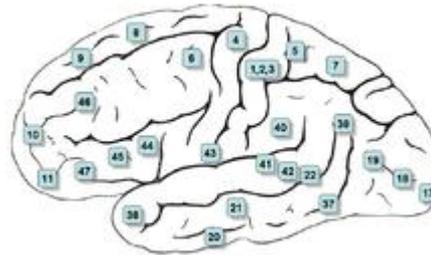


Chapters 2 & 3

Theories about Brain and Language



Previous Chapter

- Neurolinguistics
- **Main theories**
 - ▣ **Localism, Associationism, Dynamic localization**
 - ▣ **Holism**
 - ▣ **Evolution-based theories**
- Perspectives/Approaches
 - ▣ Developmental
 - ▣ Cross-linguistic
 - ▣ Pathological/Rehabilitative
 - ▣ Neuroimaging (tools)
 - ▣ Engineering/Computer modelling

Linguistic theories

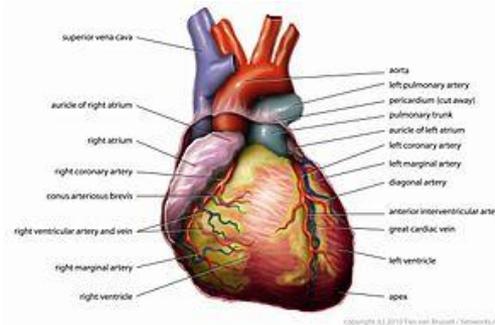
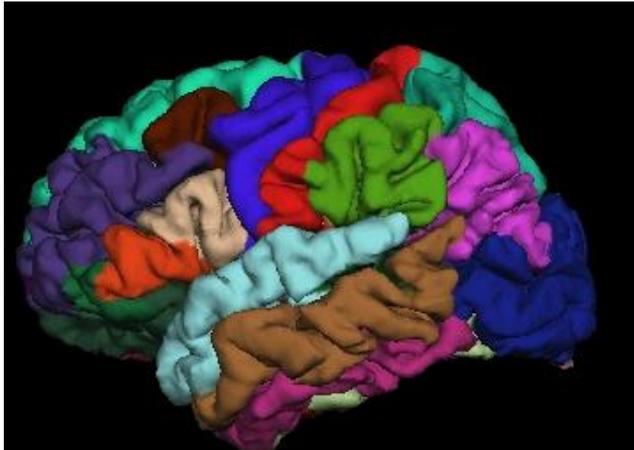
- Jakobson
- Chomsky
- ...

□ [Intro to linguistics](http://www.distance.mun.ca/media/files/linguistics/ling_hi.html)

http://www.distance.mun.ca/media/files/linguistics/ling_hi.html

Views on human nature and the brain

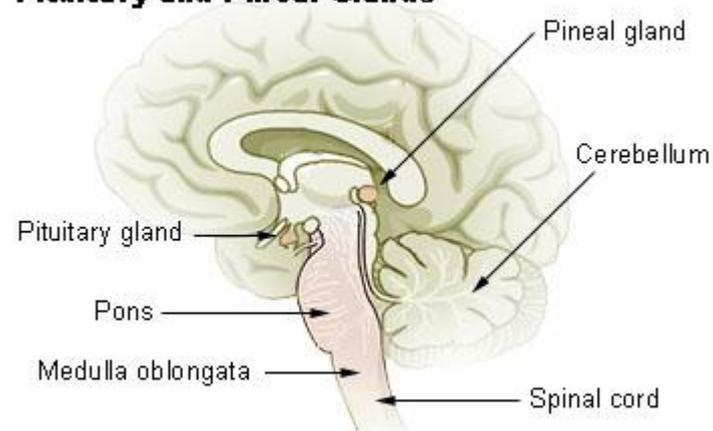
- Plato (424-348 BC): Parts of soul in different parts of **brain** - center of all senses
- Aristotle (384 – 322 BC): Soul in **heart**; brain is the “cooler.”
- Galen (129-217 AD): **ventricles** in the brain contain “instruments of the soul”



Views on Human Nature and the Brain

- Descartes (1596-1650): pineal gland is the seat of soul

Pituitary and Pineal Glands



Functional localization

- Gall (1758 – 1828): craniology (phrenology)
- Gall made several assumptions as the basis for his theory:
 - that a number of innate abilities exist
 - that it is impossible to reduce these abilities to a unity and that they are independent of each other
 - that the real nature of the abilities cannot be examined, only their material conditions, which are in the organism
 - that these material conditions must be in the cortex.

Functional localization

- Broca's aphasia (1861)

<http://www.youtube.com/watch?v=f2liMEbMnPM>

- Wernecke's aphasia (1874)

<http://www.youtube.com/watch?v=aVhYN7NTIKU>

Dynamic functional localization

- *Vygotsky emphasized that it is necessary to first investigate what is to be localized, before posing the question where.*
- *Functions must be analyzed with respect to the ontogenetic development.*
- *Vygotsky sees a function as a complex adaptive activity of the whole organism to a task. The activity can be performed in different ways, by the cooperation of several organs. This dynamic cooperation is controlled by neural structures which monitor different organs and are localized in different places.*

Associationism

- Wernicke imagined a specific “language gyrus” from Wernicke’s area (with receptive function) to Broca’s area (with expressive function). Lesions in one of these areas or in the connection between them would cause aphasia.
- Lichtheim found it necessary to postulate a third language center with unspecified localization, the “concept center”, in the model of language function which he theoretically constructed departing from Wernicke’s model.

Evolution-based theory

- J. H. Jackson(1874): two levels of language: *automatic and propositional*.
- The automatic level consists of stereotyped sentences, certain neologisms (= newly made words) and swearing.
- The propositional level is defined partly by its form and partly by its degree of flexibility. Aphasia stands for an inability to “propositionalize”, i.e., to use language in the service of thought, which is why intelligence is necessarily reduced.
- The nervous system functions and develops in a hierarchical way:
 - from simple to more complex
 - from lower centers to higher centers
 - from more organized centers to more complex centers
 - from automatic to intentional

Jackson's warning

- He distinguished three levels of function: *elementary reflexes, automatic actions and intentional actions*. *These levels are not localized to any centers.*
- Localization rather is vertically oriented, from low level (spinal column and brain stem) to intermediate level (motor and sensory) and further to high level (frontal).
- Jackson's warning: "localization of symptoms can never be identified with localization of function"

- From Theory to Practice – Explaining Aphasia
- Example video
- <http://www.youtube.com/watch?v=1apITvEQ6ew>

Aphasia types - Boston

	Fluent speech	Speech comprehension	Repetition	Naming
Wernicke	+	-	-	-
Transcortical sensory	+	-	+	-
Conduction aphasia	+	+	-	-
Transcortical motor	-	+	+	-
Broca	-	+	-	-
Global	-	-	-	-
Anomic	+	+	+	-
Isolated speech area	-	-	+	-

Typical localization of brain damage - Boston aphasia types

Aphasia type	Most typical location of lesion
Wernicke's aphasia:	Wernicke's area
Transcortical sensory aphasia:	Posterior parietal lobe
Conduction aphasia:	Often deep lesion between Wernicke's and Broca's areas, including white fiber bundles (the arcuate fasciculus)
Transcortical motor aphasia:	Area in front of the Rolandic fissure (the supplementary motor area)
Broca's aphasia:	Broca's area
Global aphasia:	Large cortical and subcortical areas around the Sylvian fissure
Anomic aphasia:	Often impossible to localize, traditionally said to be present with lesions affecting the angular gyrus
Isolated speech area:	Like transcortical sensory + transcortical motor aphasia, in so called "watershed areas" (borders between the areas of supply for the different arteries).

Aphasia – Luria’s framework

Speech comprehension

Linguistic process	Brain area	Type of aphasia
<i>I. Comprehension of a word</i>		
1. Isolation of phonemes (acoustic analysis)	secondary auditory zone, LH	acoustic aphasia
2. Identification of meaning (“image”)	tertiary, posterior zone, LH	amnesic aphasia
<i>II. Comprehension of meaning in a phrase as a whole</i>		
1) Keeping elements in memory	secondary, auditory zone + deep medial-temporal zone, LH	acoustic-mnesic aphasia
2) Simultaneous synthesis and logical plans	tertiary, posterior zone, LH	amnesic aphasia
3) Active analysis of the most significant elements	frontal zones	

Aphasia: Luria's framework

Spontaneous speech production

Linguistic process	Brain area	Type of aphasia
1. Intention, plan	frontal lobes	general lack of initiative
2. Inner speech with predicative structure (linear plan)	frontal lobes	dynamic aphasia

More on Luria

- Luria sees the brain as a functionally connected system, where a task can be performed by different mechanisms with the same result. The activity is complex and demands cooperation between several zones. It is thus not possible to localize a language function to a certain area because the function is lost when that area is damaged. On the other hand, different cortical and subcortical areas give specific contributions to every complex system of activity, which is why antilocalism can not be accepted.

Hierarchy of Structures

- Block I, subcortical structures (including the limbic system) and the brain stem (including the reticular formation), has the function of regulating tone (=tension) or degree of awareness.
- Damage to Block I causes a non-specific reduction of cortical tone, which reduces the selectivity in psychological processes.

- Block II, the post-central cortex (including visual, auditory and sensory areas in the parietal, occipital and temporal lobes, receive, analyze and store information. Primary zones are highly modality specific (e.g. the auditory center) and handle perception. Secondary zones handle the analysis within each modality and tertiary zones coordinate the analyses from the different modalities. The tertiary zones are in the border area between cortex of the occipital, temporal and parietal lobes and are seen as specifically human.
- Block II is said to be responsible for the paradigmatic organization of verbal communication, i.e., the organization of phonemic, lexical, morphological, syntactic and semantic units in the linguistic code.



□ Block III, the pre-central cortex (the frontal lobes) programs, regulates and controls mental activity. Primary, modality specific zones are in the motor cortex, secondary zones in the pre-motor cortex and tertiary zones in the prefrontal parts of the frontal lobes. The tertiary zones form intentions and programs and are seen as superordinate to all other parts of the cerebral cortex, monitoring behavior.

- Block III is responsible for syntagmatic organization of verbal communication, i.e., the organization of connected utterances

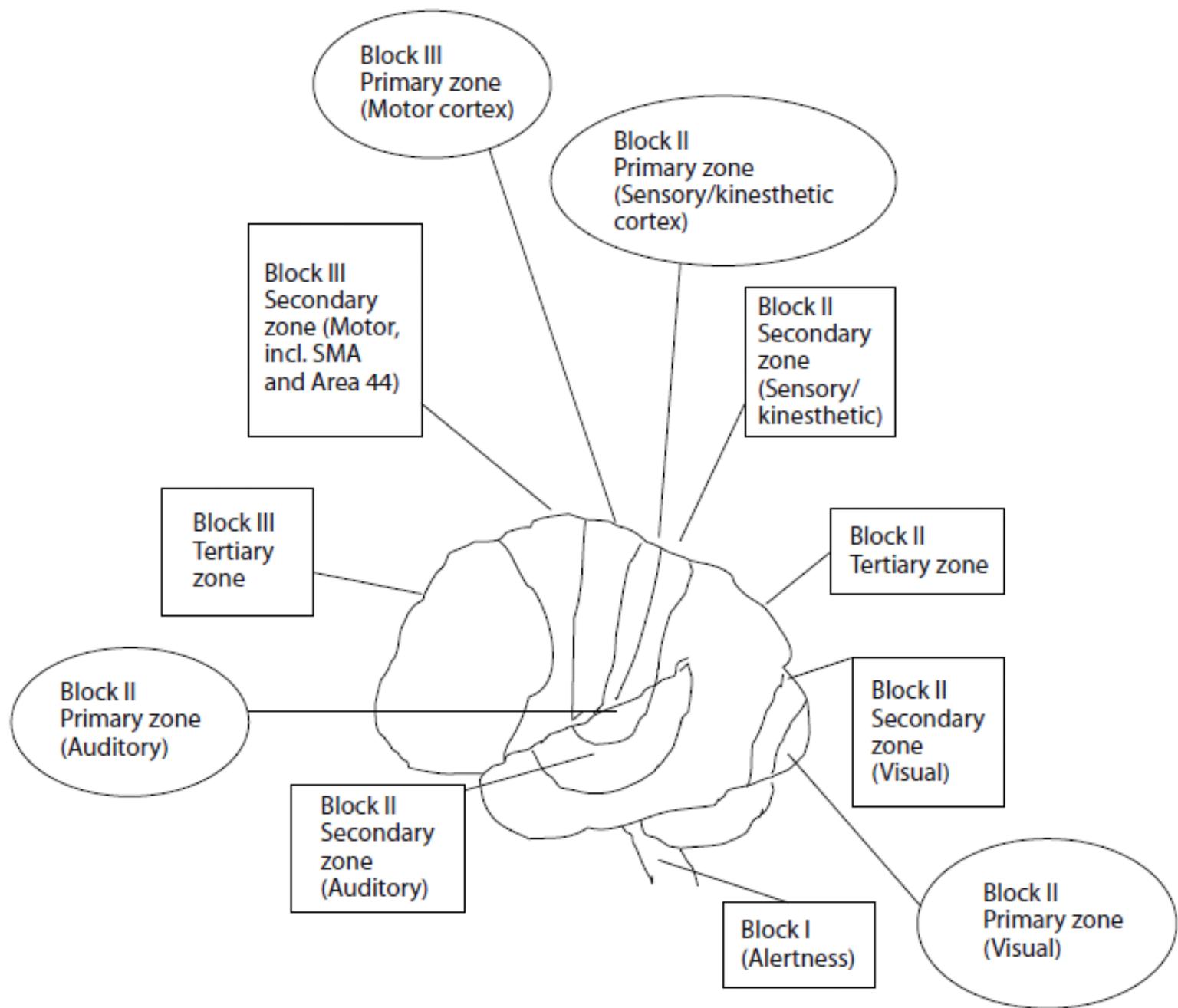


Figure 3.3. Blocks (units) and zones of the brain, according to Luria