XIXth Century: Localization of Functions to Different Parts of the Brain

Studies by Bell and Magendie initiated an extremely important scientific procedure, ______________________________, where a specific part of the nervous system is ________________, and the resulting functional loss is assessed.

- An early champion of this method was the French physiologist Marie-Jean-Pierre Flourens (1823).

- Using ablation of the cerebellum, Flourens experimentally showed the role of this brain area in ___________________________.

An extreme view of localization of function was proposed by the Austrian medical student ________________.
- According to him, the bumps on the surface of the skull reflects the “bumps” on the surface of the brain (known today as ____).  
- These bumps were proposed (1809) to be responsible for personality traits such as generosity, hope, cautiousness, spirituality, secretiveness, and destructiveness (35 traits total).  
- The size of the bumps would determine how much of a specific “trait” an individual would express.

This pseudo-scientific claim was supported by collecting and carefully measuring the skulls of hundreds of people representing an extensive range of personality types.
The “science” of correlating the structure of the head with personality traits was called ___________.

- An example of a _______________ is shown below.

![Phrenology Map](Image)

**Figure 1.10**

A phrenological map. According to Gall and his followers, different behavioral traits could be related to the size of different parts of the skull. (Source: Clarke and O’Malley, 1968, Fig. 118.)

- Phrenology was never taken seriously by the scientific community.

- For instance, ____________________________________________
  _______________________________________________________
  _______________________________________________________

- However, he also erroneously concluded that all regions of the cerebrum participate equally in all cerebral functions = __________
  _______________________________________________________

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In the mid-Nineteenth century, strong experimental support for localization of function came from ablation deficits, this time, those produced by _____________________________.

- As early as 1825, the frontal lobe was suggested to be an important area for _______ (French physician Jean-Baptiste Bouillaud).

- However, it was not before the early 1860’s that this theory received acceptance. In 1861, the French neurologist Paul Broca identified a limited lesion to ________________________________ in a man who had lost the ability to speak prior to death (see below).

![Central sulcus](image)

**Figure 1.12**
The brain that convinced Broca of localization of function in the cerebrum. This is the preserved brain of a patient who had lost the ability to speak before he died in 1861. The lesion that produced this deficit is circled. (Source: Corsi, 1991, Fig. III,4.)

- In 1863, Broca reported 8 additional cases of people who lost the faculty of speech: all these patients demonstrated brain lesions in the same brain area, and they were all on the ____ side of the brain.
- In 1864, Broca made the following additional observations:
  ___________________________________________________________
  ___________________________________________________________

- Broca proposed that: ________________________________
  _________________________________________________________

- Patients with these inferior frontal lobe lesions normally could
  _________________________________________________________

- Shortly after, the German neurologist Karl Wernicke (1874)
  reported that lesions, again in the left hemisphere, but in a region
  distinct from Broca’s area, disrupted ________________.

- This region involved the superior-posterior temporal lobe,
  also known as (AKA) ____________________.

- In this instance, however, the patients could not ____________
  __________, but could generate speech, even if it was ____________.

- These observations reinforced the localization of language ability
  to the left hemisphere.
Broca, Wernicke, and others’ findings led to the hypothesis of “lateralization of function”: _______________________________ 

______________________________________________________

________________________.

- the left hemisphere is the ____________ hemisphere for language functions, and given the results of Broca and Wernicke, different parts of the left hemisphere are important in different language functions.

- Broca’s aphasia, AKA expressive aphasia, was mainly believed to be a deficit of: _________________________________________

__________________.

- Wernicke’s aphasia, AKA receptive aphasia, was mainly believed to be a deficit of: ________________________.

Modern test of lateralization of function in normal people involve 

______________________________________________________

___________________________, which only blocks the function of the injected hemisphere (Wada procedure, 1949, MNI).

- _____ of individuals have language functions predominantly to the left hemisphere.

- note, however, that the contralateral hemisphere always plays some role in the function of the dominant hemisphere, but to a lesser extent (see results of functional imaging on next overhead).
Functional evidence of laterality of function:

- Many individuals displaying language deficits following a stroke sustain ____ hemispheric damage (upon postmortem examination).
- Wada procedure indicated that 90% of people showed speech impairments only upon __________________________.
- Electrical stimulation of the brain on the left side often _________ (Penfield, 1950’s).
- Brain imaging studies (PET, fMRI) performed in humans engaged in some language-related activity typically reveal ___________ ________________ of the left hemisphere.

Anatomical evidence of laterality of function:
- left Sylvian (lateral) fissure ________ than the right one.
- the left planum temporale, part of Wernicke’s area, is ________ in approximately 65% of individuals (Geschwind & Levintsky, 1968).

- brain asymmetry has often been proposed to account for the advantages provided by having areas of the brain that perform similar functions to be located in the same hemisphere.

N.B. left planum temporale larger even in the brains of human fetuses, suggesting preexisting anatomical asymmetries.
Early 20th Century, short move against localization of functions
- influenced mostly by Karl Lashley and his failure to localize
____________________.
- his experimental work from 1915-1950 made use of several types of animals, in which various cortical lesions were made in order to
__________________________.
- in his studies, Lashley varied systematically the size of the lesions, and their locations.
- found that larger cortical destruction led to more errors.
- however, site of lesions made no difference.
- led to concept of __________: ____________________ ____________________
- also led to concept of __________: ____________________ ____________________
- because of these results, Lashley concluded that memory & other cognitive functions were ______ ____________________
- these results are now explained on the basis that animals can learn the task using several different strategies, any one of which would be sufficient to “reduce” memory impairment (i.e., # of errors).
Lashley’s views subsided quickly following the observations of the neurosurgeon _____________ (1950’s), and the unfortunate fame of a treated epileptic patient, _______

- Penfield operated on individuals with untreatable epilepsy.
- used electrical stimulation to test for brain regions critical to speech.
- he mapped out functions associated with stimulation of the pre- and post-central gyrus (__________________________).

Primary motor strip
Primary somatosensory strip

Features of sensorimotor strips:

1. _______________________:
   right hemisphere connected to left side of body and vice versa.
2. Sensorimotor strip surrounds the _____________, with 1y motor area located mostly in precentral gyrus, and the 1y somatosensory area located mostly in the postcentral gyrus, but with some overlap.
3. Sensorimotor strips have a systematic “map-like”, _____________ connection with the body.
4. The “map-like” layout of the sensorimotor strip is distorted due to ___________________ (e.g. hands, mouth, lips). This distorted layout is graphically represented by a _____________ (little man).
5. Electrical stimulation of 1y motor cortex results in _____________ _____________, never complex skilled movements.
6. Electrical stimulation of 1y somatosensory cortex results in simple sensations, such as _______________________; does not lead to sensation of pain or temperature, or textural sensation (something soft or sharp).
Penfield studies in humans thus strongly suggested a high degree of localization for ________________ functions.

- he also observed a relatively high degree of lateralization of speech production in that, more often than not, speech could be disrupted by left, but not right, hemisphere stimulation around __________ ______________.

The results of one of Penfield’s patient, H.M., revealed the localization of critical memory functions to ________________ ________________.

- H.M. underwent __________________________________ to treat his severe case of epilepsy.
- although the intervention nearly completely cured his seizures, he was left without the ability to learn any new ________________ ________________.
- provided strong evidence for localization of memory functions to structures of medial temporal lobe, including hippocampus, amygdala, and surrounding neocortex.