Lecture 17 (March 5\textsuperscript{th}):
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) √ last lecture
2) SYMPATHETIC SYSTEM (global effects)  
(branch of Autonomic Nervous System)

First, a Quick Review of the 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**: increase breathing rate, 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 two lectures ago and will be part of system (3), coming up in a few slides
Effects of Adrenaline/Noradrenaline

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

b) stimulates liver to breakdown GLYCOGEN -> 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

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 Physical Health

Types of Physical Illness

Normal Illness: e.g., the flu

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

Malingering: fooling the doctor

Munchausen’s: Making yourself sick

Psychosomatic:

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)
The Influence of Psychological State on Psychical Health

Can a person be healed/hurt through their mind state?
“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
Can this approach go awry? The “guilty” cancer patient?
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 metabolism too high, 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

First, a Brief Overview of Immune System
(for you to teach yourselves)

**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)
4) Immune Deficiencies (con’t)

**Anxiety Dampens the Immune System**

e.g., Studies of **Upper Respiratory Infection**
   - Daily log of anxiety and illness (natural correlational)
   - Daily log of anxiety and then expose people to virus

   (virus is “necessary but not sufficient”)

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

**HOW DOES THIS HAPPEN?**

When energy in the body is used for stress conditions, there is less energy left over for *homeostatic* functions, *like protein synthesis to create immune cells*

In fact, studies show that **immune cell counts** are decreased during stressful times

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