

Challenges in the investigation of cerebral function: Neuroanatomical substrates of language processing*

1. Introduction

2. Why it is difficult to investigate the brain

- 2.1. Sheer numbers
- 2.2. Difficulty of correlating anatomy with function
- 2.3. Pathways are complex, parallel and hierarchical
- 2.4. Variation, major and minor
- 2.5. Plasticity

3. Methods for investigating the brain

- 3.1. Investigation of the brain in pathological conditions
 - 3.1.1. Organic pathologies
 - 3.1.2. Traumatic lesions
 - 3.1.3. Surgical ablation
 - 3.1.4. Stimulation mapping (electrical)
 - 3.1.5. Electroencephalograms and microelectrode recordings
 - 3.1.6. Optical intrinsic signal imaging
- 3.2. Investigation of the brain under non-pathological conditions
 - 3.2.1. Selective anesthetization
 - 3.2.2. Transcranial magnetic stimulation
 - 3.2.3. Imaging
 - 3.2.3.1. Electroencephalography
 - 3.2.3.2. Magnetoencephalography
 - 3.2.3.3. X-rays
 - 3.2.3.4. Computerized tomography, computerized axial tomography
 - 3.2.3.5. Magnetic resonance imaging, nuclear magnetic resonance
 - 3.2.3.6. Positron emission tomography
 - 3.2.3.7. Single-photon emission computerized tomography
 - 3.2.3.8. Functional magnetic resonance imaging
 - 3.2.3.9. Summary of imaging techniques

4. Anatomy

- 4.1. Difficulties in investigating language-related neuroanatomy
 - 4.1.1. Difficulties in localization
 - 4.1.2. Difficulties due to parallel processing
 - 4.1.3. Difficulties due to variation within and across individuals
 - 4.1.4. Difficulties due to multifunctionality of a given cortical area
- 4.2. Language areas in the "dominant" (usually the left) hemisphere
 - 4.2.1. Broca's area
 - 4.2.2. Wernicke's area
 - 4.2.3. Arcuate fasciculus
 - 4.2.4. Angular gyrus
 - 4.2.5. Exner's area
- 4.3. Language areas in the "non-dominant" (usually the right) hemisphere

5. Aphasias and related disorders

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- 5.1. Disorders which are classified primarily according to lesions
 - 5.1.1. Disorders resulting from lesions to the cerebral cortex
 - 5.1.1.1. Broca's aphasia
 - 5.1.1.2. Wernicke's aphasia
 - 5.1.1.3. Conduction aphasia
 - 5.1.1.4. Transcortical motor aphasia
 - 5.1.1.5. Transcortical sensory aphasia
 - 5.1.1.6. Global aphasia
 - 5.1.1.7. Amusia and aprosodia
 - 5.1.2. Disorders resulting from lesions outside the cerebral cortex
 - 5.1.2.1. Subcortical aphasia
 - 5.1.2.2. Scanning speech
 - 5.1.2.3. Dysarthria
 - 5.1.2.4. Aphemia
 - 5.1.2.5. Deafness
- 5.2. Disorders which are classified primarily according to signs and symptoms
 - 5.2.1. Dysgrammatisms
 - 5.2.1.1. Agrammatism
 - 5.2.1.2. Paragrammatism
 - 5.2.2. Anomias and other category-specific disorders
 - 5.2.2.1. Category-specific disorders
 - 5.2.2.2. Anomia
 - 5.2.2.3. Modality-specific anomias
 - 5.2.3. Disorders specific to a given input or output modality
 - 5.2.3.1. Agraphia, dysgraphia, paraphasia
 - 5.2.3.2. Alexia, paralexia
 - 5.2.3.3. Aphasias of Braille reading
 - 5.2.3.4. Aphasias of sign language
 - 5.2.4. Dyslexias
 - 5.2.5. Agnosias
 - 5.2.6. Miscellaneous disorders and signs
 - 5.2.6.1. Mutism
 - 5.2.6.2. Palilalia
 - 5.2.6.3. Paraphasia
 - 5.2.6.4. Phonetic disintegration syndrome
 - 5.2.6.5. Stuttering
 - 5.2.6.6. Telegraphic speech and writing

6. Reasons for accepting or rejecting argumentation

7. Relevance to linguistic theory

8. Conclusions

§1. Introduction

When I first heard of Broca's and Wernicke's areas in a linguistics course, I wondered why more specific information was not presented. "What's holding up the show?" I thought. "Why can't they just stick some electrodes in there so we can see what's *really* going on when the brain processes language?" It turns out that there are a variety of ways of investigating the brain (including "sticking some electrodes in there"), each with its own advantages and limitations. Even though some of these procedures are very advanced, there are various characteristics of the brain itself which pose considerable obstacles to its study.