hemisphere, particularly surgery of lesions close to the language area. How best to perform resection of lesions in the language area of the brain without inducing a postoperative language disorder, thus protecting the patient's quality of life, has become an issue of particular concern in neurosurgery currently [2] [3] [4] [5].

The localization of cortical sites essential for language was assessed by stimulation mapping in the left, dominant hemispheres of 117 patients. Sites were related to language when stimulation at a current below the threshold for afterdischarge evoked repeated statistically significant errors in object naming. The language center was highly localized in many patients to form several mosaics of 1 to 2 sq cm, usually, one in the frontal lobe and one or more in the temporoparietal lobe. The area of individual mosaics and the total area related to language were usually much smaller than the traditional Broca-Wernicke areas. There was substantial individual variability in the exact location of language function, some of which correlated with the patient's sex and verbal intelligence. These features were present for patients as young as 4 years and as old as 80 years, and for those with lesions acquired in early life or adulthood. These findings indicate a need for revision of the classical model of language localization. The combination of discrete localization in individual patients but substantial individual variability between patients also has major clinical implications for cortical resections of the dominant hemisphere, for it means that language cannot be reliably localized on anatomic criteria alone. A maximal resection with minimal risk of postoperative aphasia requires individual localization of language with a technique like stimulation mapping [6].

The term language area or language centre (or more accurately centers, e.g. Broca's area and Wernicke's area) refers to the areas of the brain which serve a particular function for speech processing and production.

see also Frontal language area.

New medical imaging techniques such as PET and fMRI have allowed researchers to generate pictures showing which areas of a living brain are active at a given time. In the past, research was primarily based on observations of loss of ability resulting from damage to the cerebral cortex. Indeed, medical imaging has represented a radical step forward for research on speech processing. Since then, a whole series of relatively large areas of the brain have been found to be involved in speech processing. In more recent research, subcortical regions (those lying below the cerebral cortex such as the putamen and the caudate nucleus) as well as the pre-motor areas (BA 6) have received increased attention. It is now generally assumed that the following structures of the cerebral cortex near the primary and secondary auditory cortices play a fundamental role in speech processing:

Superior temporal gyrus (STG): morphosyntactic processing (anterior section), integration of syntactic and semantic information (posterior section)

Inferior frontal gyrus (IFG, Brodmann area (BA) 45/47): syntactic processing, working memory

Inferior frontal gyrus (IFG, BA 44): syntactic processing, working memory

Middle temporal gyrus (MTG): lexical semantic processing

The left hemisphere is usually dominant in right-handed people, although bilateral activations are not uncommon in the area of syntactic processing. It is now accepted that the right hemisphere plays an important role in the processing of suprasegmental acoustic features like prosody.

Most areas of speech processing develop in the second year of life in the dominant half (hemisphere) of the brain, which often (though not necessarily) corresponds to the opposite of the dominant hand. 98% of right-handed people are left-hemisphere dominant, and the majority of left-handed people as well.

The differentiation of speech production into only two large sections of the brain (i.e. Broca's and Wernicke's areas), accepted long before the advent of medical imaging techniques, is now considered outdated. Broca's Area was first suggested to play a role in speech function by the French neurologist and anthropologist Paul Broca in 1861. The basis for this discovery was analysis of speech problems resulting from injuries to this region of the brain, located in the inferior frontal gyrus. Lesions to Broca's Area resulted primarily in disruptions to speech production. Damage to Wernicke's Area, which is located in the lower part of the temporal lobe, lead mainly to disruptions in speech reception. This area was named for German doctor Carl Wernicke, who discovered it in 1874 in the course of his research into aphasias (loss of ability to speak).

Broca's Area is today still considered an important language center, playing a central role in processing syntax, grammar, and sentence structure.

In summary, these early research efforts demonstrated that semantic and structural speech production takes place in different areas of the brain

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Much of the language function is processed in several association areas, and there are two well-identified areas that are considered vital for human communication:

Wernicke's area and Broca's area. These areas are usually located in the dominant hemisphere (the left hemisphere in 97% of people) and are considered the most important areas for language processing. This is why language is considered a localized and lateralized function.

However, the less-dominant hemisphere also participates in this cognitive function, and there is ongoing debate on the level of participation of the less-dominant areas.

Other factors are believed to be relevant to language processing and verbal fluency, such as cortical thickness, participation of prefrontal areas of the cortex, and communication between right and left hemispheres.

see Broca's area

Resection of gliomas in the dominant and in the non-dominant hemisphere induces postsurgical shifts and increase in language activation, indicating that infiltrating gliomas have a widespread influence on the language network. The dominant hemisphere gained most of the language activation irrespective of tumor localization, possibly reflecting recovery of pre-surgical tumor-induced suppression of these activations [7].

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