

Hormones and Sexual Behavior

Reproductive Behavior

Mechanisms of Hormone Action

- 3 Types of Hormone
 - protein hormones and peptide hormones
 - steroid hormones
 - sex hormones: estrogens, progesterone, and androgens

protein hormones and peptide hormones

- act by binding to receptors on surface of cell
- releases second messenger inside the cell (often Cyclic AMP)
- activates a number of enzymes that can alter metabolism of cell or ability of ions to cross membrane

Steroid hormones

- released by adrenal cortex
- enter cell and attach to receptors in the cytoplasm
- which move to the nucleus and affect which genes will be expressed
- elevate blood sugar, enhance metabolism, helps body adapt to prolonged stress

Sex Hormones: estrogens, progesterone, and androgens

- are actually steroids
- can react with receptors on cell membrane
- sometimes increase number of dendritic spines
- attach to a receptor that turns a gene on or off
- called sex-limited genes because effect is much stronger in one sex than in the other (eg: breast development gene)

Steroids and negative feedback

- When athlete takes steroids to develop muscle, high levels of steroids produce negative feedback on anterior pituitary
- anterior pituitary cuts back on production of hormones that control gonads
- decreased testis size, breast growth, increased cholesterol levels, depression

Control of Hormone Release

- Pituitary Gland
 - anterior pituitary: endocrine gland
 - synthesizes six hormones that control other glands
 - controlled by the hypothalamus
 - posterior pituitary or neurohypophysis: neural connection
 - half gland half nucleus
 - connected to the hypothalamus
 - produces releasing hormones which flow through the blood to the anterior pituitary

Organizing effects of Sex Hormones

- Organizing effects
 - determine if brain and body will develop as female or male
 - mostly occur during sensitive periods
 - shortly before and after birth in rats and birds
 - 3rd or 4th month in humans
- Activating effects
 - occur any time in life when a hormone temporarily activates a particular response
 - last hours, weeks, or months

Sex Differences in the Gonads and Hypothalamus

- at early stage of prenatal development, every mammal has identical gonads.
- Both male and female have set of Wolffian Ducts and a set of Mullerian Ducts

Development of Male Gonads

- Male has extra Y chromosome that causes primitive gonads to develop into testes
- developing testes produce testosterone
- testosterone causes Wolffian ducts to develop into seminal vesicles and vas deferens
- peptide hormone “Mullerian inhibiting hormone causes Mullerian ducts to degenerate

Development of Female Gonads

- Genetic female (XX) chromosomes would also develop male gonads if exposed to enough testosterone
- normally not enough testosterone to masculinize gonads so
- gonads develop into ovaries (instead of testes)
- Mullerian ducts develop into uterus and vagina

Sexual Differentiation of the Nervous System

- exposure to testosterone causes various structures in the nervous system to become sexually differentiated
- Female hypothalamus capable of generating a cyclic pattern of hormone release as in menstrual cycle
- If exposed to testosterone during critical period hypothalamus is masculinized and no longer able to cycle

Sexual Differentiation of the Nervous System

- medial preoptic nucleus of the hypothalamus 2-3 times larger in male than in female
- sexual differentiation depends on exposure to testosterone during a sensitive period
 - shortly before and after birth in rats and birds
 - 3rd or 4th month in humans

Rat Studies

- female rat injected with testosterone during this period is partially masculinized
 - clitoris larger than usual
 - intermediate reproductive structures
 - doesn't cycle at maturity
 - behavior is masculinized
 - mounts other females and makes copulatory thrusting movements rather than arching her back to let males mount her

Rat Studies

- male injected with estrogens still develops as a male
- develops as female only if deprived of testosterone through castration or other means
- nature would make every mammal a female unless told to do otherwise by testosterone

Mechanism of action of organizing effects of testosterone

- testosterone enters the cell
- converted to estradiol by aromatizing process
- evidence:
 - androgens that don't aromatize are not effective in masculinizing
 - chemicals that block aromatization block organizing effects

The mystery

- estradiol is female hormone, if testosterone must be converted to estradiol to enable it to masculinize the fetus, why doesn't the estradiol produced by the female fetus masculinize it
- many fetal mammals produce alpha-fetoprotein (not present in adults)
- alpha-fetoprotein binds with the naturally produced estrogen and blocks it from entering the cell
- testosterone can enter the cell and be converted to estradiol to do its work

Sex Differences in Nonreproductive Characteristics

- males tend to be larger
- females live longer and devote more attention to infant care
- males more aggressive
- female monkeys exposed to elevated levels of testosterone during sensitive period more aggressive, more threatening gestures

Human studies

- girls who were exposed to elevated androgen levels during prenatal development (because of a gene that causes inadequate cortisol production and excess production of androgens from the adrenal gland) tend to spend more time than most other girls playing with boy's toys, more likely than other girls to choose boys as their favorite playmate.
- May be treated differently by parents and others because of somewhat masculine appearance.

Activating Effects of Sex Hormones

Sexual Behavior

- activate sexual response by enhancing sensations
 - estrogens enlarge area of skin that activates pudendal nerve
- ventromedial nucleus and medial preoptic area (MPOA) of hypothalamus
 - activity increases during copulation
 - stimulation of MPOA increases male typical sex behavior in males and female typical in females
 - damage to MPOA eliminates or alters sexual behavior

Effect of Hormones on Sexual Behavior in Men

- Impotence
 - decrease in testosterone generally decrease sexual activity
- treatment of sex offenders
 - cyproterone: blocks binding of testosterone to receptors
 - medroxyprogesterone: decrease testosterone production
- problem is they have to take the drug
 - newer drug under development that can be given as injection

Effect of Hormones on Sexual Behavior in Women

- menstrual cycle
 - follicle-stimulating hormone (FSH) released after menstrual cycle over
 - » promotes growth of a follicle which nurtures the ovum (egg)
 - » follicle develops more and more FSH receptors and becomes more sensitive to it
 - estradiol produced by follicle (when mature) leads to sudden surge in release of
 - luteinizing hormone from anterior pituitary.
 - This causes follicle to release the ovum
 - remnant of the follicle (corpus luteum) produces progesterone
 - Progesterone level rises inhibiting production of LH
 - Levels of LH, FSH, estradiol and progesterone decline
 - if egg not fertilized the lining of the uterus is cast off (menstruation) and cycle begins again

Birth Control Pill

- combination pill
 - contains both estrogen and progesterone
- high level of estrogen suppresses release of FSH so follicle doesn't develop
- progesterone blocks release of LH so even if one develops it won't be released

Changes in Sexual interest in women

- midpoint of periovulatory period is time of maximum fertility and highest estrogen levels
- 2 studies of women not on pill indicate women initiate more sexual activity (either with partner or masturbation) during periovulatory period than at other times of the month
- rate erotic video more pleasurable and arousing at this time also

Nonsexual Behavior

- aggression
- increased levels of estrogen stimulate increased production of dopamine type D2 receptors and serotonin type 5HT2A receptors in nucleus accumbens, prefrontal cortex, olfactory cortex and other areas which control reinforcement, mood, and emotion
- decline in estrogen just before menstruation
 - » may lead to irritability, discomfort, depression
- increased estrogen associated with improved verbal memory, memory for recent events, fine motor skills
- increased testosterone associated with improved spatial skills

Puberty

- starts when hypothalamus begins to release luteinizing hormone releasing hormone at a rate of about one burst per hour

Parental Behavior

- late in pregnancy, female rats produce pattern of hormones incompatible with parental behavior
 - if exposed to infant rats they respond less than virgin rats
- by time of delivery hormone balance has shifted
 - marked increase in prolactin and oxytocin
 - increase in oxytocin necessary for maternal behavior
 - drugs that block oxytocin block some main maternal behaviors

Parental Behavior - hormone dependent phase

- if inject virgin rats with mother rats' plasma (contains all mothers hormones)
- quickly showed rat parenting behavior

Parental Behavior - experience dependent phase

- leave virgin female rat with 5-10 day old babies
- interest develops over several days
- after six days, adoptive mother builds nest, assembles babies, licks them, does everything else a normal mother would do
- Even males will develop most of the maternal behaviors if left with the babies for a few days
- pheromones in baby rats stimulate hormone production which supports parenting behavior

Parental Behavior - Brain Areas

- MPOA increased activity in both hormone dependent and experience dependent phase
- damage reduces parenting behavior in both phases
- experience dependent phase related to areas that process information from the vomeronasal organ
- vomeronasal organ responds to pheromones
- unfamiliar infant pheromones inhibit maternal behavior

Parental Behavior - Brain Areas

- early hormone dependent phase
 - parent is not familiar with the newborn's pheromones so vomeronasal would inhibit maternal behavior -- but
 - hormone effects (oxytocin) in MPOA strong enough to overcome this
- later experience dependent phase
 - mother has become familiar with the babies pheromones and now parenting behavior maintained by experience even though mothers hormones are returning to non-pregnant levels

Variations in Sexual Development and Orientation

Determinants of Gender Identity

- Gender identity: how we identify sexually and what we call ourselves.
- Not the same as biological sex differences
- gender role
 - the activities a society encourages for one sex or the other
 - determined by culture and upbringing
 - can have female gender identity but reject your cultures gender role
- Some people clearly dissatisfied with assigned gender, a small number (transsexuals) insist on sex change

Intersexes or Pseudohermaphrodites

- exposure to excess testosterone
 - » mother's adrenal produces excess testosterone and other androgens
 - » certain antimiscarriage drugs
 - » placenta may lack the enzyme that converts testosterone to estrogen
- partial masculinization
- genitals do not match normal development for their genetic sex
- can surgically alter child to give them the appearance of one sex or the other but
- do not know how to raise these children, results of studies are ambiguous, nothing seems to work

Testicular Feminization

- also known as androgen insensitivity
- XY chromosome (genetic male)
- body lacks mechanism that allows androgens to bind to genes so develop mostly as female
- has two internal testes, no ovaries or uterus
- reared as female, takes female gender identity
- don't know about it until puberty
- breasts develop, hips broaden, doesn't menstruate
- surgically enlarge the small vagina
- adjusts well as a female

Nature vs Nurture in Sexual Development

- Certain genetic males in the Dominican Republic were born with a gene that prevents penis growth early in life.
- Low levels of hormone that converts testosterone to DHT (5-alpha-dihydrotestosterone) which masculinizes the genitals
- probably normal testosterone levels so brain masculinized properly
- reared as girls until age 12 then grew a penis
- reassigned as a boy
- nearly all cases developed clear male gender identity and directed sexual interest toward women

Nature vs Nurture in Sexual Development

- Accidental penis removal during circumcision
- parents advised to have him surgically altered and rear as a girl
- never adjusted to female identity
- played with male toys, wanted to live as a boy
- eventually changed name and had surgery to restore penis
- got married, and adopted wife's children

Possible Biological Bases of Sexual Orientation

- For most people sexual orientation just happens, develops at an early age, do not know how or why it develops as it did.
- Sexual orientation is like left or right handedness, it is not something that people choose or that they can easily change

Genetics

- Bailey, Pillard, et al 1991, 1993
- Sexual orientation in adult relatives of a homosexual man or woman
- 52% concordance for monozygotic twin for males
- 48% for females
- Limited samples
- not 100% concordance which expect if genetic

Genetics

- Hamer, Hu, Magnuson, Hu, & Pattatucci, 1993
- data supports idea that may be a relevant gene on X chromosome of homosexual males
- would be passed by mother
- There is higher incidence of homosexuality in mothers family
- very small samples
- genes could produce their effects very indirectly

Hormones

- hormone levels in homosexual men and women are the same as heterosexual
- could depend on testosterone levels during sensitive period
 - no human evidence
 - animal studies generally find changes in the genitals as well as sexual orientation but homosexuals genitals are identical to heterosexuals

Hormones

- Could be stress
 - stress pregnant female rats by confining under bright lights for 2 hrs per day
 - produce endorphins in response to stress
 - endorphins cross placenta and have anti-testosterone effects on hypothalamus
 - genitals develop normally
 - as adults males respond sexually to both males and females
- This indicates that the parts of development which are related to anatomical development of genitals are somewhat independent of parts related to sexual orientation

Hormones

- even in rats born of stressed mothers, rearing practices affected their sexual preference
- those reared with males responded sexually only to males
- those reared with non stressed males and females developed mixed response

Hormones

- What is true of rats may not be true of humans
- types of sexual response shown in male rats (arching back, etc.) have no analog in humans

Hormones

- Ellis, Ames, Peckham, & Burke, 1988
 - contacted 283 mothers of homosexual and heterosexual men
 - mothers of homosexuals reported more stress during second trimester of pregnancy
- Bailey et al couldn't replicate this result

Hormones

- What about hormones in female homosexuality
- in late 50's and early 60's some women took diethylstilbestrol (DES) to prevent miscarriage.
- DES can exert masculinizing effects similar to testosterone
- Ehrhardt et al 1985
 - 30 adult females whose mothers took DES
 - 7 reported some degree of homosexual or bisexual response
 - in control group only 1 reported homosexual or bisexual response

Brain Anatomy

- in heterosexuals, males brains differ in certain areas. Do homosexual's brains resemble heterosexual males or heterosexual females
- Gorski & Allen 1992
 - anterior commissure in homosexual males as large as women's
- Suprachiasmatic nucleus (SCN) larger in male homosexuals than in male heterosexuals
 - male rats deprived of testosterone during the critical period cycle in sexual preference preferring male partners early in day, female partners later in day
 - cycle could be controlled by SCN

Brain Anatomy

- LeVay 1991
 - interstitial nucleus 3
 - part of sexually dimorphic nucleus of Medial Preoptic Area (MPOA)
 - 41 people
 - 16 heterosexual males
 - 6 heterosexual women
 - 19 homosexual males
 - heterosexual males had much larger interstitial nucleus 3's

Brain Anatomy

- problems with LeVay
 - all subjects died of AIDS
 - » need to replicate with patients who didn't have AIDS
 - were brain differences present since childhood or did differences develop in adulthood, perhaps as a result of sexual activity
 - we don't know what interstitial nucleus 3 does in humans
 - » damage to IN3 in rats decreases sexual behavior but no change in sexual preference
 - » damage to IN3 in ferrets causes shift to preferring male partners
 - » there were significant differences in the group means but groups overlapped quite a bit