Sex and the Brain

Reading Assignments:
1. Sex & The Brain
2. New Insights into Gendered Brain Wiring
   (follow-up study to Sex & the Brain)
3. Faking It: Orgasms & The Brain
4. Brain Scans Find the Penis At Last
6. Menstrual Synchrony in Women
8. The Call of Pheromones
9. Boys Will Be Boys
**The brain is the “sexiest” organ!**

1. It receives and interprets sexual stimuli.
2. It controls production of sex hormones (estrogen/testosterone).
3. It controls egg & sperm development.
4. It is location of pleasure centers that reinforce sexual activity.
5. There are many documented brain differences between the sexes.

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**1. Brain receives & interprets sexual stimuli.**

- Touch (tactile stimuli)
- Sound (voice or other)
- Smell (pheromones)
- Sight (visual signals – like WHR)
- Taste (aphrodisiacs and other)
- Thoughts ★
2. Brain controls production of sex hormones (Steroidogenesis)

Review of Reproductive A & P

- Remember that the Hypothalamus of the brain secretes GnRH.
- This causes the pituitary gland to secrete LH & FSH.
- LH causes the testes to make estrogen & testosterone & the ovaries to make FSH causes ovaries & testes to make eggs & sperm.

2. Brain controls production of sex hormones

Embryonic exposure to sex hormones:

- Exposure to estrogen or testosterone causes during embryonic development causes “organizational changes” = changes that, once they occur, cannot be undone (permanent!).

Exposure of fetus to testosterone causes masculinization of body & brain.

Exposure of fetus to estrogen causes feminization of body & brain.
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  Ex. At 8 weeks gestation genes on male embryo’s Y-chromosome cause testes formation. **Brain directs testes to make testosterone (T).**

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If no Y-chromosome, no testis formation. **By default** embryo develops ovaries. **Brain directs to produce estrogen (E).**

Exposure of fetus to testosterone causes masculinization of body & brain.  
Exposure of fetus to estrogen causes feminization of body & brain.
Exposure of embryo to sex hormones causes development of primary sexual characteristics:

- Male embryo with testes & testosterone develops:
  - Penis
  - Scrotum
  - Vas deferens, ejaculatory duct
  - Urethra opens at head of penis (connected to reproductive tract)
  - Seminal vesicles, prostate, & bulbourethral glands
  - Masculinized brain

Brain controls production of sex hormones.
Exposure of embryo to sex hormones causes development of Primary Sexual Characteristics:

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  - Penis
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  - Vas deferens, ejaculatory duct
  - Urethra opens at head of penis (connected to reproductive tract)
  - Seminal vesicles, prostate, & bulbourethral glands
  - Masculinized brain

- **Female embryo with ovaries & estrogen develops:**
  - Vaginal canal
  - External genitalia (labia, clitoris)
  - Urethra separate from reproductive tract
  - Uterus, cervix, & fallopian tubes
  - Feminized brain

**2. Brain controls production of sex hormones**

At puberty a SURGE of sex hormones causes development of Secondary Sexual Characteristics:
2. Brain controls production of sex hormones

At puberty a **SURGE** of sex hormones causes development of Secondary Sexual Characteristics:

**Testosterone surge causes males to develop:**
- Enlarged penis
- Pubic, facial, and body hair
- Thickened more square jaw & heavy brow
- Deepened voice & adam's apple
- Muscularity
- Get taller
- Body odor & acne
- Sperm production
- Nocturnal emissions (wet dreams)
- More aggression
- Sex drive (**Libido**)

![Testosterone and Estrogen molecules](image)

**Estrogen surge causes females to develop:**
- Enlarged breasts
- Pubic and body hair
- More angular jaw & delicate brow
- Change in body fat distribution (hips)
- Body odor & acne
- Monthly ovulation & menstruation
- Sex drive (**Libido**)
Libido & hormones

**Hormones that INCREASE libido:**
- Testosterone (for men & women)

**Hormones that DECREASE libido:**
- Progesterone
- Cortisol (stress hormone) decreases T & E.

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Libido & hormones

**Other things that INCREASE libido - Aphrodisiacs**

- **Oysters** (contain zinc, known to ↑ libido

- **Chocolate** contains:
  - phenylethylamine – stim. Limbic system
  - serotonin - euphoria
  - dopamine – addiction center of brain
Libido & hormones

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- **Spanish fly** = powdered emerald green beetle contains cantharadin – causes inflammation & swelling in urinary tract. Sensation confused with swelling of genitals during arousal.

- **Rhinocerous horn (powder)** – popular in Asia
  [These don’t do anything & kills endangered species!]

- **Tiger penis** – popular in Asia
  [This doesn’t work either & kills endangered species!]
3. Brain controls egg & sperm development: (Gametogenesis)

Review of Reproductive A & P

- Remember that the __________________ of the brain secretes GnRH.
- This causes the _______________ gland to secrete LH & FSH.
- FSH causes the testes to mature __________ & the ovaries to mature __________.

5. There are many documented brain differences between the sexes.

Sex and Brain Differences in:

A) Brain structures
   i. Location of pleasure centers
   ii. Sexual orientation
   iii. other structures

B) Problem solving

C) Emotions

D) Visual focus

E) Perception & effect of pheromones

F) Other (behavioral)
5. There are many documented brain differences between the sexes.

i. Differences in Brain Pleasure Centers:

The **Amygdala** is the site for the female orgasm!
(See reading assign: “Faking It: Orgasms & The Brain”.

Amygdala located in the **limbic system** of the brain.
(limbic system is site of emotions & memory)

- During *real* orgasm – amygdala shuts off.
- During *fake* orgasm – amygdala remains active.

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i. Differences in Brain Pleasure Centers:

Location of female libido

= **Ventromedial nucleus of hypothalamus (VNH)**

Researcher in Japan noticed that when he blocked effect on estrogen on ventromedial nucleus in female mice they had no interest in mating.

*Source:*
5. There are many documented brain differences between the sexes.

i. Differences in Brain Pleasure Centers:

Location of sensations of male penis = **homunculus**
(parietal lobe cortex & operculum)

[See reading assign: “Brain Scans Find the Penis At Last”]

J. of neuroscience (Christian Kell) used **functional MRI scans** when different parts of body were “stimulated” in men.

> When penis stimulated these areas of brain (**green**) activated.
> **strangely enough**, if big toe stimulated it also shows here (**red**)! 😊

*Source: http://www.jneurosci.org/cgi/content/full/25/25/5984*
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ii. Differences in Brain With Men, Women, & Sexual Orientation.

Another brain area important in libido
= Sexually dimorphic nucleus of hypothalamus (SDNH)

- Important in libido.
- Is larger in men than in women.
  - Activity of this area in men is always “active”
  - Of this area in women is “cyclical” – sometimes off, sometimes on.
- Is larger in straight men than in gay men (more similar to women)
  - Possible differences in brain between gay & straight.
  - Controversial between researchers:
    - Swaab – saw no diff. in SDNH between straight & gay men.
    - LeVay – says there is diff. in SDNH between straight & gay men.

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ii. Differences in Brain With Men, Women, & Sexual Orientation.

Glutamate = Brain neurotransmitter.
Altering levels of glutamate in fruit flies causes males to perceive other male’s pheromones as sexually attractive. Males mate w/other males.

AND = a pheromone in male armpit sweat, which activates the ventromedial nucleus of hypothalamus (VNH) in straight women and gay men.

(See reading on Supplements Page: “Pheromone Attracts Gay Men and Straight Women.”)

Scientist Ivanka Savidc, regarding her research published in 2005, on whether sexual orientation is determined at birth:

**Quote:**

“*I want to be extremely cautious – this [my study] does not tell us anything about whether sexual orientation is hardwired in the brain. It doesn’t even say anything about that.*”

Research has come a long way ...

Based on more research The **American Psychological Association** (largest association of psychologists worldwide) wrote the following on its website:
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Based on more research The **American Psychological Association** (largest association of psychologists worldwide) wrote the following on its website:

"There are numerous theories about the origins of a person's sexual orientation; most scientists today agree that sexual orientation is most likely the result of a complex interaction of environmental, cognitive and biological factors. In most people, sexual orientation is shaped at an early age. There is also considerable recent evidence to suggest that biology, including genetic or inborn hormonal factors, play a significant role in a person's sexuality. In summary, it is important to recognize that there are probably many reasons for a person's sexual orientation and the reasons may be different for different people.”


5. There are many documented brain differences between the sexes.

iii. Differences in Other Brain Structures:

**Corpus callosum**
- White matter of brain that communicates between left and right brain hemispheres.
- Is larger in women than in men.
- Thought responsible for greater multi-tasking abilities.

**Hippocampus**
- Area of brain thought to play role in spatial learning
  - Ex. Being able to navigate mazes & maps,
  - being able to mentally rotate 3-dimensional objects.
- Is larger in men than in women.
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B) Differences in Problem Solving

Cognitive Skills:
(See reading assign: “Sex and the Brain” & “New Insights Into Gendered Brain Wiring”)

<table>
<thead>
<tr>
<th>Males tend to:</th>
<th>Females tend to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better at spatial tasks</td>
<td>Less so</td>
</tr>
<tr>
<td>Navigate mazes faster w/fewer errors</td>
<td>Navigate mazes slower w/more errors</td>
</tr>
<tr>
<td>Better at mathematical reasoning</td>
<td>Less so</td>
</tr>
<tr>
<td>Less so</td>
<td>Better at mathematical calculations</td>
</tr>
<tr>
<td>More accuracy w/throwing skills</td>
<td>Less so</td>
</tr>
<tr>
<td>(probably due to childhood activity)</td>
<td>Better at precision manual tasks</td>
</tr>
<tr>
<td>Less so</td>
<td>Better at verbal memory &amp; vocabulary</td>
</tr>
<tr>
<td>Less so</td>
<td></td>
</tr>
</tbody>
</table>

Still much controversy about these sex-dependent cognitive differences
(see Reading “New Insights into Gendered Brain Wiring, or a perfect case study in neurosexism?”)

These are generalities and DO NOT always represent all people!
These differences do not imply genetic superiority/inferiority.
These likely reflect differences in “nature” and culture.
These don’t account for training/practice (which can improve initial abilities).
[Males and females get the job done – in slightly diff. ways.]
5. There are many documented brain differences between the sexes.

C) Differences in Emotions

**The Emotional versus Systemizing Brain:**
(see reading assign: “The Empathizing Brain”)

**Females tend to have more empathizing brain:**
- Better at recognizing emotions in others & responding appropriately.
- Much could be “nurture” (way girls are raised vs boys)

**Males tend to have more systemizing brain:**
- Better at analyzing and building systems.
- Much could be “nurture” (way girls are raised vs boys)

D) Differences in Visual Focus

Can see differences between males & females at birth: Reading assign.
Sugar & Spice – the Empathizing Brain

**At 24 hrs old:**
- Girls stare longer at faces.
- Boys stare longer at mechanical objects (like nursery mobiles)
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D) Differences in Visual Focus
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At 24 hrs old:
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At 10 months: (pregnant women’s amniotic sacs tested for testosterone, then babies, after birth were tested)
- Children exposed to higher testosterone in womb – make less eye contact.
- Children exposed to less – make more eye contact.

At 24 months: (same study as above)
- Children exposed to higher testosterone in womb – start talking later.
- Children exposed to lower testosterone in womb – start talking sooner.
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E) Differences in Perception of Pheromones

**Pheromones** = secretions from skin, which contain hormones like T & E2, among others, that we don’t consciously smell BUT it affects our behavior.

**Vomeronasal organ** = structure in brain that senses pheromones.
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E) Differences in Perception of Pheromones

Ex. 1) Remember the MHC T-Shirt Test? (Evolution of sex notes)

Ex. 2) Androstenol (Bathroom Stall Study)
(see reading assign: “The Call of Pheromones” – work by Gustavson)

- **Androstenol** = male androgen pheromone from armpit sweat.
- Gustavson sprayed random bathroom stalls with it and recorded which stalls people chose. (**Remember ... that is a split-second decision we make!**)
- Results: Men avoided tainted stalls but women selected them!
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E) Differences in Perception of Pheromones

Ex. 1) Remember the MHC T-Shirt Test? (Evolution of sex notes)

Ex. 2) Androstenol (Bathroom Stall Study)

Ex. 3) Athena pheromone study

(See reading assign: “Sex Pheromone Spray Boosts Senior Romance”)

- A pheromonal researcher (Winnifred Cutler) studied a proprietary chemical (found in female armpit sweat called “Athena” (10-13).
- Studied men’s rating of attractiveness to this odor.
- Results: highly attractive to men
- (Researcher now trying to market this chemical)

- Another study examined post-menopausal women using Athena for 6 weeks.
- Women kept diary of sexual activity.
- Result: Women using Athena report greater sexual activity than women not using it.

Ex. 4) “BoarTaint“ (Androstenone)

- Don’t confuse with androstenol.
- Pheromone in boar (male pig) sweat & urine.
- Someone decided to try it out in humans.
- Found to be ↑ libido in women.
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E) Differences in Perception of Pheromones

Ex. 4) "BoarTaint“ (Androstenone)
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Ex. 5) AND (From earlier notes: AND attracts gay men & straight women.)
5. There are many documented brain differences between the sexes.

E) Differences in Perception of Pheromones

Ex. 5) AND (From earlier notes: AND attracts gay men & straight women.)

Ex. 6) Bremolanotide
- Another pheromone in armpit sweat.
- Marketed as intra-nasal spray.
- Found to ↑ libido in men and women.

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E) Differences in Perception of Pheromones

Ex. 7) Menstrual Synchrony in Women (the “McClintock Effect”) (See reading assign: “Menstrual Synchrony”)
- Women release pheromones (like Athena) having effect other women.

- Women who live, work, spend significant time together synchronize their menstrual cycles. (Have period on same week)

- Thought an evolutionary adaptation in social groups, many women having children at same age – have lots of helpers w/child care.

- Also thought to play competitive advantage for males (all females ovulating in same time period levels the fertility playing field.)
5. There are many documented brain differences between the sexes.

F) Other Behavioral Differences
(See reading assign: “Boys will be Boys”)

Sex differences in behavior before 18 months of age.

**Males tend to:**
- Like a lot of action (motion)
- Start walking earlier
- Start talking later
- Prefer looking at groups of faces rather than individual ones
- Express fear later than girls
- Gain precision manual skills later than girls
- “Feel” emotional without showing it outwardly

**Females tend to:**
- Be less active than boys
- Start walking later
- Start talking sooner
- Prefer looking at individual faces rather than groups of faces
- Express fear sooner than boys
- Gain precision manual skills earlier than boys
- Show emotions more clearly (outwardly) than boys