The Biology of Sex and Gender
Chapter 7

- Sex as a form of motivation
- The biological determination of sex
- Gender-related behavioral and cognitive differences
- Biological origins of gender identity
- Sexual orientation
Sex as a Form of Motivation
Arousal and Satiation

• Sex is like hunger and thirst.
  • Arousal and satiation.
  • Hormonal control.
  • Controlled by specific areas of the brain.

• Sex also differs in important ways from hunger and thirst.
  • Not a homeostatic tissue need (sex not required for survival).
  • Reproduction, however, is a species need.
Sex as a Form of Motivation

Figure 7.1: Phases of the Sexual Response Cycle

- William Masters and Virginia Johnson’s human sexual responses occur in 4 Phases.
  - Excitement phase
  - Plateau phase
  - Orgasm
  - Resolution phase
  - Refractory phase (Male only)
- **Coolidge effect (Male only)**
- A popular new series on Showtime network (“Masters of Sex”)

Sex as a Form of Motivation

The Role of Sex Hormones. Figure 7.2: Female-Initiated Activity During the Menstrual Cycle.

- **Castration**
  - Removes major source of sex hormones
  - Loss of (or drastic decrease in) sexual motivation

- **Sex hormones**
  - **Androgens (Testosterone)**
  - **Estrogen**
    - **Estrus** (period of ovulation: a.k.a. being ‘in heat’)
  - Progesterone
  - Anti-Androgen drugs have proven highly effective for treating deviant sexual behavior.
  - Human females (unlike many other species) may be willing to engage in sex at any time during their cycle.
Sex as a Form of Motivation

Figure 7.2: Female-Initiated Activity During the Menstrual Cycle.

Sex as a Form of Motivation

Figure 7.3: Testosterone and Sexual Behavior

Sex as a Form of Motivation
Brain Structures and Neurotransmitters. Figure 7.4: The Sexually Dimorphic Nuclei of the Rat

- **Important to both sexes**
  - **Medial preoptic area (MPOA)** of the hypothalamus
  - **Medial amygdala** in the temporal lobe (also involved in aggression and emotional processing)

- **Brain area important for females:**
  - **Ventromedial hypothalamus (vmH)**

- **Brain areas important for males**
  - **Paraventricular nucleus (PVN)**
  - **Sexually dimorphic nucleus (SDN) of MPOA**

Sex as a Form of Motivation
Brain Structures and Neurotransmitters

• Dopamine (D)
  • Drugs that increase D increase sexual activity and orgasmic activity. D1 receptor stimulation activates the parasympathetic system.

• Serotonin (S)
  • Ejaculation is accompanied by increases in S in lateral hypothalamus
  • Drugs that increase S impair sexual ability and orgasm.

Garrett: Brain & Behavior 4e
Sex as a Form of Motivation
Odors, Pheromones, and Sexual Attraction

- Humans distinguish 10,000+ odors from only a few hundred receptors.
- “T-shirt studies” indicate that people can distinguish family members from others based on genetically-determined odor.
- Men most attracted to t-shirts of women who were ovulating when smell samples were taken.
- **Major histocompatibility complex (MHC) differences**
  - Women prefer odors of men who differ in MHC
  - Couples similar in MHC are less fertile.
  - Greater sexual satisfaction.
Sex as a Form of Motivation

Figure 7.6: The Olfactory and Vomeronasal Systems

- **Pheromone**
  - Chemical released into environment
  - Affects another individual (usually of same species)

- **VNO (Vomeronasal organ)**
  - Connects to the MPOA and amygdala.
  - Function in humans is uncertain

- Other odor cues detected by olfactory receptors
Sex as a Form of Motivation
Odors, Pheromones, and Sexual Attraction. Application: Of Love and Bonding

• In humans, oxytocin is involved in bonding, muscle contractions associated with lactation and orgasm, and social recognition.
• Prairie voles mate for life, while other voles do not.
  • Higher oxytocin release
  • Higher vasopressin release and receptors

SOURCE: Todd Ahern / Emory University
The Biological Determination of Sex

The Biological Determination of Sex. A Glossary of Terms

• **Sex**
  - Biological characteristics that divide individuals into male and female categories.

• **Gender**
  - Behavioral characteristics associated with being male or female.

• **Gender Role**
  - Societal set of behaviors considered socially appropriate for a particular sex.

• **Gender Identity**
  - Subjective feeling of being male or female.
The Biological Determination of Sex

Figure 7.7: Female and Male X and Y Chromosomes.

- Sex cells contain one sex chromosome each
  - If fetus gets two X, female child
  - If fetus gets a Y from the dad, male child
- **Presence or absence of Y chromosome** determines sex of child.
The Biological Determination of Sex

Figure 7.8: Development of Male & Female Internal Organs
The Biological Determination of Sex
Figure 7.9: Differentiation of Male and Female Genitals

- **Sex organs (gonads)**
  - Female (No SRY present)
    - **Ovaries**
    - **Müllerian ducts** develop
    - External genitalia remain female in appearance
  - Male (SRY present)
    - **Testes** release **Müllerian inhibiting hormone** and *dihydrotestosterone*
    - These hormones allow **Wolffian ducts** and male external genitalia develop
The Biological Determination of Sex
Organizing and Activating Hormonal Effects

Organizing Effects
- Mostly occur prenatally and shortly after birth.
- Affect structures and are permanent.
- Examples
  - Development and maturation of genitalia
  - Increase in stature
  - Increase in sexual behaviors

Activating Effects
- Activating effects can occur at any time in life.
- Effects are reversible if hormone removed
- Examples
  - Breast development
  - Areas of body for fat deposition
  - Muscle and hair growth
  - Sexual interest and intimacy
The Biological Determination of Sex
Prenatal Hormones and the Brain.

• Estradiol *defeminizes* the male brain
  • Increased male-typical behaviors when testosterone converted into estradiol in neurons through aromatization

• Estradiol *feminizes* the female brain.
  • Females reduce sexual interest and receptivity when estrogen level is low.
Gender-Related Behavioral & Cognitive Differences

Figure 7.11: A Spatial Rotation Task

- **Maccoby & Jacklin (1974)**
  1. Girls have greater verbal ability.
  2. Boys excel in visual-spatial ability (mental rotation).
  4. Boys are more aggressive.

- **However**
  - Much overlap between males and females
  - Differences are task-specific.

Are these the same shape?
Gender-Related Behavioral & Cognitive Differences
Origins of Male-Female Differences

• Change testosterone or estrogen levels, change resulting behaviors
  • Changing hormone levels affect sex-specific behavior
  • Transsexuals taking opposite sex hormones become more proficient in that sex’s behaviors. Example: increasing testosterone improves spatial skills.

• Also sex differences in pain tolerance, stress reaction, susceptibility to various psychological disorders
Biological Origins of Gender Identity

Gender Identity Reversal. Figure 7.12: BSTc Size in a Male-to-Female Transsexual

- **Transsexuals**
  - Individuals believing they are the wrong sex (gender identity doesn’t match the person’s sex)
  - 1-5 per 1,000 people
  - Genetics (CYP17, AR genes) and development times (brain vs. genitals) differ

- **Brain changes**
  - **Third Interstitial Nucleus of the Anterior Hypothalamus (INAH-3)** smaller
  - Responses to sex-specific pheromones (AND, EST)
  - **Central Bed nucleus of Stria Terminalis (BSTc)** smaller

Biological Origins of Gender Identity

Figure 7.13: An XY Individual with Androgen Insensitivity.

- **Difference in Sexual Development (DSD)**
  - Ambiguous internal and external organs
  - Gonads are consistent with their chromosomes
- **Male** (affecting XY individuals) showing female external sexual attributes and behaviors.
  - Dihydrotestosterone (diHT) deficient, or
  - **Androgen Insensitivity Syndrome (AIS)** from genetic absence of androgen receptors
  - Estrogen released from testes and adrenal glands will feminize the body.

SOURCE: Photo courtesy of Terry Cyr. Used with permission of Eden Atwood (pictured above).
Biological Origins of Gender Identity
See Figure 7.14: Female Infant with Congenital Adrenal Hyperplasia

- **Female** (person with 46 XX DSD) showing male external attributes and behaviors
  - **Congenital Adrenal Hyperplasia (CAH)**
    - Adrenal glands produce large amounts of prenatal androgen.
    - Some treatments being developed for use during fetal development
    - note that androgens are also produced by testes (in males with CAH) and ovaries (in lesser amounts).

SOURCE: Used with permission of Thomas A. Wilson MD, School of Medicine, Stony Brook University Medical Center.
Biological Origins of Gender Identity
Ablatio Penis: A Natural Experiment.

• Penis destroyed early in life
  • “Neutral at birth” argument.
  • “Sexuality at birth” argument.

• Results (only 3 cases)
  • Two reverted to male, and the other accepted a female identity, but was a tomboy, chose a typically masculine occupation, and was bisexual.
  • Reassignment based on genital appearance, but contrary to prenatal hormonal influence

See Figure 7.15: David Reimer, 1965-2004.
Sexual Orientation

Introduction

• Homosexual
  • Regular activity or continuing preference for same-sex experiences (usually since childhood, 3% of population)

• Incidences
  • Same-sex activity since puberty: 9% of men and 4% of women
  • Homosexuality & Bisexuality: 2.8% of men and 1.4% of women
  • Asexual: No interest in sex: 1% of the population
Sexual Orientation
Social Influence Hypothesis

• Little support for the social influence hypothesis.
• Twin studies and family studies have provided consistent evidence supporting biological basis.

The Biological Hypothesis

• Seventy percent of homosexuals remember feeling “different” as early as 4 or 5 years of age
• Homosexuals show a high rate of gender nonconformity during childhood:
  • Mannerisms and dress typical of opposite sex
  • engaging in activities usually preferred by the other sex
  • preferring other-sex companions
Genetic and Epigenetic Influences.
Figure 7.16: Possible Locations of Genes for Male Homosexuality.

• 2-7x higher among siblings of homosexuals, and concordance of 18-50%
• In women, one of each pair of X chromosomes is turned off. This can occur in the same chromosome throughout the body
  • 4% of women with no gay sons,
  • 13% of women (1 gay son) and 23% (2+ gay sons)
• Research links prenatal stress and parental hormonal sensitivity as well.
• Mothers of multiple male offspring make antibodies against male-specific proteins, reducing their effects in later born males.
Figure 7.17: Genetic and Environmental Contributions to Sexual Orientations

Homosexuality unrelated to hormone levels in adulthood, but may alter developing brains

Spatial, verbal fluency trends towards opposite sex in homosexual individuals

Prenatal Influences on Brain Structure & Function

Figure 7.19: Responses of Heterosexual Women, Homosexual Men, and Heterosexual Men to a Presumed Male Hormone

- Homosexual and transsexual individuals respond to the pheromones AND and EST like their opposite sex counterparts

Brain differences in the homosexual brain

- Third interstitial nucleus of the anterior hypothalamus (INAH3) is smaller in gay men.
- Suprachiasmatic nucleus (SCN) is larger in gay men and secretes more vasopressin.

There is relatively little research on masculinization in homosexual women.
However, lesbians are like males in two characteristics associated with prenatal androgen exposure:
- Smaller index-to-ring finger ratio;
- Weaker evoked otoacoustic emissions.
Social Implications of the Biological Model

Inborn model is feared by some, but others suggest increase in acceptance

- Civil liberties protection only for “inborn” characteristics
- Some fear “disease” or “defective” labels
- But this view leads to more positive attitudes
  - US moral acceptance rose 16% in last 10 years
  - Currently > 50% support same-sex marriage
- Prominent activists in our society