

Psychology 1010

Week 1

What exactly is psychology?

- _____ – the scientific study of behavior and mental processes.
- _____ – any movement or posture produced by an individual that influences its relationship to the environment.
 - Behavior: head turn, speaking, walking, nest building.
 - Not behavior: thinking, feeling, digesting, heart beat, hearing.
- Note: non-behavioral processes affect behavioral output.

What exactly is psychology?

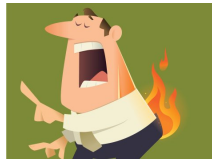
- **Mental processes** – things such as thinking and feeling that can't be directly observed (except maybe with brain scanning equipment!).



fMRI of a person imagining a motor task (lab of Andre Szameitat)

What exactly is psychology?

- Mental processes are difficult to study because:
 - They can't be directly observed.
 - Brain activity can be correlated with certain thoughts or feelings, but isn't definitive.
 - People don't always tell the truth (on purpose or not!).



What exactly is psychology?

- The first attempts to answer questions about the mind were philosophical:
 - Is knowledge/behavior innate or learned?
 - *Tabula rasa* – the idea that at birth, human minds are a blank slate.



– Seen today in the nature/nurture "debate."

- Modern psychology: questions must be testable using the scientific method!

Historical Ideas in Psychology

- _____ – the idea that certain smaller elements combine to create the entire mental experience.
 - Associated with **Wilhelm Wundt**, who established the first psychology laboratory in Germany in the late 1800s, and his student **Edward Titchener**.



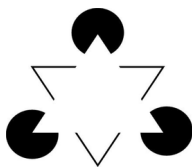
Historical Ideas in Psychology

- _____ – individuals describe their mental processes.
 - Titchener would have subjects look at an object and describe it in detail (color, texture, brightness, shape etc.).
- Problems with this approach?



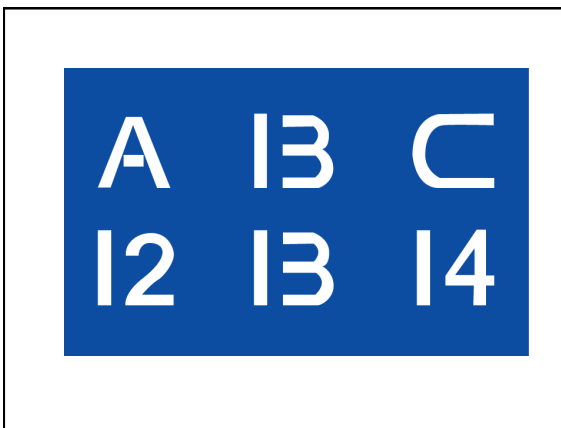
Historical Ideas in Psychology

- _____ **psychology** – idea that the whole of perception is greater than the sum of the parts. Associated with **Max Wertheimer**.



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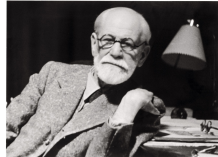


Historical Ideas in Psychology

- **Functionalism** – how does a behavior assist an organism with survival and/or reproduction in its environment?
 - Based on Darwin's idea of evolution through natural selection.
 - Associated with **William James**.
 - Paved the way for evolutionary psychology, and is a part of mainstream psychology today.

Historical Ideas in Psychology

- _____ **Theory** – behavior is the result of unconscious and often conflicting desires (psychodynamics).
 - Associated with Sigmund Freud, who used psychoanalysis to treat psychological disorders.
 - Based on Freud's own thoughts, not on experimentation.



Historical Ideas in Psychology

- _____ – the idea that since the mind can't be directly observed, only observable behavior should be studied and quantified.
 - Based in part on studies of salivation in dogs by Pavlov (classical conditioning).
 - Associated with John B. Watson, B.F. Skinner, and Edward Thorndike.



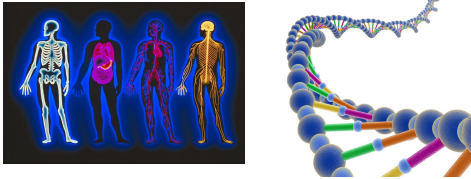
Historical Ideas in Psychology

- _____ – emphasizes free will of people to choose their own behavior. States that people are innately good until corrupted by society. Examines the idea of motivation.
 - Associated with Abraham Maslow and Carl Rogers.



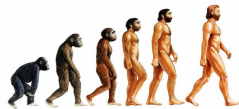
Modern Ideas in Psychology

- **Biological Perspective** – examines the physical causes for behavior.
 - Includes genetics, hormones, brain structures, physiology etc.



Modern Ideas in Psychology

- **Evolutionary Psychology** – takes the history of the species into consideration when examining behavior. Asks how a behavior (currently or in the past) assists with survival/reproduction.
 - Many people today have a preference for calorically dense foods, which would have provided a survival advantage to our ancestors.



Ideas in Psychology

- **Cognitive Psychology** – modern study of mental processes such as problem solving or memory.
 - Utilizes experimentation to make inferences and answer questions about mental processes.
 - E.g. will math students do better by just reading information on their own, receiving oral instruction from a teacher, or both?
 - Associated with **Ulric Neisser**.



Modern Ideas in Psychology

- Other modern approaches to psychology include:
 - **Developmental psychology**: how behavior changes across the lifespan.
 - **Social psychology**: how other people affect thoughts and behavior.
 - **Individual differences**: studies the varieties of behavior instead of averages. Associated with the study of personality.
 - **Clinical psychology**: identifying and treating abnormal behavior.

Nature of Science

- Science as a way of knowing: scientists assume that the universe works in predictable ways that can be measured with systematic observation.
- Scientific ideas are subject to change.
- Most well-established scientific ideas are durable (often subject to revision, not outright rejection).

Nature of Science

- Science can't answer all questions, e.g. questions about the supernatural, or how people "ought" to behave in a moral sense. (Only questions about the natural world can be addressed)
- Science demands evidence!
- Results should be _____ – others should be able to do the same test, and get the same results.
- Scientists should try to avoid bias (though they're not always successful!).

Nature of Science

- The next time you hear a claim from a friend/on the news/in class, analyze it using critical thinking skills to determine for yourself if you think the claim is valid.



Nature of Science

- Recently, a number of scientists set out to replicate findings of previously published articles in psychology (The Reproducibility Project).
- Many of the studies failed to replicate (i.e. the results were not the same).
- This type of study is helping the whole field to conduct better science.

Nature of Science

- 1) Determine what the claim is.
- 2) What evidence is there to support the claim?
- 3) Are there other ways to interpret the data?
- 4) Are there other data that would be useful? What are they/are they available?
- 5) What's the best conclusion?

Goals of Psychology

- **behavior** – observe and document behavior.
- **behavior** – anticipate behavior based on previous observations. May be based on correlations.
- **Explain behavior** – determine the causes of behavior.
- **Control behavior** – if causes are known, we can attempt to change or control behavior.

Scientific Method

- Observation – an individual observes a phenomenon to be studied.
 - Note: casual observations are often inaccurate! This makes formal testing necessary.
- Hypothesis formation – make a statement regarding the reason for the observed phenomenon.
 - Must be testable, and falsifiable.

Scientific Method

- A claim is falsifiable if a single observation could show it to be false.
 - Example: all humans reproduce sexually. This statement is falsifiable, since if we found a single human who did not reproduce sexually, the statement is false.
 - Example: Loch Ness has a monster. This statement is not falsifiable, since lots of observations have shown no Nessie.

Scientific Method

- A claim is testable if it can be investigated using currently available scientific methods.
 - Example: Fish have souls. This claim is not testable, since we don't have a way to measure a "soul."
 - Example: Male robins that sing loudest get the largest number of mates. We can measure loudness, count mates etc., so this claim is testable.

Scientific Method

- Test the hypothesis.
 - Others must be able to replicate.
- Analyze and interpret data.
 - Usually utilizes statistical methods.
- Reject/revise hypothesis.
- _____ – others in the scientific community scrutinize papers before they are published to make sure methods are appropriate, interpretations reasonable etc.

Research Design

- There are several ways to conduct science, including:
 - Descriptive studies
 - case studies
 - surveys
 - correlational studies
 - Experimental studies



Research Methods: Case Studies

- **_____ studies:** examination of a particular individual in detail because only one or a few subjects of a particular type are available.
 - E.g. a person with a specific type of brain damage is examined to determine what kinds of cognitive deficits resulted from the injury.

Research Methods: Case Studies

- Pros:
 - Can help us understand relationships we wouldn't be able to otherwise.
 - Provides a good starting point for further investigation.
- Cons:
 - Sometimes individual cases are unusual, (i.e. they're not _____).
 - There's not necessarily a causal link between a particular injury and behavior.

Research Methods: Surveys

- Surveys are questionnaires that seek to gather information about attitudes or opinions.

- Researchers need to make sure they have a

_____,
a group of people that reasonably approximates the population being studied.

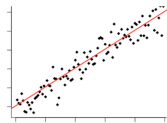


Research Methods: Surveys

- Pros:
 - Lots of data can be collected quickly.
- Cons:
 - People might not always pay close attention to the questions they are answering.
 - People sometimes lie (on purpose or not!).

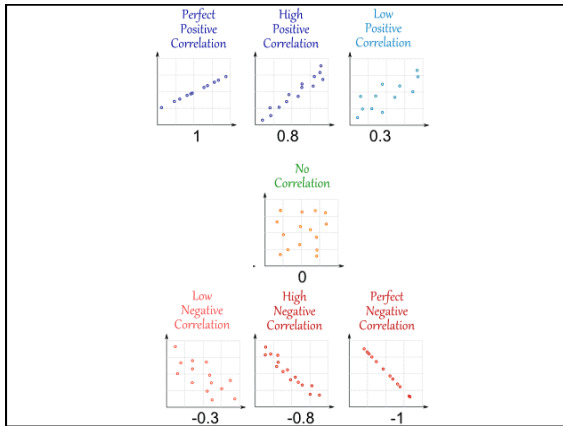
Research Methods: Correlational Studies

- **Correlational Studies:** gathering data about a large group and looking for statistically significant trends.
- E.g. comparing data of people with a particular type of cancer with people that don't have the cancer to see if there is a difference (diet, age, smoking history etc.).



Correlation

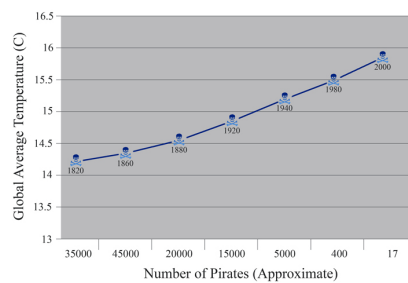
- **Correlation** _____: value between -1 and 1 that indicates the strength of the correlation between 2 variables.
- Examples:
 - Positive correlation: age and height from ages 0-20.
 - Negative correlation: amount of exercise per week and blood pressure.
 - No correlation: hair length and IQ.



Correlation

- Pros:
 - Lots of data!
 - A few individuals won't skew the results.
 - Useful for making predictions (e.g. which type of people are most likely to get diabetes).
 - It's sometimes the only option available (when ethics prevent actual manipulation of variables).
- Cons:
 - Can indicate correlation, but not necessarily causation!!!

Global Average Temperature Vs. Number of Pirates



In 2007, National Geographic printed an article about the rise in global temperatures, and another article about the decline in Malacan pirates.

Correlation and Causation

- With correlations, we can't necessarily tell which variable is influencing the other.
 - If we find a correlation between education and IQ, is education influencing IQ, or IQ influencing amount of education?
- Or, there might be a third variable influencing both.
 - Maybe socioeconomic status of the family influences both education and IQ, but education and IQ don't directly influence one another.

Research Methods: Experiments

- **studies** – researcher manipulates one or more variables and measures the effects of manipulation. All other variables are held constant.
- Pros:
 - Experiments are the gold standard in science because they indicate causality.
- Cons:
 - They might be more expensive and/or time-consuming than other methods.

Research Methods: Experiments

- **variable** – a variable that the researcher manipulates.
- **variable** – a variable that is potentially changed as the result of experimental manipulation.

Functional Relationship

- The relationship between changes in an independent variable and changes in a dependent variable is called a _____.
- Also known as a “cause and effect” relationship.
- Researchers are often interested in finding out if there is a functional relationship between an environmental variable and behavior.

Experiment Example

- A researcher is wondering whether a new drug shortens the duration of a common cold.
- A group of subjects are deliberately infected with the same cold virus. Half are given the new drug, half are given a _____ (a pill containing no active ingredients). Why use a placebo?

Research Methods: Experiments

- When possible, procedures should be _____.
 - Experimenters don’t know (until the experiment is over) whether they were administering the active drug or a placebo.
 - Subjects don’t know whether they were taking an active drug or placebo.



Research Methods: Experiments

- _____ – if an experimenter expects differences between groups, s/he might treat the groups differently, leading to different outcomes.

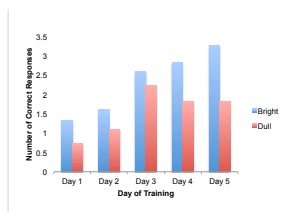
Research Methods: Experiments

- In a study (Rosenthal and Fode, 1963), students trained rats to run a maze.
- One group of students was told that their rats were “maze smart,” the other group was told their rats were “maze dumb.” Rats were not actually different.



Research Methods: Experiments

- Rats that students believed were “smart” performed better than rats that students believed were “dumb.”



Rosenthal and Fode, 1963

Experiments

- _____ **group** – the group of subjects that receives the experimental treatment (new drug).
- _____ **group** – the group of subjects that does not receive the experimental treatment (placebo).
 - Control groups are needed for comparison to know whether the manipulation had an effect or not.

Embedded question

- From the previous example where experimenters want to know if a new drug shortens the duration of a cold:
- Which is the independent variable?
- _____
- Which is the dependent variable?
- _____

Between vs. within subjects

- **Between-subjects experiments** – different subjects appear in groups that differ with respect to the independent variable.
- **Within-subjects experiments** – the same subjects are measured before and after a treatment, and the measurements are compared.

Between Groups

Group 1

Group 2

Within Groups

The diagram illustrates within-group stability. It is divided into two panels: "Group 1, Time 1" on the left and "Group 1, Time 2" on the right. A large blue arrow points from the left panel to the right panel. Both panels contain 12 identical blue smiley faces, representing the same group of individuals at two different time points. The spatial arrangement of the smiley faces is nearly identical in both panels, indicating that the group's composition and internal structure remain stable over time.

[illegible]

Experiments

- _____: any variable other than the independent variable that might affect the outcome (dependent variable) of an experiment.
 - Age might affect how quickly a person recovers from a cold.
- Confounding variables need to be controlled for in experiments.

[illegible]

Between subjects experiments

- Care needs to be taken to ensure that the groups do not differ from one another with respect to an important (confounding) variable.
- This can be done by:
 - **Random assignment** of subjects to treatment groups. This should minimize the effects of individual variables.
 - Matching – potential subjects are matched based on their similarities, and placed in different groups. This ensures to an even greater degree that confounding variables are controlled for.

[illegible]

Between subjects experiments

- From our previous example, if we think age might be a factor in how quickly a person recovers from a cold, people are matched according to their age and put in different groups.

[illegible]

Each number represents the age of someone in your subject pool (20):

41 21 41 56 64
31 37 67 40
42 55 89 19
66 32 36 80
26 59 24

First, arrange subjects in order of age:

19	41
21	42
24	44
26	55
31	56
32	59
36	64
37	67
40	80
41	89

Then, match each subject with the subject that is closest to him or her in age:

19	41	19 → 21
21	42	24 → 26
24	44	31 → 32
26	55	36 → 37
31	56	40 → 41
32	59	41 → 42
36	64	44 → 55
37	67	56 → 59
40	80	64 → 67
41	89	80 → 89

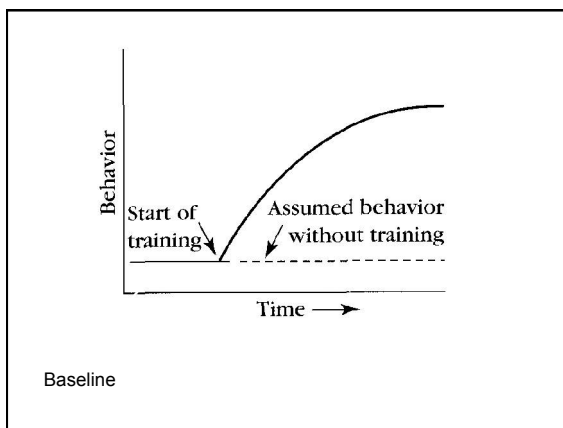
Then, assign each group to a different treatment condition.

drug treatment group	placebo group
19	→ 21
24	→ 26
31	→ 32
36	→ 37
40	→ 41
41	→ 42
44	→ 55
56	→ 59
64	→ 67
80	→ 89

This will help ensure that differences in age are not the reason the groups differ with respect to the duration of the cold.

Within subjects experiments

- Maybe you want to know how a particular teaching method affects learning.
- You could measure students before using the method to see what they know, and again after to see how much they have learned.
- The measurement before the treatment is called a _____ measurement, which is needed to be able to measure change (similar to a control group for a between-groups experiment).



Within subjects experiments

- Let's say you want to see if the administration of caffeine leads to better cognitive performance.
- You can use the same subjects, and test their performance on a cognitive task without caffeine, and with caffeine.
- Half the subjects should be tested without caffeine first, and half with caffeine first, to make sure there are no differences from practicing the test.
- Since you're using the same subjects, you don't have to worry about differences in individuals across groups!

Limits of Experimental Research

- Variables are simple and highly controlled (not like the real world).
 - But... experiments provide a level of control that allows us to better see the impact of the independent variable.
- Experiments also often require a large number of subjects.
- Experiments give us an idea of how an *average* individual will behave, which might not be helpful when examining a single individual.

Advantages of Experimental Research

- Cause and effect relationships can be determined!



Experiments

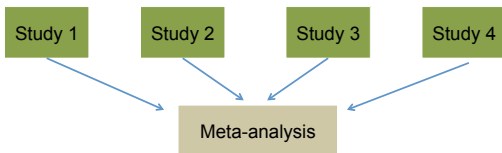
- _____ – we need to precisely define what we mean by a particular behavior in order to measure it.
 - Aggressive behavior can be measured in terms of amount and volume of yelling (observable), but not by amount of anger (not observable).
- What are some operational definitions of “getting well” after a cold?

Experiments

- Operational definitions of getting well might include:
 - Nasal stuffiness (measured in amount of air passed per second) decreases more quickly.
 - Body temperature (if a fever was present) decreases more quickly.
 - Subjective ratings of well-being increase faster (how do you feel on a scale of 1-10?).

Experiments

- _____ – a statistical analysis of a large number of studies to get a better sense of a phenomenon than just a single study could provide.



Laboratory vs. Field Experiments

- **Laboratory experiments** – environments are artificial, but most variables are closely controlled.
- **Field (naturalistic) experiments** – studying subjects in their natural environment. Environments are more authentic, but many variables can not be controlled.

Laboratory vs. field experiments

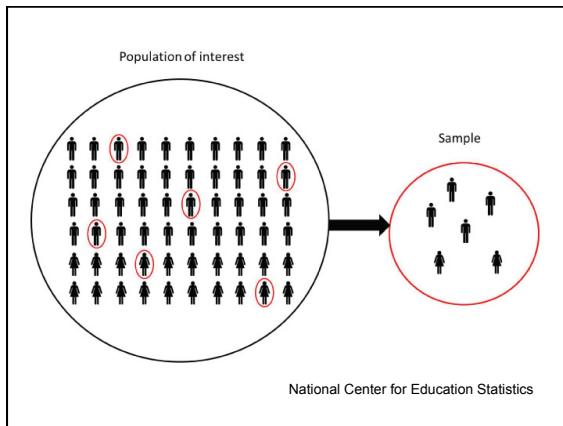
- _____ – observing individuals in their natural environment in order to make correlations/predictions.
 - **Reactivity, or the Hawthorne Effect** – individuals might behave differently in the presence of an observer.

Subjects

- _____ – all of the people that a scientist is interested in for a particular study. Could include:
 - All women
 - All people with a psychiatric disorder
 - All people in a particular age range

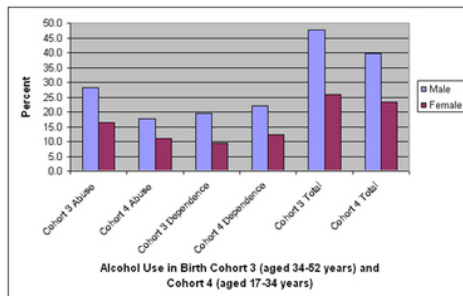
Subjects

- **Sample:** a subset of the population of interest.
 - Scientists can't study all individuals in their population of interest, so they take a subset of the population.
- _____ **sample:** portion of the population of interest that reflects the population as a whole. Often achieved with a **random sample** to avoid **sampling bias**.



Change across time

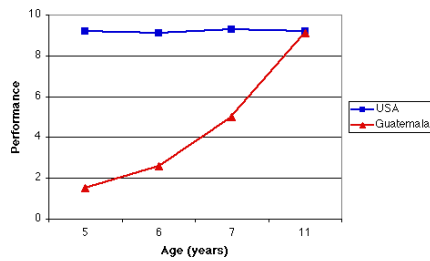
- – study of different groups of people of different ages.
 - **Cohort effects** – historical factors that influence an age group might be responsible for the outcome of a study, not actual differences.
 - Cons: Can't tell sequences of change across time, or consistency of behavior of an individual across time.
 - Pros: Can be done quickly, and can give useful leads.



Keyes et al. 2008

Designs for studying age-related changes

- _____ – study the same group at different points in time.
 - **Practice effects** – groups may figure out how to take a test, and therefore do better on subsequent offerings.
 - **Attrition** – individuals disappear.
 - Takes money and time, but can determine individual changes across time.



Jerome Kagan

Experiments

- _____ – the experiment measured what it was supposed to measure.
 - Using an individual's problem-solving ability to estimate aggression is not valid.
 - Is an IQ test a valid measure of intelligence?



Validity

Validity: The extent to which a study actually measures the concept it is supposed to measure.



Experiments

- _____ – how consistent a measurement is.
 - E.g. you put the same object on a scale over and over, and get a very similar measurement.
 - **Inter-rater reliability** – how likely it is that 2 people take the same measurement and get the same outcome.
 - E.g. 2 people measure the beak of a bird and get similar outcomes.

Reliability

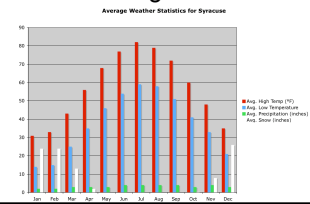
Reliability: The consistency of an operational measure across time and observers (inter-rater)



Week 2

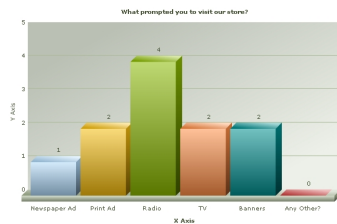
Descriptive Statistics

- **Descriptive statistics** – help us to understand patterns in data, but can't tell us if the patterns or differences between groups are meaningful.



Descriptive Statistics

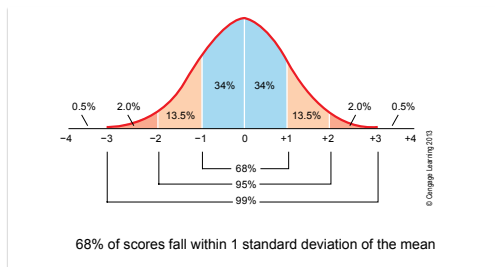
- **Frequency distribution** – looks at how many subjects belong in each category.



Descriptive Statistics

- – average of scores (add all scores up, divide by number of subjects). Good for when data are regularly distributed (no extreme scores, or **outliers**).
- – most scores occur at the mean, with symmetrical distributions on either side.

Standard Normal Distribution

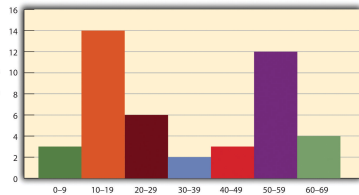


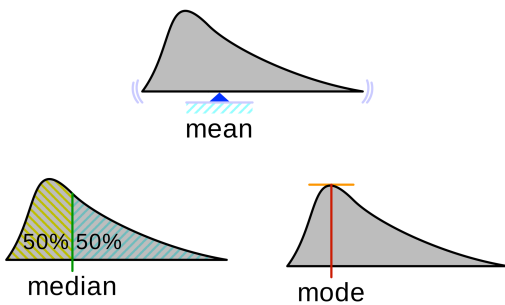
Descriptive Statistics

- – the score that appears in the middle. I.e. half the scores are higher, half are lower (if there are an even number of data points, you average the 2 in the middle to get the median).

Descriptive Statistics

- **Mode** – score that appears most frequently. Can be useful if there is more than one peak in the data (_____).



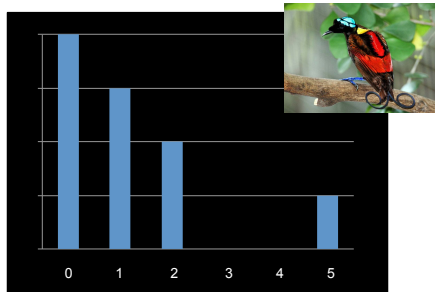


Descriptive Statistics

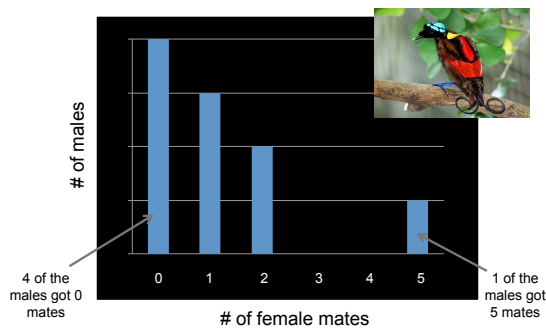
- Let's look at an example of mean, median, and mode in a hypothetical bird species...
- While out studying a new type of bird of paradise in New Guinea, you wanted to know how many mates each male obtained.
- Of the 10 males you observed, you mark down how many different females each male mated with.

Male band number	# of female mates
1	0
2	1
3	0
4	2
5	5
6	2
7	0
8	1
9	1
10	0

Frequency Distribution



Frequency Distribution



Descriptive Statistics

- Mean # of mates –
 $0+1+0+2+5+2+0+1+1+0 = 12$
- $12/10 = 1.2$ mates on average.
- Is this the best way to think about these data? In other words, does just knowing the mean give you an idea of what the data are like overall?

Male band number	# of female mates
1	0
2	1
3	0
4	2
5	5
6	2
7	0
8	1
9	1
10	0

Descriptive Statistics

- Median # of mates –
 $0,0,0,0,1,1,1,2,2,5$
- The 2 numbers in the middle are both 1. Average of 1 and 1 is 1.
- The median is 1.
- Is this a good way to think about these data?

Male band number	# of female mates
1	0
2	1
3	0
4	2
5	5
6	2
7	0
8	1
9	1
10	0

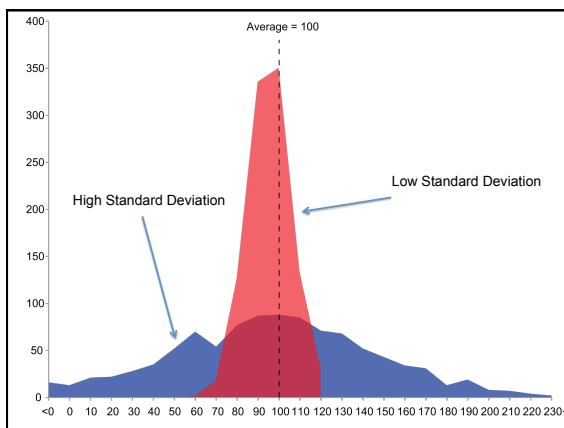
Descriptive Statistics

- Mode: $0,0,0,0,1,1,1,2,2,5$
- The number that occurs most frequently is 0.
- The mode is 0.
- Is this a good way to think about these data?

Male band number	# of female mates
1	0
2	1
3	0
4	2
5	5
6	2
7	0
8	1
9	1
10	0

Descriptive Statistics

- Standard Deviation – a measure of variability that tells us how tightly clustered the scores are around the mean.
- A low standard deviation indicates that the scores are tightly clustered.
- A high standard deviation indicates that the scores are more spread out.



Mean = 5, Std Dev = 1.095

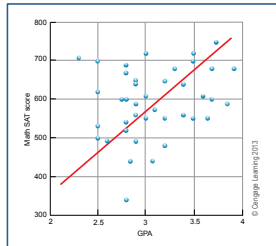
subject number	Hours of video game playing
1	5
2	5
3	6
4	5
5	6
6	4
7	4
8	3
9	7
10	5

Mean = 5, Std Dev = 3.317

subject number	Hours of video game playing
1	7
2	2
3	6
4	9
5	1
6	8
7	10
8	3
9	0
10	4

Descriptive Statistics

- Also note that correlation coefficients are another type of descriptive statistic.



Significance?

- After you collect data, how do you know that any differences you see between groups are meaningful? **Inferential statistics!**
- _____ – there is only a small chance that the differences you see were the result of chance.
- “Significant” does not necessarily imply “important.” Statistically significant differences might be small!

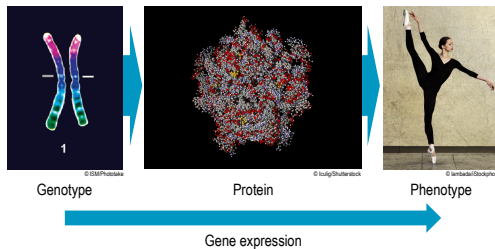
Significance?

- $p \leq 0.05$ is a standard level of significance.
- It means that there was only a 5% chance that the results would be obtained by chance.
- This means we sometimes get significant results that are NOT real, and we sometimes get non-significant results that are! It's a calculated risk...

Genes and Environment

- _____ – the complement of genes a particular organism has.
 - **Gene** – segment of DNA in a particular location that codes for a functional molecule.
 - **Gene expression** – all cells contain an individual's entire complement of DNA, but only certain genes are expressed at a given time (or at all).
- _____ – observable characteristics of an organism.

Genes produce proteins that eventually lead to phenotypes.

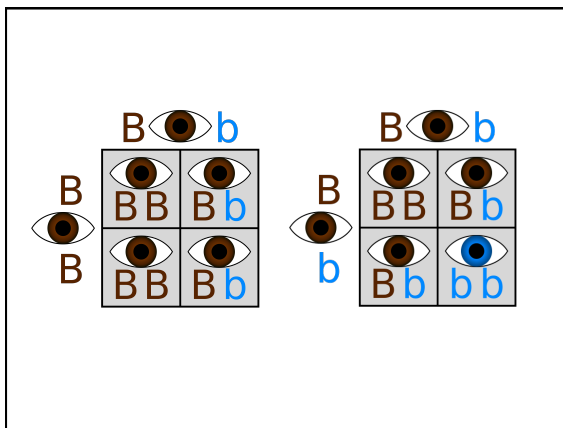


Genes and Environment

- **Alleles** – different versions of a gene.
 - Alleles “for” eye color might include blue, green, and brown.
 - We inherit one allele for any given gene from each parent.
- _____ – having 2 copies of the same allele for a given gene.
- _____ – having 2 different copies of an allele for a given gene.

Genes and Environment

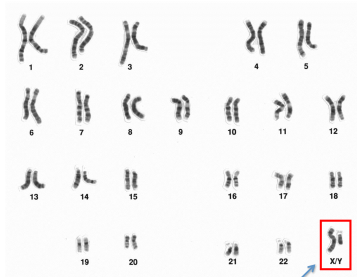
- _____ – if an allele is dominant, it will be expressed, regardless of the other allele for that gene.
- _____ – if an allele is recessive, it will only be expressed if the other allele is also recessive.
 - Note: not all genes are strictly dominant/recessive!



Sex Chromosomes

- Of human's 23 pairs of chromosomes, 22 contain the same genes.
- One pair, the sex chromosomes, contain different genes, and they look very different.
- Female humans have two "X" chromosomes, and male humans have an "X" and a "Y".

Sex Chromosomes

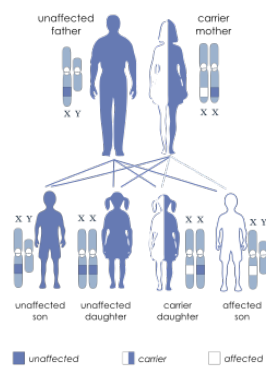


This individual is a male (X/Y)

Sex Chromosomes

- X chromosomes have around 2,000 functional genes, Y chromosomes have less than 100.
- _____ – when a male inherits a deleterious (i.e. bad) recessive allele on his (only) X chromosome, it will be expressed.
 - Examples: baldness, red-green colorblindness, hemophilia
 - Men inherit these traits more often than women because women need 2 copies of any recessive allele to have the trait.

X-linked recessive inheritance



“Nature vs. Nurture”

- Today, you still hear people talk about the “nature/nurture debate,” and whether traits are due to “genes or the environment.”
 - E.g. “did Charles Starkweather kill 11 people across Nebraska and Wyoming in the 1950s because of his genes, or his upbringing?”
- What? This makes no sense!

“Nature vs. Nurture”

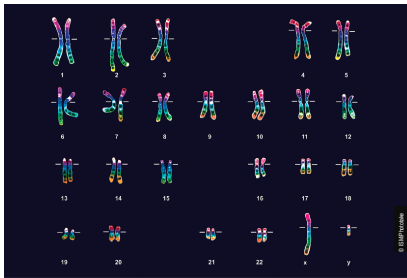
- Think of a cake... what percentage of the cake's taste or texture is due to the baking temperature? How about the flour content?
- Hopefully this question doesn't make sense to you... it's the combination of all the ingredients, plus the baking time, temperature etc. that make the finished cake what it is. Same with organisms!



“Nature vs. Nurture”

- An individual's phenotype is **always** the result of the **interaction** between his or her particular genetic makeup, and his or her particular environment.
- Genetically identical individuals raised in different environments (even slightly different) will have different traits, and genetically different individuals raised in precisely the same environment will also have different traits.

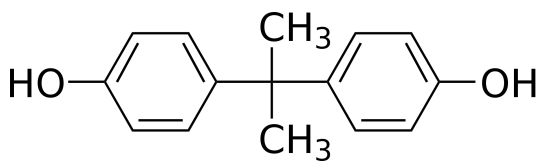
-
- If identical twins are genetically identical, how do they end up being different?
 - _____ – “above the genome” – the epigenome controls the expression of particular genes without changing the underlying DNA sequence. Changes can be handed down to future generations!



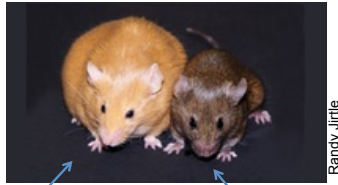
Every cell in the body carries the full set of DNA needed to provide the “blueprint” for a person.

Epigenetics

- Exposure to bisphenol A (a chemical found in plastics) causes pregnant mice to give birth to babies that are more prone to obesity, cancer, and diabetes.



Genetically identical mice

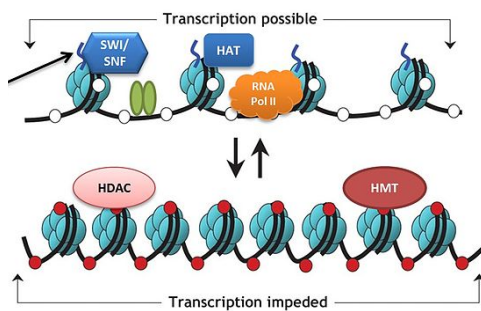


Randy Jirtle

Mom was exposed
to bisphenol A while
pregnant

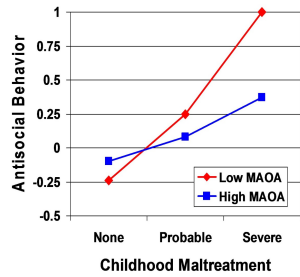
Mom was NOT
exposed to
bisphenol A while
pregnant

DNA Methylation



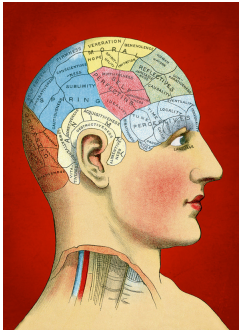
Genes *and* environment

- MAOA (monoamine oxidase A) catalyzes neurotransmitter reactions (e.g. dopamine and serotonin).
- Genes for the enzyme MAOA come in 2 forms. 1 results in lower, and 1 in higher levels of MAOA.
- In a thorough study in New Zealand, it was found that:
 - Boys that were abused as children were more likely to be aggressive as adults, but *only* if they had the low-MAOA gene.
 - If boys were not abused as children, they were less likely to be aggressive if they had the low-MAOA gene.



(Caspi et al. 2002)

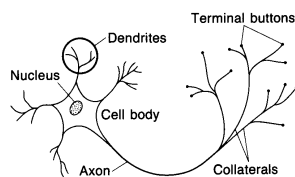
Biological Psychology



- Examines the influence of biology (e.g. neural structures, hormones, etc.) on behavior, and behavior on biology.
- _____ – the idea that bumps on the head could indicate a person's proclivities.
- Does this seem reasonable?

Neurons

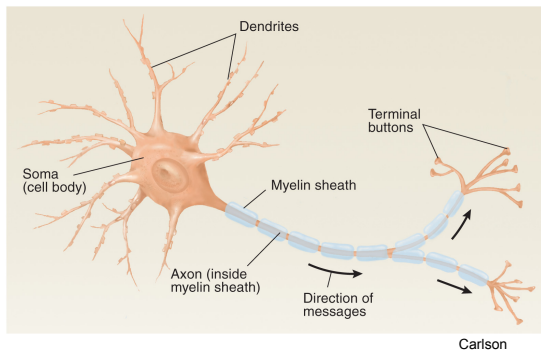
- Neurons (nerve cells) transmit and process information in the nervous system.
- The human brain has _____ neurons!



Neurons

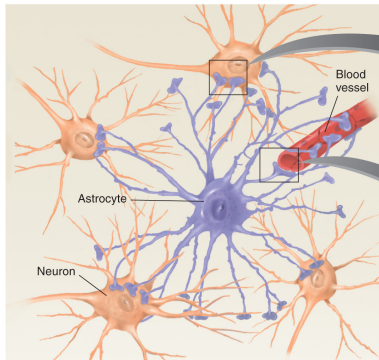
- Though there are many different shapes and sizes of neurons, most have:
 - _____ – cell body of the neuron that contains the nucleus.
 - _____ – branched structure attached to the soma that receives information from the terminal buttons of other neurons.
 - _____ – thin, cylindrical structure that conveys information from the soma to its terminal buttons.
 - _____ – bud at the end of an axon that sends information to another neuron.

A Neuron



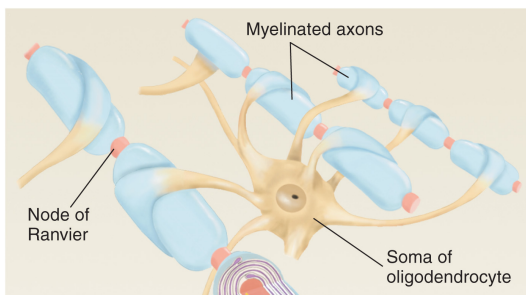
Glial Cells

- Non-neuronal cells that provide support and assist with functions in central nervous system neurons.
 - **Astroglia** (a.k.a. astrocytes): form a “mesh” in which neurons are suspended. Assist with passage of chemicals from blood to neurons.
 - **Oligodendrocytes**: send out extensions that wrap axons with **myelin** (fatty insulating substance).



Structure and Location of Astrocytes

Carlson

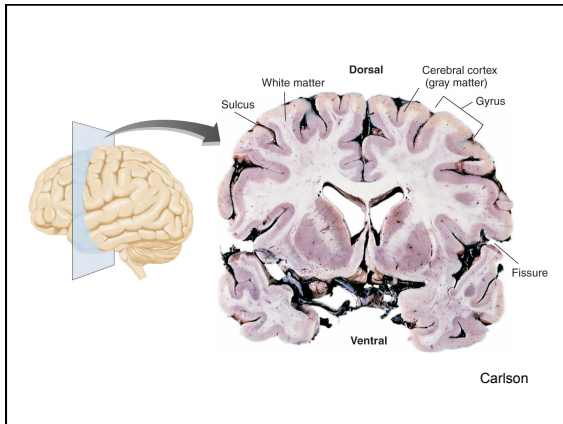


Carlson

Oligodendrocyte

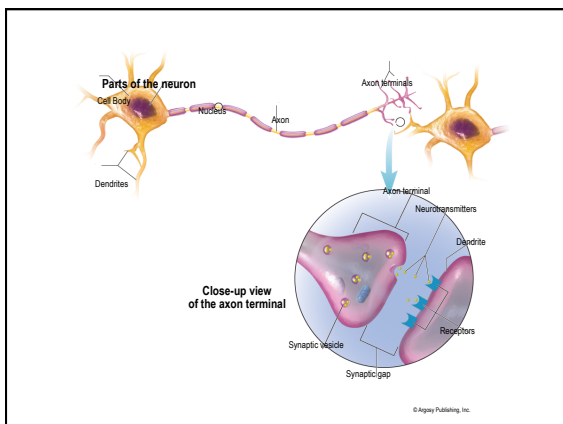
Cortex

- **Cerebral cortex** – outer covering of the cerebrum.
- Consists mostly of glia, cell bodies, and dendrites (grayish hue – **grey matter**).
- Just beneath the cortex are myelinated axons connecting the cortex to other brain areas. This area appears white (**white matter**) because of the myelin.



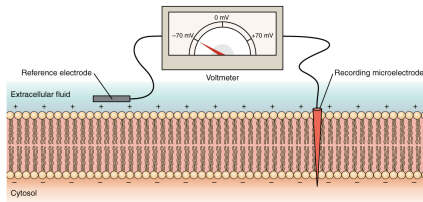
Neural Communication

- _____ – electrical impulse that travels down the axon of a neuron, and leads to chemical communication with another neuron.
- _____ - a junction between the terminal button of one neuron and the membrane of another neuron. Neural communication takes place across this gap.



Electrical Potentials

- The inside of an axon is negatively charged compared with the outside. This difference in electrical charge is called the _____
potential or resting potential.



Electrical Potentials

- If the difference in charge between inside and outside the cell is reduced, the membrane becomes _____.
- When the difference in charge between the inside and outside of the cell becomes greater, the cell membrane becomes _____.

Electrical Potentials

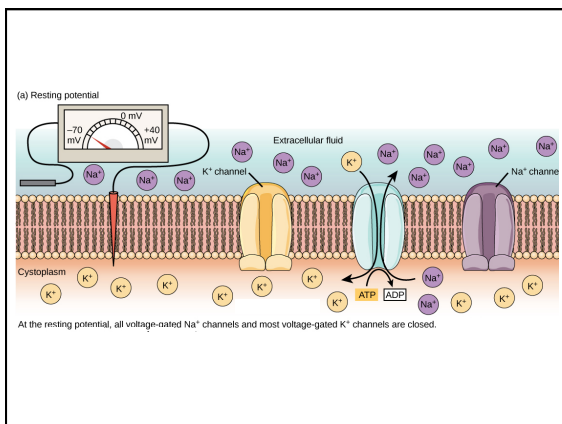
- If a membrane is depolarized to a particular point (the _____), the membrane potential will briefly reverse (the inside becomes positive with relation to the outside).
- This is called an _____, and is the basis for the conduction of information down the axon.

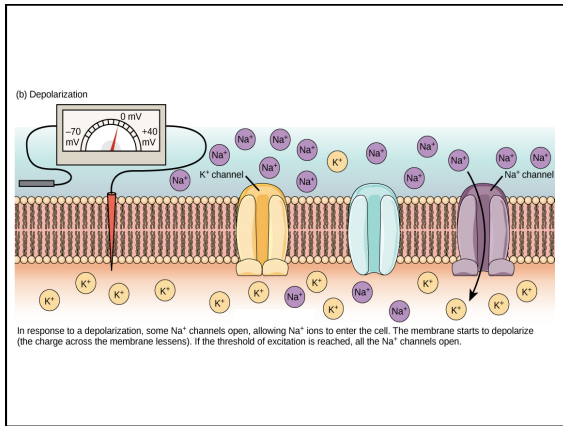
Electrical Potentials

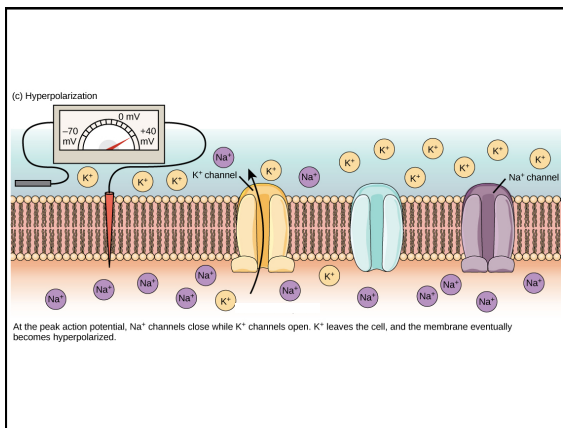
- When threshold is reached, sodium (Na^+) channels in the cell membrane open, allowing sodium into the cell.
- This reverses the potential of the cell, making the inside temporarily more positively charged than the outside.

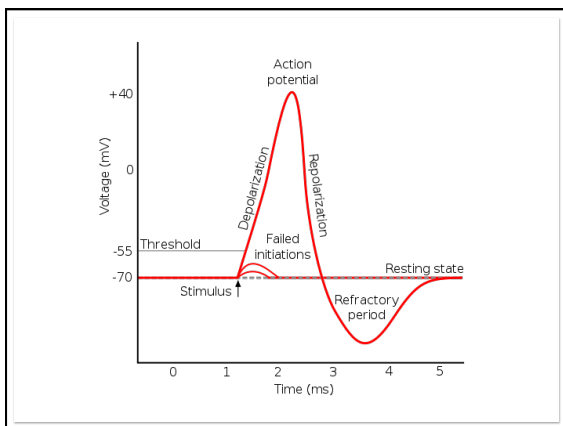
Electrical Potentials

- Potassium (K^+) channels then open, allowing potassium to leave the cell.
- This returns the cell to its resting potential, after a brief “overshoot” where the cell becomes hyperpolarized.









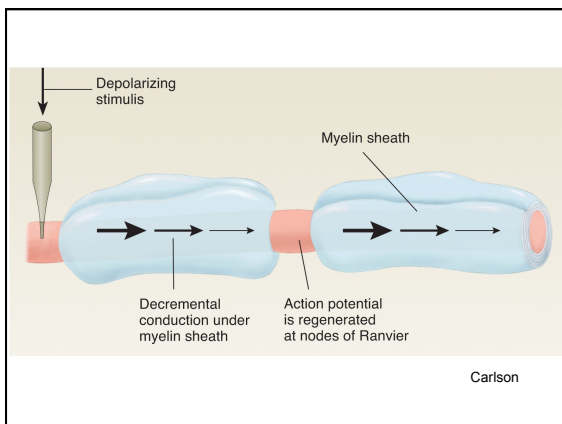
Neurons

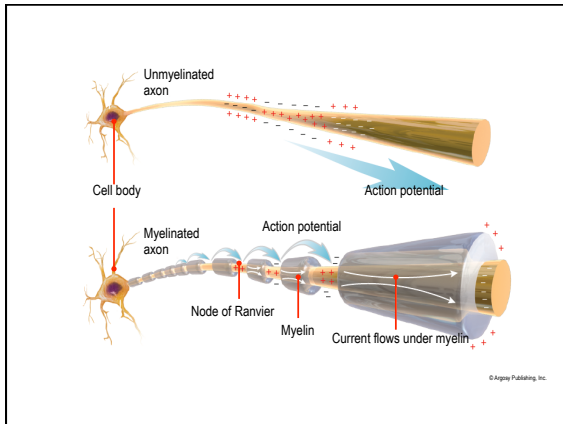
- _____ – fatty substance that insulates axons and allows them to communicate faster than they could otherwise.
- Invertebrates don't have myelin, and neural communication is less efficient and slower (neurons are also larger).



Neurons

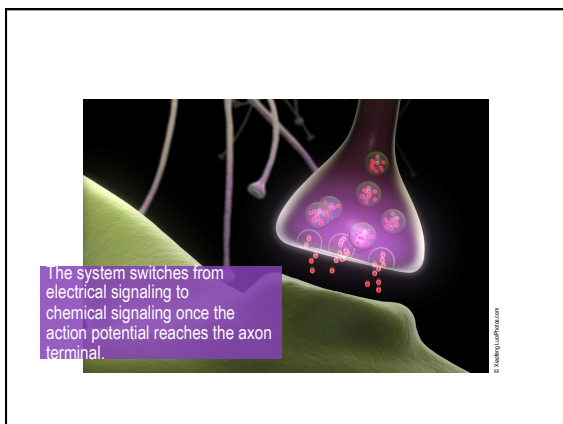
- _____ – portion of a myelinated neuron that is unmyelinated.
- _____ – action potentials appear to “jump” from one node to another. Electrical signal is actually conducted decrementally under the myelin.
- This signal is still strong enough when it reaches the next node to generate a new action potential.





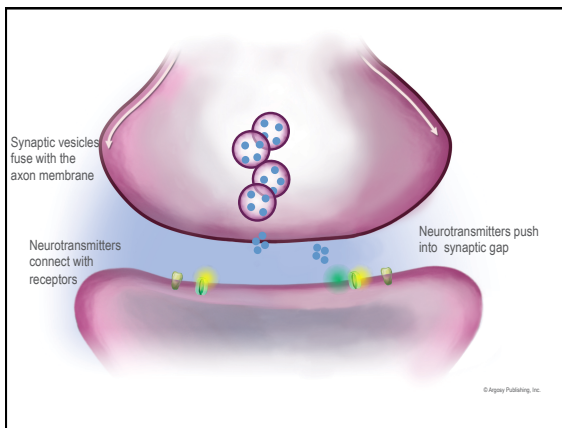
Neurons

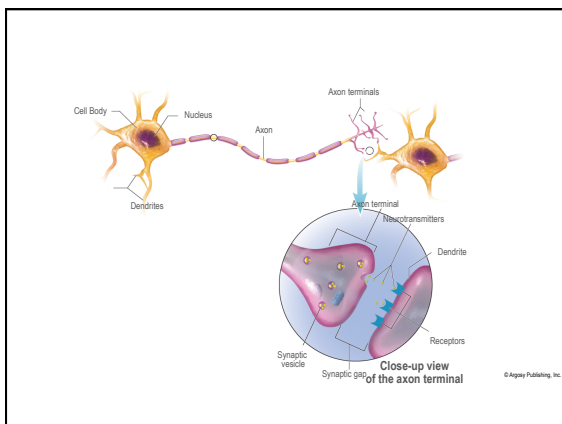
- When an action potential reaches the terminal button of an axon, it releases chemicals that communicate with other neurons.
- _____ – gap between neurons.
 - Chemicals called _____ are released by a neuron into the gap, then bind to receptors on another neuron.



Neurons

- _____ – contain neurotransmitters. Fuse with the neuronal membrane to release neurotransmitters into the synapse.
- **Receptors** – channel in the receiving membrane that receives neurotransmitters.
- **Reuptake** – neurotransmitters return to their original neuron and are taken back in. Some are broken down by enzymes, some are re-used.



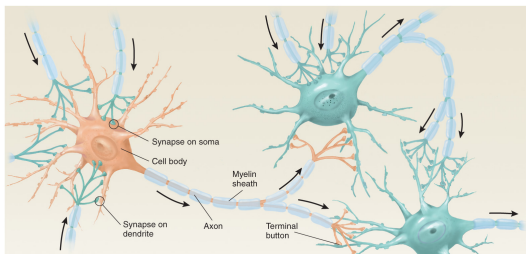


Neurons

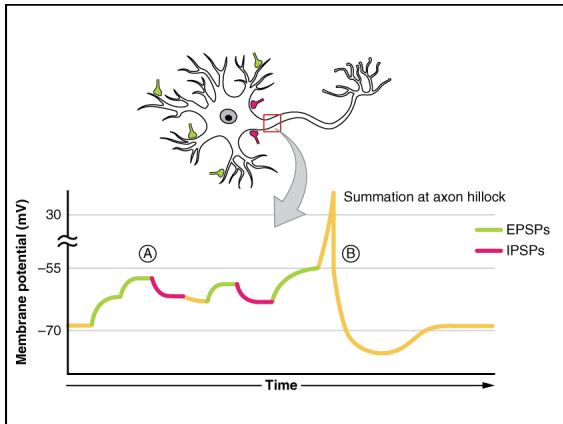
- Sometimes neurotransmitters depolarize the postsynaptic membrane, making an action potential more likely.
- Sometimes neurotransmitters hyperpolarize the postsynaptic membrane, making an action potential less likely.

Neurons

- Each neuron might receive information from dozens or hundreds of other neurons, and each neuron can also influence several other neurons.
- – signals come together near where the axon starts.
 - If there are enough excitatory signals, an action potential will result (all or nothing).
 - Inhibitory signals can cancel out excitatory signals.

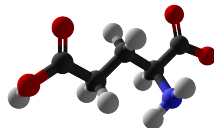
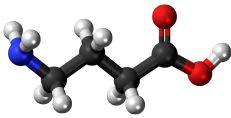


Carlson



Neurotransmitters

- Most synapses in the brain (in all animals including humans) communicate via:
 - _____ (gamma aminobutyric acid) – usually inhibitory.
 - _____ – usually excitatory. All sensory input (except pain) is initiated by glutamate.

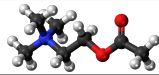


Neurotransmitters

- GABA and glutamate are responsible for most of the information transmission in the brain.
- All other neurotransmitters in the brain play a supporting role to GABA and glutamate.
- Both are called the “_____” of the nervous system because of their widespread use in synapses.
- Implicated in general arousal and routine “vegetative” behaviors.

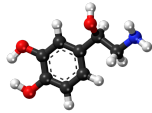
Acetylcholine

- Acetylcholine (ACh) is responsible for ALL muscular movement.
- Effects are excitatory in skeletal muscle, but inhibitory on the heart.
- Involved in regulation of REM sleep, perceptual learning, and memory.
- Individuals with _____ (symptoms include forgetfulness) have fewer cholinergic neurons (neurons that use ACh) in the neocortex.

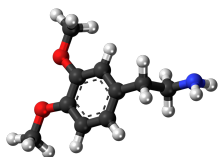


Norepinephrine (noradrenaline)

- Almost every part of the brain receives input from neurons using norepinephrine.
- Involved in attention (vigilance) and overall emotional tone.
- Too little norepinephrine is related to major depression, too much can lead to mania.

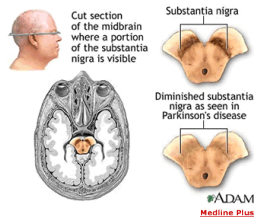


- _____-neurotransmitter involved in movement, attention, learning, and reinforcement.
- Most drugs of abuse stimulate dopamine circuits.



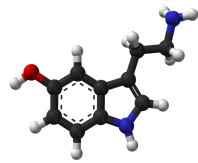
Parkinson's Disease

- Neurodegenerative disease
 - loss of dopamine-secreting neurons
- Symptoms:
 - resting tremor
 - movement initiation problems



Serotonin

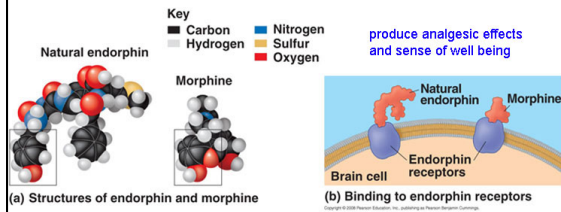
- Involved in mood, aggression, appetite, arousal, pain perception, respiration, and dreaming.
- Too little serotonin has been linked to depression and obsessive compulsive disorder.
- Too much has been linked to schizophrenia.



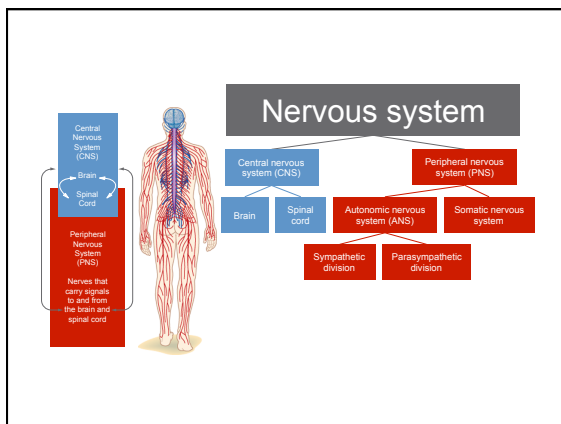
Neurotransmitters

- _____ – involved with perception of pain, defense responses, and reinforcement or “reward.” Responsible for “runners high.”
 - Endorphins = naturally-occurring opioids.
- **Opiates** – class of drugs (opium, morphine, heroin, Oxycontin) that bind to endogenous opioid receptors.

Endorphins and morphine



Week 3



Why have a nervous system?

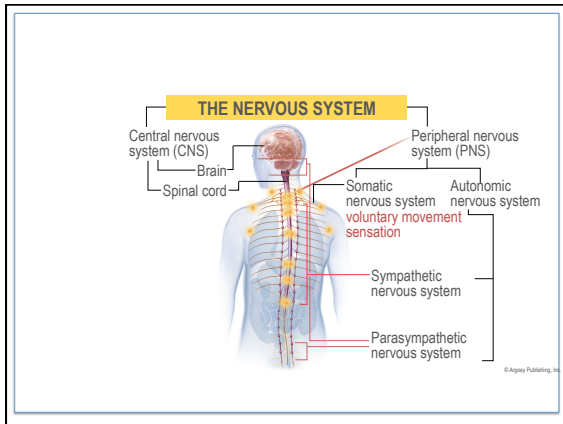
- The human nervous system (brain in particular) has evolved to solve species-typical problems (note: these problems are those our ancestors faced, some of which are the same today, some of which are very different).
 - Getting food
 - Avoiding danger
 - Caring for offspring
 - Attracting mates
 - Navigating a social environment (average group size is correlated with neocortex size in primates and other animals)

Vertebrate Nervous System

- **Nervous system (CNS)** – includes brain and spinal cord.
- **nervous system (PNS)** – all nerves outside the brain and spinal cord.
 - **Somatic nervous system** – nerves that connect sense organs to CNS, and CNS to muscles and glands. Includes voluntary movement.
 - **nervous system** – neurons that control *involuntary* muscles like heart, intestines, etc. Important for homeostasis (temperature, hunger, breathing etc.).

Vertebrate Nervous System

- Autonomic nervous system:
 - **nervous system** - a network of nerves that prepare the body for vigorous activity – “fight or flight.” Increase respiration and heart rate, decrease digestion.
 - **nervous system** - network of nerves that facilitate nonemergency responses, e.g. increase digestion, decrease heart rate, decrease respiration – “rest and digest.”

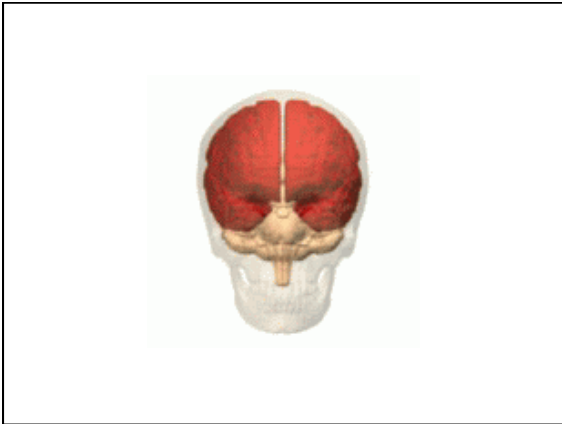


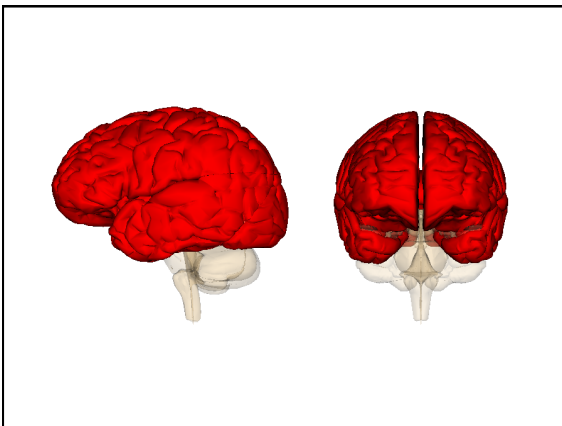
Sympathetic Activity

- Long term stress can lead to health issues if left unchecked.
- This is due to too much activity in the sympathetic nervous system, and the parasympathetic system is unable to keep up.

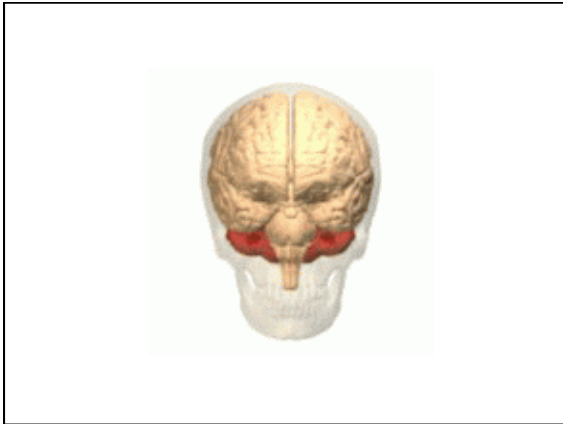
- _____ – the large area that we generally think of as “the brain.”
- The right half of the brain receives input from and sends commands to the left side of the body, and vice versa.

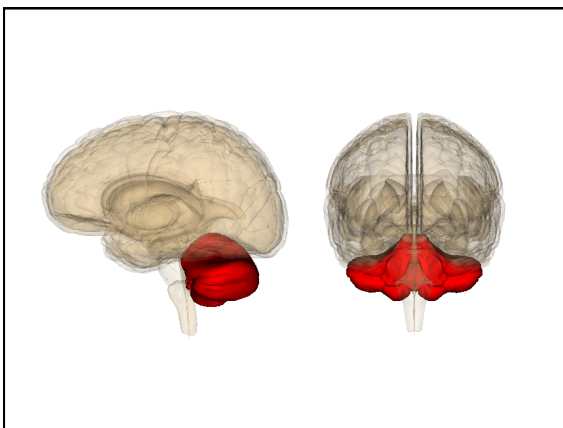






- _____ – large hindbrain structure that is involved with control of movement. More nerve cells here than the rest of the brain combined!
 - Looks like a miniature version of the cerebrum, with a cortex as well as internal structures.
 - Damage to cerebellum can lead to jerky and poorly- coordinated movements, and can even make it impossible to stand upright.
 - The cerebellum integrates information from visual, auditory, vestibular, and somatosensory areas with muscle movements to result in coordinated and smooth movements.



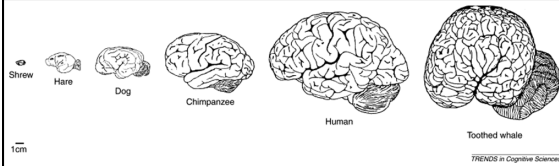


Cortex

- **Cerebral cortex** - the convoluted outer layer of the cerebrum. Beneath this layer are subcortical structures, including:
 - Thalamus
 - Basal ganglia
 - Hypothalamus
 - Hippocampus
 - Amygdala
 - Nucleus accumbens

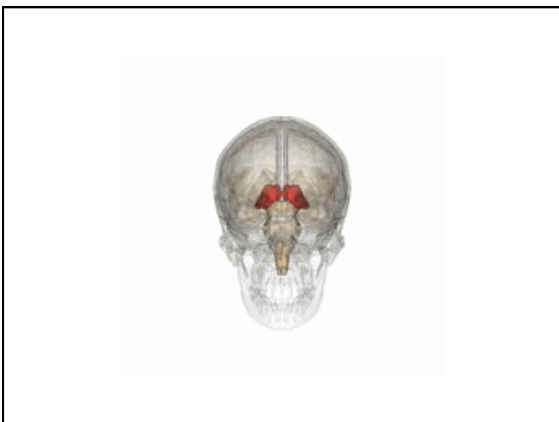
Cortex

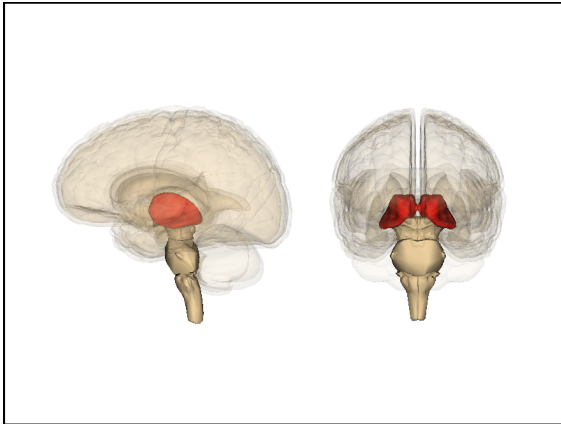
- The cortex is convoluted (i.e. wrinkly) in order to fit a greater surface area inside the skull.
- In general, species with more convoluted brains are considered more intelligent than those with less convoluted brains.



Thalamus

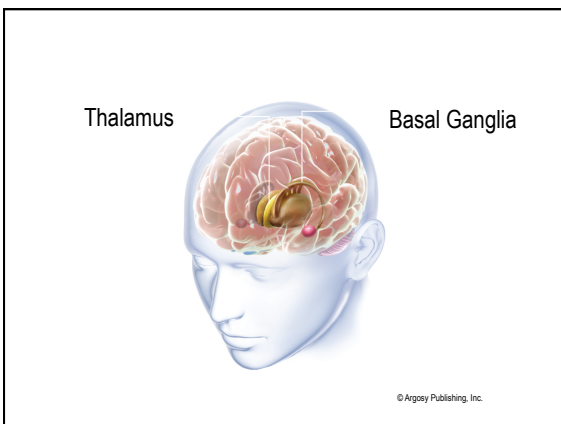
- **Thalamus** - _____ of the brain. All senses (except olfaction) pass through thalamus before continuing on to the cerebral cortex.
- Some thalamic nuclei have simple, discrete functions, while others are involved in complex or general messages.
- Involved with memory and consciousness (sleep).



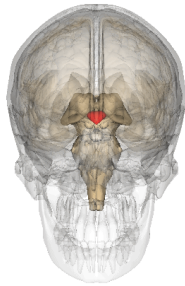


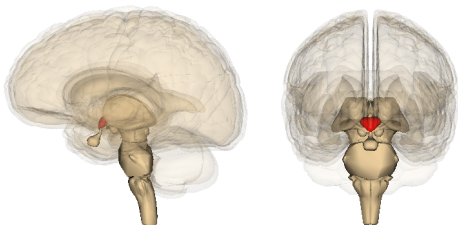
Basal Ganglia

- **Basal Ganglia** – group of structures involved in cognition and voluntary movement.
- Damage to the basal ganglia can lead to too much motor stimulation, or not enough...
- **Huntington's Chorea and Tourette Syndrome** – characterized by involuntary twitches or tics - _____.
- **Parkinson's disease** is caused by degeneration in structures of the basal ganglia.
 - Symptoms of Parkinson's disease: muscle weakness, tremors, rigidity of limbs, poor balance, and difficulty initiating movements.



- _____
- _____ - complex area with many connections to other parts of the brain.
 - Is involved with hormone production, metabolism regulation, and drives like aggression, fear, and sex.
 - Think of the four "F"s: fighting, feeding, fleeing, and (ahem) mating.
 - Autonomic nervous system responses.

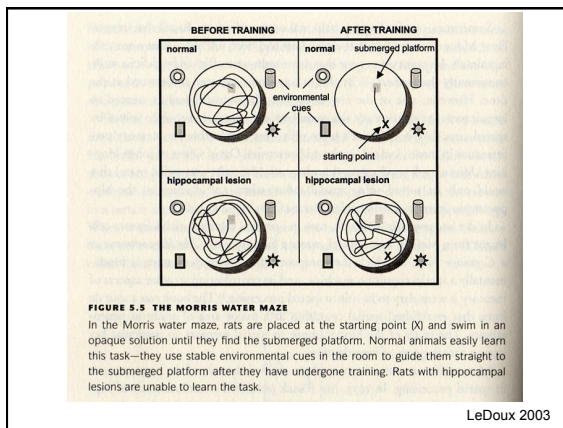


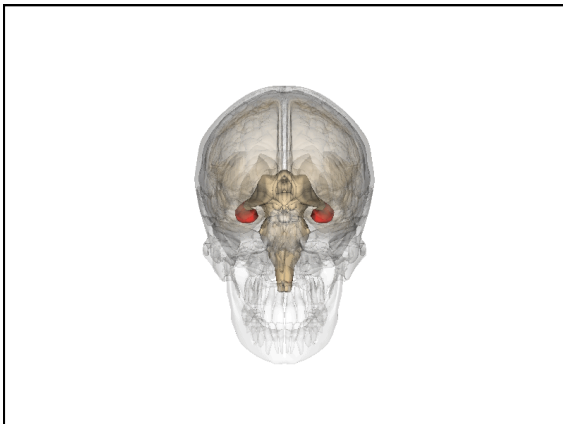


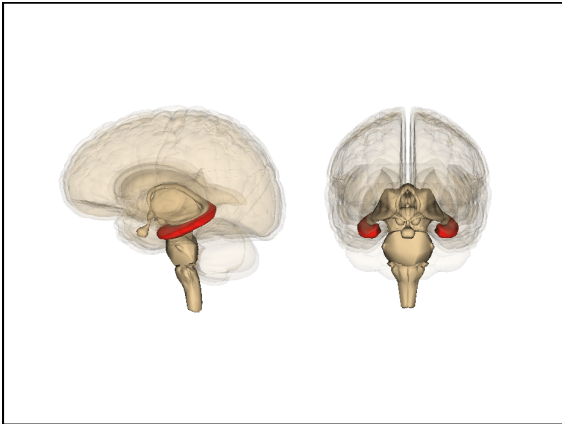
Hippocampus

- The hippocampus is involved in the formation of long-term memory, and also spatial memory.
- Rats with hippocampal lesions can not find their way out of a simple water maze.



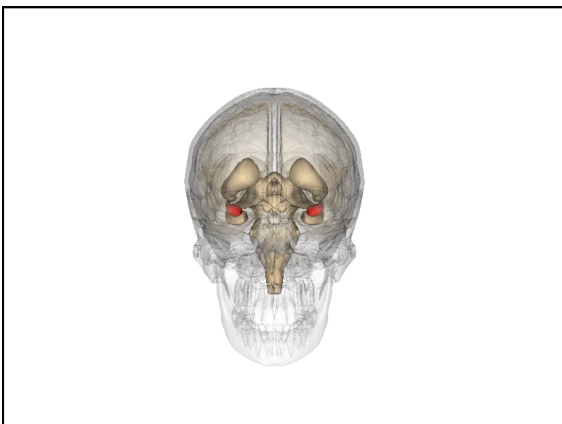


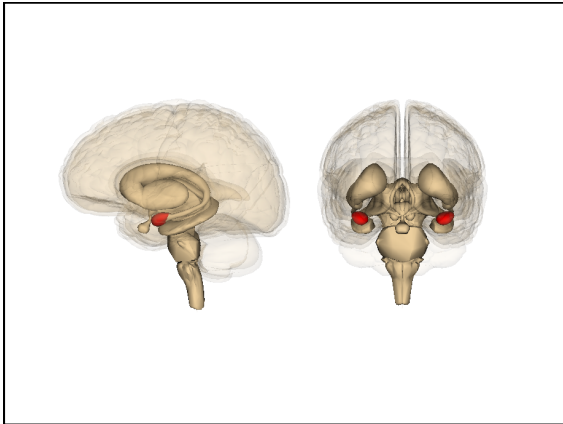


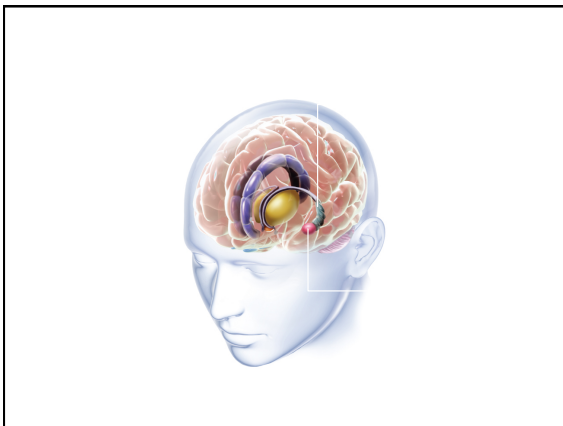


Amygdala

- The amygdala is the single most important (though not only) structure involved in emotion toward negative stimuli (fear).
- If the amygdala is destroyed in monkeys, they will approach things they usually fear (e.g. snakes), they have fewer circulating stress hormones, and they are less likely to develop ulcers.
- If the amygdala is electrically stimulated in monkeys, they show behavioral signs of fear and stress, and are more aggressive.
- Cats that have had their amygdala removed will stroll through a room of monkeys (_____!).





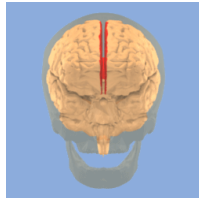


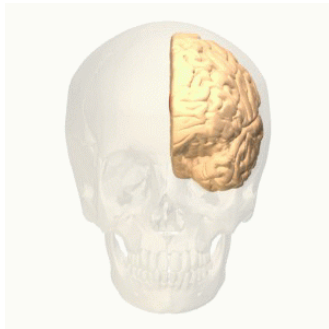
Nucleus Accumbens

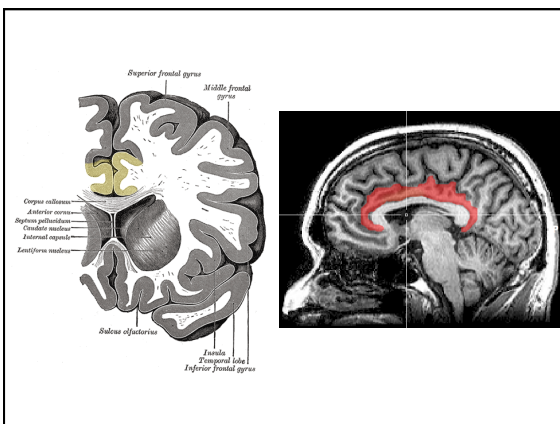
- When we experience something pleasurable, there is an increase of dopamine in the **nucleus accumbens**.
- Addictive drugs can hijack this system.

Cingulate Cortex

- **Cingulate cortex (gyrus)** - cortex that is found in the longitudinal fissure (splits brain in half from front to back).







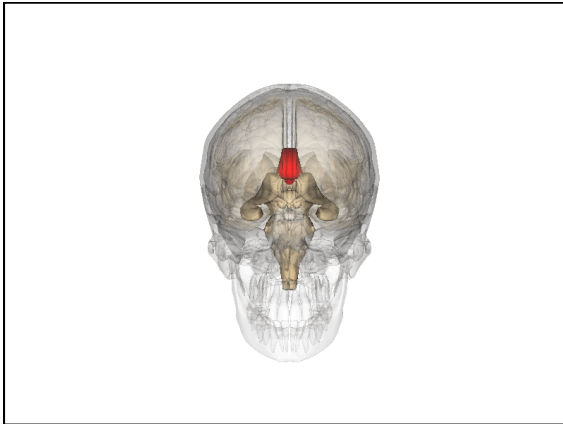
Cingulate Cortex

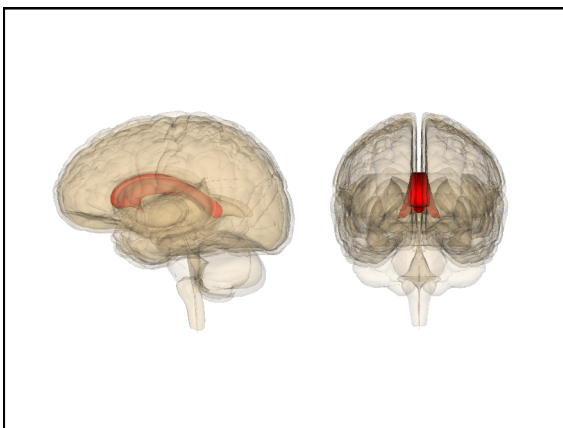
- **Cingulate cortex** is involved with:
 - Formation of long term memories
 - Coordination of sensation with emotion
 - Emotional response to pain
 - Aggression
 - Shifting attention from one task to another
 - Motivation
 - Detecting errors

Cingulate Cortex

- Individuals with obsessive compulsive disorder show increased amounts of gray matter in their cingulate cortex:
 - Compulsive worrying
 - Hold grudges
 - Difficulty “going with the flow”
- _____ – individuals with lesions in the cingulate cortex are awake and vigilant, but do not speak or move (aka “vigilant coma”). Those that recover claim they heard requests etc., but had no motivation to act.

- _____
- _____ - connects the 2 hemispheres of the brain and allows them to communicate. Leads to a “unified” experience (perceptions, memory etc.).
 - In part, connections are from one region to the identical region on the other side of the brain.





Brain Lateralization

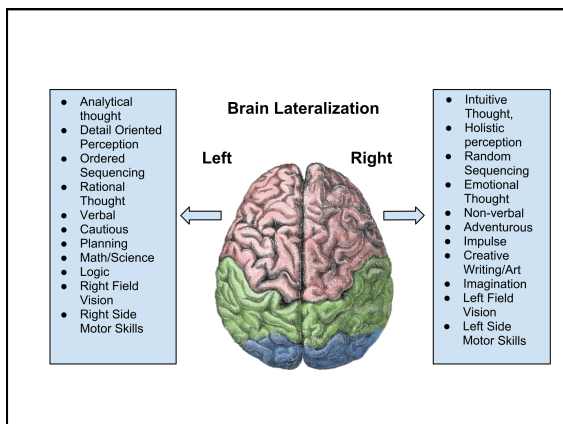
- The two cerebral hemispheres do not always perform identical functions – in other words, some functions are **lateralized**, or are performed primarily on one side of the brain (lateralization is reversed in some people!).
- Connections of most regions are _____. I.e. the motor area on the right side of the brain controls the left side of the body, and vice versa.

Brain Lateralization

- Right hemisphere – specialized in synthesis of information to perceive isolated elements as a whole.
- Functions include drawing, reading maps, constructing complex objects (spatial tasks), and music.
- Negative emotions.

Brain Lateralization

- Left hemisphere – analysis of information, recognizing serial events (events that occur one after another), controlling sequences of behavior.
- Serial functions include verbal activities like talking, understanding speech, reading, writing, math, and logic.
- Positive emotions.



Split Brain

- People that are prone to severe epilepsy that can't be controlled by drugs sometimes undergo a surgery (**split brain procedure** or _____) that severs the corpus callosum that connects the two halves of the brain.
- This prevents seizures by not allowing either side of the brain to overstimulate the other.

Split Brain

- After the operation, each side of the brain is independent, with its own sensory stimulation, motor systems, and memories.
- Though individuals that have undergone this procedure appear mostly normal, different parts of the body sometimes "_____."

Split Brain

- A case study:
- A woman was shown a cup in her right visual field. When asked what it was, she identified it as a cup.
- She was then shown a spoon in her left visual field. She said that she saw nothing.
- She was asked to pick what she was shown from a group of objects with her left hand. She picked up the spoon. When asked what it was, she replied "pencil." (it was still in her left visual field)

Procedure

The split-brain subject fixates on the dot in the center of the screen while an image is projected to the left or right visual field. He is asked to identify verbally what he sees.

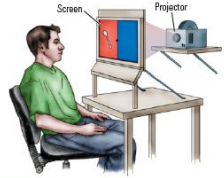


Figure 11.7

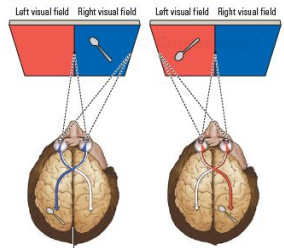
Split-Brain Phenomenon Basic testing arrangement used to lateralize visual and tactile information and allow tactile responses. (Adapted with permission from S. P. Springer and G. Deutsch, *Left Brain, Right Brain: Perspectives from Cognitive Neuroscience*, 5th ed. New York: W. H. Freeman and Company, 1998, p. 37.)

Kolb

Results

If the spoon is presented to the right visual field, the subject verbally answers, "Spoon."

If the spoon is presented to the left visual field, the subject verbally answers, "I see nothing."



Conclusion

When the left hemisphere, which can speak, sees the spoon in the right visual field, the subject responds correctly. When the right hemisphere, which cannot speak, sees the spoon in the left visual field, the subject does not respond.

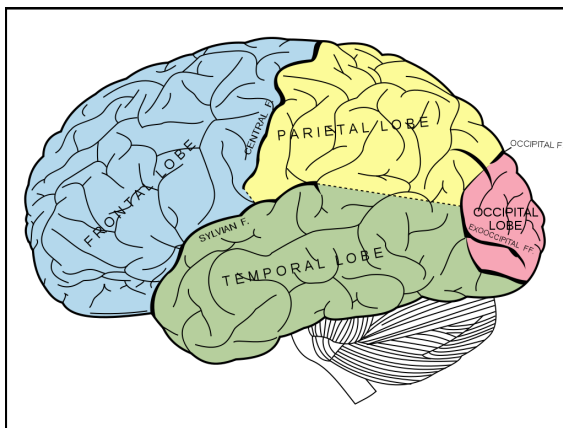
Kolb

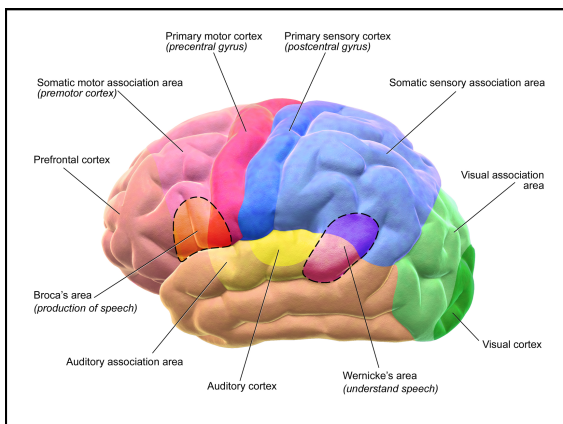
Split Brain

- **_____ syndrome:**
 - Damage to the corpus callosum.
 - People do not have conscious control of limbs.
 - A hand might do something the person does not consciously want (e.g. engage in a fight, strangle oneself, etc.).
 - Patients might claim limb is not their own.

Brain Lobes

- The cerebrum has four lobes (frontal, occipital, temporal, and parietal).
- _____ **lobe** - contains primary motor cortex (initiation of movement) and prefrontal cortex.
- _____ **lobe** – contains primary visual area. Damage to part of the occipital lobe leads to blindness in related visual field (on opposite side).
- _____ **lobe** – involved with processing auditory information, and also more complex visual aspects such as recognition of faces.
- _____ **lobe** – contains primary somatosensory cortex, which relays information about touch, and body positions.
- “**Association areas**” found throughout cortex.





Frontal Lobe

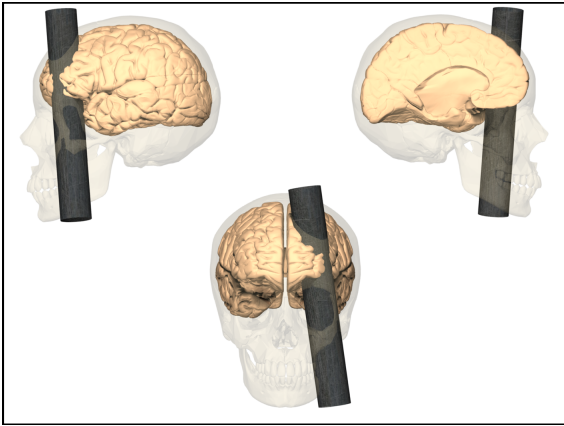
- _____ – Important for:
- Working memory (remembering recent stimuli).
- Attention (not becoming distracted by extraneous stimuli).
- Monitoring the emotional value of outcomes of actions.
- Formulating plans and strategies. “Executive functions.”
- Associative learning.
- Behaving appropriately for the context (with grandparents vs. with friends, at a football game vs. in class etc.).

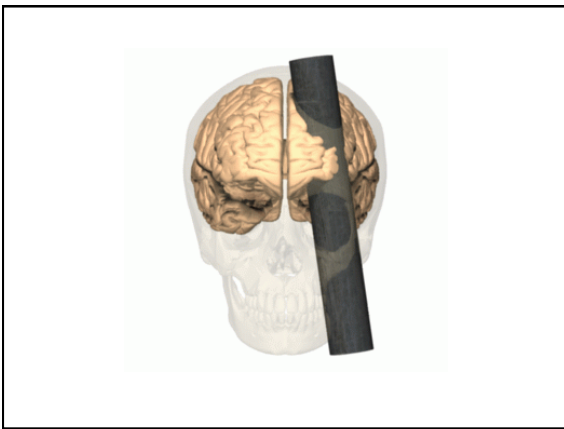
Prefrontal Cortex



Phineas Gage

- Was a railroad worker that was considered one of the best by his employers (reliable, competent etc.).
- While blasting rock in Vermont, he forgot to put sand over the explosives before tamping them down.
- His tamping rod, which weighed 13.25 pounds, was 3'7" long, and 1.25" in diameter, was forced up under his left cheek, passed behind his left eye, and exited the top of his skull. It landed 80 feet away.







Phineas Gage

- After the accident, Gage could talk lucidly, and walk without much assistance. Upon meeting the doctor, he said "here is business enough for you."
- Despite a serious infection that left him near comatose at times, he was considered completely physically healed after just 2 months.
- Though he was blind in his left eye, he had no apparent speech, language, memory, motor, or intelligence deficits. But...
- His _____ had changed!

Phineas Gage

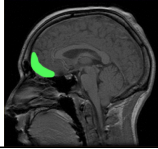
- His personal and social responsibility appeared to be gone, and he spoke so offensively that women were advised not to be in his presence since he might offend their "delicate sensibilities."
- He went from being one of the most valuable workers on the railroad to having a difficult time holding a steady job.
- He died about 12 years after the accident from a convulsion.

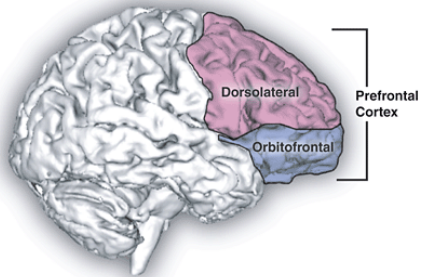
Frontal Lobe

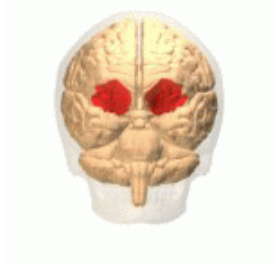
- Individuals with prefrontal damage (like Gage):
 - Difficulty identifying emotional facial expressions.
 - Poor self-insight (do embarrassing things).
 - Poor decision-making ability.
 - Difficulty distinguishing whether an insult was the result of a social faux pas, or was intentionally hurtful.
 - Inappropriate emotions are used to guide decisions.
E.g. inappropriate teasing of strangers might lead to pride instead of embarrassment.
 - Difficulty maintaining relevance in a conversation.

Frontal Lobe

- **Orbitofrontal Cortex** – part of prefrontal cortex involved with decision making, emotion, and reward.
- Orbitofrontal cortex is one of the last areas to mature (about _____).





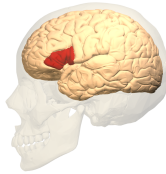


Prefrontal Cortex

- Characteristics of _____ cortex damage:
 - Antisocial behavior – disregard for others (lying, stealing, lack of remorse).
 - Inability to control impulses.
 - Reduced inhibition (public masturbation or urination, inappropriate sexual advances).
 - Aggression and irritability.
 - Emotional dysregulation - Self-regulatory disorder.

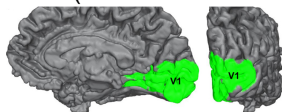
Frontal Lobe

- _____ – area in the frontal lobe involved with speech.
- If _____ area is damaged, patients can understand speech, but can't produce it.

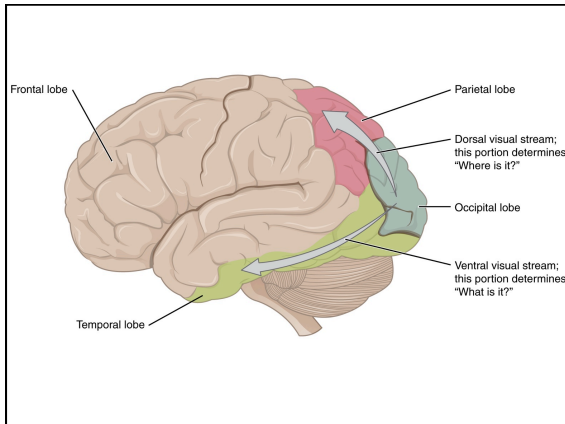


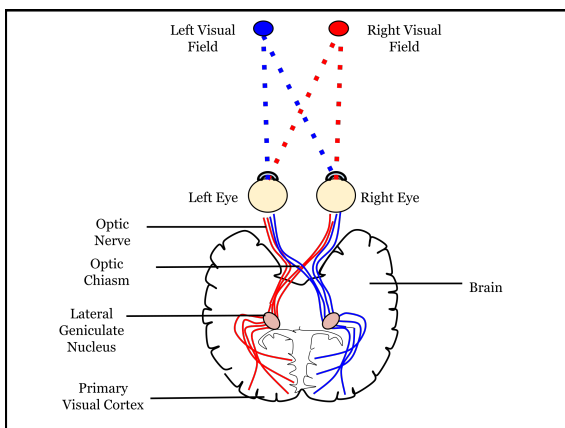
Occipital Lobe

- The occipital lobe contains the _____, also called **V1**.
- Vision “begins” in area V1, and then continues to other areas (visual association areas).



- Temporal lobe identifies what the object is
- Parietal lobe identifies where it is, or where it's going.

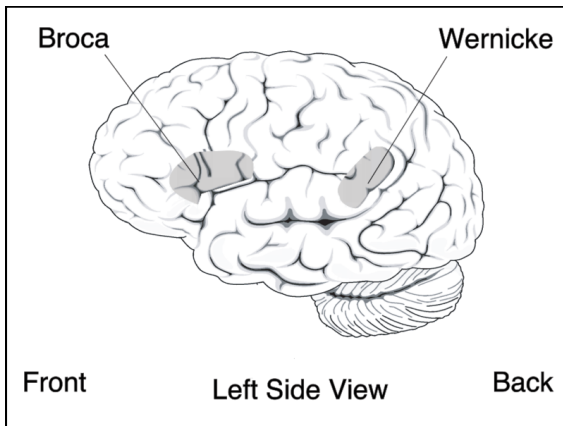




Temporal Lobe

- **Temporal lobe** – primarily involved in auditory information. Also more complex visual aspects such as recognition of faces and objects.
- _____ – area of the temporal lobe involved with speech comprehension. Individuals with damage in this area have difficulty understanding speech, and their own speech sounds fluent, but is meaningless.





Parietal Lobe

- **Parietal Lobe** – important for:
 - Knowing _____.
 - Judging where things are and how fast they're moving.
 - Processing the sense of touch.



Parietal Lobe

- If a person has right hemisphere parietal lobe damage, they sometimes suffer from _____, where they essentially ignore the left half of their body and world (this doesn't happen with left hemisphere damage).
- Impaired attention.



Special Neurons

- mirror neurons – special neurons in the frontal and parietal lobes that fire when performing an action, as well as seeing someone else perform the action.
- These neurons also fire when viewing others' facial expressions.
- Important for self awareness, social awareness (e.g. intentions of others), and empathy.
