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.
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 society 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 defecteminizes** 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.
Genetic and Epigenetic Influences

Figure 7.17: Genetic and Environmental Contributions to Sexual Orientations

Prenatal Influences on Brain Structure & Function

Figure 7.18: Sex-atypical Cognitive Performance in Homosexuals

- 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

Prenatal Influences on Brain Structure & Function

Figure 7.20: INAH3 in a Heterosexual Man (left) & a Homosexual Man (Right)

• 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.

Heterosexual male

Homosexual male

Prenatal Influences on Brain Structure & Function
Homosexuality in women

• 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