Announcements (2/4/19)

- Electricity Test next week (Feb 11)
- Lab: Meet Feb 13

Lecture 3

4 February, 2019

Electricity Test Objectives

- Describe positive and negative charges
- State the law of attraction and repulsion
- Describe free electrons
- Describe the relationship between electromotive force, resistance, and flow (i.e. understand Ohm’s Law)
- Draw a simple DC electric circuit comprised of a battery and:
  - Single resistor
  - Resistors in series
  - Resistors in parallel
- Solve for voltage, current, or resistance in simple DC circuits:
  - In Series
  - In Parallel
- Reduce a compound circuit to a simple equivalent
- Describe the difference between alternating and direct current (AC/DC!)
- Describe the role of a capacitor in an AC and DC circuit

Brief Review

![High Pass](image1.png)  ![Low Pass](image2.png)
Capacitor Time Constants

Over time...
- Capacitor’s voltage increases
- Current flow grinds to a halt

The capacitor’s time constant $T_C$:
- The time in seconds for it to become 63.2% charged ($1 - e^{-t/T_C} = 0.632$)
- The time in seconds for current flow have slowed by 63.2% from its starting value

Today:

Basic Neuroanatomy (continued)

The Electrodermal Response System

V. Organization of the nervous system

A. Central nervous system
   1. Brain
   2. Spinal cord

V. Organization of the nervous system

B. Peripheral nervous system
   1. Somatic system
   2. Autonomic system; two branches work in generally antagonistic fashion

Somatic System

- Descending motor tracts within spinal cord synapse at approximate level of exit
- Post-synaptic neuron directly innervates target
- 2-neuron system
Autonomic System

- Descending motor tracts within spinal cord
  - synapse not necessarily at level of exit
- After exit, synapse again before innervating target
- 3-neuron system

V. Organization of the nervous system

B. Peripheral nervous system

2. Autonomic system
   a. Sympathetic nervous system
      1. tends to have system-wide effects
      2. flight or fight; activity
   b. Parasympathetic nervous system
      1. tends to affect one organ at a time
      2. quiescent processes—digestion, protects and conserves energy
      3. “rest and digest”

VI. The common household brain

A. Overview of brain
   1. The primitive central core
   2. Limbic system, or the “Inner Lizard”
   3. Cerebrum (AKA cerebral hemispheres)
      a. Ontogeny
      b. Phylogeny
      c. Ontogeny recapitulates phylogeny
   4. These three layers are interconnected extensively; do not function independently

Next
"... this history of the embryo (ontogeny) must be completed by a second, equally valuable, and closely connected branch of thought - the history of race (phylogeny). Both of these branches of evolutionary science, are, in my opinion, in the closest causal connection; this arises from the reciprocal action of the laws of heredity and adaptation... 'ontogenesis is a brief and rapid recapitulation of phylogenesis, determined by the physiological functions of heredity (generation) and adaptation (maintenance).'

Haeckel, E. 1899. Riddle of the Universe at the Close of the Nineteenth Century.

Directions please!

- lateral--side;
- medial--middle
- ipsilateral--same;
- contralateral--opposite
- proximal--toward the soma;
- distal--away from the soma
- anterior--front;
- posterior--back
- ventral--front
- dorsal--back
- rostral--towards the nose;
- caudal--towards the tail
- efferent--output/motor;
- afferent--receiving/sensory
B. Brain Specifics

1. Primitive central core
   a. Cerebellum
      1. "little brain"
      2. smooth coordination of movements
      3. learning of complex motor activities

b. Thalamus & Hypothalamus: located just above the brain stem & tucked inside the cerebral hemispheres
   1. Thalamus is a relay station for sensory information
      a. "Gateway to the cortex"
      b. coming from spinal cord to cortex
      c. taste touch hearing vision -- olfaction is exception

b. Thalamus & Hypothalamus:
   2. Hypothalamus
      a. literally = "under thalamus"
      b. 4 F's:
         Emotion/Motivation
         Thirst/Hunger
         Body Temp
         Sexual Drives
         Feelings/Fleeing/Fighting
         Feeding
         Fever
         Fourth F
B. Brain Specifics

1. Primitive central core

b. Basal Ganglia:
   1. Necessary for voluntary motor movements
   2. Involved in numerous disorders
      a. Parkinson’s
      b. Obsessive-Compulsive

c. Reticular system
   1. diffuse from brainstem to thalamus
   2. 3 A’s, arousal, awareness, attention

B. Brain Specifics

2. Limbic system
   a. A group of structures lying along the innermost edge of the cerebral hemispheres
   b. Involved in instinctual behaviors in lower animals (caring for young, mating, fleeing from attackers, fleeing from prey)
   c. Involved in memory and emotion in humans
   d. Especially important structures within the Limbic system:
      i. Hippocampus
      ii. Amygdala

The common household brain

3. The cerebral hemispheres
   a. Grey matter vs white matter
The common household brain

3. The cerebral hemispheres
   b. Four lobes: Sample Functions
      1. frontal Planning, Abstract thought, Motor
      2. parietal Sensory Integration, Spatial analysis
      3. occipital Visual Perception
      4. temporal Object Identification, sound discrimination

The common household brain

3. The cerebral hemispheres
c. Somatosensory area
   1. heat, cold, touch, pain, sense of body movement
   2. contralateral
   3. space appropriated in accord to amount of use or need

The common household brain

3. The cerebral hemispheres
d. Motor area
   1. topographic organization--Homunculus
   2. contralateral control of body

The common household brain

3. The cerebral hemispheres
e. Visual area
   1. Contralateral visual field
   2. Primary vs Secondary
The common household brain

f. Auditory area
   1. bilateral representation
   2. contralateral stronger

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The common household brain

g. Association areas
   1. functions which are not directly sensory or motor
   2. Examples:
      a. motor planning
      b. thought
      c. Speech
      d. problem solving
      e. complex object recognition (e.g. prosopagnosia)

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Luria’s Functional Systems

1. Primary
   a. Motor (precentral gyrus);
      (1) topographic organization
   b. Sensory
      (1) Somatosensory (post central gyrus)
      (2) Visual (Occipital cortex)
      (3) Auditory (Banks of Lateral Sulcus)

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Luria’s Functional Systems

2. Secondary
   a. Motor (rostral to precentral gyrus): motor programming,
      sequences of movements
   b. Sensory (caudal to postcentral gyrus): unimodal sensory integration
Luria’s Functional Systems

3. Tertiary

a. Motor (frontal lobes): goal directed acts, long-term & short-term planning, internal manipulation of "ideas" and representational systems that are basic to abstract thought

b. Sensory (parietal and to some extent temporal): **cross-modal** integration of sensory information

Skin Conductance:

Pontificating about sweat

Two types of Sweat Glands

- **Eccrine**
  - forms basis of skin conductance recording
  - located all over body, but dense concentrations on surface of hands and feet
  - has many functions

- **Apocrine**
  - found with hair follicles
  - dense under armpits and genital areas
  - function in humans remains a matter of debate
  - not widely studied by psychophysiologists

Functions of Sweat Glands

- Thermoregulation
- Thermal Preparation
- Facilitate manipulative contact
- Minimize abrasion
- Accentuate Tactile Acuity
- Odiferous communication? (Apocrine)

After Edelberg, 1972

Anatomy of a Gland and the Skin

- Sweat glands primarily driven by sympathetic innervation that is cholinergic
- Sudomotor fibers originate in the sympathetic chain, terminate on sudomotor cell in the sweat gland
- Stratum Corneum acts as a variable resistor, with decreased resistance due to sweat

Functions of Sweat Glands

- Thermoregulation
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Central Control

Distributed, multiple pathways

- Contralateral cortical and basal ganglion influences
- Premotor Cortex:
  - Excitatory
  - Situations requiring fine motor control
- Frontal Cortex:
  - Excitatory and inhibitory
  - Attention, orienting
- Ipsilateral hypothalamus and limbic system
- Thermoregulation
- Emotion
- Reticular formation
- EDA associated with:
  - Gross movements
  - Increased muscle tone

From Dawson et al, 2016
Acronym Glossary

- **EDA** = electrodermal activity
- **GSR** = galvanic skin response
- **Skin Resistance** (exosomatic method)
  - **SRL** = skin resistance level (tonic); 10,000-500,000Ω
  - **SRR** = skin resistance response (phasic); 100-10,000 Ω
- **Skin Conductance** (exosomatic method)
  - **SCL** = skin conductance level (tonic); 2-50 μsiemens
  - **SCR** = skin conductance response (phasic); 0.05-5 μsiemens
  - **SSCR** or **NSSCR** = spontaneous or non-specific skin conductance response
- **Skin Potential** (endosomatic method)
  - **SPL** = skin potential level (tonic); 0-60 mV
  - **SPR** = skin potential response (phasic); 0.1-10 mV

Unfounded is the complaint that the study of science and the technical application of the forces of nature gives to mankind a thoroughly material direction, makes them proud of their knowledge and power, and alienates ideal endeavours. The deeper we penetrate into the harmonious action of natural forces regulated by eternal unalterable laws, and yet so thickly veiled from our complete comprehension, the more we feel on the contrary moved to humble modesty, the smaller appears to us the extent of our knowledge, the more active is our endeavour to draw more from the inexhaustible fountain of knowledge, and understanding, and the higher rises our admiration of the endless wisdom which ordains and penetrates the whole creation.

Werner von Siemens 1816-1892
The “Father of Electrical Engineering” in Germany

Glands Act as Resistors in Parallel

- Resistance will therefore decrease with increased recording surface area – keep surface area constant across subjects
- Resistance is not linearly related to the # of resistors
  \[
  \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_n}
  \]
- Conductance, however, is linearly related to the number of resistors in the circuit
  - Therefore, there exists a linear relation between measures of conductance and sweat secretion
  - Not so for Resistance
  - The metric of conductance more accurately reflects the activity of the system

<table>
<thead>
<tr>
<th></th>
<th>SRL (Ω)</th>
<th>SCL(μS)</th>
<th>SRR</th>
<th>SCR</th>
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<tr>
<td>R1</td>
<td>100,000</td>
<td>10</td>
<td></td>
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<td>10.1</td>
<td>1000</td>
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<td>R2</td>
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<td>R2</td>
<td>19,000</td>
<td>52.6</td>
<td>1000</td>
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•Conductance is the Reciprocal of Resistance
  •This shows how two vastly different responses will appear the same using skin resistance response metrics
Recording -- Placement

From Dawson et al 2016

Recording Considerations

- Prep the Skin?
  - Never abrade
  - Don’t use other agents (ETOH)
  - Washing with soap and H2O recommended to standardize across subjects

- Electrodes – Ag-AgCl
  - More expensive and fragile (unless sintered)
  - But well worth it – resist polarization

- Conductive Paste
  - Because current passed continuously, can interact with with the tissue
  - Unibase + physiological saline (Fowles et al, 1981) will keep properties of tissue and paste constant over duration of recording session
  - Other gels are bad news;
    - highly conductive, but saturated with NaCl
    - over time will migrate to skin tissue, inflating SCL

- Surface Area Exposed
  - Keep constant across subjects and session

- Constant Voltage Amplification
  - Preferred over Constant current (Lykken and Venables, 1971)

- Temporal responsivity – SC system is S...L...O...W

The Generic SCR

- Latency typically 1-3 secs
- Rise time typically 1-4 secs

From Dawson et al 2016

Scoring Issues

- Responses that ride on responses
- Range Correction (Lykken et al., 1966)
  - Level
    \[
    \frac{SCL_{\text{relevant}} - SCL_{\text{irrelevant}}}{SCL_{\text{max}} - SCL_{\text{min}}} \]
  - Response
    \[
    \frac{SCR_{\text{relevant}}}{SCR_{\text{irrelevant}}} \]
- Note also slope and intercept regression approaches

Applications

- Orienting (Bauer, 1984; Tranel and Damasio, 1985)
- Fear conditioning (Öhman)
- Individual Differences
- Deficient anticipatory (Hare)
- Deception Detection
Applications

➤ Orienting (Bauer, 1984; Tranel and Damasio, 1985)
➤ Fear conditioning (Őhman)
➤ Individual Differences in Neuroticism
➤ Deficient anticipatory anxiety in psychopathy (Hare)
➤ Deception Detection (Myriad authors)

Neuroticism

➤ A trait-like tendency to experience negative affect and for increased reactivity to stress and aversive stimuli
➤ Would skin conductance reflect greater physiological reactivity to negative stimuli, and poorer physiological recovery?

Norris, Larsen, & Cacioppo (2007), *Psychophysiology*

Anticipatory Arousal in Psychopathy

➤ Hare Countdown Task (1965)
➤ #’s appear from 1..8
➤ At “8” punishment is given (shock):

Fearless Dominance
(dual-process model of Psychopathy)

➤ Orienting (Bauer, 1984; Tranel and Damasio, 1985)
➤ Fear conditioning (Őhman)
➤ Individual Differences in Neuroticism
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