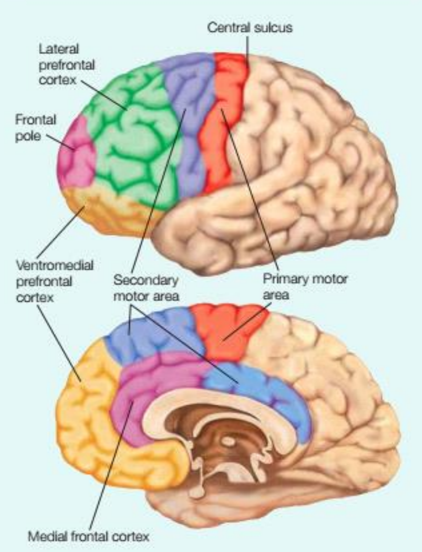
Cognitive Control

Wednesday, April 25, 2018 2:04 PM

What Is Cognitive Control?

- Cognitive control refers to mental abilities that involve planning, controlling, and regulating the flow of information processing.

The Anatomy Behind Cognitive Control



The prefrontal cortex includes all of the areas in front of the primary and secondary motor areas. The four subdivisions of prefrontal cortex are the lateral prefrontal cortex, ventromedial prefrontal cortex, frontal pole, and medial frontal cortex. The most ventral part of the ventromedial prefrontal cortex is frequently referred to as the orbitofrontal cortex, referring to the cortex which lies above the bony orbits of the eyes.

- Prefrontal cortex includes four major components: lateral prefrontal cortex, frontal pole, medial frontal cortex, and ventromedial prefrontal cortex. All are associated with cognitive control.

Cognitive Control Deficits

- The ability to make goal-directed decisions is impaired in patients with frontal cortex lesions, even if their general intellectual capabilities remain unaffected

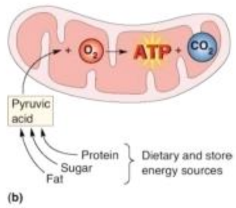
Goal-Oriented Behavior

- Goal-oriented behaviors allow humans and other animals to interact in the world in a purposeful way.
- A goal-oriented action is based on the assessment of an expected reward and the knowledge that there is a
causal relationship between the action and the reward. Goal-oriented behavior requires the retrieval, selection, and manipulation of task-relevant information.
- A habit is a response to a stimulus that is no longer based on a reward.
- Working memory consists of transient representations of task-relevant information. The prefrontal

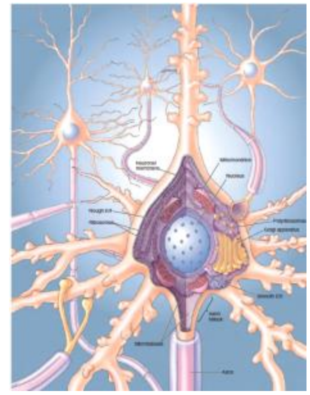
Outline for: Basic neurophysiology

Tuesday, January 30, 2018 10:06 AM

The structure of neurons:

- Neurons are the cells that transmit information throughout the nervous system.
- Most neurons consist of a cell soma (body), axon, and dendrites.
  - The soma (body) includes
    - Cytosol: watery fluid inside the cell
    - Organelles: membrane enclosed structures within the soma
      - Mitochondria: generate most of the cell's supply of adenosine triphosphate (ATP, chemical energy)
        - 

        - Mitochondria: part of the Krebs cycle (complicated cycle, main point: a single cell is a complex)
    - Cytoplasm: contents within a cell membrane (e.g., organelles, excluding the nucleus)
  - The axon is isolated by myelin
    - Myelin allows for the rapid transmission of action potentials down an axon.
    - Along the axon: **Nodes of Ranvier**: the spaces between sheaths of myelin where voltage-gated Na+ and K+ channels are located and action potentials occur.
- A membrane surrounds the neuron:
  - Barrier that encloses cytoplasm
  - Important to maintain electrical and chemical gradings → important to life
  - The membrane consists of lipids
    - Lipids are hydrophobic opposed to hydrophilic, meaning they do not dissolve in water



Neuronal Signaling

- A resting neuron is more negative on the outside, than the inside around called **the resting membrane potential,** -70 mV.
  - Due to difference in concentration of ions on the inside and the outside of the membrane
  - Na^+ and Cl^- concentrations are greater outside of the cell, and K^+ concentrations are greater inside the cell
  -

Outside	Inside
$[K^+]_o$ = 5 mM	$[K^+]_i$ = 100 mM
$[Na^+]_o$ = 150 mM	$[Na^+]_i$ = 15 mM
$[Ca^{2+}]_o$ = 2 mM	$[Ca^{2+}]_i$ = 0.0002 mM
$[Cl^-]_o$ = 150 mM	$[Cl^-]_i$ = 13 mM

  - **Polarized:** When a neuron has a negative membrane potential
- The neuroal membrane is peppered with transmembrane proteins enabling ions to move through the membrane
  - **Ion channels:** Proteins selective to ions to pass through the membrane (passive)
    - Hydrophilic channel
    - Since there are many more K+ channels, than other channels, the membran is more permeable for K+ than Na +
    - Two types of channels:
      - **Non-gated ion channels:** Always allows associated ions to pass through
      - **Gated ion channels (e.g. voltage gated channels):** Open or close due to change in voltage or chemical or physical stimuli
  - **Ion pumps:** Active transport of ions across the membrane against their concentration gradients (from low to higher concentration)
- How does the neuron maintain resting membrane potential?
  - The answer is: **Na+/K+-pump (sodium-potassium pump)** and the fact that **the membrane is more permeable for K+.**
    - **Na+/K+-pump:** For each molecule of ATP that is hydrolyzed, the resulting energy is used to move three Na^+ ions out of the cell and two K^+ ions into the cell
    - To even out the concentration gradient of ions, K+ ions are carried out of the neuron, leaving it more negative than the outside
      - Creating an electrochemical gradient: More negative on the outside than the inside

? I thought, they worked opposingly?
Slide 43: Indikerer lidt, at den er negativt ladet??

- How does the signaling occur?
  1: Environmental stimuli occur, triggering the sodium channels to open → increasing the charge inside the membrane
    - The stimuli has to be strong enough to reach the threshold of -55 mV, otherwise it is a graded potetial, which is a local phenonemeon**. All-or-nothing phenomenon.**

  2: If the increase in charge inside the neuron is large enough, the gated ion channels will open, and sodium ion will rush into the neuron causing a **depolarization** + 40 mV
    - A chain reaction of depolarization will move along the axon. If one area is depolarized, changing the current → causing other gated ion channels to open

  3: **Repolarization:** The potassium gated ion channels open, trying to even out the balance

  4: **Hyperpolarization:** Too many potassium leaves the neuron, until the sodium-potassium pump starts working again

    Refractory period: During this transient **hyperpolarization** state, the voltage-gated Na+ channels are unable to open, and another action potential cannot be generated → the current to go only ONE way.
- The amplitude of the action potential does not depend on the size of the triggering depolarization, as long as that depolarization reaches threshold for initiating the action potential.
  - The amplitude is determined by the **rate of firing**

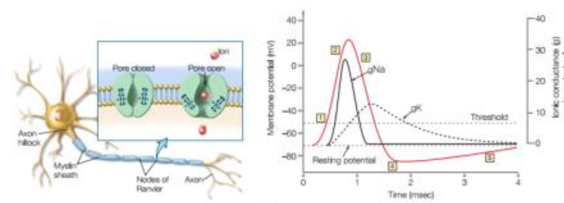
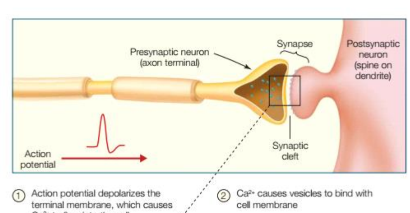


FIGURE 2.11 The neuronal action potential, voltage-gated ion channels, and changes in channel conductance.
(a) An idealized neuron with myelinated axon and axon terminals. Voltage-gated ion channels located in the spike-triggering zone at the axon hillock, and along the extent to the axon, open and close rapidly, changing their conductance to specific ions (e.g., Na^+), alerting the membrane potential and resulting in the action potential (**inset**). (b) Relative time course of changes in membrane voltage during an action potential, and the underlying causative changes in membrane conductance to Na^+ (gNa) and K^+ (gK). The initial depolarizing phase of the action potential (red line) is mediated by increased Na^+ conductance (black line), and the later repolarizing, descending phase of the action potential is mediated by an increase in K^+ conductance (dashed line) that occurs when the K^+ channels open. The Na^+ channels have closed during the last part of the action potential, when repolarization by the K^+ current is taking place. The action potential undershoots the resting membrane potential at the point where the membrane becomes more negative than the resting membrane potential.

- **Synaptic Transmission**
  - Neurons communicate with other neurons in the **synapses**, where chemical and electrical signals can be conveyed between neurons
    - found on dendrites and at axon terminals or on the neuronal cell body.
  - **Two kinds of transmission:**
  - Chemical synapse.
    - Release of neurotransmitters and the binding of those to the postsynaptic neuron causes excitatory or inhibitory postsynaptic potentials
      - If the potentials are excitatory or inhibitory epends on the properties of the postsynaptic receptor - not the neurotransmitter

Chemical synapse:



- Chemical synapse.
    - Release of neurotransmitters and the binding of those to the postsynaptic neuron causes excitatory or inhibitory postsynaptic potentials
        - If the potentials are excitatory or inhibitory epends on the properties of the postsynaptic receptor - not the neurotransmitter
    - The proces: Neurotransmitter synthesis → Load neurotransmitter into synaptic vesicles → Vesicles fuse to presynaptic terminal → Neurotransmitter spills into synaptic cleft → Binds to postsynaptic receptors → Biochemical/electrical response elicited in postsynaptic cell → Removal of neurotransmitter from synaptic cleft
        -

Removal of neu	rotransmitters: can be accomplished by (a) active reuptake back into the presynaptic terminal, (b) enzymatic breakdown of the transmitter in the synaptic cleft, or (c) diffusion of the neurotransmitter away from the region of the synapse.

- Electrical synapse:
    - Pass current directly from one neuron (presynaptic) to another neuron (postsynaptic) via specialized channels in gap junctions that connect the cytoplasm of one cell directly to the other

- **The Role of Glial Cells**
    - **Glial cells** = nonneural cells that serve various functions in the nervous system: Provide support, nutrition , insulation, and helps signal transmission in the nervous system
    - Types of glial cells:
        - Astrocyte: helps form the blood–brain barrier.
        - Oligodendrocyte: forms myelin in the central nervous system, which aids the speed of information transfer = **Nodes of Ranvier**
        - Schwann cell:forms myelin in the peripheral nervous system.
            - When axons are myelinated, it is possible to change the current for one part of the axon to the next, leaping from each node of Ranvier to the other = **Saltatory conduction**
    -

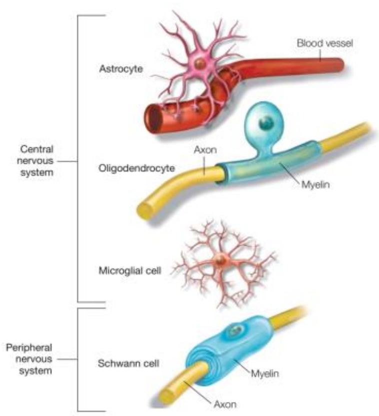


FIGURE 2.15 Various types of glial cells in the mammalian central and peripheral nervous systems.
An astrocyte is shown with end feet attached to a blood vessel. Oligodendrocytes and Schwann cells produce myelin around the axons of neurons—oligodendrocytes in the central nervous system, and Schwann cells in the peripheral nervous system. A microglial cell is also shown.

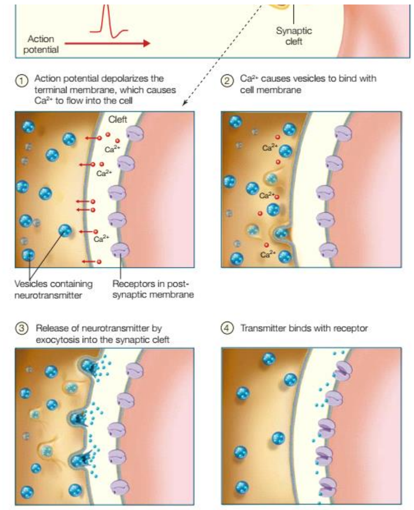


FIGURE 2.12 Neurotransmitter release at the synapse, into synaptic cleft.
The synapse consists of various specializations where the presynaptic and postsynaptic membranes are in close apposition. When the action potential invades the axon terminals, it causes voltage-gated Ca^{2+} channels to open (1), which triggers vesicles to bind to the presynaptic membrane (2). Neurotransmitter is released into the synaptic cleft by exocytosis and diffuses across the cleft (3). Binding of the neurotransmitter to receptor molecules in the postsynaptic membrane completes the process of transmission (4).

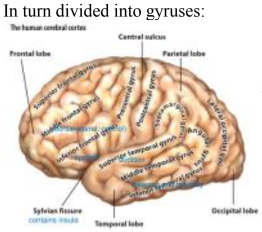
Outline for: Neuroanatomical Overview

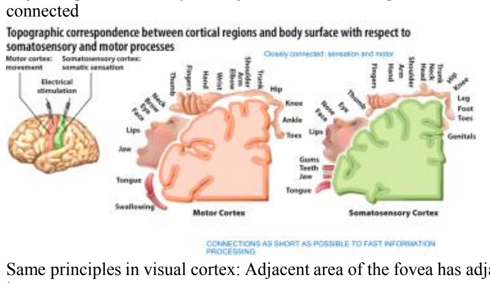
Tuesday, February 6, 2018 10:52 AM

Why learn neuroanatomy?

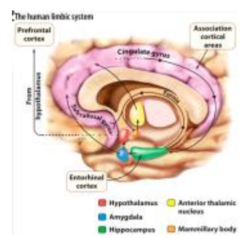
- The structure implies function, which is what we are investigating
  - If damage to the same area create similar deficits → evidence for structure-function
- Connections between areas may be functionally relevant to see interconnections e.g. structures important for language
- Inspiration for development of AI

The Bigger Picture

- Overview of Nervous system
  - The central nervous system: Brain and spinal cord.
    - Nucleus: Neurons buried in white matter, which is relatively compact arrangements of nerve cell bodies and their connection
    - The white matter: Axon and glial cells forming tracts interconnecting the brain (white by myelin)
    - The grey matter: neurons arranged in layers forming a sheet tissue
  - The peripheral nervous system: All nerves and neurons outside of the central nervous system
  - The autonomic nervous system: Involved in controlling the action of smooth muscles, the heart, and various glands.
    - Subdivided into sympathetic and parasympathetic systems:
      - The sympathetic system uses the neurotransmitter norepinephrine. This system increases heart rate, diverts blood from the digestive tract to the somatic musculature, and prepares the body for fight-or-flight responses by stimulating the adrenal glands.
      - The parasympathetic system uses acetylcholine as a neurotransmitter. It is responsible for decreasing heart rate and stimulating digestion.
- Navigation of the brain:
  - Directions refered to as:
    - Ventral: Towards the belly
    - Dorsal: Towards the back
    - Rostral: Towards the beak
    - Caudal: Towards the tail
  - Sections of the brain
    - Coronal section
    - Horizontal section
    - Sagittal section
- **The CNS (central nervous system):** Brain and spinal cord
  - Mammalian brains although they differ in size, built after similar principles (evidence for nurture in the nature vs. Nurture -debate)
  - The human brain is not particularly special:
    - Humans have larger brains, but it is the same scale between brain areas as in other primates
      - Einstein had a small brain → considered a genious
    - The cerebral cortex, which is said to be larger than other primates, does not contain many neurons compared to the cerebellum
      - Maybe the superiority is in its connectivity in the cortex, which consists of a high amount of white matter.
  - Brain autonomy:
    - **Telencepthalon**: Most cognitive processes take place here (most intereting to us)
      - Subdivided into: Limbic System, Basal Ganglia, and Cerebral Cortex
        - The limbic system includes subcortical and cortical structures that are interconnected and play a role in emotion.
        - The basal ganglia are involved in a variety of crucial brain functions, including action selection, action gating, reward-based learning, motor preparation, timing, task switching, and more.
        - The Cerebral Cortex
          - The cerebral cortex is a continuous sheet of layered neurons in each hemisphere.
          - Divided into lopes:
            - Frontal lope: planning, cognitive control, and execution of movements
            - Parietal lope: receives sensory input about touch, pain, temperature, and limb position, and it is involved in coding space and coordinating actions
            - Temporal lope: contains auditory, visual, and multimodal processing areas.
            - Occipital lope: processes visual information.
            - In turn divided into gyruses:
            - 

            - Gyri are the protruding areas seen on the surface of the cortex; sulci, or fissures, are the enfolded regions of cortex
          - Brodmann divided the brain into distinct regions based on the underlying cytoarchitectonics.
          - Topography is the principle that the anatomical organization of the body is reflected in the cortical representation of the body, both in the sensory cortex and motor cortex.
            - Adjacent part of the body has adjecent brain areas: e.g. sensation and motor cortex is closely connected
            - 

            - Same principles in visual cortex: Adjacent area of the fovea has adjacent localization in the occipital lope.
        - Association cortices are those regions of cortex outside the sensory specific and motor cortical regions.
          - Receives and integrates input from multiple sensory modalities
    - Brainstem:
      - Subdivided into three main parts: the medulla (myelencephalon), the pons and cerebellum (metencephalon), and the midbrain (mesencephalon).

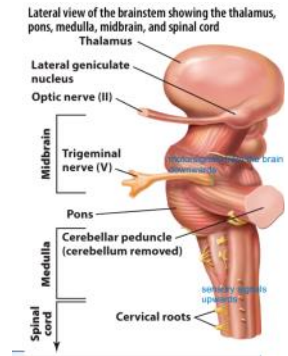


Brainstem:

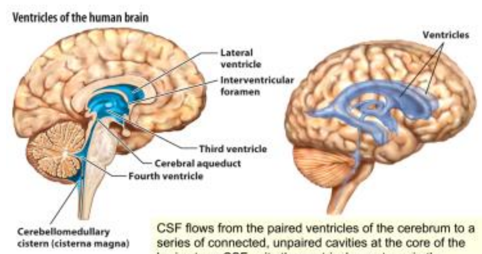
Lateral view of the brainstem showing the thalamus,

- Association cortices are those regions of cortex outside the sensory specific and motor cortical regions.
  - Receives and integrates input from multiple sensory modalities

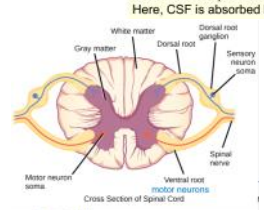
Brainstem:

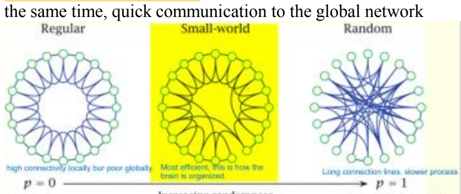


- Brainstem:
  - Subdivided into three main parts: the medulla (myelencephalon), the pons and cerebellum (metencephalon), and the midbrain (mesencephalon).
  - **Mesencepthalon (midbrain):**
    - Processing visual and auditory data
    - Generation of reflexive somatic motor responses
    - **The tectum** (latin: roof): Dorsal part of the midbrain, involved in involuntary visual and auditory processing
    - **The tegmentum** (latin: the covering): Medial part of the midbrain, which is primary area for dopamin syntheses including several nuclei e.g. substantia nigra (motor dopamine system) and ventral tegmental area (cognition/emotion reward system)
  - **Metencephalon**
    - **Cerebellum** (little brain)
      - Integrates information about the body and motor commands and modifes motor outflow to effect smooth, coordinated movements
      - Receives: motor outputs and sensory inputs describing body position, inputs from vestibular projections involved in balance, auditory and visual inputs, also project to the cerebellum from the brainstem.
      - Sends: via thalamus to the motor and premotor cortex, via nuclei of the brainstem to descending projections to the spinal cord.
    - **Pons**
      - Relay sensory information to thalamus
  - The brainstem's neurons carry out many sensory and motor processes, including visuomotor, auditory, and vestibular functions as well as sensation and motor control of the face, mouth, throat, respiratory system, and heart.
  - The brainstem houses fibers that pass from the cortex to the spinal cord and cerebellum, and sensory fibers that run from spinal levels to the thalamus and then to the cortex
  - Many neurochemical systems have nuclei in the brainstem that project widely to the cerebral cortex, limbic system, thalamus, and hypothalamus.
- Diencepthalon: Subcortical structures are composed of groups of nuclei with interconnections to widespread brain areas.
  - Subdivided into
    - Thalamus:
      - Relay station for almost all sensory information (Gateway to the cortex)
      - Divided into several nuclei that act as specific relays for incoming sensory information
    - Hypothalamus: Important to autonomic nervous system
      - Control piuitary gland, which releases hormones into the bloodstream where they can circulate to influence other
        tissues and organs (e.g., gonads).
      - Involved in maintenance of body temperature, sleep and drives (emotions)
- Ventricles
  - Structures used as landmarks for fMRI scans
  - Functions: Cushening (the brain has no skeleton→ need for ventricles in order to release the pressure from the skull to the brain), getting rid of waste material

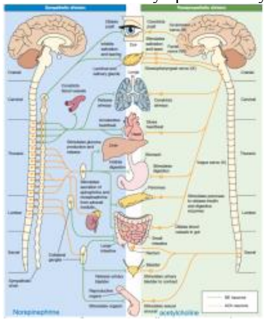


CSF flows from the paired ventricles of the cerebrum to a series of connected, unpaired cavities at the core of the brain stem. CSF exits the ventricular system via the subarachnoid space through openings near the cerebellum. Here, CSF is absorbed by the blood vessels.



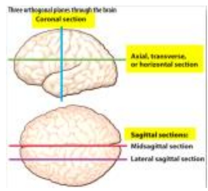
- The corpus callosum: Main fiber tract that connects the two hemispheres of the brain
- Most primitive towards ventral and most complex towards dorsal? (debatable, since cognition can affect the repile brain e.g. breath can be hold)
- Connections of the brain:
  - **Small world architecture:** The brain is constructed in a manner that allows both a high degree of local efficiency and at the same time, quick communication to the global network
  - 

- Spinal cord:
  - The spinal cord conducts the final motor signals to the muscles, and it relays sensory information from the body's peripheral receptors to the brain.
    - Ventral part (towards the belly): Conducts the final motor signals to the muscles,
    - Dorsal part (towards the back): Relays sensory information from the body's peripheral receptors to the brain.
- CNS is connected to the vasculature of the brain by the blood–brain barrier (BBB):
  - Astrocytes restricts the diffusion of objects (such as bacteria) and large hydrophilic molecules in the blood from entering the brain,
  - Allows small hydrophobic molecules such as oxygen, carbon dioxide, and hormones.
  - Many neuroactive agents, such as dopamine and norepinephrine cannot cross the BBB.
  - Plays a vital role in protecting the central nervous system from blood-borne agents

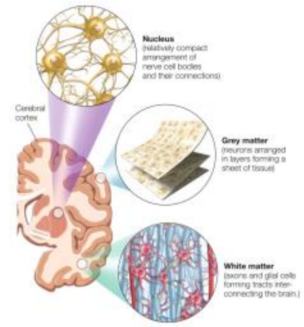
- **The ANS (autonomic nervous system):**
  - Two divisions: Parasympathic vs. Sympathic nervous system
  - 

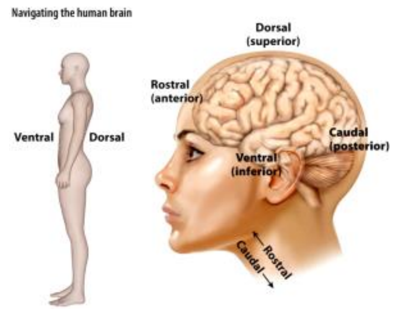
- **Development of the Nervous system**
- Already after a few days of gestation, the embryo has developed into a disklike structure with three distinct layers:
  - Endoderm (ventral): gives rise to many of the internal organs, such as digestive system
  - Mesoderm (middle): gives rise to the skeleton and the muscles

    - Ectoderm (dorsal): from which the skin and all nerves are created.
- After 18 days the ectoderm begins to thicken, and the neural plate develops.
- A few days later a groove is created, as the neural plate begins to fold
    - Subsequently the folds fuse dorsally, forming the neural tube.
    - The entire CNS is created from the walls of this tube, and the hollow inside becomes the fluidfilled ventricles.
- In the rostral end of the neural tube, three swellings occur:
    - The whole brain derives from these three primary vesicles
    - Proscencephalon or forebrain: Differentiates into the diencephalon (differentiates into the thalamus (through which almost al l information in the brain pass) and the hypothalamus (involved in hormonal control of body and brain)) the two telencephalic v esicles (which turn into the cerebral hemispheres) and optic vesicles
    - Mesencephalon or midbrain: differentiates dorsally into the tectum (latin: ”the roof”), involved in eye -movement and sound processing; and ventrally into the tegmentum (latin: ”the covering”),
    - Rhombencephalon or hindbrain:
        - Rostal hindbrain: differentiates into the cerebellum (”the little brain”) involved in execution of motor programs, pons (latin: ” the bridge”) relays information between cortex and cerebellum
        - Caudal hindbrain: differentiates into the medulla oblongata, where the corticospinal tract decussates.


Three orthogonal planes through the brain
Coronal section
Axial, transverse, or horizontal section
Sagittal sections:
Midsagittal section
Lateral sagittal section

CNS:


Nucleus
(relatively compact arrangement of nerve cell bodies and their connections)
Cerebral cortex
Grey matter
(neurons arranged in layers forming a sheet of tissue)
White matter
(axons and glial cells forming tracts inter-connecting the brain.)


Navigating the human brain
Dorsal
(superior)
Rostral
(anterior)
Ventral
Dorsal
Caudal
(posterior)
Ventral
(inferior)
Rostral
Caudal

Outline for: fMRI and other methods

Tuesday, February 13, 2018 5:49 PM

Different approaches for studying the brain:

- Methods for the Study of Neural Function:
    - **Single-cell recording**: Allows recordings from individual neurons i.e. measures membrane potential.
        - Often used on animals due to invasiveness
    - **Multiunit recording:** The activity of hundreds of cells can be recorded at the same time.
    - **Electroencephalography (EEG):** Measures the electrical activity of the brain.
        - **An event-related potential (ERP):** A change in electrical activity that is time-locked to specific events based on averaging of experimental stimuli. (Good temporal resolution)
    - **Electrocortogram (ECoG)**:Similar to an EEG, except that the electrodes are placed directly on the surface of the brain.
    - **Magnetoencephalography (MEG):** measures the magnetic signals generated by the brain.
        - The electrical activity of neurons also produces small magnetic fields, which can be measured by sensitive magnetic detectors placed along the scalp.
        - MEG can be used in an event-related manner similar to ERPs, with similar temporal resolution. (The spatial resolution can be superior because magnetic signals are minimally distorted by organic tissue such as the brain or skull)

- The methods of neural function relies on cognitive subtraction
    - Compare a task involving a particular cognitive component to a task similar task that does not in order to find the associated area of the brain
    - Challenge: When you add a cognitive component to your low level processing task, they often change.
    - Examples on cognitive subtraction: You can subtract anything, but is it meaningful?
        - Peterson et al. PET study of single-word processing
        - Die Hard 4.0 vs Italian for Beginners Might not be comparable : Dif languages etc.

Romantic movies - Temporal lobes
Intrepretation: language
Action movie
Interpretation: Motion processing

- Methods for study of structure of the brain
    - **Computed tomography (CT or CAT)** uses X-rays to image the 3-D structure of the brain.
    - **Magnetic resonance imaging (MRI)** exploits the magnetic properties of the organic tissue of the brain to image its structure (anatomy)
        - An MR-scanner consists of multiple magnets
            - The main magnet creates a strong stable magnetic field, which is always on.
                - 10000 stronger than the earths magnetic field
            - The gradient coils make the main field vary slightly for localisation purposes
                - The scanner vibrates, which is the source of the noise
            - Radio Frequency (RF) coils produce and send radio waves
            - Radio Frequency (RF) coils receive radio waves
        - The structural MRI relies on different types of tissue have differnt types of relaxation (the realignment of the molecules' spin to the magnetic field of the MR-scanner)
        - The spatial resolution of MRI is superior to CT.
    - **Diffusion tensor imaging (DTI)**, performed with MR-scanners, is used to measure white matter pathways in the brain and thus can offer information about anatomical connectivity between regions
        - Water diffuse in all directions, if unhindered i.e. hydrophobic materials
        - In white matter, it can only diffuse along fiber trats

- The Marriage of Function and Structure: Neuroimaging
    - **Positron emission tomography (PET):** Measures metabolic activity in the brain by monitoring the distribution of a radioactive tracer.
        - Procedure:
            - A substance are labelled with a radioactive isotope of some sort.
                - A popular tracer is 15O because it decays rapidly and the distribution of oxygen increases to neural regions that are active.
            - The substance is injected into the bloodstream or inhaled (depend on the wished type of measurement)
                - For the measurements of the perfusion scans often used water injected into the bloodstream (stays within the bloodstream)
                    - fMRI is often used for this types of measurements today
                - For oxygen metabolism scans often used oxygen, since it is able to cross the bloos brain barrier (inhaled)
            - The substance enters the brain, emits a positron, which meets with a negatively charged electron.
            - The electron and the positron merge, and gamma radiation is released.
            - This radiation can be picked up by the scanner and be used to tell where the substance went.
        - Downsides in PET: Radioactive tracers (limited exposure), poor temporal resolution, very expensive
    - **Functional magnetic resonance imaging (fMRI):** uses MRI to measure changes in the oxygen content of the blood (hemodynamic response). These changes are assumed to be correlated with local changes in neuronal activity. (function)
        - fMRI measures the BOLD-effect, which relies on three assumptions:
            - 1: When a brain area becomes more active the surrounding blood vessels dilate in order to attrack more oxygenated blood
            - 2: Water molecules have a spin, giving it magnetic properties. The magnet from the MR-scanner forces the molecules into alignment. When radio waves are emitted this cause disturbance in the alignment with the magnetic field from the MR-scanner. When the emission of radio waves stop, the molecules will realign with the grand magnetic field and while doing so emitting radio waves. The signal starts of strong due to alignment between the spin of the molecules, the later desynchronization will cause the signal to fade.
            - 3: Deoxygenated blood opposed to oxygenated blood causes disturbances in the magnetic fields, which cause water molecules to desynchronize faster.
            - ERGO: Activation of a brain area → the vessels to widen → more oxygenated blood→ less magnetic field disturbances → the spin of the water molecule synchronizes for a longer period of time → the signal wished measured stays for a longer period of time
        - The BOLD signal has a significant delay relative to stimulus onset and onset of neural spiking

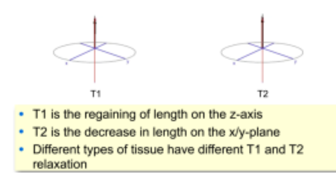
PET:
FMRI pretty much replaced this technique, besides studying Raclopride/dopamin (Was an early studytechnique - which might be why dopamine is so well studied and considered important today!)
Albert Gede (Head of CFINN before it was called CFINN), said that we look under the streetlight when we lost our key on our way home, not because we know it's there, but because it's where we're able to look

Raclopride - A dopamine antagonist (Occupies places in the brain where there could otherwise be dopamine. Tells you about the binding potential of dopamine)

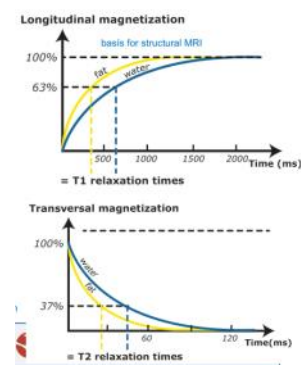
Plus many other things..

Beta amyloid plaques - PiB(Pittsburgh compound B) may be used in studies of Alzheimer's disease..

Different signal types: Relaxation as vectors



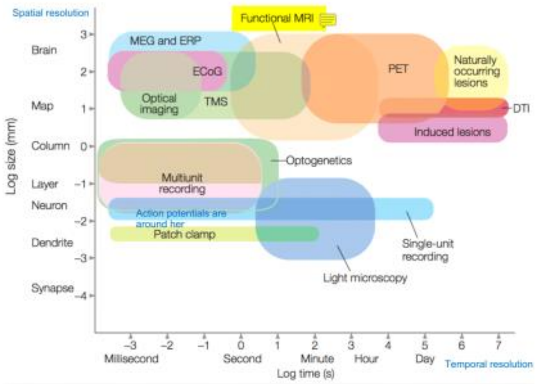
Different tissue types have different T1 and T2 relaxation rates



- Over time the scanner signal drifts causing the baseline signal intensity to vary

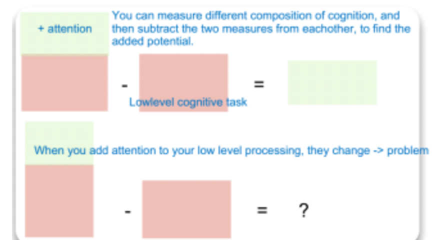
- Every method has its advantages:

-



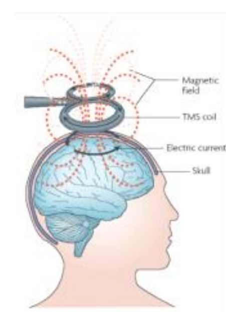
Another method for studying the function: Damaged Brain

- Research involving patients with neurological disorders is used to examine structure–function relationships.
    - Single and double dissociations can provide evidence that damage to a particular brain region may result in a selective deficit of a certain cognitive operation.
        - Single dissociation: If a patient is impaired on a particular task (task A), but relatively spared on task B
        - Double dissociation: If one patient is impaired on a particular task (task A) but relatively spared on task B and another patient is impaired on task B, but relatively spared on task A
- Types of damaged brains:
    - **Brain lesions**, either naturally occurring (in humans) or experimentally derived (in animals), allow experimenters to test hypotheses concerning the functional role of the damaged brain region.
    - **Cerebral vascular accidents, or strokes**, occur when blood flow to the brain is suddenly disrupted.
    - **Tumors** can cause neurological symptoms either by damaging neural tissue or by producing abnormal pressure on spared cortex and cutting off its blood supply.
    - **Degenerative disorders** include Huntington's disease, Parkinson's disease, Alzheimer's disease, and AIDS-related dementia.
    - **Neurological trauma** can result in damage at the site of the blow (coup) or at the site opposite the blow because of reactive forces (countercoup). Certain brain regions such as the orbitofrontal cortex are especially prone to damage from trauma.
    - **Epilepsy** is characterized by excessive and abnormally patterned activity in the brain.
- Surgical procedures have been used to treat neurological disorders such as epilepsy or Parkinson's disease. Studies conducted in patients before and after surgery have provided unique opportunities to study brain behavior relationships



Temporary lesions:

- **Transcranial magnetic stimulation (TMS)**: Allows investigation of causality
    - Uses magnetic pulses to transiently alter local brain physiology.



Outline for: Hemispheric Specialization

Tuesday, February 20, 2018 1:09 PM

Anatomy of the hemispheres:

- The hemispheres are connected by:
  - **Corpus callosum** (primarily): The largest fiber system in the brain
    - In humans, this bundle of white matter includes more than 250 million axons.
    - Divided into: Genu, body and splenium
      - However, no clear landmarks to define the separation
      - When the posterior half of the callosum is sectioned in humans, transfer of visual, tactile, and auditory sensory information is severely disrupted.
      - The anterior part of the callosum is involved in the higher order transfer of semantic information.
    - The connections in corpus callosum can be homotopic and heterotopic connections.
      - Homotopic fibers connect the corresponding regions of each hemisphere
      - Heterotopic fibers connect different areas
    - The brain areas connect accordingly in corpus callosum
      - e.g. the connection between posterior brain areas pass through the posterior part of the corpus callosum
    - ? Corpus callosum allows syncronization
    - Generally the body size correlate with size of corpus callosum
      - No one knows why…
  - Two smaller bands of fibers: Primarily connects the subcortical parts of the brain
    - **Anterior commissure**: connects regions of the temporal lobes including the amygdalae
    - **Posterior commissure:** contains fibers tha contribute to the papillary light reflex
- Differences in neural connectivity and organization may underlie many of the gross asymmetries between the hemispheres.
- Both laterilization in structure and function:
  - **Structure:** Certain areas are overdimensionized in the left hemisphere. Likely due to the development of language in this hemisphere
  - **Function:** See below

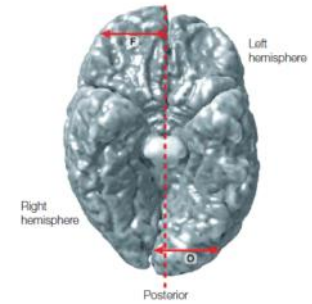


FIGURE 4.5 Anatomical asymmetries between the two cerebral hemispheres. View looking at the inferior surface of the brain; note that the left hemisphere appears on the right side of the image. In this computer-generated reconstruction, the anatomical asymmetries have been exaggerated.

There are functional differences between the right and left amygdala. In one study, electrical stimulations of the right amygdala induced negative emotions, especially fear and sadness. In contrast, stimulation of the left amygdala was able to induce either pleasant (happiness) or unpleasant (fear, anxiety, sadness) emotions. Other evidence suggests that the left amygdala plays a role in the brain's reward system.

Laterilization in function

- During the second half of the 20th century, lateralization studies became very populair → numerous amount of studies to support whatever thesis
  - "Despite all we have learned about hemispehric difference and specializations, the fundamental mystery remains today" - Gazzaniga
- The most acknowledge lateralizations: Speech, vision,
- **Speech**: Left lateralization
  - 96 % of humans, regardless of handedness, have a left-hemisphere specialization for language
    - However, exceptions are found: The Wada test is used to identify which hemisphere is responsible for language before brain surgery is performed.
  - Lesions in left hemisphere can lead to aphasia
    - e.g. Sarah Scott: Typical symptoms of Broca's aphasia: Telegram-style utterances, lack of words, but meaningful uttarances
  - Planum temporale (Wernickes area) is usually larger in the left hemisphere
    - Seldom example on an anatomical index is correlated with a well-defined functional asymmetry?
    - Experiment: Correlation between cognitive scores and symmetry of the planum temporale
      - Results: VERY small correlation, if there is a connection between function and structural differences
  - Differences have been found in the specifics of cortical microcircuitry between the two hemispheres in both anterior (Broca's) and posterior (Wernicke's) language associated cortex.
- **Vision**: The right hemisphere receives input from the left part of the visual field and visa versa
  - Split-brain patients cannot name or describe visual and tactile stimuli presented to the right hemisphere, because the sensory information is disconnected from the dominant left (speech) hemisphere.
    - They will, however, be able to choose a corresponding object using the hands → they are aware of the object, though an inability to name it

65% had bigger left planum temporale • 24% were symmetric

These numbers still hold up, pretty well
But there has been 100s of thoutands studies on this the last few decades - So you'll be able to find the data you want

out of dozens of split-brain patients who have b n carefully examined, only six showed clear evidence of residual linguistic functions in the right hemi- sphere. And even in these patients, the extent of right- hemisphere language functions is severely limited and restricted to the lexical aspects of comprehension. Interestingly, the le and right lexicons of these spe- cial patients can be nearly equal in their capaci , but they are organized quite di erently. For example, both hemispheres show a phenomenon called the word supe- riori e ect (s Chapter 5). Normal English readers are be er able to identi le ers (e.g., L) in the context of real English words (e.g., belt) than when the same le ers ap- pear in pseudowords (e.g., kelt) or nonsense le er strings (e.g., ktle). Because pseudowords and nonwords do not have lexical entries, le ers occurring in such strings do not receive the additional processing bene t bestowed on words. us, the word superiori e ect emerges.
While the patients with right-hemisphere language exhibit a visual lexicon, it may be that each hemi- sphere accesses this lexicon in a di erent way. To test this possibili , investigators used a le er-priming task. Participants were asked to indicate whether a brie y ashed uppercase le er was an H or a T. On each trial, the uppercase le er was preceded by a lowercase le er that was either an h or a t. Normally, participants are signi cantly faster, or primed, when an uppercase H is preceded by a lowercase h than when it is preceded by a lowercase t.

no evidence of le er priming for le visual eld (LVF) tri- als but clear evidence of priming for trials of the right visual eld (RVF). us, the lack of a priming phenom- enon in the disconnected right hemisphere suggests a de cit in le er recognition, prohibiting access to par- allel processing mechanisms. J.W. exhibited a varie of other de ciencies in right-hemisphere function as well. For example, he was unable to judge whether one word was superordinate to another (e.g., furniture and chair), or whether o words were antonyms (e.g., love and hate).

- **Other lateralizations from the book:**
  - There may be two lexicons (associations of words with specific meanings), one in each hemisphere.
    - The right hemisphere's lexicon seems organized differently from the left hemisphere's lexicon, and these lexicons are accessed in different ways.
  - The right hemisphere has been linked to one aspect of speech perception, prosody, the way we vary articulation to convey affect or intonation.
  - Some studies show that the right hemisphere is specialized for visuospatial processing.
  - The right hemisphere has special processes devoted to the efficient detection of upright faces.
    - The left hemisphere outperforms the right hemisphere when the faces are dissimilar, and the right hemisphere outperforms the left when the faces are similar.
  - Although touching any part of the body is noted by either hemisphere, patterned somatosensory information is lateralized.
    - A split-brain patient who is holding an object in the left hand is unable to fnd an identical object with the right hand.
  - Surprisingly, split-brain patients can use either hemisphere to direct attention to positions in either the left or the right visual field.
  - Patients with left-sided lesions were slow to identify local targets, and patients with right-sided lesions were slow with global targets
    - The left hemisphere is more adept at representing local information and the right hemisphere is better with global information.
  - The left hemisphere contains "the interpreter"
    - A system that seeks explanations for internal and external events in order to produce appropriate

response behaviors.

Studies on lateralization

- Development of the studies on lateralization is based on research on split-brainers
    - A notion being: The corpus callosum is often only ruptured on those with the need e.g. epilepsy patients, whose brains may already be damaged
- Evidence on lateralization is also found in normal brains:
    - Facial expressions: Both hemispheres can generate spontaneous facial expressions, but you need your left hemisphere to produce voluntary facial expressions → People appear to have two neural systems for controlling facial expressions
    - Handedness is phenomenon
    - Ocular dominance: 97 % have a dominant eye, the phenomenon is correlated with handedness
    - Situs inversus: Due to asymmetrical motions of protein cilia in a structure called "the node" on the ventral surface of embryos in early stages of development the heart develop in the right side of the body
    - The drawing experiment: Tendency for Danish speakers to imagine them in a left-to-right manner corresponding to the reading direction:
    - The dichotic listening task: Often a right ear dominance, this is typically the ear shadowed during the task

The Evolutionary Basis of Hemispheric Specialization

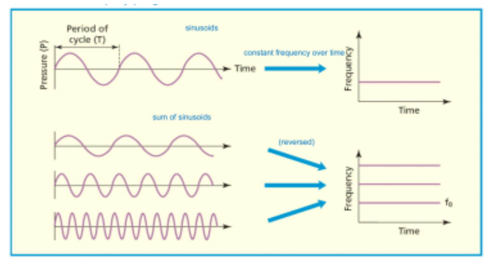
- Hemispheric specialization is not a unique human feature, though it is most extensive in humans.
    - The evolutionary pressures underlying hemispheric specialization—the need for unifed action, rapid communication, and reduced costs associated with interhemispheric processing—exist across species.
- In general, many tasks can be performed successfully by either hemisphere, although the two hemispheres may differ in efficiency.
- Sarah Scott improves her ability to speak over the years → redundant areas of the brain, functions happen multiple places
    - Evolution does don't remove the old solution even though it has found a new

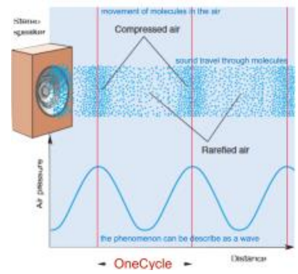
Outline for: Perception focus on hearing

Tuesday, February 27, 2018 1:05 PM

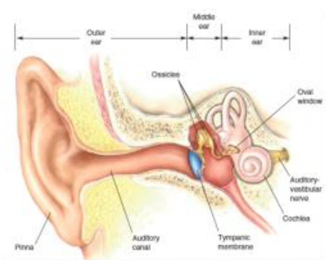
Audition

- Audition is more than detection of sounds: Involves constructing a model of the world
    - What objects do sounds correspond to?
    - Which location do they come from?
- The nature of sound: Sound is movement of molecules in the air
    - A tone can be either pure or more complex
        - Pure tones: Only has energy in a certain frequency and is constant over time
            - Example: Sine wave
        - More complex sounds: Has energy in multiple frequencies, which varies over time i.e. sum of sinusoids
            - Example: White noise most complex sound: The energy is randomly distributed over frequencies and fluctuates over time - difficult to predict (high entropy)
        - In speech is vowels more like pure tones with higher harmonics, whereas the consonants are more like white noise.
    - Changed in air pressure have the characteristic properties: amplitude and frequency
        - Frequency: Number of oxilaries
            - High frequency waves is perceived as having a higher pitch
        - Intensity: The amplitude of the waves
            - High-intensity waves are peceived as louder sound
        - Pitch and volume are psychological properties, whereas frequency and amplitue are physical properties
            - → Not a one-to-one mapping e.g. the example of the missing fundamental, where the same a note with 1000 Hz is perceived eventhough only the overtones are played





- Transformation of sound to neural signals:
    - The pathway through the ear:
        - 1: **Outer ear**
            - The pinnae: The outer gristle of the ear shaped to amplify certain frequencies and cause delay in sound due to reflections of sound on the shapes of the pinnae → important for locating sound
            - The ear canal: The canal the sound travels along upto the ear drum
        - 2: **Middle ear:**
            - Converts airborne vibrations from the ear drum to liquid-borne vibrations in the inner ear
            - The ossicles - the malleus, incus and stapes (three small bones) amplify sound pressure by acting as levers, and by applying the force on a smaller area (The oval window).
            - This enables sound to produce movement inside the fluid-filled space of the cochlear
                - The ossicles equally serve as an active volume control: By contracting the tensor tympani muscle and the stapedius muscle, the chain of the ossicles becomes more rigid thereby adjusting reactions to louder sounds.



        - 3: **Inner ear:**
            - The inner ear converts the liquid-bore sounds to neural impulses
            - Consists of
                - Vestibular System: Important for maintaining balance
                - Cochlea: Signals are processed in the hair cells and basilar membrane of the cochlea.
                    - In the basilar membrane: Sound pressure travels from the base of the scala vestibuli, were it is initiated at the oval window by the stapes, through the helicotrema, and down the scala Tympani, where it makes the membrane at the round window move.
                    - Low frequencies travel far along the basilar membrane, wheres high frequencies travel shorter.
                        - Explain the phenomenon, tinitus. The hair cells first in the beginning of the basilar membrane are more exposed to sound, if overstimulated they lay down, leaving a constant activation of the high-frequency cells
                    - Sound produces motion in the basilar membrane relative to the tectorial membrane - thereby bending the hairs (stereocilia) on the hair cells

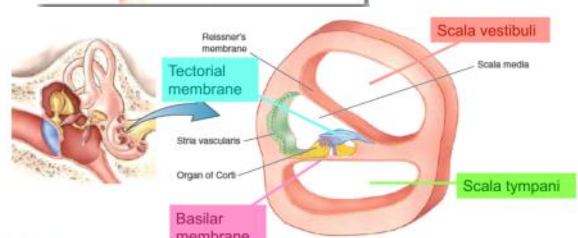


FIGURE 11.7

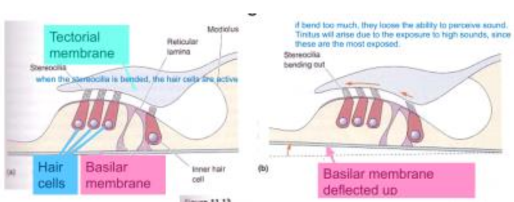


Figure 11.13

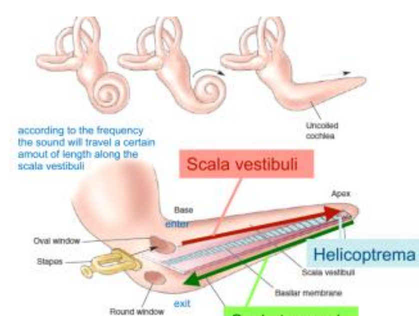
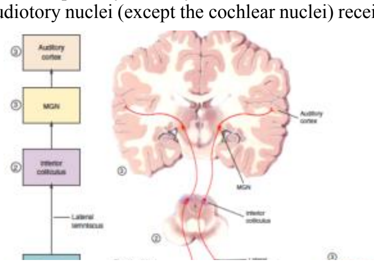
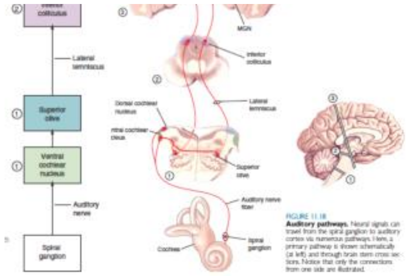


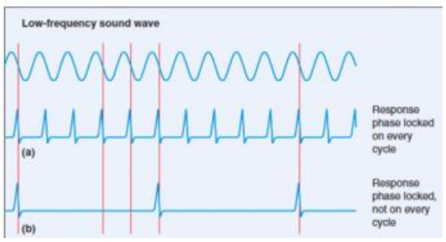
FIGURE 11.8

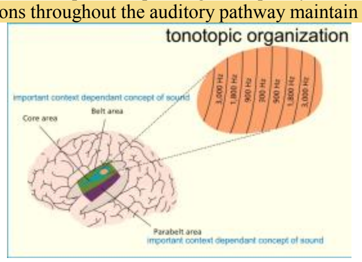
    - The pathway from the ear
        - The cochlea sends its information in the form of neuronal signals to the inferior colliculus and the cochlear nucleus. Information then travels to the medial geniculate nucleus of the thalamus and on to the primary auditory cortex.
        - All audiotory nuclei (except the cochlear nuclei) receive imput from both ears





- Frequency and intensity is encoded, when perceiving sound:
    - Frequency tuned neurons in the auditory nerve.
    - Intensity is coded in the firing rates and in the number of active neurons
    - The volley principle allows one-to-one maping to a certain degree: When more than one cell (as in (b)) go together to give the whole series of waves in a phaselocked manner. This is possible only up to 4kHz.



    - Above this frequencies are represented by tonotopy alone: The fact that particular beuron fires, instead of the tops corresponding to frequency
- Neurons throughout the auditory pathway maintain their tonotopic arrangement as they travel up to the cortex
    - 

- Sound localization is aided by the processing of differences in interaural time and interaural sound intensity, which are each coded separately in the brain.
- For localization of sound: see slide
- For summary: See slide

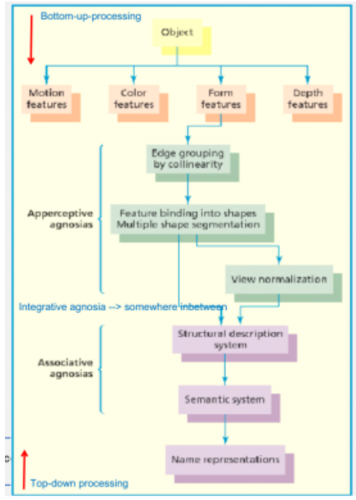
Similarities to the visual system:

COMPARISONS BETWEEN THE AUDITORY AND VISUAL SYSTEMS

	Auditory system	Visual system
Thalamo-cortical route	Medial geniculate nucleus projects to primary auditory cortex	Lateral geniculate nucleus projects to primary visual cortex
Organizing principle of early neural processing	Tonotopic organization (orderly mapping between sound frequency and position on cortex)	Retinotopic organization (orderly mapping between position on retina and position on cortex)
Temporal and spatial sensitivity	Temporal > Spatial fast	Spatial > Temporal
Functional specialization of feature processing	Less well documented in the auditory domain	Well documented for color and movement
Higher-order context-dependent pathways	Evidence for separate auditory pathways for "what" versus "where"/"how" maybe signal is mixed between hemispheres	Evidence for separate visual pathways for "what" versus "where"/"how"

Outline for: Object recognition

Monday, March 12, 2018 8:23 AM

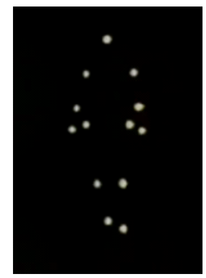


Principles of Object Recognition

- Memory and perception are tightly linked.
- Sensation, perception, and recognition refer to distinct phenomena.
- People perceive an object as a unified whole, not as an entity separated by its color, shape, and details.
- Although our visual perspective changes, our ability to recognize objects remains robust →object constancy
  - Object constancy refers to the ability to recognize objects in countless situations, despite variation in the physical stimulus
    - Words do not have object constancy - when shown a mirrored image of a word, the brain does not get "bored"
  - Disproves the template matching model: A vast amount of templates should be stored in order to hold up.

Visual perception in the brain

- "What"-pathway: The ventral stream (occipitotemporal pathway) is specialized for object perception and recognition.
  - Lesions of the ventral pathway may have severe problems in consciously identifying objects, yet they can use the visual information to guide coordinated movement.
- "Where"-pathway: The dorsal stream (occipitoparietal pathway) is specialized for spatial perception
  - Lesions of the dorsal pathway can recognize objects but cannot use visual information to guide action (Optic ataxia) Reaching for something: she gropes about like a person trying to nd a light switch in the dark
- The parietal lobe: Neurons have large, nonselective receptive fields that include cells representing both the fovea and the periphery.
- The temporal lobe: Neurons have large receptive fields that are much more selective and always represent foveal information. Posterior to anterior
- The lateral occipital cortex is critical for the recognition of the shape of an object.

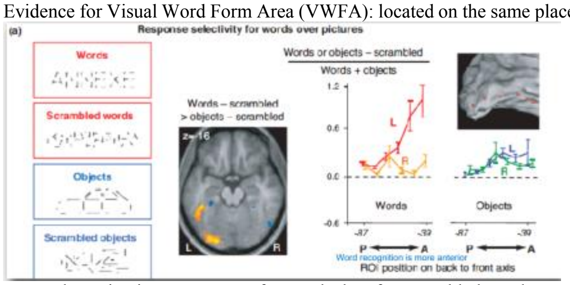


Biological motion

Types of object recognition

- Holistic vs. Analytic processing
  - Holistic processing is a form of perceptual analysis that emphasizes the overall shape of an object, a mode of processing that is important for face perception.
    - The Margret Thatcher illusion is a product of the holistic processing of faces
    - Different objects may depend more or less on holistic analysis
  - Analytic processing is a form of perceptual analysis that emphasizes the component parts of an object, a mode of processing that is important for reading.

As predicted, house perception did not depend on whether the test items were presented in isolation or as an entire object, but face perception did (Figure 6.34b). Participants were much be er at identi ing an individual facial feature of a person when that fea- ture was shown in conjunction with other parts of the person's face.

- Word recognition
  - Words can be processed holistically or by its parts
    - Difficult words often by its parts → the sounds to shape a full word
    - Shorter words are recognized as a hole → word superiority effect
  - Evidence for Visual Word Form Area (VWFA): located on the same place as FFA except it is left lateralized
  - 

    - The activation was greater for words than for scrambled words
    - The more it could be a word → the more activity in the VWFA e.g. er more likely than XS

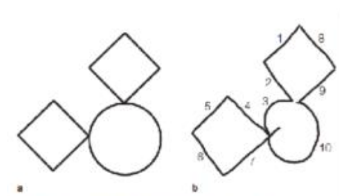


FIGURE 6.19 Patients with integrative agnosia do not see objects holistically.
Patient C.K. was asked to copy the figure shown in (a). His overall performance (b) was quite good: the two diamonds and the circle can be readily identified. However, as noted in the text, the numbers indicate the order he used to produce the segments.

Face perception tasks involve within-category discriminations; object perception tasks pically involve be n-category discriminations. Per- haps the de cits s n in prosopagnosia patients re ect a more general problem in perceiving the subtle di erences that distinguish the members of a common category.

e patient literature fails to support this hy- pothesis, however. For example, a man who became a sh p farmer (W.J.)

- Face recognition
  - Multiple face recognition modules:
    - Fusiform Face Area (FFA): Ventral part of the temporal lopes
      - Important for recognition of faces
    - Superior temporal sulcus (STS): Involved in face perception in monkeys
      - Hypothesis: STS is important for social interactions
    - Study, which detangles the difference between FFA and STS: Gazzaniga p. 252
- Biological motion (a seperate phenomeonn?): A particular type of motion involving humans, which is processed in a seperate module
  - Biological motion is perceived as dots in a pattern
    - Movement, activity and gender can often be deduced from these pattern

Deficits in object recognition

- Agnosia (lack of knowledge): the inability to recognize objects, when using a given sense e.g. vision, even though the sense is basically intact
  - When using other senses, the knowledge of the object can be accessed → opposed to amnesia
    - Case: G.S. Unable to access the knowledge of a viewed lockpad, the hands, however, know the function of it and starts to rotating.
  - Types of agnosia (the distinctions differ):
    - Apperceptive agnosia: Inability to acheive object constancy (referring to the ability to recognize objects in a vast number of orientations)
      - Objects can often be recognized in their prototypical orientation, however not in unusual views
      - Usually occurs with posterior hemisphere lesions
    - Integrative agnosia: Inability to make holistic perception (see figure)
      - Unable to use gestalt principles to group a percept into objects
      - Case: HJA: Unable to transform objects from a picture into a scene. Recognizes a dog, a tree (a christmastree), the door → unable to see it is an indoors scene
    - Associative agnosia: The inability to assign meaning to objects
      - Patients can perceive objects, but do not recognize them

- Case: FRA could not name the objects, but was capable of colouring them

- Prosopagnosia: The inability to recognize faces (another type of agnosia)
  - Often caused by bilateral occipitotemporal lesions
    - In unilateral cases right hemisphere lesions are more prominent → face recognition is lateralized to the right hemisphere
  - Double dissociation between prosopagnosia and visual agnosia: face and object perception happens in two different modules
    - Case: WJ was unable to recognize his family, but still able to recognize his sheep
    - Case: CK could recognize faces, but not objects. Example: picture to the right (able to recognize the face, when the picture is turned upside down, but not the vegetables in the upright position)
- Agnosias rarely occur alone
  - The pattern of the occurrences:

Table 6.2 Patterns of Co-occurrence of Prosopagnosia, Object Agnosia, and Alexia

Pattern	Number of Patients	
Deficits in all three	21	
Selective deficits		
Face and objects	14	
Words and objects	15	
Faces and words	1 (possibly)	May be due to lateralization effects
Faces alone	35	
Words alone	Many described in literature	
Objects only	1 (possibly)	

Other visual deficits:

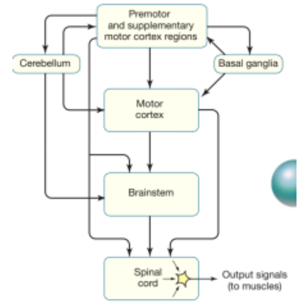
- Achromotopsia: The inability to perceive colors
  - Retinal color blindness: A genetic inability to distinct certain colours predominantly in males
  - Cerebral achromotopsia: Rare condition due to lesions in V4 (a module in the ventral pathway associated with colour perception)
    - Unilateral lesions gives contralateral color deficits (most often)
    - Bilateral lesions → rare
- Akinetopsia: The inability to perceive motion, the world is perceived similair to stop-motion-movies
  - Due to bilateral lesions in V5 (a module in the dorsal pathway associated with motion perception)
    - ONLY occurs with bilateral lesions
- Optic ataxia: The inability to use visual information to guide movement coordination
- Acquired alexia: Characterized by reading problems that occur after a patient has a stroke or head trauma.

Outline for: The Acting Brain

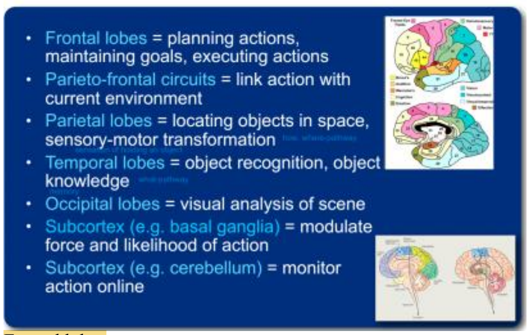
Tuesday, March 20, 2018 3:49 PM

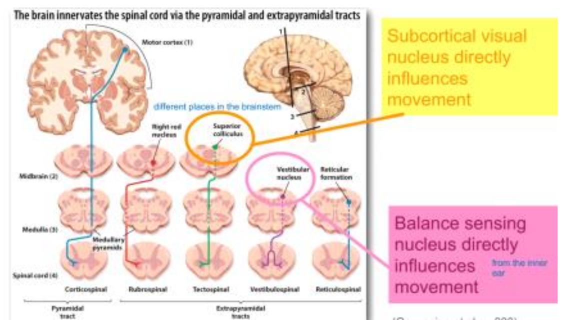
Action and perception is closely intertwined

- Perception is a means to action
- Action is a means to perception

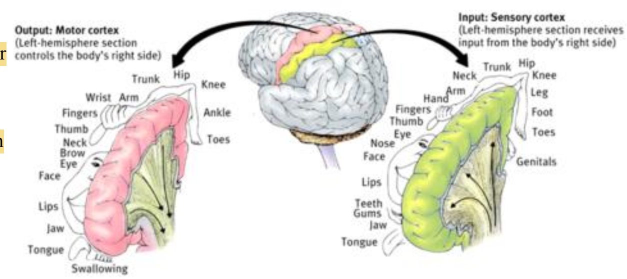


The Anatomy and Control of Motor Structures

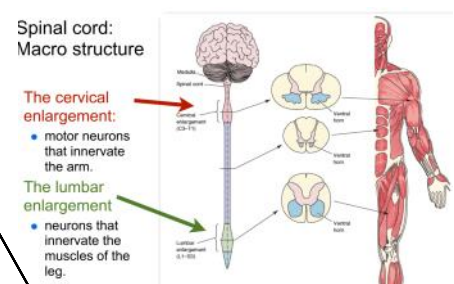
- Primary motor pathways in the brain:
  - Premotor and supplementary motor cortex regions:
    - Initiate movement: Receive input from many regions of the cortex by way of corticocortical connections (descending fibers that originate in the cortex and project monosynaptically to the spinal cord)
  - Motor Cortex: Goal-directed plans turn into concrete executable form   anterior <-> Posterior frontal lobe
  - Brainstem → Spinal Cord → Muscles: The plan from the motor cortex goes via the brainstem to the spinal cord and becomes an output in the muscles
    - Some cortical axons terminate on brainstem nuclei, thus providing a cortical influence on the extrapyramidal tracts (neural pathways that project from the subcortex to the spinal cord)
    - The cortex sends massive projections to the basal ganglia and cerebellum.
- Brain areas relevant for movement
  - Actions involves almost the entire brain:
  - 



  - Frontal lobes:
    - Involved in coordination of cognition generally (both external actions and internal thoughts)
    - Damage to this region does not impair physical movement but actions become inappropriate or disorganized
    - Involved in selection and maintenance of goals and responses
    - ddsdd: Executes all voluntary movements of the body
      - The primary and secondary motor cortices contain somatotopic representations, although the maps are not as well defined as is seen in sensory cortices.
        - The homungulus was first discovered by Penfield (1950), who used electrical stimulation of the motor cortex to initiate movement
        - The homungulus emphasizes important features of the human being: "Humans manipulate objects and talk about it", Mikkel
      - The frontal eye field: Voluntary movement of eyes



  - Two prominent subcortical structures involved in motor control:
    - Cerebellum: Monitor action online
    - Basal ganglia: modulates the force and likelihood of an action
      - Consists of dopaminergic neurons
      - Parkinsons disease is proof that the dopamine circuit is crucial for movement
        - Occur due to damage of the subthalamic nucleus   Slow movements
          Huntington : uncontrolable

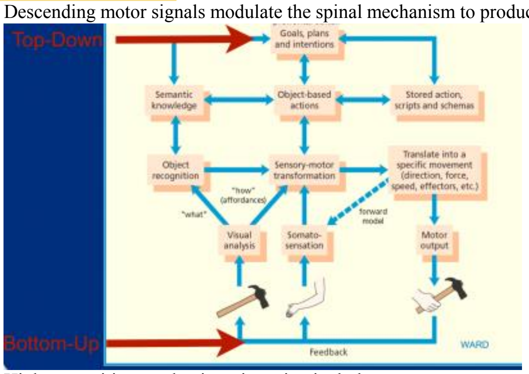


- From brain to muscle:
  - Extrapyramidal tracts and corticocortical connections connect the brain to the spinal cord
  - Spinal Cord:
    - The cervical enlargment: Motor neurons that innervate muscles of the arm
    - The lumbar enlargement: Neurons that innervate the mucles of the leg
  - Alpha motor neurons provide the point of translation between the nervous system and the muscular system, originating in the spinal cord and terminating on muscle fibers.
  - Action potentials in alpha motor neurons cause the muscle fibers to contract
    - The neurotransmitter: acetylcholine
  - Action includes two signals: Exhibitory signal and inhibitory signal
    - To produce movement, excitatory signals to one muscle, the agonist, are accompanied by inhibitory signals to the antagonist muscle via interneurons.
    - In this way, the stretch reflex that efficiently stabilizes unexpected perturbations can be overcome to permit volitional movement
  - Motor cortex neurons show directional tuning: Neurons are responsive for movement in a particular direction
    - Experiment: Monkeys moves a lever towards the light in a multi-unit recording
      - Result: Neurons in the motor cortex are activated for certain directions
    - Population vector: The outcome outcome direction is determined by the sum of directional neurons
  - A part of the body that can move is referred to as an effector
  - Are movement plans based on the trajectory or the goal of the movement?
    - Experiment: Monkeys had their afferent (feedback) input severed, and was to move towards targets in the dark
      - Manipulation: An opposing force sometimes stopped the initial movement (the mokey was unaware)
      - Result: Movements still ended up in the right place, suggesting endpoint control
- From muscle to brain
  - Proprioceptive neurons constitute a feedback system, where bodily sensation of location in space is send

FIGURE 8.25 Differential neuro- chemical alterations in Huntington's and Parkinson's diseases.
As in Figure 8.23, green links indicate excitatory projections, and red links indicate inhibitory projections. (a) In Huntington's disease, the inhibitory projection along the indirect pathway from the striatum to the external segment of the globus pallidus (GPe) is reduced. The net consequence
is reduced inhibitory output from
the internal segment of the globus pallidus (GPi) and thus an increase
in cortical excitation and movement. (b) Parkinson's disease primarily re- duces the inhibitory activity along the direct pathway, resulting in increased inhibition from the GPi to the thala- mus and thus a reduction in cortical activity and movement.

to the brain
   - Proprioceptive neurons:
      - Muscle spindles (stretch receptor): Becomes active, when the musces stretches
      - Mechano-receptors:
   - The primary motor cortex and the primary somasensory areas are intertwined i.e. in the sensation of pain an action is required or when linking together the position of an object in retinal space with the position of the limbs in bodily space = sensory-motor transformation

- The motor system is hierarchically organized. Subcortical and cortical areas represent movement goals at various levels of abstraction
   - Descending motor signals modulate the spinal mechanism to produce voluntary movements.



   - Higher cognitive mechanisms in action include:
      - The goals, plans and intentions of an individual
      - Stored semantic knowledge of objects and their uses
      - Stored motor programs for specific objects (e.g. lifting cups) and schemas for familiar situations (e.g. making tea)
   - More basic cognitive mechanisms in action include:
      - Object recognition (ventral "what" route)
      - Locating an object in space (dorsal "where" or "how" route)
      - Linking object shape and location with limb positions and motor commands (sensorymotor transformation)
      - Knowledge of the present state of the body (somatosensation) and position of limbs in space (proprioception)
      - Selecting a specific movement (direction, force etc.)
      - Generating the movement
      - Monitoring the progress and outcome of the action (feedback)
   - Forward model:
      - The cerebellum receives a a copy of motor signals being sent to the muscles
      - It also receives massive feedback from the sensory system
      - By comparing, the cerebellum checks if the movement is coordinated e.g. if you hit the nail or not
         - The forward model is the reason for you not being able to tickle yourself, the somasensory system already known what you are up to
- Why is action computationally difficult?
   - Infinite number of motor solutions for picking up an object, e.g. in terms of joint positions and Trajectories
   - However, some motor functions are stored routines of actions and action sequences that minimize the problem
      - Neurons within the spinal cord can generate an entire sequence of actions without any external feedback signal. These circuits are called central pattern generators.
      - e.g. same handwriting used for blackboard writing and regular writing
- Is the brain nessesary in movement? Lower motor processing
   - Many processes happen independantly of the brain e.g. reflexes
      - Experiment: Sherrington and Brown disconnected the spinal cord from the cortex in a cat and found it could still walk → motor neurons and stretch receptors work together independantly of the brain
- Doing nothing is also an action
   - Given that the world is never stable, doing nothing is a fairly complex task
      - The vestibular system consists of semi-cicular canals, which allows different dimensions of movements to be evaluated.
         - The haircells of the vestibular system respond to gravity rather than sound
         - This can be used for coding any orientation of the head

Deficits in movement:
- Hemiplegia: Loss of the ability to produce voluntary movement
   - Results from damage to the primary motor cortex or the corticospinal tract, and the deficits are present in effectors contralateral to the lesion.
- Parkinson:
- Huntington:

The Brain–Machine Interface
- Brain–machine interface systems use directional neurons to directly control robotic devices such as a computer cursor or a prosthetic device.
- Early BMI systems required two phases.
   - In the first phase, neural activity was recorded while the animal produced movement and the tuning properties (such as preferred direction) were recorded.
   - In the second phase, the output from these neurons was used to control an interface device.
- Current studies are exploring how decoders can be adapted through experience in BMI control and are looking at the stability of such systems over extended periods of time. Advances on these problems are essential for building BMI systems that will be useful in clinical settings
   - Current implants are temporary due to inflammation risks
-

- Brodmann area 6 includes secondary motor areas. The lateral aspect is referred to as premotor cortex, and the medial aspect as supplementary motor area.
-

Computational Issues in Motor Control

Physiological Analysis of Motor Pathways
- The neurophysiological evidence points to a more nuanced picture than we might have anticipated from our hierarchical control model. Rather than a linkage of different neural regions with specific levels in a processing hierarchy, one that moves from abstract to more concrete representations, the picture reveals an interactive network of motor areas that represent multiple features.
- Motor neurophysiologists correlate cellular activity in motor cortex with the animal's behavior.
- A common observation is that neurons in motor areas exhibit a preferred direction, in which the firing rate is strongest for movements in a limited set of directions.
- The population vector is a representation based on combining the activity of many neurons.
- Population vectors that provide a close match to behavior can be constructed from many motor areas, although this does not mean that all of these cells represent movement direction.
- Before movement even begins, the population vector is a reliable signal of the direction of a forthcoming movement. This f nding indicates that some cells are involved in planning movements as well as executing movement.
- Neurons have dynamic properties, coding different features depending on time and context. There need not be a simple mapping from behavior to neural activity.
- The heterogeneity of responses exhibited by neurons in M1 includes both motor and sensory information.

Goal Selection and Action Planning
- The affordance competition hypothesis proposes that the processes of action selection (what to do) and specification (how to do it) occur simultaneously within an interactive neural network that continuously evolves from planning to execution.
- Action selection involves a competitive process.
- Rather than view selection and planning as serial processes, neural activity reveals that there is parallel activation of multiple goals and movement plans.
- Supplementary motor area is important for coordinating motor behavior in time (sequential movements) and between limbs (bimanual coordination).
- Parietal motor areas also show topography: Different regions of the intraparietal cortex are associated with hand, arm, and eye movements.
- Parietal motor representations are more goal oriented, whereas premotor-motor representations are more closely linked to the movement itself.
- Conscious awareness of movement appears to be related to the neural processing of action intention rather than the movement itself

Movement Initiation and the Basal Ganglia
- The output from the basal ganglia, via thalamic projections, influences activity in the cortex, including the motor cortex.
- All of the output signals from the basal ganglia are inhibitory. Thus, in the tonic state, the basal ganglia dampen cortical activity.
- Movement initiation requires disinhibition: The striatal projection to the GPi inhibits an inhibitory signal, resulting in excitation at the cortex
- Striatal neurons influence the output nuclei of the basal ganglia via the direct pathway and the indirect pathway.
- Dopamine is produced in the substantia nigra pars compacta, a brainstem nucleus that projects to the striatum. It has an excitatory effect on the direct pathway and an inhibitory effect on the indirect pathway.
- Parkinson's disease results from cell death in dopamineproducing cells in the substantia nigra.
- Parkinson's disease includes disorders of posture and locomotion, hypokinesia (the absence or reduction of voluntary movement), and bradykinesia (slowness in initiating and executing movement).
- The drug L-DOPA is used in treating Parkinson's disease because it can compensate for the loss of endogenous
dopamine.
- Deep-brain stimulation is a surgical technique in which electrodes are implanted in the brain. This procedure has become a novel treatment for Parkinson's disease. Implants usually are placed in the subthalamic nucleus.
- The basal ganglia may play a general function in state changes. For the motor system, a state change would correspond to the initiation of a new movement. In the cognitive system, a state change could be a change in mental set, such as when we change from one goal to another. Dopamine acts as a reinforcement signal to bias some states over others.

Action Understanding and Mirror Neurons
- Mirror neurons are neurons in premotor cortex and other areas (like the parietal lobe) that respond to an action, both when that action is produced by an animal and when the animal observes a similar action produced by another animal.
- The mirror system has been hypothesized to be essential for comprehending the actions produced by other individuals.
- The engagement of the mirror system is modulated by motor expertise.

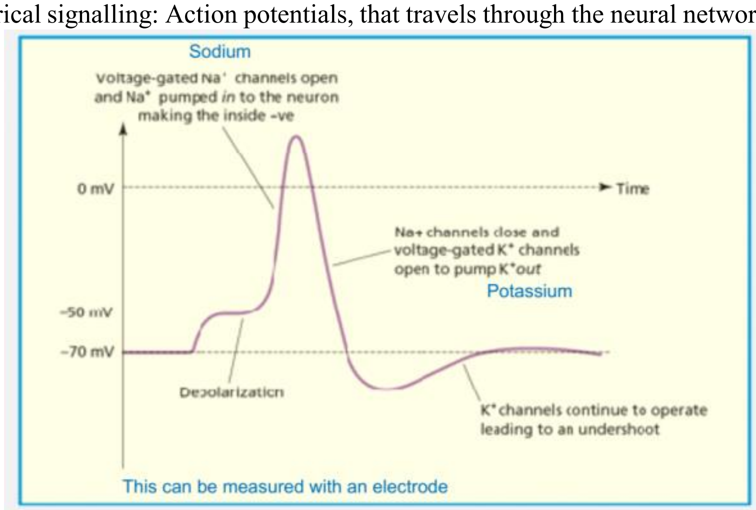
According to Hickok:
• There is no direct evidence in monkeys that mirror neurons support action understanding.
• Mirror neurons are not needed for action understanding
• Macaque mirror neurons and mirror-like brain responses in humans are different
• Action execution and action understanding dissociate in humans
• Damage to the hypothesized human mirror system does not cause action understanding deficits

Learning and Performing New Skills
- Sensorimotor learning is improvement, through practice, in the performance of motor behavior.
- The cerebellum is critical for error-based learning. Errors are derived from a comparison of the predicted and observed sensory information. The errors are used to update a forward model, a representation that can be used to generate the sensory expectancies for a movement.
- The predictive capacity of the cerebellum is also important for online control. By anticipating the sensory consequences of movement, it helps compensate for delays introduced by sensorimotor processing.
- The primary motor cortex is critical for the long-term retention of skills. Consolidation is enhanced by dopaminergic input to the motor cortex from the ventral tegmental area of the brainstem.
- Skill requires extensive hours of practice. Expertise is skill specific, but it may be more closely related to domain-independent factors such as motivation rather than a propensity, or inclination, for particular types of

performance

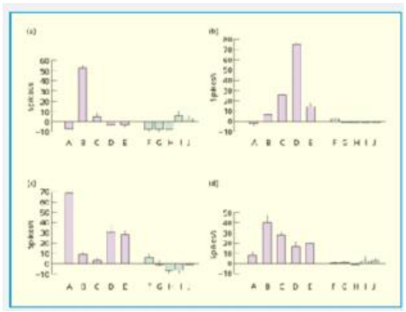
Outline for: EEG and event-related potentials

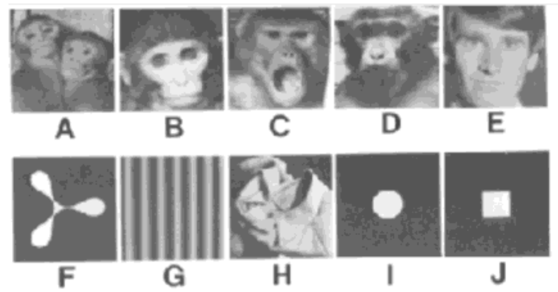
Tuesday, March 20, 2018 3:48 PM

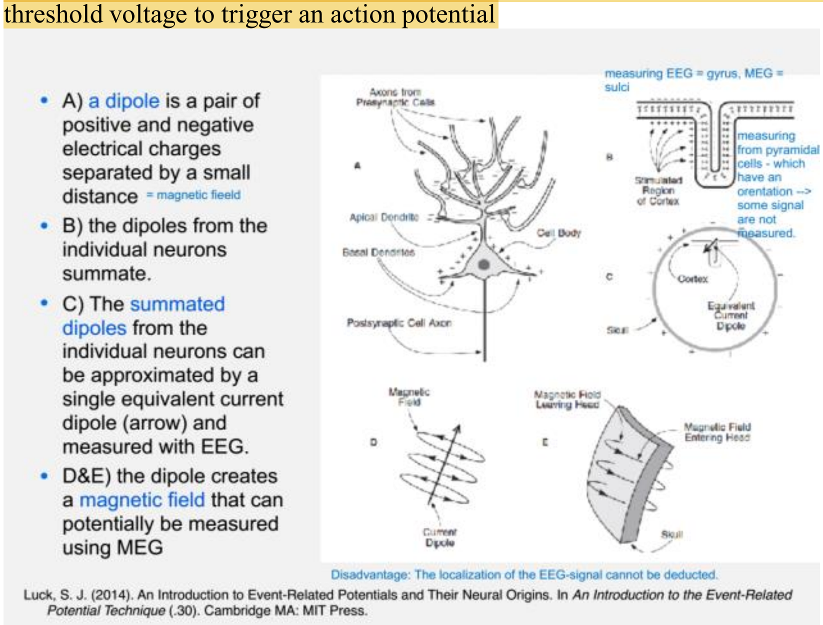
- Methods in electrophysiology
    - These methods only record the activity, they do not stimulate neural activity
    - Invasive methods (participants often only animals):
        - Intracellular recording: A recording from the inside of the cell
        - Extra-cellular recording: A recording from the outside of the cell
            - Electrocortogram (ECoG) is similar to an EEG, except that the electrodes are placed directly on the surface of the brain.
        - The measurements is either single-cell or multiple-cell recordings
            - Single-cell recordings: Records increases and decreases in the activity of individual neurons
                - This can be put in relation to stimulation of one of the senses or behavior
                - Single cell recordings are conducted on humans in very few cases:
                    - Experiment: Epilepsy patient navigated through a virtual town while single cell recordings were conducted to reveal the existence of place cells
                - Most single cell recordings are done on animal:
                    - Experiment: Electrodes implanted in the visual cortex of a cat revealed neuron with edge-detector functions.
                    - Experiment: Electrodes implanted in rats' brains revealed place cells - cells, that respont to different locations independant of orientation.
            - With multiunit recording, the activity of hundreds of cells can be recorded at the same time.
    - Non-invasive methods:
        - Magneto-encephalography: measures the magnetic signals generated by the brain.
            - The electrical activity of neurons also produces small magnetic felds, which can be measured by sensitive magnetic detectors placed along the scalp.
            - MEG can be used in an event-related manner similar to ERPs, with similar temporal resolution. The spatial resolution can be superior because magnetic signals are minimally distorted by organic tissue such as the brain or skull.
            - MEG is expensive opposed to EEG
        - Electro-encephalography: Measures the electrical activity of the brain.
            - The EEG signal includes endogenous changes in electrical activity as well as changes triggered by specific events (e.g., stimuli or movements).
        - Event-related potential (ERP): A change in electrical activity that is time-locked to specific events, such as the presentation of a stimulus or the onset of a response. When the events are repeated many times, the relatively small changes in neural activity triggered by these events can be observed by averaging of the EEG signals. In this manner, the background fluctuations in the EEG signal are removed, revealing the event-related signal with great temporal resolution.
- Electrophysiology measures electrical signalling (real brain activity)
    - Electrical signalling: Action potentials, that travels through the neural network
        - 

    - Opposed to e.g. fMRI and PET, which investigate surrogate measures of brain activity, such as blood flow.
- Electrophysiology and measurements of neural activity have given rise to investigate, how information is represented in the brain
    - Rolls and Deco summarize three:
        - Local representation: All information about a stimulus/event is carried by one of the neuros e.g. a grandmother cell
        - Fully distributed representation: All the information about a stimulus/event is carried by all the neurons of a given

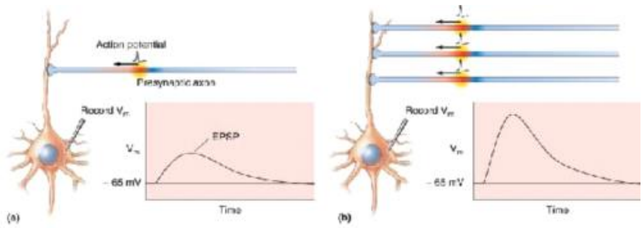
population. The pattern of activation is what make up the representation
- Spares distributed representation: A population of neurons make up together the representation (inbetween solution)
  - Sparse distributed representation is most recognized, since some functional localization e.g. fusiform face area are discovered which questions the validity of the thesis of fully distributed representation. Equally the local representation is problematic, since the existence of population vectors
  - Example on distributed neural representations:

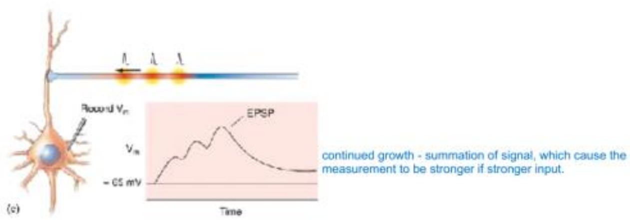




- How does EEG/MEG work?
  - Different neural codings
    - Rate coding: That a stimulus is associated with an increased firing rate e.g. the Hally Berry-neuron
    - Temporal coding: That a given stimulus is associated with greater synchronisation of firing across different neurons (e.g. integration)
      - Two types of syncronization:
        - One neuron is the catalysator for a groups of neurons, which starts firing
        - A population of neurons are constantly active, sometimes the neurons synchronize
      - If two regions start firing in synchrony e.g. without general increase in firing rate, then this may indicate that some kind of information integration is taking place
      - The analysis of synchronization is called oscillation rate analysis, which is the typical approoach, when processing EEG data
      - Temporal coding cannot be meassured with fMRI, since an increased synchronization does not nessecarily follow an increased BOLD-response
  - Synchronization and summation makes a signal
    - Summation: The process that determines whether or not an action potential will be triggered by the combined effects of excitatory and inhibitory signals, both from multiple simultaneous inputs (spatial summation), and from repeated inputs (temporal summation). Depending on the sum total of many individual inputs, summation may or may not reach the threshold voltage to trigger an action potential
    - 

      - Whether the effect is positive or negative just implies the direction of the dipole
    - EPSP summates, when…

- ▪ 



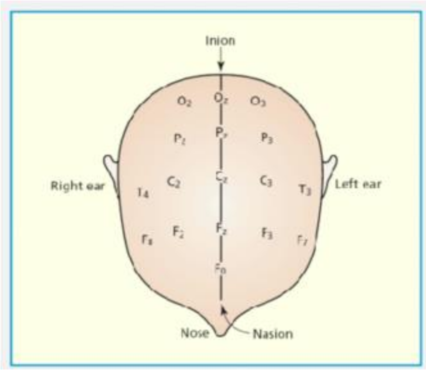
- Advantage vs. Disadvantage in EEG
  - Spatial resolution of EEG measurements
    - The number, location and magnitude of electrical sources are unknown, therefore there is an infinite number of ways the easured signal could have arisen (inverse problem)
    - Due to the "inverse problem" of getting from a surface measure to its origin(s), the spatial resolution of EEG is poor.
  - EEG is cheaper than MEG (and fMRI and PET)
  - Great temporal resolution

- Oscillation-based Analyses
  - Neurons tend to fire in synchrony with each other; but at different rates (frequencies)
  - Different oscillation frequencies characterise the different phases of sleep-wake cycle
  - Different frequencies also characterise certain cognitive functions
    - Increased alpha (7-14Hz) linked to visual attention (inhibition)
    - Increased gamma (30Hz+) linked to perceptual grouping

Name	Amplitude (μV)	Frequency (Hz)	Associated Behavior	Representative Samples
Alpha	20-200	8 – 13	Awake, resting state	
Beta	~100	14 – 30, can be as high as 50	Beta I – Attention Beta II – Intense, mental activity	
Theta	~100	4 – 7	Emotional stress	
Delta	~100	< 3.5	Deep sleep, serious disease	

- Averaging the oscillations reduces the effects of random neural firing and artefacts and allows the signal to be put in relation to some aspect of an event (ERP)
  - Different peaks approximately reflect the functioning of different cognitive stages
    - Not a simple relationship between ERP peak and cognition, because each peek is a sum of different electrical activitied (many constalations could cause the outcome)
  - Different components found by EEG:
    - The effect of mismatch negativity occurs, when a sound is unexpected relative to preceding sounds. This can be distinguised on the ERP signal.
      - ▪ The effect equally found in Hungarian and Finish phonemes. The languages have similar phonemes - the longer from the standard - the larger the mismatch negativity
      - ▪ The effect was also found during playing a piece of music → mismatch negativity is linked to expectation
    - N400 is a robust component of a negative-polarity brain wave related to semantic processes in language
      - ▪ Reading creates anticipations of a certain sentences finish, if violated the N400 effect occurs
      - ▪ Slower than mismatch negativity and requires attention
      - ▪ Different parameters predict the amplitude of the N400
        - ▪ A repeated word is more predictable than an unrepeated word
        - ▪ Context constrins possible words late in sentence but less in the beginning

        - Frequent words are more predictable than infrequent words
        - Meaning is predictable
      - Experiment: The peanut in love: The peanut was in love gives smaller N400 than the peanut was salted
        - The linguistic system is flexible, according to the context, we are able to assign human values to objects
    - P600/SPS is a large positive component elicited after a syntactic and some semantic violations.
      - Mikkel says: Controversial: In general, the later the component is in time, the more skeptical one should be. 600 ms is loong time in terms of brain processes

- Practical execution of EEG measurements:
  - The 10-20 system of electrodes are used in a typical EEG/ERP experiment
    - Recoring sites in the 10-20 system:
    - 

  - THERE IS A VIDEO IN MIKKEL SLIDE

Outline for: Memory - mangler

Tuesday, April 24, 2018 9:00 AM

Outline for: Emotion - mangler

Tuesday, April 24, 2018 9:00 AM

What Is an Emotion?

- Most psychologists agre that emotion consists of three components:
  1. A physiological reaction to a stimulus,
  2. a behavioral response, and
  3. a feeling

Neural Systems Involved in Emotion Processing

- Many parts of the nervous system are involved in our emotions
  - Emotions are triggered by an episodic memory, in which case our memory systems are involved
  - When emotions are triggered by an external event or stimulus (as they ofen are), our sensory systems play a major role
  - The physiologic components of emotion (that shiver up the spine, or the racing heart and dry mouth people experience with fear) involve the autonomic nervous system (ANS), a division of the peripheral nervous system.
    - the sympathetic system promotes “fght or flight” arousal
    - the parasympathetic promotes “rest and digest.”
- The Papez circuit describes the brain areas that James Papez believed were involved in emotion. They include the hypothalamus, anterior thalamus, cingulate gyrus, and hippocampus. The limbic system includes these structures and the amygdala, orbitofrontal cortex, and portions of the basal ganglia.
- Investigators no longer think there is only one neural circuit of emotion. Rather, depending on the emotional task or situation, we can expect different neural systems to be involved.

Categorizing Emotions

- Most emotion researchers agree that the response to emotional stimuli is adaptive, comprised of thre psychological states: a peripheral physiological response (e.g., heart racing), a behavioral response, and the subjective experience (i.e., felings). What they don’t agre on are the underlying mechanisms.
- The crux of the disagrement among the different theories of emotion generation involves the timing of these three components and whether cognition plays a role.
- In an effort to apply some order and uniformit to our defnition of emotion, researchers have focused on thre primary categories of emotion:
  1. Basic emotions comprise a closed set of emotions, each with unique characteristics, carved by evolution, and reflected through facial expressions.
  2. Complex emotions are combinations of basic emotions, some of which may be socially or culturally learned, that can be identifed as evolved, long-lasting felings.
  3. Dimensions of emotion describe emotions that are fundamentally the same but that differ along one or more dimensions, such as valence (pleasant or unpleasant, positive or negative) and arousal (very pleasant to very unpleasant), in reaction to events or stimuli.
- Basic emotions
  - Innate, universal and short-lasting human emotions
  - Paul Ekmans theory: Anger, fear, digust, sadness, happiness, and surprie are the six basic human facial expressions and that each expression represents a basic emotional state, these emotions does not vary across cultures
  - Addionally suggested pride and shame may be basic emotions
- Complex emotions

  Complex emotions, such as love and jealousy, are considered to be refned, long-lasting cognitive versions of basic

emotions that are culturally specifc or individual.
    - According to Ekman parental love, jealousy etc. Is complex emotions, since they can last a lifetime
    - No universal expression exist for romantic love, therefore a complex emotions according to Ekman
- Dimensions of emotions
    - Another way of categorizing emotions is to describe them as reactions that vary along a continuum of events in the world, rather than as discrete states.
    - Feldman-Barret: Emotional reactions to a stimuli can be characterized by two factors:
        - valence (pleasant - unpleasant) and
        - Arousal (intensity of the internal emotional response)
    - Rolls: Emotional reactions to a stimuli can be characterized by the actions and goals they motivate
        - Approach or withdrawel from a situation
- Emotions have been categorized as either basic or complex, or varying along dimensional lines.
- Six basic human facial expressions represent emotional states: anger, fear, disgust, happiness, sadness, and surprise.
- Complex emotions (such as love) may vary conceptually as a function of culture and personal experiences.
- The dimensional approach, instead of describing discrete states of emotion, describes emotions as reactions that vary along a continuum.

Theories of Emotion Generation
- Emotions are made up of three psychological components—a physiological response, a behavioral response, and a subjective feeling—that have evolved to allow humans to respond to signifcant stimuli. The underlying mechanisms and timing of the components are disputed
- Researchers do not agree on how emotions are generated, and many theories exist
- James-Lange Theory: William James proposed that the emotions were the perceptual results of somatovisceral fedback fom bodily responses to an emotion-provoking stimulus
    - e.g. you are afraid, beacause you tremble
- Cannon-Bard Theory: An emotional stimulus was processed by the thalamus and sent simultaneously to the neocortex and to the hypothalamus that produced the peripheral response. Thus the neocortex generated the emotional feling while the periphery carried out the slower emotional reaction
    - The neuronal and hormonal feedback processes are too slow to precede and account for emotions
- Appraisal theory: A group of theories in which emotional processing is dependent on an interaction beten the stimulus properties and their interpretation.
    - e.g. Lazarus proposed a version of appraisal theory in which emotions are a response to the reckoning of the ratio of harm versus beneft in a person’s encounter with something.
- Singer-Schahter theory: Emotional arousal annd then reasoning is required to appraise a stimulus before the emotion can be identified
- Constructivist theories: Emotion emerges fom cognition as molded by our culture and language
- Evolutionary Psychology approach : Emotions are conductors of an ochestra of cognitive programs that need to be coordinated to produce succesful behavior
- LeDoux's high road and low road: humans have to emotion systems operating in parallel. One is a neural system for our emotional responses that is separate fom a system that generates the conscious feling of emotion.

The Amygdala
- The amygdala is the most connected structure in the forebrain.
- The amygdala contains receptors for many different neurotransmitters and for various hormones.
- The role that the amygdala plays in emotion is still controversial.
- The amygdala is critical for the acquisition and expression of an implicitly conditioned fear response, whereas the hippocampus is criticl for the explicit conditioned fear response

Interactions Between Emotion and Other Cognitive Processes

- Fear-conditioning paradigm

- Two parthways for fear-conditioning:
  - Superior dorsal lateral amygdala undergo changes that pair CS)conditioned stimulus) and US (unconditioned stimulus)
  - The lateral nucleus is connected to the central nucleus in amygdala, which initiate an emotional respone is a stimulus is determined dangerous
  - Information about the fear-inducing stimulus reaches the amygdala through to separate but simultaneous pathways
    - One goes directly fom the thalamus to the amygdala without being fltered by conscious control.
      - Signals sent by this pathway, sometimes called the low road, reach the amygdala rapidly , but are incomplete
    - At the same time, sensory information about the stimulus is being projected to the amygdala via another cortical pathway, sometimes referred to as the high road.
      - The high road is slower, but more complete
      - This route goes via the thalamus, which sends the information to the sensory cortex for finer analysis, which sends it to the amygdala

- The role of the amygdala in learning to respond to stimuli that have come to represent aversive events through fear conditioning is said to be implicit.
  - Learning is expressed indirectly through a behavioral or physiological response
- The amygdala is critical for indirect expression of the conditioned fear
  - i.e. skin conductance when told a stimulus elicits a shock

- Explicit emotional learning
  - Is the persistence of emotional memories is related to the action of the amygdala during emotional arousal?
    - Experiment: Rats with injected with a drug to induce arousal show improved memory
      - With lesion to the amygdala this enhancement of memory is blocked
    - → Amygdala's role is modulatory: Depend on hippocampus for memory acquisition, but on the amygdala for arousal-dependant modulation
    - Studies point to the conclusion that the amygdala modulates hippocampal, declarative memory by enhancing retention by enhancing hippocampal consolidation, rather than by altering the initial encoding of the stimulus
      - also suggests that the amygdala can interact directly with the hippocampus during the initial encoding phase
  - Extreme arousal or chronic stress may actually impair performance of the hippocampal memory system.
    - due to the effect of excessive stress hormones, such as glucocorticoids, on the hippocampus.
- The influence of Emtoion on perception and attention
  - When attentional resources are limited it is the arousing emotional stimuli that reach awareness
    - Amygdala plays a critical role in enhancing our attention when emotional stimuli are present and has a leading role in mediating the transient changes in visual cortical processin
  - Emotion-laden stimuli receive greater atention and priorit perceptual processing
- Emotion and decision making
  - Somatic marker hypothesis: emotional information in the form of physiological arousal, is neded to guide decision making.
    - When presented with a situation that requires us to make a decision, we may react emotionally to the situation around us. Tis emotional reaction is manifest in our bodies as somatic markers—changes in physiological arousal.
  - Three types of emotions influence decision making:

            - 1: Your current emotional state.
            - 2: Your anticipatory emotions; the ones that occur before you make your decision.
            - 3: Based on personal experience, the emotion that you expect to fel afer you have made the decision
    - Orbitofrontal cortical damage impairs the ability to respond to changing patterns of reward and punishment
        - It is difficult to reverse an association, once it's learned
    - OFC is selectively active for the magnitude of reward and punishment and for their changing paterns
        - Lesion to the OFC therefore results in poor decision making
        - People with OFC damage have normal emotional reactions to their wins and losses, but they do not fel regret.
    - Experienced felings about a stimulus and felings that are independent of the stimulus, such as mood states, have four roles in decision making.
      1. Tey can act as information.
      2. Tey can act as "common currency" beten disparate inputs and options (you can fel slightly aroused
      by a book and very aroused by a swimming pool)
      3. Tey can focus atention on new information, which can then guide the decision.
      4. Tey can motivate approach or avoid behavior decisions.
- Emotion and social stimuli
    - Depending on the specifc facial expression, it appears that different neural mechanisms and regions of the brain are at work, not for processing specifc facial expressions per se, but more generally for processing different emotions
- TAKE-HOME MESSAGES:
    - Fear conditioning is a form of classical conditioning in which the unconditioned stimulus is aversive. It is a form of implicit learning.
    - The amygdala is heavily involved in fear conditioning (a form of implicit memory).
    - The conditioned stimulus is a neutral stimulus that, through classical conditioning, will eventually evoke a response. The unconditioned stimulus is the stimulus that, even without training, evokes a response.
    - The unconditioned response is the response naturally elicited (without training) by the unconditioned stimulus. The conditioned response is the response that is elicited (with training) by the conditioned stimulus. Usually the unconditioned response and the conditioned response are the same (e.g., the startle response in the rat), but they have different names depending on what elicits the response.
    - Patients with bilateral amygdala damage fail to acquire a conditioned response during fear conditioning, indicating that the amygdala is necessary for such conditioning to occur
    - Information can reach the amygdala via two separate pathways: The "low road" goes directly from the thalamus to the amygdala; the "high road" goes from the cortex to the amygdala.
    - The amygdala is also important for explicit memory of emotional events. First, the amygdala is necessary for normal indirect emotional responses to stimuli whose emotional properties are learned explicitly, by means other than fear conditioning. Second, the amygdala can enhance the strength of explicit (or declarative) memories for emotional events by modulating the storage of these memories.
    - The amygdala appears to be necessary for automatically deriving information from the eyes of others when identifying emotional facial expressions. This ability is especially critical for the proper identifcation of fear, because the def ning characteristic of fear is an increase in the volume of the eye whites.
    - When looking at faces, the activity of the amygdala increases with the degree of difference from a categorically average face.
    - The amygdala is activated by novel stimuli independent of valence and arousal.
    - Attention, perception, and decision making are all affected by emotion.

Get a Grip! Cognitive Control of Emotion

- James Gross' theory of emotional suppresseion: Gross hypothesized that " shuting down" an emotion at different points in the process of emotion generation would have different consequences and thus, could explain the divergent conclusions.

- To test his theory, he compared reappraisal, a form of antecedent- focused emotion regulation, with emotion suppression, a response-focused form.
- Results: Consiuos reappraisal reduces the emotional experience; this finding supports the idea that emotions, to some extent, are subject to conscious cognitive control.

- Different cognitive reappraisal goals and strategies activate some of the same PFC regions as well as some regions that are different.
- Emotion regulation is complex and involves many processes.
- Emotion regulation is dependent on the interaction of frontal cortical structures and subcortical brain regions.
- Different emotion regulation strategies have different physiological effects.

Other Areas, Other Emotions

- Insula
  - Tere is a signifcant correlation beten insular activit and the perception of internal bodily states (interospection)
    - The junction where cognitive and emotional information are integrated
  - the insula may play a broad role in integrating affective and cognitive processes, whereas the amygdala may have a more selective role in affective arousal, especially for negative stimuli
- Disgust
  - The anterior insula is essential for detecting and experiencing disgust
  - Results provide additional evidence that the insula is a neural correlate of disgust identifcation in others and of experiencing disgust directly
- Happiness
  - A complex phenmenon to study…
- Love
  - "Love is a complicated business, and it appears to light up much of the brain—but you didn't ned an fMRI study to tell you that"

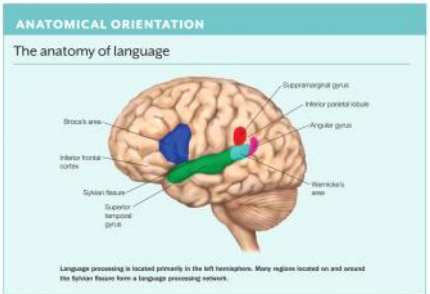
  - Different brain areas are associated with the processing of different emotions. The orbitofrontal cortex is activated when identifying angry facial expressions and hearing angry prosody, and the anterior insula is linked to identifcation and experience of disgust.
  - The insula appears to play a broad role in integrating affective and cognitive processes

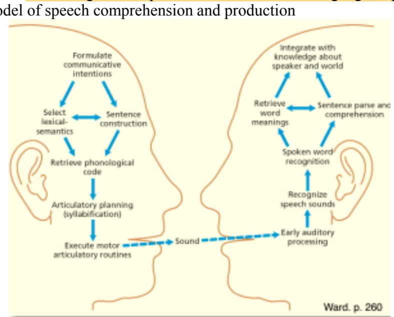
Unique Systems, Common Components

- Emotion research has shifed fom identifing areas that specialize in a specifc emotion to characterizing how these areas interact and determining if there are any interactions common to different tpes of emotional experience.
- Ultimately, understanding how we perceive and experience emotion will require studying the interactions of a diverse set of neural structures.

Outline for: Language

Tuesday, April 24, 2018 9:00 AM

- The anatomy of language
  - 

  - The perisylvian region including the highligthed areas above is the main region for language
    - Especially, the left hemisphere is critical for language production and comprehension.
    - The right hemisphere does have roles in language, especially in processing the prosody of language
- A model of speech comprehension and production
  - 

    - NOTE: The arrow should be doubleheaded. Top-down processing changes the bottom-up perception - we predict
- Speech comprehension
  - Models of language involve unifying information from linguistic inputs or from retrieved linguistic representations with stored knowledge.
  - White matter tracks in the left hemisphere connect frontal and temporal lobes to create specific circuits for speech, semantic analysis, and syntactic processing
  - Spoken-word recognition processing proceeds anteriorly in the superior temporal gyrus (STG): Phoneme processing appears localized to the left mid-STG, integration of phonemes into words appears localized to the left anterior STG, and processing short phrases appears to be carried out in the most anterior locations of STS.
  - Distinguishing speech from nonspeech sounds occurs in the mid-portion of the superior temporal sulcus (STS), but no lexical-semantic information is processed in this area.
  - Segmentation problem: No pauses between phonemes in speech that correspond to words, who do we segregate?
  - Written Input: Reading words:
    - Written-word processing takes place in occipitotemporal regions of the left hemisphere. Damage to this area can cause pure alexia, a condition in which patients cannot read words, even though other aspects of language are normal.
    - Occipitotemporal regions of the left hemisphere may be specialized for the identifcation of orthographic units.

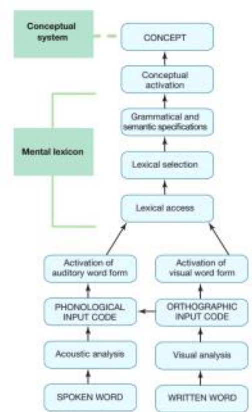


FIGURE 11.8 Schematic representation of the components involved in spoken and written language comprehension. Inputs can enter via either auditory (spoken word) or visual (written word) modalities. Notice that the information flows from the bottom up in this figure, from perceptual identification to "higher level" word and meaning activation. So-called interactive models of language understanding would predict top-down influences to play a role as well. For example, activation at the word-form level would influence earlier perceptual processes. We could introduce this type of feedback into this schematic representation by making the arrows bidirectional (see "How the Brain Works: Modularity Versus Interactivity").

- Speech production:
  - Models of language production must account for the selection of the information to be contained in the message; retrieving words from the lexicon; sentence planning and grammatical encoding using semantic and syntactic properties of the word; using morphological and phonological properties for syllabif cation and prosody; and preparing articulatory gestures for each syllable.
  - Levelts model
    - Each stage in Levelt's model for language production occurs serially, and its output representation is used for input to the next stage. It avoids feedback, loops, parallel processing, and cascades, and it f ts well with the findings of ERPs recorded intracranially.
  - Lexical selection can be infl uenced by sentence context.
  - Lexical access and selection involve a network that includes the middle temporal gyrus (MTG), superior temporal gyrus (STG), and the ventral inferior and bilateral dorsal inferior frontal gyri (IFG) of the left hemisphere.
  - Left MTG and STG are important for the translation of speech sounds to word meanings.
  - Syntactic parsing is the process in which the brain assigns a syntactic structure to words in sentences.
  - Syntactic processing takes place in a network of left inferior frontal and superior temporal brain regions that are activated during language processing

- Deficits in language
  - Anomia: inability to find the words to label things in the world(not a deficit of knowledge)
  - Dysarthria: Loss of control of articulartory muscles
    - A muscle deficit - not an aphasia
  - Apraxia: Articulatory planning deficit
  - Aphasia: Language deficits over and above motor and articulatory problems
    - Broca's aphasia:
      - Broca investigated the patient "Tan", named so, since it was the only word he uttered → lesions in Brocas area
      - Brocas aphasia not always linked to Broca's area lesions
      - Symptoms:
        - Slow, effortful speech
        - Speech articulation problems
        - Grammatical problems
    - Wernicke's aphasia:
      - "(…) deduced that a lesion of the auditory center in the first temporal convolution would leave people fluent, but unable to understand speech or use words properly. In other words, such a lesion would abolish sound images" (Klangbilder)
      - Originally linked to damage solely in Wernicke's area (the posterior uperior temporal gyrus), today Wernicke's aphasia is also linked to damage outside the classic Wernicke's area.
      - Symptoms:
        - Able to talk fluently, but with no understanding of semantics
        - Repetition is faulty

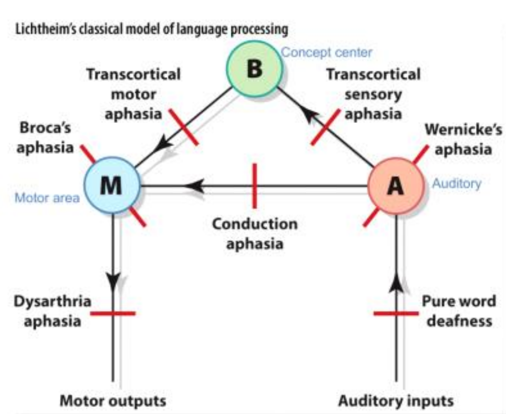
- 

Table 20.1 Characteristics of Types of Aphasia

- Originally linked to damage solely in Wernicke's area (the posterior uperior temporal gyrus), today Wernicke's aphasia is also linked to damage outside the classic Wernicke's area.
- Symptoms:
  - Able to talk fluently, but with no understanding of semantics
  - Repetition is faulty
  - No motor symptoms

- The classical model of language processing:
  - Different aphasias can be explained in term of disruptions of connections between three different areas:
    - linguistic information, word storage (A 5 Wernicke's area),
    - speech planning (M 5 Broca's area)
    - conceptual information stores (B)
      - The areas are located in separate brain regions interconnected by white mater tracts.
    - NOTE: Everyone agrees the model has flaws, it is however often still applied
      - Flaws:
        - Broca's aphasic patients also have some problems in comprehension
        - A deficit in "motor images" doesn't explain one of the main symptom (agrammatism)
        - Many patients who meet criteria for Broca's aphasia have damage in temporal lobes not Broca's area (Dronkers)
        - Wernicke's aphasic patients also have problems in speech production (e.g. neologisms)
        - Wernicke's area involved in a variety of functions, including linking acoustic information with visual and motoric information
  - If the Lichtenheim model is assumed it will result in 7 different types of aphasia:
    - Cortical motor aphasia
      - Lesion to M (Broca's aphasia)
      - *"Speech comprehension is intact, but the patient presents either muteness or a vocabulary limited to a few words. Spontaneous speech and repeating as well as the voluntary mental sounding out of the word are not possible"*
    - Cortical sensory aphasia
      - Lesion to A (Wernickes aphasia)
      - *"Cortical sensory aphasia is characterized by lack of comprehension of speech and inability to repeat it. However, the patient is able to speak spontaneously, and while vocabulary is unlimited, it is characterized by frequent word-transposition, that is, paraphasia (saying another word, than you meant to say, either syntactic, phonologically or semantic related)"*
    - Conduction aphasia
      - Lesion between A and B
      - *"Conduction aphasia is primarily characterized by negative symptoms. If motor or sensory aphasia is not evident, but speech is paraphasic, presenting word-transposition, on may predict a disturbance in conduction between centers a and b."*
      - Everything has to go through meaning, which inhibits the ability to repeat non-sense words
    - Transcortical motor aphasia
      - Lesion between M and B
      - *"Transcortical motor aphasia. This is the form on which Lichtheim's nomenclature founders. He interpretes this type as aphasia in spite of retained ability to speak, which, however, is restricted to repeating. There is loss of spontaneous speech but no evidence of impairment in speech comprehension."*
    - Subcortical motor aphasia
      - Lesion between M and motor outputs
      - *"Subcortical motor aphasia. This form is differentiated from the preceding type by the complete integrity of the wordconcept. The muteness is the same as that found in type 4. The patient is able to indicate the number of syllables [contained in a word corresponding to an object presented to him]."*
    - Transcortical sensory aphasia
      - Lesion between B and A
      - *"Transcortical sensory aphasia. Impairment in comprehension of speech with preservation of the ability to repeat it. Symptoms of paraphasia are evident in spontaneous speech."*
    - Subcortical sensory aphasia
      - Lesion between A and audiotory inputs
      - *"Subcortical sensory aphasia presents the same lack of comprehension of the spoken word and the same impairment in word mimicry. Spontaneous speech, however, is fully maintained, because the word-concept remains intact."*
  - NOTE: No aphasia related to area B, indicating this is not an area
- Classical models are insufficient to understanding neural basis for language

Evolution of Language

- Animal calls can carry meaning and show evidence of rudimentary syntax. In general, however, animal calls tend to be inflexible, associated with a specif c emotional state, and linked to a specifc stimulus.
- Many researchers suggest that language evolved from hand gestures, or a combination of hand gestures and facial movement.
- Areas that control hand movement and vocalizations are closely located in homologous structures in monkeys and humans

Table 20.1 Characteristics of Types of Aphasia

TYPE OF APHASIA	SITE OF BRAIN DAMAGE	COMPRE-HENSION	SPEECH	IMPAIRED REPETITION	PARAPHASIC ERRORS
Broca's	Motor association cortex of frontal lobe	Good	Nonfluent, agrammatical	Yes	Yes
Wernicke's	Posterior temporal lobe	Poor	Fluent, grammatical, meaningless	Yes	Yes
Conduction	Arcuate fasciculus	Good	Fluent, grammatical	Yes	Yes
Global	Portions of temporal and frontal lobes	Poor	Very little	Yes	—
Transcortical motor area	Frontal lobe anterior to Broca's	Good	Nonfluent, agrammatical	No	Yes
Transcortical sensory	Cortex near junction of temporal, parietal, and occipital lobes	Poor	Fluent, grammatical, meaningless	No	Yes
Anomic	Inferior temporal lobe	Good	Fluent, grammatical	No	

Bear, M. F., Conners, B. W., & Paradiso, M. A. (2016). *Neuroscience - Exploring the Brain* 4th ed., p. 627). Lippincott Williams & Wilkins.