Emotions and Stress
What is Emotion?

• 3 aspects of an emotion:
  1. Cognition
  2. Readiness for action:
     Autonomic nervous system
  3. Feeling
One theory is that sympathetic nervous system arousal and muscle reactions occur first and determine the intensity of the emotion.
Fig. 12-1, p. 355
According to that theory:

1. People with a weak autonomic response should feel less emotion.
2. Increasing one’s sympathetic response should enhance an emotion.
Is physiological arousal NECESSARY for emotion?

• People with “pure autonomic failure” report feeling emotion less intensely.
  – Pure autonomic failure - output from the autonomic nervous system almost entirely fails.
  – They can label emotions cognitively, but don’t FEEL much emotion.
What is Emotion?

• Creating certain body actions may also influence emotion.
  – Smiling slightly increases happiness.
  – Frowning results in stimuli seeming slightly less pleasant.
• Perception of the body's actions can contribute to emotional feeling.
• But emotion also requires the cognitive aspect.
What is Emotion?

- The **limbic system** includes forebrain areas surrounding the thalamus; it is critical for emotion.
- Brain imaging studies show that many other areas of the cerebral cortex, especially the **frontal** and **temporal** lobes, are activated during an emotional experience.
The limbic system

- Cingulate gyrus
- Anterior thalamic nuclei
- Septal nuclei
- Frontal lobe
- Olfactory bulb
- Amygdala
- Fornix
- Mamillary bodies
- Hippocampus
- Parahippocampal gyrus
  (limbic lobe)
Emotions are not localized in specific parts of the cortex. A single emotion increases activity in several parts of the brain.

Neutral face: activates the visual cortex especially on right

Happiness: Both temporal lobes, medial & orbital frontal lobe, anterior cingulate
Sadness:

More right than left hemisphere activation: orbital frontal, right temporal, right occipital cortex
Anger: right prefrontal, right & left anterior cingulate.

Fear: Left Middle temporal
Disgust: Right orbito-frontal, left & right anterior cingulate

Overall, activation was highest in the right frontal areas, especially in the happy, sad, and disgust conditions.
There is some localization of feelings of disgust.

- The insular cortex is strongly activated during exposure to stimuli perceived as “disgusting”.
  - It is also the primary taste cortex.
- “Dis-gust” = “bad taste”
  - It also reacts to frightening stimuli.
Areas of activation in insula cortex during various emotions. (A stroke destroying most of the right insula in a smoker abolished the craving for cigarettes.)
What is Emotion?

• The two hemispheres of the brain play different roles in emotion.

• Frontal and temporal areas of the left hemisphere: “approach” and the Behavioral Activation System.
  – Marked by low to moderate arousal.
  – Characterizes either happiness or anger.
What is Emotion?

- The Behavioral Inhibition System (BIS): increased activity of the frontal and temporal lobe of the right hemisphere.
  - Increases attention and arousal.
  - Inhibits action.
  - Stimulates emotions such as fear and disgust.
What is Emotion?

- Differences in frontal cortex activity are related to personality.
- People with greater activity in the left hemisphere tend to be happier, more outgoing and friendlier.
- People with greater right hemisphere activity tend to be socially withdrawn, less satisfied with life, and prone to unpleasant emotions.
What is Emotion?

• The right hemisphere seems to be more responsive to emotional stimuli than the left.
• Damage to the right temporal cortex leads to difficulty identifying emotions of others.
Why Emotions?

- One major function of emotion: to help us make decisions.
- Emotions are an important component of moral decisions.
  - Prefrontal cortex (PFC) damage in adulthood: a man knew the outcome of taking money dishonestly, but neither the approval for returning the money nor the bad consequences of taking the money made any difference emotionally to him.
- 2 young adults with PFC damage in infancy stole, lied, abused others, had no friends, and could not keep a job.
Ethical question:

• Should we punish a person for criminal acts when brain damage prevents him or her from feeling any moral responsibility?

• Should we keep such a person in a mental hospital, in order to protect the public from him or her?
Attack & escape behaviors:
Pain, threat or other unpleasant stimuli often lead to an attack.

Associated with increased activity in the amygdala.
Attack and Escape Behaviors

- Twins studies show a genetic contribution to the likelihood of violent behavior.
- In adulthood, monozygotic (identical) twins resembled each other much more than dizygotic (fraternal) twins in delinquent behaviors.
Attack and Escape Behaviors

- Smoking habits of the mother are an important prenatal factor influencing violent behavior.
- The effect is stronger if the mother smoked and also had physiological complications during pregnancy.
(a) Offspring arrested for nonviolent crime, %

(b) Offspring arrested for violent crime, %

Cigarettes mother smoked daily in 3rd trimester

Fig. 12-6, p. 362
Environmental factors can combine with genetic factors to influence behavior.

• Adopted children have the highest probability of violent behavior if a biological parent has a criminal record and there is conflict in the adopted family household.

• A biological predisposition alone, or a troubled adoptive family by itself, produces only moderate effects.
Attack and Escape Behaviors

- In most species, males engage in more aggressive and violent behaviors than do females.
- Male aggression is influenced by testosterone (T).
- Men with the highest rates of violent behavior also have slightly higher T levels.
Testosterone levels of men convicted of various crimes
Attack and Escape Behaviors

- T alters the way people respond to stimuli.
- Increased T levels in men or women →
  - Increases in heart rate.
  - Increases attention to situations related to conflict and aggression.
T increases aggressive tendencies.
Brain abnormalities & violence

- Electrical stimulation of certain brain areas can elicit aggressive behaviors.
- The exact area of the stimulation affects the type of response:
  - Ranging from attack to facial movements or growls in animals.
Intermittent explosive disorder

- A condition marked by occasional outbursts of violent behavior with little or no provocation.
  - Sometimes linked to temporal lobe epilepsy.
- Symptoms: hallucinations, lip smacking, repetitive acts, and occasional emotional outbursts.
Intermittent explosive disorder

One young woman (Julia) had temporal lobe epilepsy that elicited violent feelings. She would go for a run in her neighborhood to work through the feelings. To protect herself on these runs she carried a knife. One night she went to the movies with her parents. The movie elicited an epileptic attack and she ran to the women’s restroom (toilet).
Intermittent explosive disorder

- Another woman brushed past her, and Julia attacked her with her knife. Fortunately, others came to stop her before she did much damage. Julia later had part of her amygdala destroyed on both sides. It stopped the violent attacks, but it affected her ability to interact socially.
Fear and anxiety

• “Fear” is associated with a strong tendency to escape from an immediate threat.
• “Anxiety” is a general sense that something dangerous might occur.
  – It is not necessarily associated with the desire to flee.
Visual, auditory, & pain information is sent to the amygdala to elicit fear responses. (Do not worry about the details.)
Attack and Escape Behaviors

• Output from the amygdala to the hypothalamus controls autonomic (especially sympathetic) fear responses.
• Axons extending from the amygdala to the prefrontal cortex regulate approach and avoidance responses.
Attack and Escape Behaviors

- Damage to the amygdala interferes with:
  - the learning of fear responses
  - retention of fear responses previously learned
  - interpreting or understanding stimuli with emotional consequences
Fear and anxiety

• In the early 1900s, studies of monkeys with damage to the amygdala showed that they were calm and displayed less fear of snakes and of larger, more dominant monkeys.
• Also decreased the monkeys’ ability to interpret social gestures.
Amygdala activation

- Brain imaging studies of humans: the amygdala responds strongly to emotional stimuli and facial expressions.
  - Not associated with just fear.
- Activity is strongest when the meaning is unclear and requires some processing.
- Looking at happy faces usually activates the amygdala only weakly.
- Amygdala also responds to stimuli not consciously perceived, such as a threatening picture flashed very briefly.
A. Eye whites in pictures of fear and happy expressions.

B. Amygdala responses to pictures of fear and happy responses.

Fig. 12-14, p. 370
Amygdala and anxiety

- Genetic variations in amygdala arousal may cause some of the variations of anxiety in the population.
- Excessive fear and anxiety disorders are associated with hyperactivity in the amygdala.
Anxiety-reducing drugs

- Drugs that control anxiety alter activity at amygdala synapses.
- Injections of drugs that stimulate the amygdala enhance the startle response.
- Injections of drugs that block GABA receptors (the main inhibitory transmitter) trigger panic.
- However, drugs that enhance GABA’s effects are used to treat anxiety.
Anxiety-reducing drugs

- Ethyl alcohol has behavioral effects similar to anti-anxiety drugs. It enhances GABA effects.
- An experimental drug inhibits the effect of alcohol on GABA receptors.
  - Should it be marketed???
  - People would not feel as drunk, but might drink more, and the alcohol would damage their liver and possibly kill the person.
Stress and Health

• Hans Selye (1979) defined stress as the non-specific response of the body to any demand made upon it.
  – He was studying the effects of ovarian extracts in rats.
    • His experimental rats got ulcers, decreased immune structures, & enlarged adrenal cortex.
    • But so did the controls!!!
    • These symptoms were due to stress resulting from his poor handling technique.
• Threats on the body activate a general response to stress called the general adaptation syndrome.
Stress responses are geared to immediate physical threats, such as threatening lions.

The sympathetic nervous system increases heart rate, blood pressure, breathing…

Cortisol from the adrenal gland releases glucose from the liver to power our muscles.
However, today’s human crises are more prolonged: Drought, famine
Psychological and social stressors: Traffic....
Psychological and social stressors: Relationships, care for dying relative
Psychological, social stressors: Debt
• These can lead to various disorders that were not experienced in simpler societies: high blood pressure, ulcers, cardiovascular disease, immune system disorders.

• Stress activates two systems:
  1. The sympathetic nervous system - “fight or flight” response that prepares the body for brief emergency responses
  2. The HPA system - the Hypothalamus, Pituitary gland, and Adrenal cortex.
Stress and Health

• The HPA system produces the main response to prolonged stressors.

• Activation of the HPA system → cortisol release.

• Cortisol enhances metabolic activity and elevates blood sugar and other nutrients.
HPA Axis

- Hypothalamus
- Releasing factor
- Anterior pituitary
  - ACTH (through blood)
  - Adrenal cortex
    - Cortisol
Prolonged stress

• Prolonged high cortisol decreases synthesis of proteins of the immune system.
• Prolonged stress of longer than a month increases the likelihood of illness.
• Also, cortisol breaks down proteins in muscle cells to use as fuel.
  – Like burning furniture to keep warm.
  – Leads to weakness.
Prolonged stress

• Prolonged stress can also be harmful to the hippocampus and can affect memory.
• Brief exposure to cortisol enhances memory.
  – It increases glutamate release in hippocampus.
  – It helps you remember stressful events.
• However, too much activity → toxicity & cell death in hippocampus.
• Stress also impairs production of new hippocampal neurons.
So what happens when stress is very intense???????????
PTSD

• Posttraumatic stress disorder (PTSD) occurs in some people after terrifying experiences.

• Symptoms:
  – Frequent distressing recollections.
  – Nightmares.
  – Avoidance of reminders of the event.
  – Exaggerated arousal in response to noises and other stimuli.
PTSD

• But not all people experiencing the same or similar traumas develop PTSD.

• What accounts for the difference?
  – Not the physical experience
PTSD

- Most PTSD victims have a smaller than average hippocampus.
  - Even identical twins of those that developed PTSD in war had a smaller hippocampus.
  - The twins had not been in the war.
- PTSD victims also show lower than normal cortisol levels after the trauma.
- People with low cortisol levels and/or a small hippocampus may not deal with stress very well.
So, how should we cope with stress?

- Controllability, or even the perception of controllability, → less sympathetic nervous system activity, less cortisol release activity, & more adaptive behavior.
  - It is also associated with less illness.
- Controllable stress may be more beneficial than no stress at all. Many people thrive on challenge.
- Prefrontal cortex evaluates controllability and inhibits stress responses.
- Brief high cortisol levels facilitate coping and increase memory (stimulate hippocampus).
Coping with stress

• Exercise
  – Increases the feeling of control.
  – Decreases physiological responses to psychological stressors.
  – Increases cardiovascular health.
  – Increases production of new neurons in the hippocampus.
Exercise is an excellent way to deal with stressors.
Coping with stress

- Social support is important.
- It has effects similar to those of controllability.
- Even subordinate baboons in Kenya have lower cortisol levels if they participate in grooming behavior and play with the kids.
Baboons grooming
Summary

- Emotional experiences arouse many brain areas. However, we cannot assign specific emotions to different brain areas, with the possible exception of disgust.

- Activation of the frontal and temporal areas of the left hemisphere is associated with approach and positive feelings. The same areas of the right hemisphere are associated with decreased activity and more negative emotions.

- People with severely impaired emotions often make poor decisions.

- However, emotions sometimes lead people to panic and act inappropriately. Although emotions can be helpful guides, we need to constrain them at times.
Summary

- Stimulation of the amygdala can increase the readiness to attack.
- Genetic or prenatal influences can alter the tendency toward violent behavior, together with family environment and other experiences.
- Testosterone can increase the readiness to attack. However, differences in T levels across males account for very little of the difference in aggressive behavior.
- Animals with damage to the amygdala often act fearless, apparently because they are slow to process emotional information.
- The human amygdala responds strongly to emotional stimuli and facial expressions.
Summary

• People vary genetically in how strongly their amygdalas respond to frightening information. That variation probably contributes to differences in anxiety disorders.

• Anti-anxiety drugs decrease fear by facilitating the binding of GABA to GABA\(_A\) receptors, especially in the amygdala.
Summary: Stress & Health

• Brief stress activates the sympathetic nervous system. More prolonged stress results in the release of cortisol from the adrenal cortex. This increases the availability of metabolic fuels.

• Although the increased fuels are helpful, a prolonged increase can drain the body of the resources it needs for other purposes.
Summary

• High cortisol levels with acute stress promote the formation of memories. However, high cortisol levels during prolonged stress can damage cells in the hippocampus, thereby impairing memory.

• After a very stressful event, some people, but not others, develop posttraumatic stress disorder (PTSD). People with a smaller hippocampus and lower cortisol levels may be more likely to have PTSD.

• Coping with stress can include gaining a sense of control, exercising, and getting social support.
Implications for humanism

- Our social interactions and moral decisions depend on appropriate emotions.
- Some groups try to stir up rage against those who are not like them—other religions, those who are not religious, homosexuals, and other racial or political groups. Five people were killed this week in the United States because they attended a liberal church that welcomes gay people. There also are many suicide bombers. How could we prevent these hate crimes?