Some General Effects of Brain Damage

FRONTAL LOBE

If you would have been using it you wouldn't be about to lose it
Frontal Lobe Lesions

- exact character depends on location of lesion
- posterior lesions (in the motor areas) result in movement disorders
- anterior lesions (in the prefrontal cortex) result in much more complex changes
The frontal lobes probably have the most diverse functions of any of the lobes in the brain (rivaled maybe by the temporal lobes), so the exact character of the abnormalities that result from frontal lobe lesions depend upon the location of the lesion.

Posterior areas of the frontal lobe are mostly motor in function. The primary motor cortex, which is the primary origin of the pyramidal tracts, is on the precentral gyrus just anterior to the central fissure. Just anterior to the primary motor cortex is the secondary motor cortex, or motor association cortex, sometimes called the premotor cortex, which is involved in motor programming (putting simple movement together into more complex movements to make them do something useful).

Anterior to the secondary motor cortex is the prefrontal cortex. Lesions or disease here result in more complex disorders, such as changes in personality, social behavior, judgment, decision making, and so on.
Frontal Lobe Lesions

primary motor cortex - precentral gyrus, origin of upper motor neurons

premotor cortex (or motor association cortex) - motor planning or programming (including Broca’s area, the motor speech area in the left hemisphere)

prefrontal cortex, including:

i) dorsolateral prefrontal cortex - will be discussed in more detail when we talk about schizophrenia (involved in working memory, cognitive flexibility, planning, and abstract reasoning)

ii) ventrolateral prefrontal cortex - stopping or inhibiting ongoing motor behavior

iii) orbitofrontal cortex - just over the eyes, function unclear, to be discussed later
Frontal Lobe Lesions

Motor and Premotor Areas

• disturbances of motor functions and movement programming up to and including hemiplegia (upper motor neuron disease)

• disturbances of voluntary gaze (patients don’t “look at the right places” to answer questions, for example)
Frontal Lobe Lesions

• speech production - Broca’s aphasia (Broca’s area and supplementary speech area in left hemisphere), in which speech is still meaningful but is no longer fluent (almost always left hemisphere damage)

• search Broca’s aphasia on YouTube to see examples illustrating the nature of this aphasia (I will provide relevant links at the website)
Frontal Lobe Lesions

Prefrontal Cortex

- disturbance in intelligence
  - but not in IQ test taking ability - IQ tests test convergent thinking (ability to converge on just one correct answer)
  - divergent thinking is impaired after frontal lobe lesions - ability to come up with multiple answers (see example on next slide)
  - failure of abstract thinking - thinking becomes concrete (For example, it becomes difficult for people to interpret “wise old sayings” such as, “A rolling stone gathers no moss.” When asked to explain the meaning of this, the patient might say, “A stone that is rolling on the ground doesn’t get any moss on it.”)
Frontal Lobe Lesions

How can your school conserve energy and reduce power bills?

The ability to think like this is impaired after frontal lobe lesions.

Example of divergent thinking - there are multiple right answers.
Frontal Lobe Lesions

- loss of behavioral spontaneity - behavior becomes repetitive and predictable
- impaired strategy formation and decision making - especially in novel situations
- impaired response inhibition - inability to stop behavior that has become inappropriate (such as walking into a wall or cursing in front of your mother) is impaired
- perseveration - the same behavior tends to be repeated over and over, even when it is not appropriate
Frontal Lobe Lesions

Brain maps reveal where decisions happen

CALTECH / USC (US) — By mapping the brains of patients with frontal lobe damage, scientists show that reasoning and behavioral control depend on a different area from decision-making.

Note: the star means this is important, so pay attention to it!

areas having to do with reasoning behavioral control are in red - ventrolateral prefrontal cortex

areas having to do with decision making are in blue - orbitofrontal cortex

MRI scans of a human brain show the regions significantly associated with decision-making in blue, and the regions significantly associated with behavioral control in red. On the left is an intact brain seen from the front—the colored regions are both in the frontal lobes. The image on the right is that same brain with a portion of the frontal lobes cut away to show how the lesion map looks in the interior. (Credit: Caltech)
Frontal Lobe Lesions

- distractibility and poor attention
- failure to attend to novel situations because of distraction

The graph shows an experiment done with stroke victims and normal controls. The stroke victims experienced strokes in the frontal lobe. The subjects were shown images on a computer screen. The images were either novel or familiar (“background”). Measured was how long the subject looked at the image (duration in milliseconds). Normal controls spent more than twice as long looking at the novel stimulus, the usual pattern, whereas stroke patients did not look at the novel stimulus any longer than they did the familiar stimulus.

**Figure 3**
Viewing duration on novel and background stimuli (mean (SEM) in ms) for normal controls and frontal lobe patients. There was a significant stimulus type by group interaction (p<0.009). Normal controls spent significantly more time than frontal lobe patients looking at novel stimuli (p<0.05); however, the two groups did not differ in their viewing duration on background stimuli.

Effects of frontal lobe damage due to stroke on attention to novel stimuli.
Frontal Lobe Lesions

• failure to comply with instructions, rule breaking, risk taking, failure to learn from experience - these behavioral features taken together are called impulsiveness
Frontal Lobe Lesions

circuits responsible for impulsive behaviors (red, yellow, and orange)

Important structures to note here are the OFC (orbitofrontal cortex), the DMStr (dorsomedial striatum, i.e., the caudate and putamen), and the STN (subthalamic nucleus, a structure I haven’t mentioned previously in the diencephalon). These structures will also figure prominently in our discussion of obsessive-compulsive disorder.

For the hopelessly curious, HPC is hippocampus, BLA is amygdala, GP is globus pallidus, NA is nucleus accumbens (two divisions), and DA stands for the neurotransmitter dopamine.
Frontal Lobe Lesions

• impaired autobiographical memory - e.g., patients can remember going to HS, they can tell what HS was like, but they can’t relate personal stories about HS
Frontal Lobe Lesions

some brain areas associated with memory

(notice dorsolateral prefrontal cortex right in the middle of it all, and don’t worry for now about the other areas)
Frontal Lobe Lesions

• impaired social and sexual behavior - personality changes

• pseudodepression - apathy, indifference, loss of initiative, reduced sexual interest, reduced verbal output

• more common with left hemisphere damage
Frontal Lobe Lesions

(remember this guy)

Astrocytoma

**History**
This 35 male, non-smoker had a 2-year history of **loss of initiative**, depression, and rejection of his personal relationships. His wife noticed that he had slowly lost his drive to win all the big deals he always done so well at work. 3 months ago he began to experience headache, which did not respond to acetaminophen or aspirin. His wife noticed that his lethargic state had increased in the past few months. 3 days ago his right arm began to convulse uncontrollably for 1 minute. The patient shrugged the incident off as some aberrant behavior and did not reveal this to wife. 1 day ago the patient began again violently shaking his right arm, and the right side of face began to twitch at the dinner table. His wife panicked and called 911. He presents to this hospital without fever, change in appetite, or fatigue.

**Physical**
Remarkable findings are bilateral papilledema, increased deep tendon reflexes of the right bicep, tricep, and, babinski sign on the right foot, reduced leg strength on the right.
Frontal Lobe Lesions

- impaired social and sexual behavior - personality changes (continued)

- pseudopsychopathy - immature behavior, lack of tact and restraint, profanity, promiscuity, lack of social grace

- often said to be more common with right hemisphere damage, but may be due to damage in the orbitofrontal cortex
Frontal Lobe Lesions

(remember this guy)

Phineas Gage

It is uncertain what the extent of damage was in Gage’s frontal lobes. Some sources say both frontal lobes must have been damaged, but others (including Harlow, who cared for him after the accident) maintain that the right frontal lobe remained largely in tact.
Temporal Lobe Lesions

• disturbances in auditory sensation and perception
• difficulty discriminating speech sounds and “tone of voice” (prosody)
• difficulty with music perception (loss of melody due to loss of pitch perception)
• auditory hallucinations - due to spontaneous activity in the auditory cortex

location of primary auditory cortex on superior temporal gyrus of the temporal lobe
Temporal Lobe Lesions

Auditory Functional MR Imaging

fMRI of auditory cortex responding to music showing activation of auditory areas in the temporal lobe

Fig. 2. —Auditory functional MR imaging with music. Axial plane is parallel to sylvian fissure at Heschl’s gyrus level. Intensity of activation varies from high (yellow) to low (blue). Bilateral activation of primary auditory cortex is seen, with extension to secondary auditory cortex more pronounced on left.
Temporal Lobe Lesions

fMRI of patient having auditory hallucinations showing activation of auditory areas in the temporal lobes
Temporal Lobe Lesions

- Wernicke’s aphasia - inability to comprehend or produce meaningful speech (damage to left posterior superior temporal gyrus)
- watch the video on aphasia if you haven’t already
Temporal Lobe Lesions

- disturbances in visual perception
- visual agnosia - the inability to identify objects by sight
- prosopagnosia - the inability to identify faces by sight
- the ventral temporal lobe is a visual processing area involved in object identification - if this area is damaged, or the flow on information from the primary visual areas is interrupted, some sort of visual agnosia is usually the result (agnosia - “no knowledge”)

![Diagram of brain regions involved in visual processing](image)
Temporal Lobe Lesions

Cecilia Burman has always had a problem with faces. As a child, she struggled to pick out her own face in school photos, and she is hard-pressed today to describe her mother's features. Over the years she has offended countless friends, passing them on neighborhood streets or in office hallways like strangers. "People think I'm just snobby," says Burman, 38, a computer consultant in Stockholm. "It makes me really, really sad to lose new friends because they think I couldn't bother to say hello."

a case of prosopagnosia

prosopon = face, agnosia = no knowledge
Temporal Lobe Lesions

- anterograde amnesia - due to ventral temporal damage and especially damage to the hippocampus in the ventromedial temporal lobe

- a person with anterograde amnesia cannot form new long-term memories, although pre-existing memories remain intact. (H.M. had surgery in 1953 to remove the hippocampus in both temporal lobes as a treatment for temporal lobe epilepsy; for him it was effectively 1953 for the remainder of his life; he died in 2008)

- similar damage due to a viral encephalitis

H.M. (Henry Molaison)
Temporal Lobe Lesions

- temporal lobe personality (very few patients display all of this syndrome) - sometimes seen in temporal lobe epilepsy (Geschwind)
  - overemphasis on trivia and petty details of daily life
  - pedantic speech and egocentricity
  - “stickiness” - person persists in discussing personal problems, and you “get stuck listening to him”
  - paranoia
  - obsessive preoccupation with religion
  - proneness to aggressive outbursts
  - hypersexuality