Emotion and Health
Chapter 8

Emotion and the nervous system
Immunity, and health
Biological origins of emotion
Emotion and the Nervous System

Figure 8.1: Sympathetic & Parasympathetic systems both involved.

- **Emotion**: defined
  - Sympathetic nervous system (Fight or Flight)
    - Stimulates adrenals to release hormones, particularly cortisol.
  - Parasympathetic nervous system (Relaxation)
    - Reduces activity, conserves and restores energy
Emotion and the Nervous System
Autonomic and Muscular Involvement in Emotion

• The Role of Feedback from the Body
  • James-Lange Theory
    • Situation causes a physiological reaction, which is then interpreted as an emotion
  • Cognitive Theory (Schacter & Singer)
    • Cognitive appraisal determines the emotion
    • Physiological arousal determines the intensity

• Neither theory has won out, but they have led to insights.
Emotion and the Nervous System

The Emotional Brain

Figure 8.4: The Limbic System

• In response to ‘stress’, the adrenal glands release stress hormones.
• These include epinephrine, norepinephrine, and cortisol
• A network of structures around the upper brain stem are also involved:
  • Areas implicated or activated by emotions include the Anterior Cingulate Cortex, the Hypothalamus, Septal Nuclei, the Amygdala, the Insular Cortex, and Basal Ganglia
  • Widely scattered brain activity also occurs as a result of emotional stimulation

Source: © Don Francis/Mardan Photography
Emotion and the Nervous System

The Emotional Brain

Figure 8.5: Location of the Amygdala, Insula, and Basal Ganglia

SOURCE: Photo courtesy of Dana Copeland.
Emotion and the Nervous System

Autonomic and Muscular Involvement in Emotion. Figure 8.3: Disabling Corrugator Muscle Reduces Amygdala Response to Simulated Anger

- Paul Ekman showed that ‘posed’ expressions could produce the intended emotion, and a distinct pattern of physiological arousal.
- Women with Botox paralysis of facial muscles.
  - Reported less negative moods
  - Produced less amygdala activity when imitating angry expressions
- Gum chewing can impair detecting emotions in pictures

Emotion and the Nervous System
Autonomic and Muscular Involvement in Emotion

• **Mirror neurons**
  • Respond while observing a specific act
  • Also respond performing the same act

• This may be why observing emotions in others activates our own brain’s emotional areas.
  • The degree of activation is related to the person’s score on a measure of empathy.
  • Autistic children, with delayed mimicry, also have low empathy
Emotion and the Nervous System

The Emotional Brain

Figure 8.6: Size Differences in the **Anterior Cingulate Gyrus**

Emotion and the Nervous System

The Prefrontal Cortex.

- Is involved in the control of risky or thrill seeking behavior
- Damage to this area early vs. late in life
  - Bechara: **Skin-conductance response (SCR)** decreases correlated to inability to understand consequences of risky behavior
- Abnormalities in the prefrontal cortex may be involved in disorders like depression and schizophrenia
- When disconnected (lobotomy) people’s capacity to make rational judgments is compromised
Emotion and the Nervous System

The Prefrontal Cortex. Figure 8.9: Comparison of Gambling Task Behavior in Controls and Patients with Damage to Prefrontal Cortex

(a) Choices from card decks

(b) Anticipatory SCRs

SOURCE: Text
Emotion and the Nervous System

The Amygdala. Figure 8.10: Activity in the Right Amygdala While Viewing Facial Expressions of Fear

Fear versus anxiety

• Damage to the amygdala does not reduce bodily induced panic (carbon dioxide exposure)
• Anxiety-reducing drugs influence action here

Emotion and the Nervous System
The Amygdala.
Figure 8.11: SM’s Brain Compared to a Normal Brain

SOURCE: Iowa Neurological Patient Registry/University of Iowa
Emotion and the Nervous System
Hemispheric Specialization in Emotion

- Left frontal - positive emotions
  - Damage- more anxiety and sadness about life

- Right frontal - negative emotion.
  - Greater autonomic responses to emotional stimuli (facial expressions, emotional scenes)
  - Damage
    - Unperturbed or euphoric even when bad things happen
    - Patients with right-hemisphere damage have trouble recognizing emotion in facial expressions and tone of voice.
    - They also have problems producing emotion in speech.
Stress, Immunity, and Health

Stress as an Adaptive Response

Figure 8.12: The Hypothalamus-Pituitary-Adrenal (HPA) Axis

Activates

- Sympathetic nervous system
  - Hypothalamic control.
  - Increases heart rate, blood flow, and respiration rate
- Hypothalamic-pituitary-adrenal (HPA) axis
  - Epinephrine & norepinephrine for short term stressors
  - Cortisol for prolonged stress
- Immune system fights off any invaders, initially.
Stress, Immunity, and Health
Stress as an Adaptive Response

• Stress may be an environmental condition, or an internal condition in response to a demanding event.
• Stress is adaptive under most circumstances.
• Brief stress increases immune system activity

Table 8.1

<table>
<thead>
<tr>
<th></th>
<th>Leucocytes</th>
<th>Natural Killer Cells</th>
<th>Microglia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrophages</td>
<td>Ingest invaders, display antigens, which attract T cells</td>
<td></td>
<td>Ingest invaders, display antigens to attract T cells in brain, spinal cord</td>
</tr>
<tr>
<td>T Cells</td>
<td>Multiply and attack invaders.</td>
<td>Make antibodies, which destroy intruders.</td>
<td>Attack cells containing viruses, certain kinds of tumor cells.</td>
</tr>
<tr>
<td>B Cells</td>
<td>Make antibodies, which destroy intruders.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Stress, Immunity, and Health

Negative Effects of Stress.

Figure 8.14: Relationship Between Stress and Vulnerability to Colds.
Figure 8.15: Increase in Cardiac Deaths on the Day of an Earthquake

- Chronic stress impairs immunity and health, particularly in the cardiovascular system.
  - Increased colds, blood pressure, sudden cardiac death

SOURCES: (LEFT) Adapted with permission from “Psychological Stress and Susceptibility To the Common Cold,” by S Cohen, A. D. Tyrrell, and A. P. Smith, New England Journal of Medicine, 325, pp. 606–612. © 1991 Massachusetts Medical Society. All rights reserved. (RIGHT) Reprinted with permission from J. Leor, W. K. Poole, & R. A. Kloner, “Sudden Cardiac Death Triggered by an Earthquake.” New England Journal of Medicine, 334, pp. 413–419. © 1996 Massachusetts Medical Society. All rights reserved.
Stress, Immunity, and Health

Negative Effects of Stress

Figure 8.16: Hippocampal Damage in a Stressed Monkey

- **Negative changes due to chronic stress**
  - Cortisol-related damage to hippocampus, gray matter
    - Elevated levels, or Increased receptor sensitivity to glucocorticoids
    - Example: Citizens near 9/11 attacks had reduced cortisol levels
  - Altered sleep cycles due to stress also cause illness
  - May trigger autoimmune diseases like Multiple Sclerosis (demyelinating)

Stress, Immunity, and Health
Social, Personality, and Genetic Factors
Figure 8.16: Post-vaccine antibody levels in relation to hemispheric activity

- Social support correlated to improved health outcomes
- Introverted, stressful personalities make less antibodies
- Genes correlated with 32% of workplace stress
  - NPY- high functioning versions have better stress reactions (Ch 6)
  - OXTR- less stress seen in individuals who make more oxytocin (Ch 7)

Pain as an Adaptive Emotion

Figure 8.18: Voluntary Ritualized Torture in Religious Practice

- Pain is a health problem (80% of doctor visits are associated with pain relief issues), but it is also adaptive
- **Congenital insensitivity to pain**
- The effect of pain depends on how it is viewed, as seen in
  - Childbirth
  - Soldiers
  - Ritualized torture
Stress, Immunity, and Health

Pain as an Adaptive Emotion.

See Figure 8.19: Painful heat effects on the somatosensory area (left of center) and anterior cingulate (midline)

- **Anterior cingulate cortex** - involved in reactions to emotional pain, as well as the anticipation of pain.
  - Independent of somatosensory cortex
  - Pain insensitivity disorders and lobotomy patients can feel emotional pain.
Biological Origins of Aggression

Definition and Types of Aggression

• Aggression: Behavior that is intended to harm.
• Two forms in animals:
  • **Predatory:** attack and kill prey... emotionless
    • Is associated with reduced serotonin activity.
  • **Affective:** characterized by emotional arousal.
    • Offensive aggression: unprovoked attack on another animal.
    • Defensive aggression: response to threat, motivated by fear.
Biological Origins of Aggression

Hormones and Aggression

Figure 8.20: Testosterone Levels of Men Convicted of Various Crimes

- Hormones and offensive aggression (like violent alcoholics)
  - Low serotonin, estrogen/progesterone
  - High testosterone and violence
- But aggression does not change with testosterone manipulation

SOURCE: Based on J. M. Dabbs et al. (1995)
Biological Roots of Aggression

The Brain’s Role in Aggression

Figure 8.21: Cat Brain Circuits for Defensive and Predatory Aggression

- Cats: defensive and predatory aggression pathways
- Humans:
  - Tumors in the hypothalamus or septal area
  - Amygdala: Seizure activity, and higher activity in murderers
- ‘Fit of Rage’ murderers have reduced activity levels in the prefrontal cortex.
- Amygdala lesions reduce aggression in 33%-100% of patients

SOURCE: Based on A. Siegel et al. (1999).
Biological Origins of Aggression
Reactive & Proactive Aggression Involve Different Patterns of Brain Function

• Antisocial personality disorder
  • Diagnostic Criteria (DSM-5)
    • Impaired self-functioning (ego-centric behaviors)
    • Impaired interpersonal functioning (lack of empathy, intimacy)
  • Pathological personality traits
    • Antagonism
    • Disinhibition
  • Physiological Mechanisms
    • Murderers: 22% less prefrontal gray matter

Biological Origins of Aggression

Neurotransmitters and Aggression. Figure 8.22: Prefrontal Dopamine and Serotonin in Rats During and Following Fights

- **Dopamine**: High in prefrontal cortex, accumbens and in aggressive psychiatric patients
- **GABA**: Inhibits aggression and impulsivity
- **Serotonin**: Low activity and aggression, impairs prefrontal cortex
  - **Testosterone**: high levels (with low serotonin)
  - **Alcohol**: depletes serotonin, triggering craving

**SOURCE:** Adapted from Figure 2b from “Aggressive Behavior, Increased Accumbal Dopamine, and Decreased Cortical Serotonin in Rats,” by Annemoon M. M. van Erp and Klaus A. Miczek, Journal of Neuroscience, 15, pp. 9320-9325. Copyright 2000.
Biological Origins of Aggression

Heredity and Environment. Figure 8.22: Genetic Influence on Violent Behavior in Victims of Childhood Maltreatment.

- **Genetics (50%)**
  - Genes influencing dopamine, GABA, serotonin systems
- **Environment (50%)**
  - Childhood neglect or maltreatment
  - Epigenetic effect on people with certain alleles that have poor childhoods
    - MAOA-L allele
    - HTR2B serotonin receptor
    - SLC6A4 gene

Biological Origins of Aggression
Neurocriminology, Responsibility, and the Law

• **Neurocriminology**
  • Genes and biology being considered as predictors of behavior
  • Before:
    • Donta Page (1999)- released early from prison for robbery despite high risk for violence due to family history and personality traits, then committed murder.
  • Now:
    • Sandy Hook shooting and the Avielle Foundation