Lecture Preview

- Nerve cells and communication in the brain
- The central and peripheral nervous systems
- Glands, hormones, and the endocrine systems
- **Mapping the brain**
- Nature and nurture

Brain Mapping Methods

- There have been many attempts to map the mind onto the brain
  - which part of the brain is related with which function

Brain Mapping Methods

- **Phrenology**
- ~ 1800's
- We know that this method is wrong
- Phrenologists examines enlargements of the skull—bumps on the head!—and associates those bumps with various personality traits and abilities
- The technique was called hand scanning

Franz Joseph Gall. A phrenologist's chart showing where certain psychological traits are supposedly associated with bumps on the skull. Today we know that this method is incorrect.

Brain Mapping Methods

- **Brain Damage**
- Understanding how the brain works by seeing how it doesn't
- Observation of behavior of patients who has a brain damage

In 2009, this photograph of a man believed by historians to be Phineas Gage (whose appearance was previously unknown) surfaced (Wilgus & Wilgus, 2009). One can clearly see (a) Gage holding the huge tamping rod that passed through his frontal lobes, (b) his missing left eye, which was destroyed by the rod, and (c) a tuft of hair on the left side of his head, presumably covering the region of his scalp from which the rod exited.

A computer-generated image showing the tamping iron that pierced through the skull and frontal lobes of Phineas Gage.

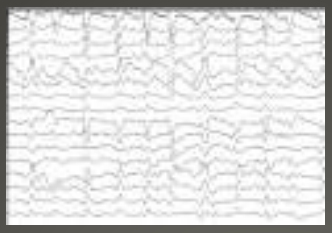
Brain Mapping Methods

- **Electroencephalograph**
  - Measures electrical activity via electrodes placed on skull
  - Can tell which regions of the brain are active during specific tasks

Brain Mapping Methods

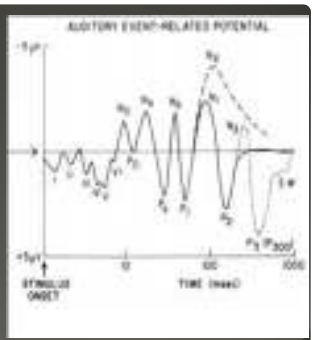
- *Neuroimaging* techniques allow us to see brain structure, function, or both
- **Computed tomography (CT)** uses multiple X-rays to construct three-dimensional images
- **Magnetic resonance imaging (MRI)** uses magnetic fields to indirectly visualize brain structure

- ERP components are extracted from EEG signal by averaging time-locked waves over many stimulus presentations



Electric Field Potentials (ERPs)

- Waves I-VI are generated in the brain-stem pathways
- P&N waves are generated in the cortical sites
- N200 – P300
  - Object recognition
- N400
  - Word expectancy



ERP Components

Brain Mapping Methods

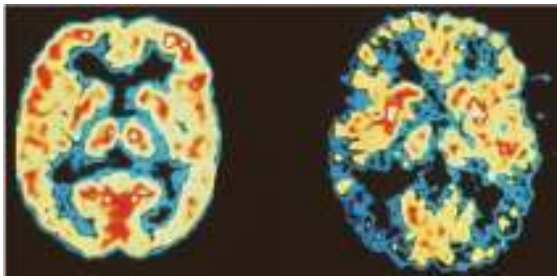
- **Positron emission tomography (PET)** measures consumption of glucose-like molecules to give a picture of neural activity
- **Functional MRI (fMRI)** uses magnetic fields to visualize brain activity
- These both measure structure and function

Brain Mapping Methods

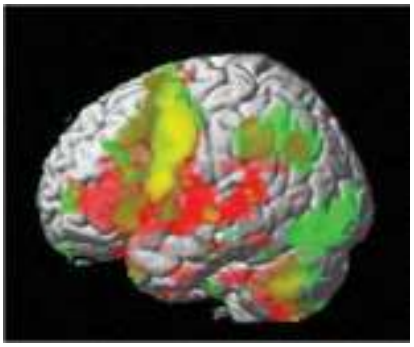
- **Transcranial magnetic stimulation (TMS)** applies strong and quick y changing magnetic fields to the surface of the skull that can either enhance or interrupt brain function
  - Allows causal determination of functioning
- **Magnetoencephalography (MEG)** measures tiny magnetic fields generated by the brain

Magnetic resonance imaging (MRI) is a noninvasive procedure that reveals high-resolution images of soft tissue, such as the brain.

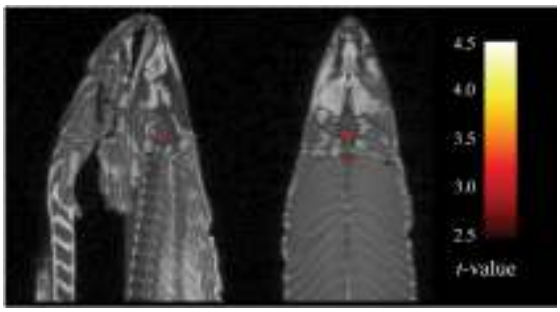
PET scans show more regions displaying low activity (blue and black areas) in an Alzheimer's disease brain *(right)* than a control brain *(left)*, whereas the control brain displays more areas showing high activity (red and yellow).



An fMRI of the brain showing areas that were active when subjects remembered something they saw (*green*), something they heard *(red)*, or both (*yellow*). *(Source:* M. Kirschen/Stanford University)



A "Fishy" Result? Researchers (Bennett et al., 2009) showed that even a dead salmon can seem to be responding to stimuli—see the red regions of "brain activation"—using standard imaging techniques (to see how, read the text). This finding doesn't show that brain imaging techniques aren't useful, of course, but they show that positive findings can sometimes arise by chance.



Brain Mapping Methods

- These pictures are not true pictures of the brain,
- They are computer generated figures to describe the activity of the human brain

Contrary to popular psychology claims that we use only 10% of our brain, we use most or even all of our brain capacity virtually all of the time.

Which Area for What Task?

- Many areas of the brain are associated with a particular function (*localization of function)*
- However, complex tasks often require numerous parts working together
  - Visual perception
- Each region participates in many functions, so coordination across multiple brain regions contributes to each function

Which Side Do We Use for What?

- Many brain functions show **lateralization**

LEFT HEMISPHERE	RIGHT HEMISPHERE
• **Fine-tuned language skills** • Speech comprehension • Speech production • Phonology • Syntax • Reading • Writing • **Actions** • Making facial expressions • Motion detection	• **Course language skills** • Simple speech • Simple writing • Tone of voice • **Visuospatial skills** • Perceptual grouping • Face perception

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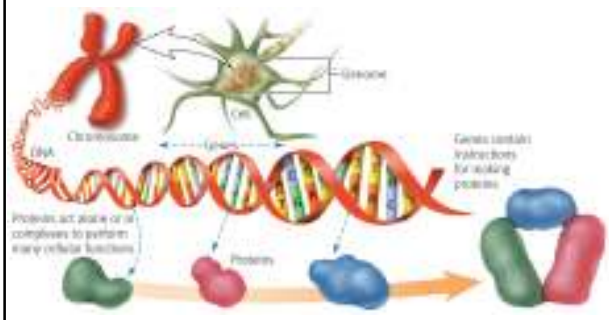
How We Come to Be Who We Are

- We have **chromosomes** inside each cell's nucleus that carry **genes**
  - Humans have 46 chromosomes, 23 from each parents
- Our **genotype** is the set of genes we have, while our **phenotype** is our observable traits
  - Genes can be dominant or recessive



Behavioral Adaption

- Some organisms have adaptations that make them better suited to their environment
- They survive and reproduce at higher rates than other organisms (fitness)
- Those adaptations then have a higher frequency in the population (evolution by natural selection)

Brain Evolution

- Humans and apes last shared a common ancestor 6-7 million years ago
- Since then, human brains have tripled in size, with the most changes in the area of the cerebral cortex
- Relative brain size appears to be associated with higher amounts of intelligent behavior

Behavioral Genetics

- Studies the relative impact of nature and nurture on psychological traits
- Estimates **heritability**—percentage of the variability in a trait across individuals that is due to genes
- Some traits are highly heritable (height), others are not (religious affiliation)

Behavioral Genetic Designs

- Scientists use three types of designs to estimate heritability of traits
  - Family studies
  - Twin studies
  - Adoption studies
- Determine how much both genes and environment contribute to a particular trait

Is the mind different from the brain?

a. Yes, the mind and brain are separate
b. No, the mind is the brain in action and, therefore, we can study both at once
c. The mind may be the brain in action, but we can't study the mind

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The human neocortex is proportionally larger and has more connections than that of other species. What may be the significance of this?

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b. To handle the more complex motor demands of the human body
c. It's dedicated to vision, because vision is most highly developed in humans
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The sympathetic nervous system is crucial for fight-or-flight responses. What would happen if it was activated for a *long* time?

a. You would be able to respond faster to threatening situations whenever necessary
b. You would respond less efficiently in an emergency because your nervous system would have habituated
c. You would develop stress-related diseases (stomach ulcers, high blood pressure)
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For the treatment of depression, what happens in the brain *after* antidepressant drugs increase neurotransmitter levels? How do these drugs **change** the brain?

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You're a subject in a psychology experiment which requires a brain scan. The researchers see an untreatable lethal brain tumor on your scan. Should they inform you?

a. Yes, I'd want to know.

b. No, if it's untreatable, I'd rather not know

If you could take a pill that would enhance ALL your memories (new, old, good, bad) would you?

a. Yes!

b. No, I'm opposed to the idea of manipulating memories.

c. No, I wouldn't want bad memories enhanced.