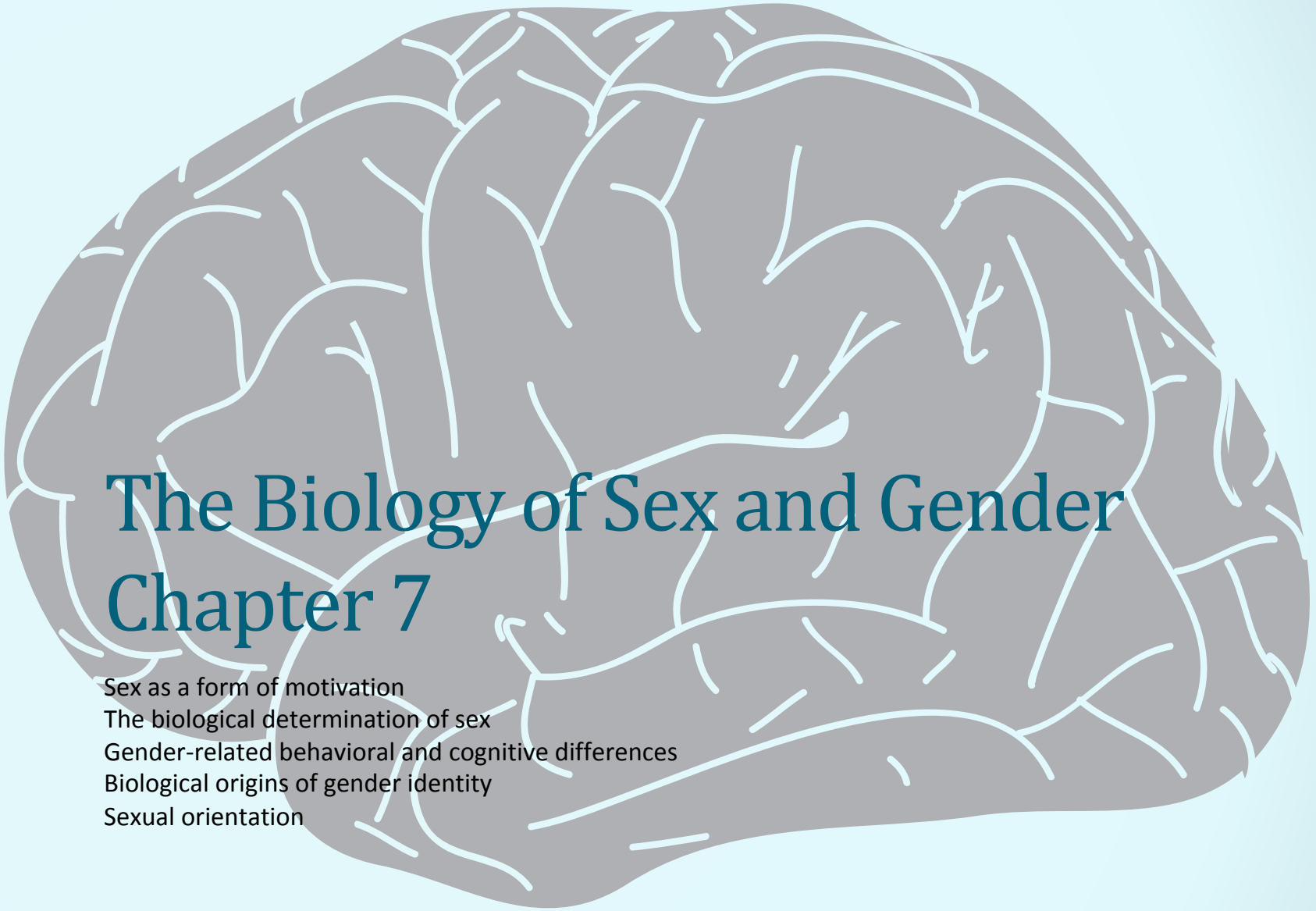


The Biology of Sex and Gender
Chapter 7

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

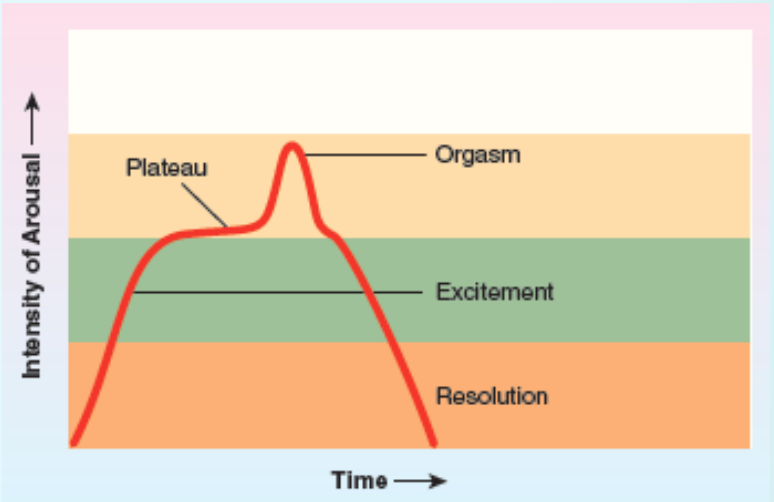
Arousal and Satiation

- 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")



SOURCE: From *Psychology: The Adaptive Mind*, 2nd ed. By Nairne. 2000. Reprinted with permission of Wadsworth, a division of Thomson Learning.

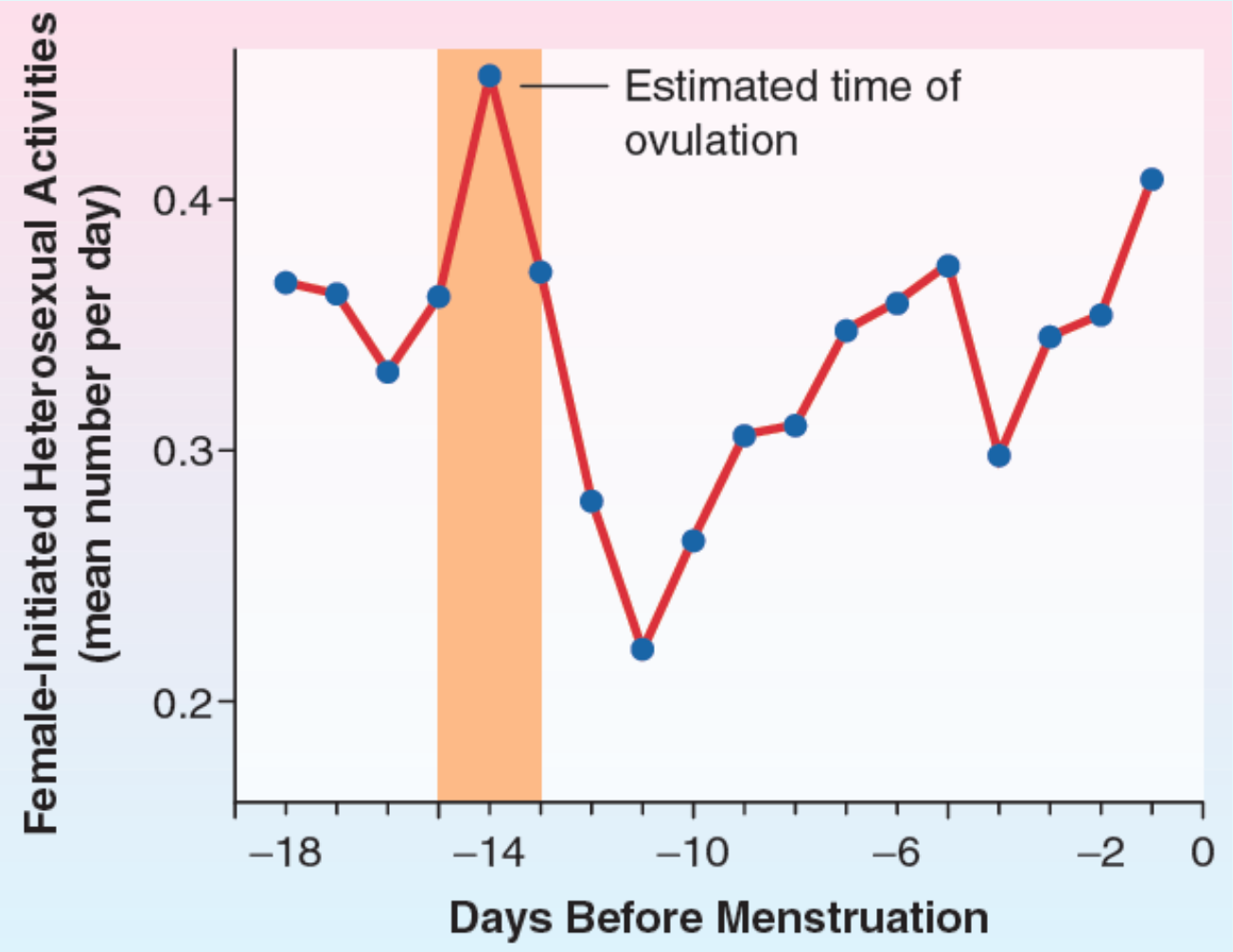
Sex as a Form of Motivation

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

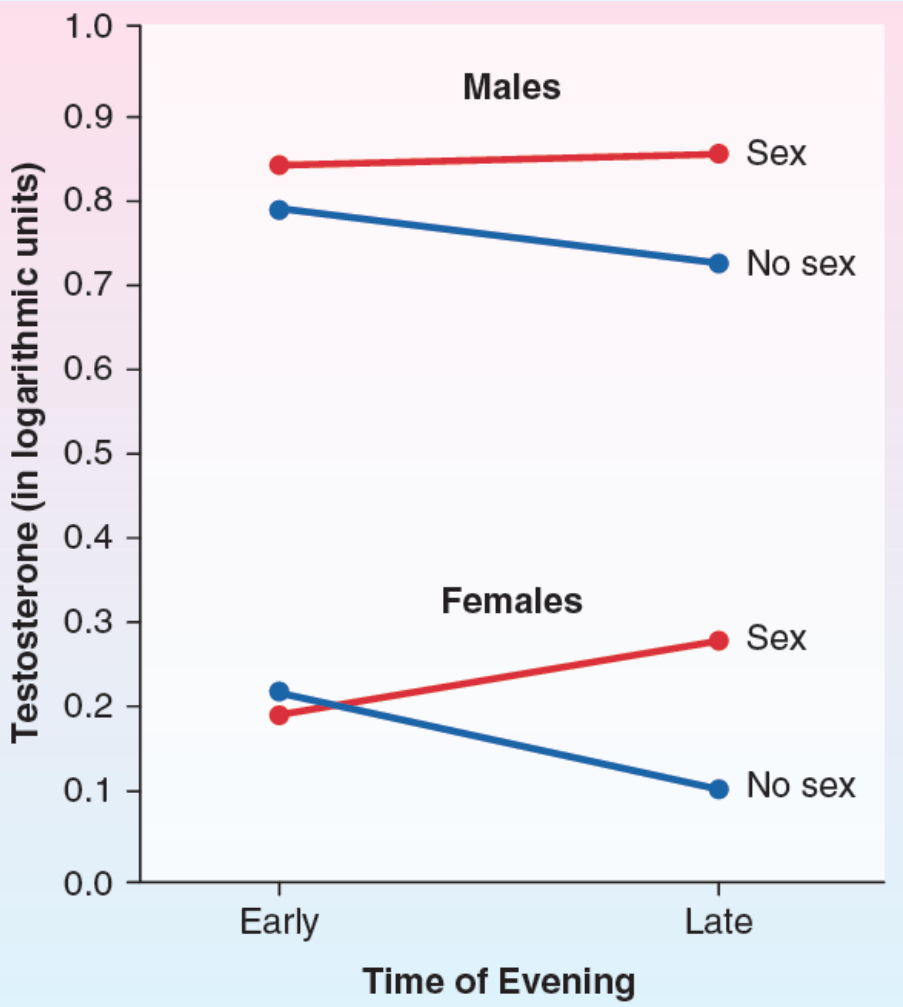
Figure 7.2: Female-Initiated Activity During the Menstrual Cycle.



SOURCE: From figure 2 from "Rise in Female-Initiated Sexual Activity at Ovulation and Its Suppression by Oral Contraceptives," by D. B. Adams, A. R. Gold, & A. D. Burt, 1978, *New England Journal of Medicine*, *299 (21)*, pp. 1145-1150.

Sex as a Form of Motivation

Figure 7.3: Testosterone and Sexual Behavior

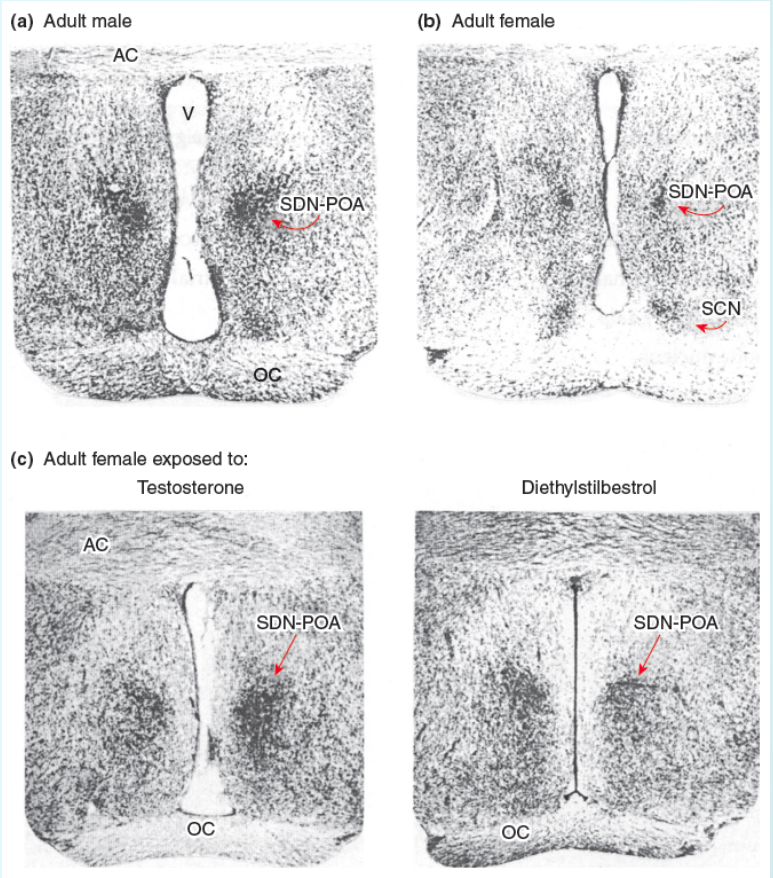


SOURCE: From figure 1 from "Male and Female Salivary Testosterone Concentrations Before and After Sexual Activity," by J. M. Dabbs, Jr. & S. Mohammed, 1992, *Physiology and Behavior*, *52*, pp. 195-197. Reprinted w/permission Elsevier Sci.

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

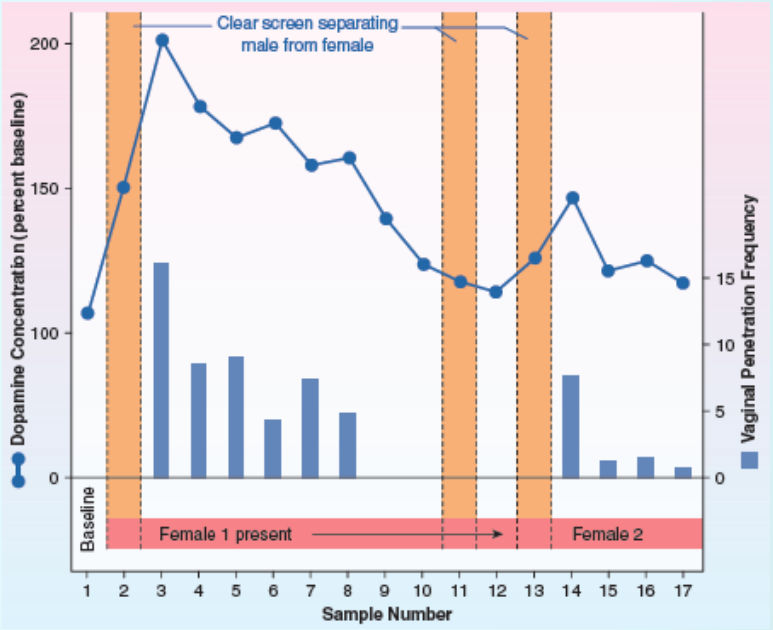


SOURCE: From "The Neuroendocrine Regulation of Sexual Behavior," by R. A. Gorski, 1974, *Advances in Psychobiology* (Vol. 2), G. Newton & A. H. Riesen (Eds.), pp. 1-58. New York: Wiley.

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

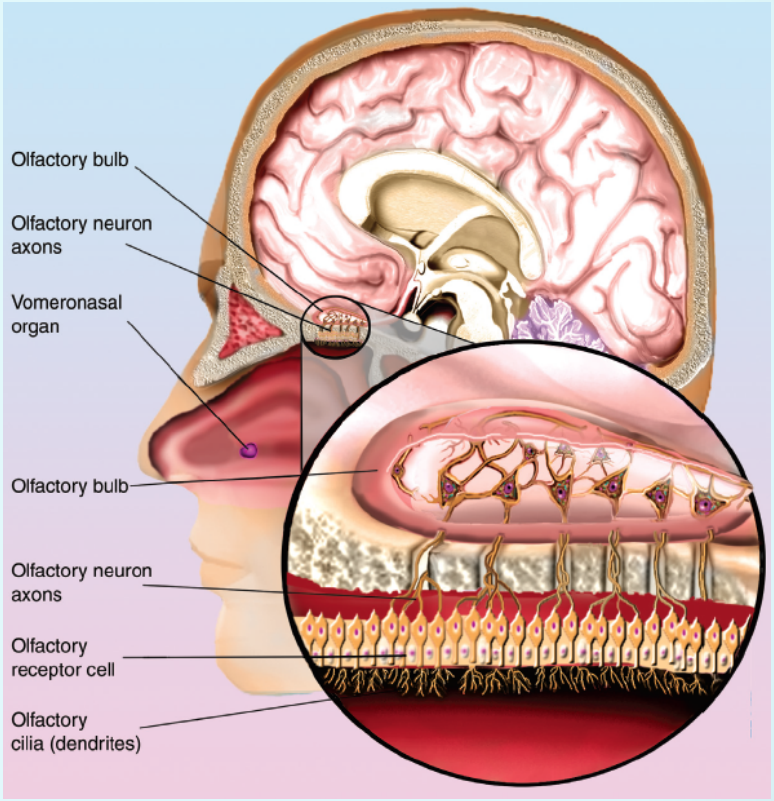
Odors, Pheromones, and Sexual Attraction

- 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

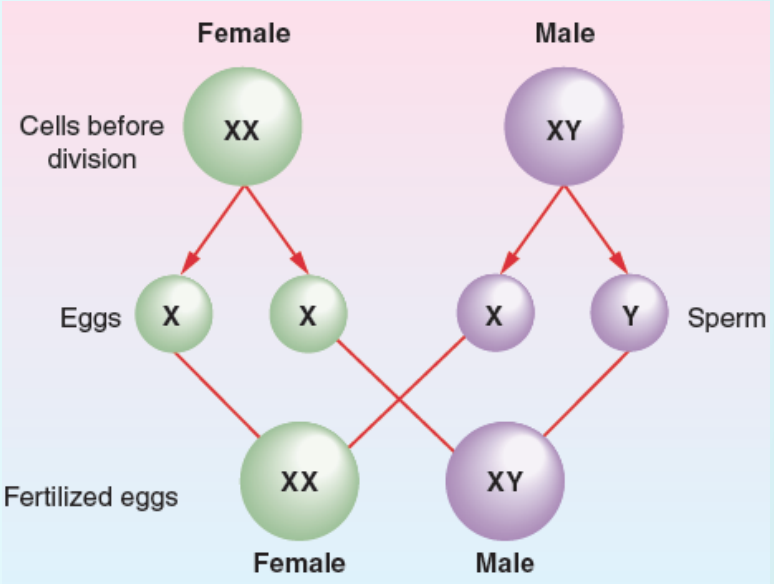
The Biological Determination of Sex. A Glossary of Terms

- **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 considered socially appropriate for a particular sex.
- **Gender Identity**
  - Subjective feeling of being male or female.

The Biological Determination of Sex

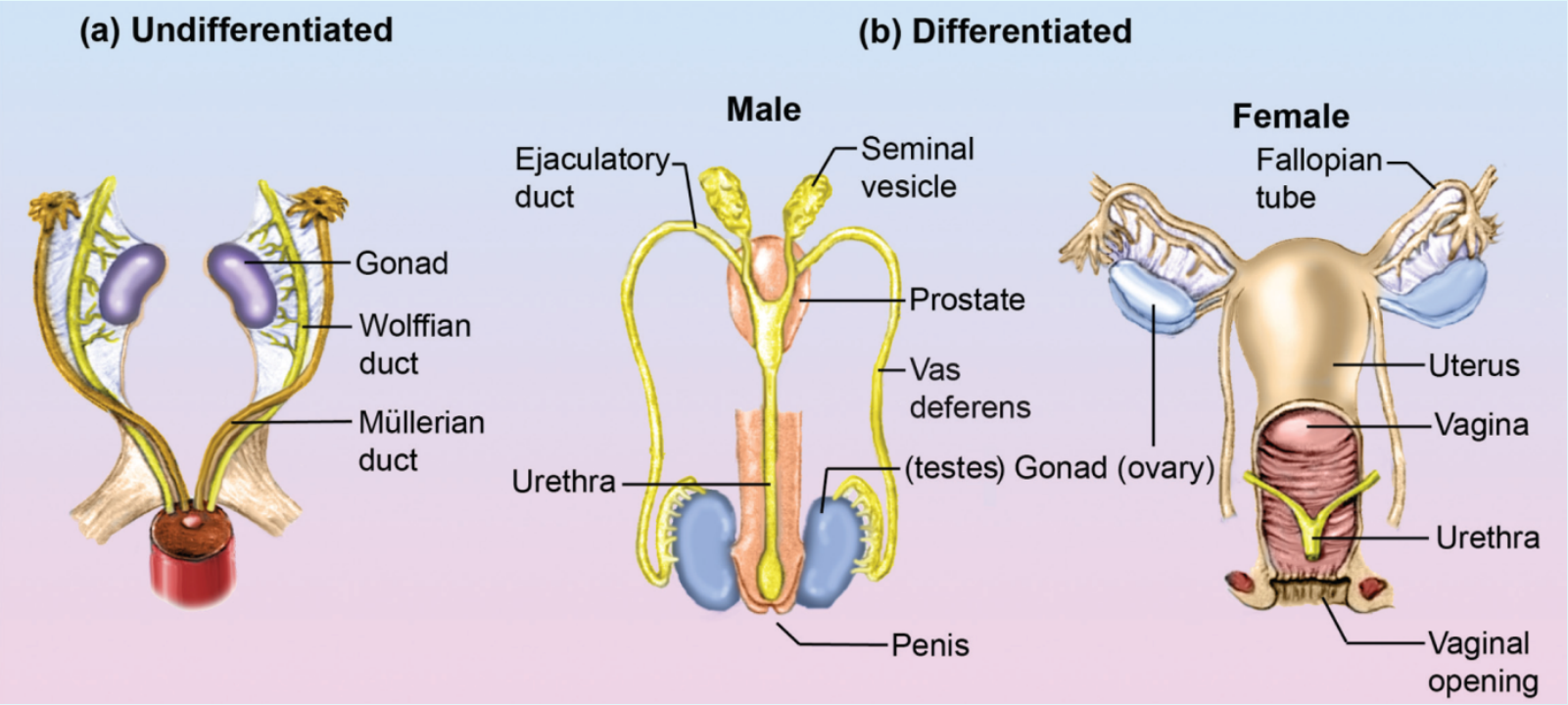
Figure 7.7: Female and Male X and Y Chromosomes.

- 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

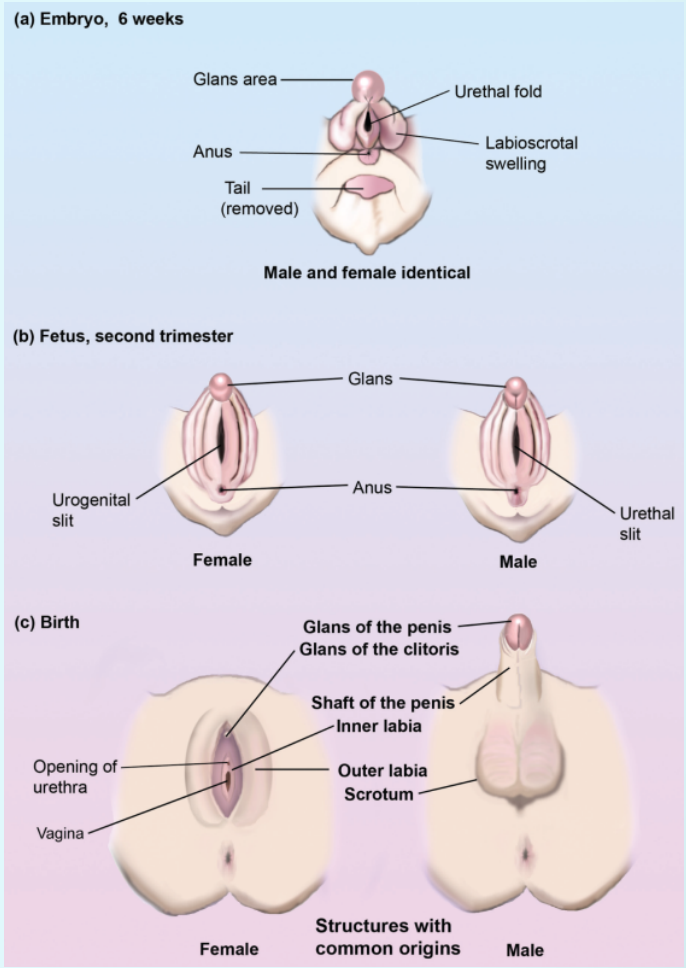
Figure 7.8: Development of Male & Female Internal Organs



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

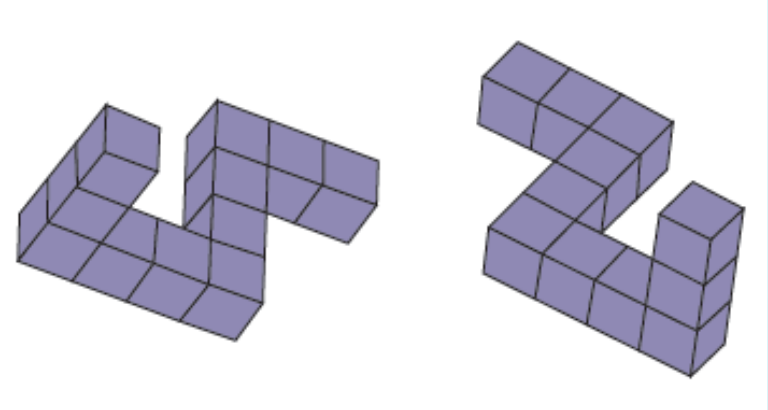
Prenatal Hormones and the Brain.

- 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).
  3. Boys excel in mathematics.
  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

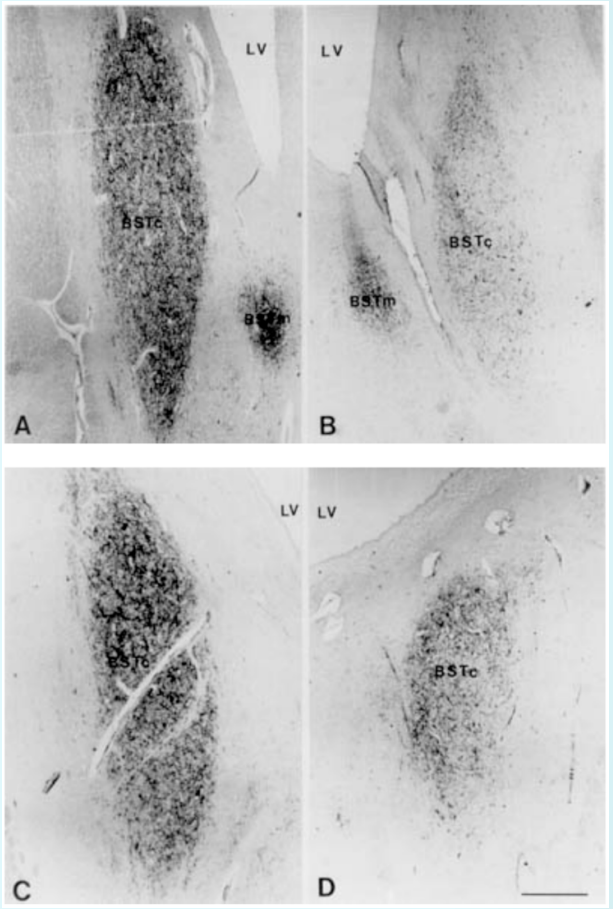
Origins of Male-Female Differences

- 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



SOURCE: Figure 2, "A Sex Difference in the Human Brain and its Relation to Transsexuality," by J. N. Zhou, M. A. Hofman, L. J. Gooren, & D. F. Swaab, 1995, *Nature, 378,* 68-70. © and reprinted by permission of Nature.

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

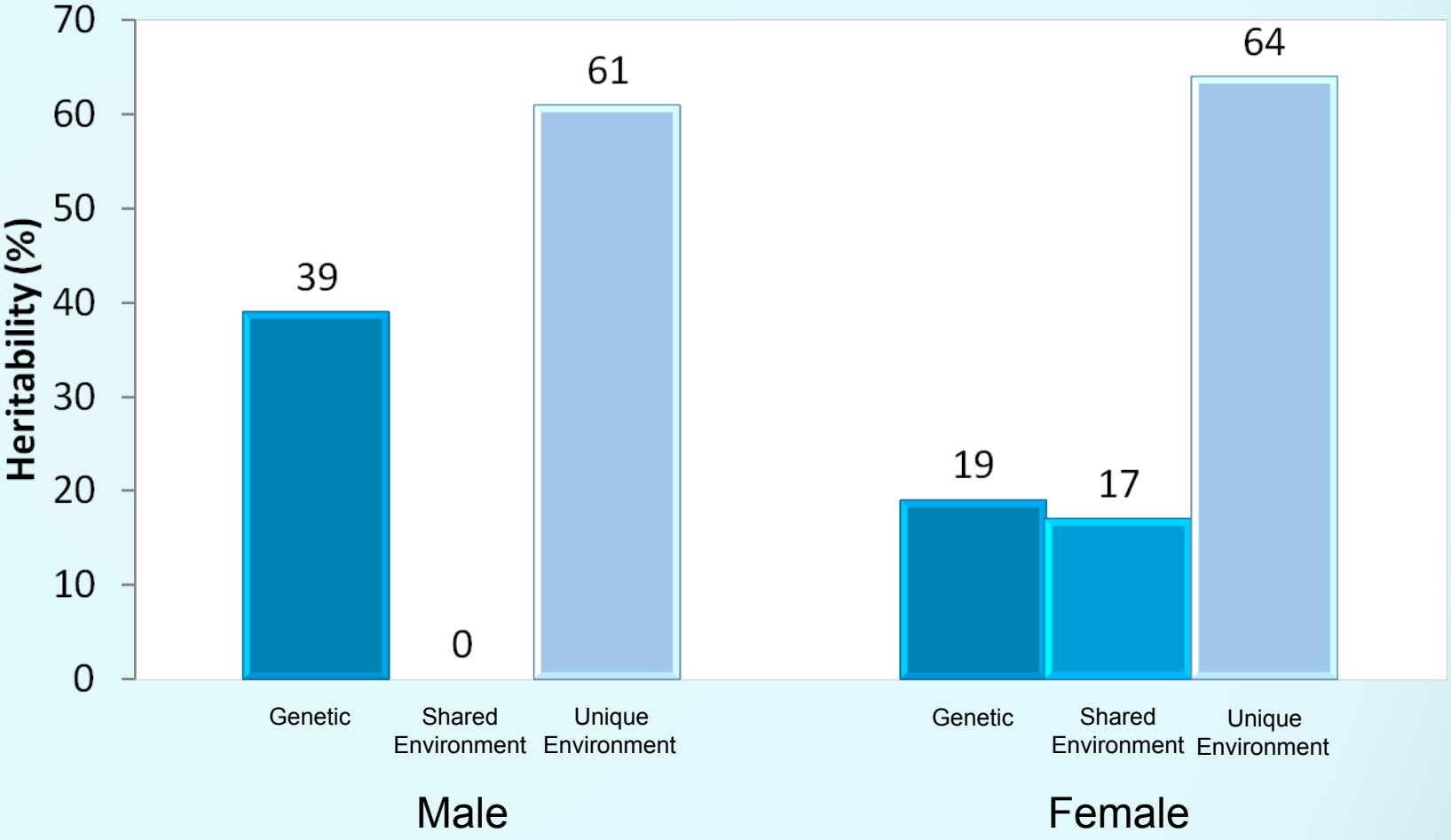
Genetic and Epigenetic Influences.

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

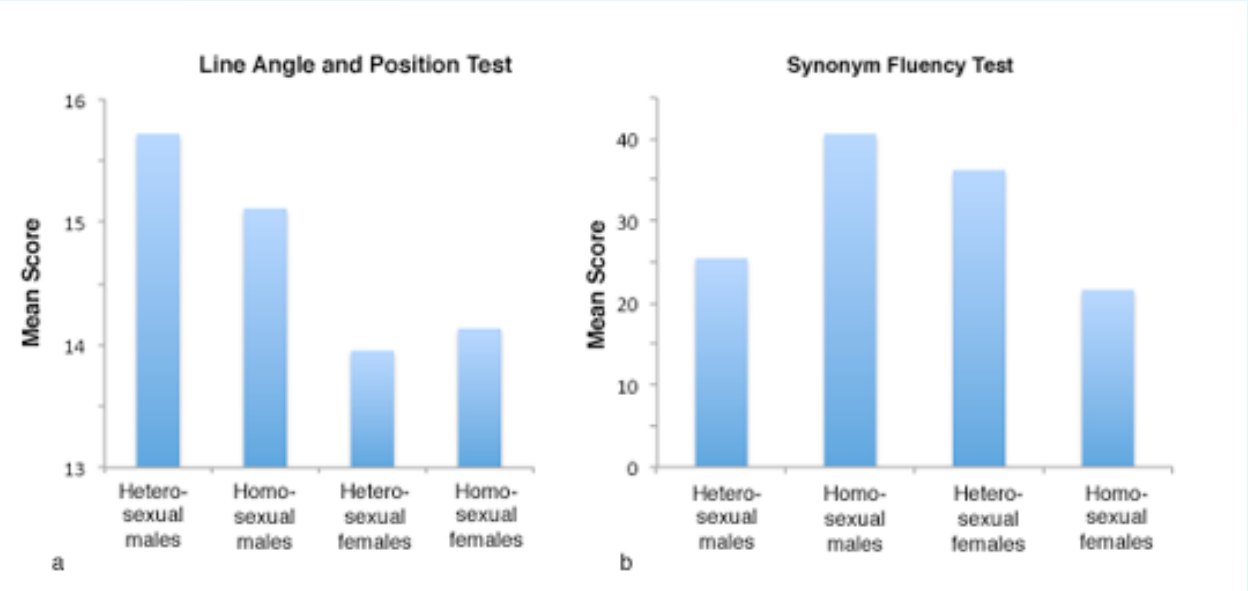


SOURCE: Based on data from Långström, N., Rahman, Q., Carlström, E., & Lichtenstein, P. (2010). Genetic and Environmental Effects on Same-sex sexual behavior: a population study of twins in Sweden. *Archives of Sexual Behavior, 39,* 75-80.

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

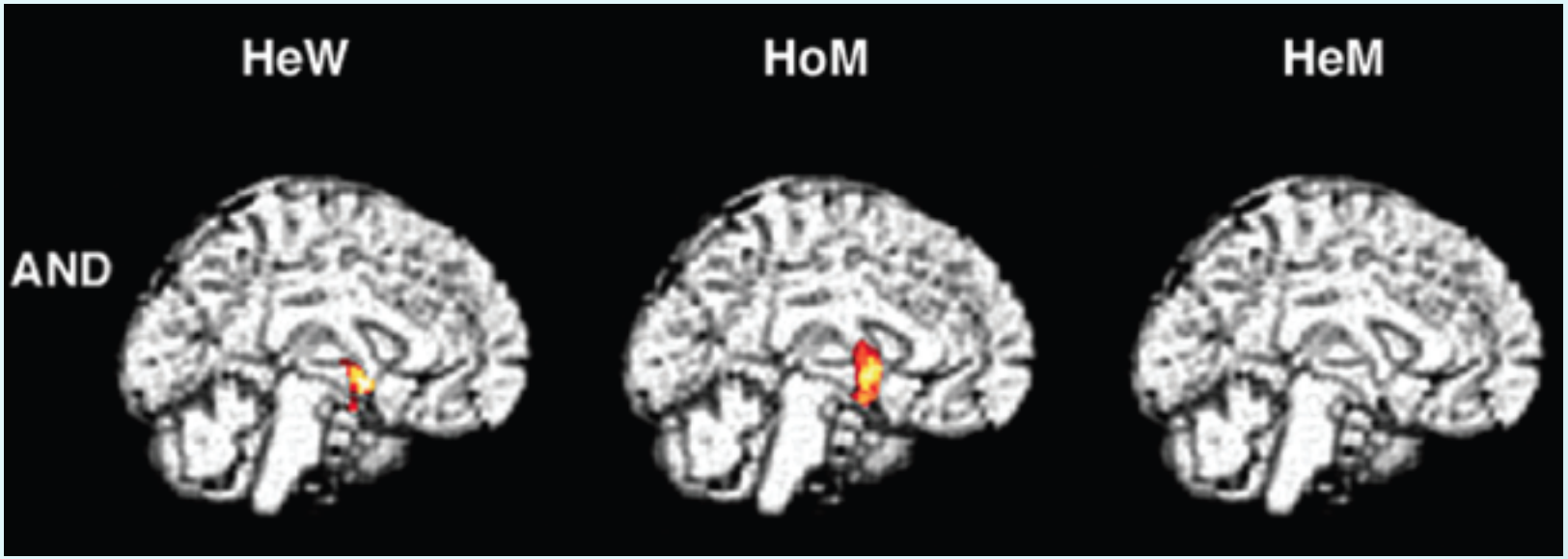


SOURCES: (a) Based on data from Rahman, Q., Abrahams, S., & Wilson, G. D. (2003). Sexual-orientation-related differences in verbal fluency. Neuropsychology, 17, 240-246. (b) Based on data from Collaer, M. L., Reimers, S., & Manning, J. T. (2007). Visuospatial performance on an internet line judgment task and potential hormonal markers: sex, sexual orientation, and 2D:4D. Archives of Sexual Behavior, 36, 177-192.

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

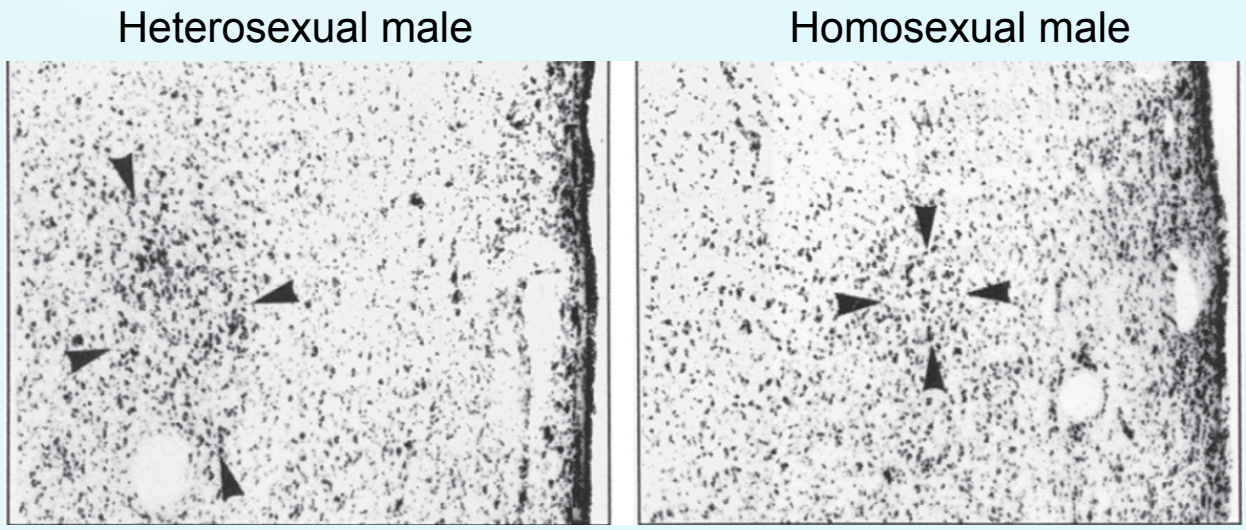


SOURCE: From figure 1 of "Smelling of Odorous Sex Hormone-Like Compounds Causes Sex-Differentiated Hypothalamic Activations in Humans," by I. Savic et al., 2002, *Neuron*, *31*, pp. 661-668.

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.



SOURCE: From "A Difference in Hypothalamic Structure Between Heterosexual and Homosexual Men," by S. LeVay, 1991, *Science*, *253*, pp. 1034-1047. Reprinted with permission from American Association for the Advancement of Science (AAAS).

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