Reorganization Components of Brain Functions for Optimization the Extent of Resection Near and Within Eloquent Cortex

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Introduction

Optimization the extent of surgical interventions near and within eloquent cortex is associated with the coordination of various factors such as achieving total resection and minimization neurological deficit.

Brain can compensate its functions after traumatic, ischemic injuries and during tumor progression.

Multistage surgical approach, high-frequency cortical subdural stimulation in Broca's area, reorganization of proper names representation prior to anterior temporal lobe surgery have demonstrated the ability to reorganize neuronal networks outside of place of resection, thereby optimizing extent of resection in eloquent cortex.

Variability in language localization and multiple cortical representations of movements make difficult plastic relocation for the whole brain function without its decomposition into components. This mosaic patterns also present a significant impediment to the integrated use of given methods of induction of brain plasticity for optimization resections in eloquent areas. Present study focuses on decomposition brain functions onto components of theirs the system-semiotic model.

Methods

Typology of diagnostic tasks for identification components of the system-semiotic model of brain function was performed using principles of parametric general systems theory.

Our approach is aimed to redistribute the networks supporting components of brain function to networks remote ipsilesional and contralateral hemisphere. This involves decomposition of cerebral functions onto system descriptors: "concept", "structure" and "substrate" that define certain sequence for relocation brain function's components. These components allow constructing integral system-semiotic models of cerebral functions of different modalities for development of visual, auditory and linguistic diagnostic tasks and compensatory trainings to recruitment alternative neuronal networks that could compensate functions of injured brain areas.

Table 1. Typology of diagnostic tasks for identification components of the system-semiotic model of brain function

Modalities of tasks	**Components** of model of brain function								
	Semiotic levels of system parameters			Categorical invariants			System descriptors		
	Syntax	Semantics	Pragmatics	Thing	Attribute	Relation	Concept	Structure	Substratum
	Typology of diagnostic tasks								
Linguistic modality	Syntactic component of paradoxes ("liar paradox")	Semantic component of classic sophisms	Pragmatic component in "pat-situations"	Proverbs about things	Proverbs about attributes	Proverbs about relations	Definition of the concept for object or process (recognition of similarities)	Identification of the structure for object or process (words, sentences recognition)	Definition of the substratum for object or process (Nonverbal objects recognition / communication)
Visual modality	Optic illusions; self-sufficiency of colors and shapes	Binary semantics of Čiurlionis paintings; Eco's paradoxes	Hyperrealism paintings; Reborn dolls	Optic illusions	Escher's illusions, constructions	Autostereogram	Famous, important faces recognition	Asymmetry of identification and distinguishing of faces	Comprehension of nonverbal facial cues
Auditory modality	Musical rhythm	Correlation between sound and meaning of the words	Assessment of a musical composition	Modulation of laughter (V.Khlebnikov's «Invocation of laughter»)	Identification of the attributes of an object or process in a musical composition ("Flight of the Bumblebee")	Identification of the relations in processes (Sufi whirling) and objects (Gaudí buildings)	Definition of meaning, purpose for musical composition	Phonemes recognition	Nonverbal auditory communication

Intersection of task's modalities and brain function's components provides typology of diagnostic tasks

Results

- Relocation of brain function's components makes the networks of affected eloquent areas less critical to surgical manipulations in cases of positive awake mapping.
- Integrated system-semiotic model of brain function specifies: plan of preoperative training for reorganization of alternative neuronal networks, extent of resection and stages of upcoming surgery.
- This approach might contribute to more effective removal of tumors, epileptogenic foci or arterio-venous malformations affecting the eloquent cortex.
- Brain functions reorganization could optimize the surgical accesses through eloquent areas to other brain structures if such accesses are most appropriate.

Conclusions

Reorganization components of brain functions optimizes the extent of resection in eloquent cortex, improves postsurgical functional outcomes, promotes preservation quality of life.

Learning Objectives

By the conclusion of this session, participants should be able to:

1) Describe the importance of optimization extent of resection near and within eloquent cortex for median survival, postsurgical functional outcomes and health related quality of life;

2) Discuss, in small groups the ways of combining different methods of reorganization neuronal networks of eloquent cortex away from place of surgery for achieving total resection and minimization neurological deficit;

3) Identify an effective treatment of tumors, epilepsy, arteriovenous malformations localized near and within eloquent areas in the cases of positive brain mapping and intraoperative neurological dysfunction.

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