Lecture 17 (Nov 28th):
STRESS RESPONSE AND HEALTH
Lecture Outline

1) Three Types of Responses to Stress
   1) Direct Behavioral
   2) Sympathetic System (Branch of Autonomic System)
   3) Hormonal

** there is a lot of redundancy between (2) and (3)

2) The Influence of Psychological State on Health

3) Effects of Long-Term Stress (Anxiety) on Health
   High Blood Pressure
   Possible Memory Loss
   Ulcers
   Immune Deficiencies
Last Lecture: What area underlies recognition of threatening stimuli / experience of fear/anger? **Amygdala**

This Lecture:

1) Fear and Anger are *negative emotions*, which are short-lived and lead to a “short-term” stress response. **How does your body respond?**
   - “fight or flight”….. which is adaptive!
   - Increase *heart rate, blood pressure* and *breathing* to bring fuel to brain and muscles!

2) “Anxiety” is a condition of “long-term" ("chronic") stress, …… which is **not** adaptive!
   - **How is the body/brain affected by anxiety?**
Short-Term Stressors ("Fight or Flight")

3 Neural Mechanisms for Responding:

Involving outputs of the AMGYDALA (from last lecture):

- Pons (through midbrain)
- Hypothalamus

1) **DIRECT BEHAVIORAL** via Pons
   (e.g., flinch, freeze, startle response)  \(\checkmark\) last lecture

Don’t worry about which ones are “innate” fear responses
2) SYMPATHETIC SYSTEM (global effects)  
(branch of Autonomic Nervous System)

**First, a Quick Review of Autonomic Nervous System**

**SYMPATHETIC:**
“fight or flight” system, energy spending

Originates in the *hypothalamus*

………which receives from the *Amygdala!* (last slide)

**PARASYMPATHETIC:**
“rest and digest” system, energy conserving

*The two systems project to organs with opposite effects*

... although not all organs receive from both (will come back to this point later)
2) SYMPATHETIC SYSTEM (con’t)

**Neuronal** projections from the **Hypothalamus** to:

**Heart**: increase *heart rate* and *blood pressure*

gets FUEL (glucose/oxygen) via blood to brain and muscles to make energy (ATP)

**Lungs**: dilate air passages

gets FUEL (oxygen) into blood

**Adrenal Medulla** (inner part of Adrenal Gland):

releases *hormones* into blood: Adrenaline and Noradrenaline

Note: The **parasympathetic** system does *not* innervate the Adrenal Gland (either the Medulla or the Cortex)

**Adrenal Cortex**

(outer part of Adrenal Gland)

We talked about last lecture and will become relevant again later today
Effects of Adrenaline/Noradrenaline

a) Increase *heart rate, blood pressure and air passages in lungs* .... *as does direct neural input from hypothalamus to heart and lungs* *(last slide!)*

b) stimulates liver to breakdown GLYCOGEN \(\rightarrow\) *Glucose*
3) HORMONAL (global effects)  
(via the endocrine part of the Hypothalamus)

Hypothalamus-Pituitary-Adrenal Cortex Axis

- Hypothalamus secretes the hormone “CRF”, which reaches the Pituitary
- Pituitary releases Adrenocorticotropic hormone (ACTH) into blood
- ACTH activates Adrenal Cortex

Adrenal Cortex releases **Cortisol** (“Stress” Steroid Hormone) into blood  
(all cells of body have receptors for)

Note: The parasympathetic system does not innervate the Adrenal Gland (either the Medulla or Cortex)
EFFECTS of CORTISOL

a) stimulates liver to breakdown GLYCOGEN -> Glucose
   (as does Adrenaline and Noradrenaline, previous slides)

b) increases heart rate, blood pressure

c) increase metabolic rate: glucose + oxygen (in the Kreb’s cycle)
   -> energy (ATP)
**BOTTOM LINE:**
- Sympathetic System (Mechanism #2, which also has a hormonal component because the Adrenal Medulla gets stimulated)
- Hormonal System (Mechanism #3)

Together, mechanisms (2) and (3) increase
1) Amount of “fuel” in blood, i.e., glucose and oxygen
2) Heart rate and blood pressure (which speeds up how quickly fuel gets to brain and muscles)
3) Metabolic rate (which makes energy (ATP) more quickly)

...... all for the purpose of getting energy (ATP) to your brain and muscles

AND THERE IS NO WAY TO TURN THIS OFF!

Because… the parasympathetic system does *not* innervate the Adrenal Gland
**Short-Term Stress** Response (from Fear/Anger) is **Adaptive**:
Needed for high levels of activity associated with “fight or flight”

**Long-Term Stress** (Anxiety) Response is **Not Adaptive**
The Influence of Psychological State on Health

Can a person be healed/hurt through her attitude?  
“mind over matter” or “brain over body”

The Placebo Effect (this is a great example!)

Behavioral Medicine ("Holistic" Medicine):  
Eating & drinking habits, stress, exercise, and attitudes

Gone Awry? The “guilty” cancer patient!

Psychosomatic Illness:

*Real illness brought on by a negative psychological state:*  
(i.e., *short- or long- term stress, or depression*)  
e.g., “stress” migraine (from short-term stress)  
e.g., being generally unwell (from long-term stress,  
more examples later)
Types of Illnesses

**Normal Illness:** e.g., the flu

**Psychosomatic:** e.g., “stress migraine”

**Hysterical Illness or “Hypochondria”:**
e.g., "I think I have Multiple Sclerosis"

**Malingering:** fooling the doctor

**Munchausen’s:** Making yourself sick
Examples of Psychosomatic Illness resulting from **Long-Term Stress** (i.e., Anxiety)

1) **High Blood Pressure** -> Cardiovascular Disease
2) **Memory Loss from Hippocampal Damage**
   - **Cortisol** ->
     - Increases cell metabolism ->
       - If too much, hippocampal cells (involved in memory) become susceptible to injury (toxins, anoxia)
       - A damaged hippocampus results in memory problems

3) **Ulcers**: Open/bleeding sores in the stomach/intestines from gastric enzymes
   - Rebound of the PARASYMP input (after SYMPATH)
   - 1990s: Helicobacter Pylori Bacteria? Necessary, not sufficient
     - It’s the *combination* of the bacteria + stress!
4) Immune Deficiencies

**Antigen**: “Foreign” particle (in particular, the protein portion) that elicits an immune response

**Leukocytes (White Blood Cells):**
- **B-cells**: make specific antibodies (proteins) that attach to and attack (specific) antigens (made in the “B”one).
- **T-cells**: directly attack (specific) antigens. Made in the bone but mature in the “T”hymus.
- **Natural Killer Cells**: (blood cells) *non-specific* killing of antigens (and tumor cells)
- **Macrophages**: remove waste, causes inflammation (as part of the immune response)
HYPOTHESIS: Anxiety Dampens Immune System

1) When energy in the body is used for stress conditions, there is less energy left over for protein synthesis (needed for the immune system).

2) Cortisol -> thought to directly inhibit immune system (e.g., reduces inflammatory response).

** This makes sense for short-term stress, but not long-term stress.

EXAMPLE EVIDENCE to Support the Hypothesis

- Immune cell counts are decreased during stressful times.

- Studies of Upper Respiratory Infection:
  - Daily Log of Anxiety and Illness (correlational)
  - Expose People to Virus when Stressed vs. Not-Stressed

Do you know why students tend to get sick AFTER finals??