



Pink Brain, Blue Brain: The Truth About Sex Differences in the Brain and Behavior

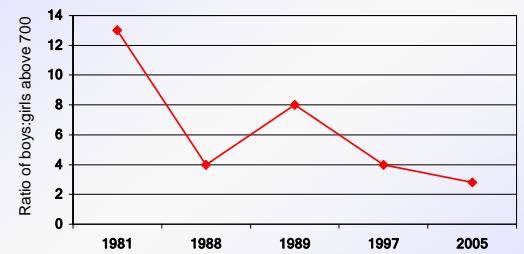
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Collage of magazine covers and a photo of a man:

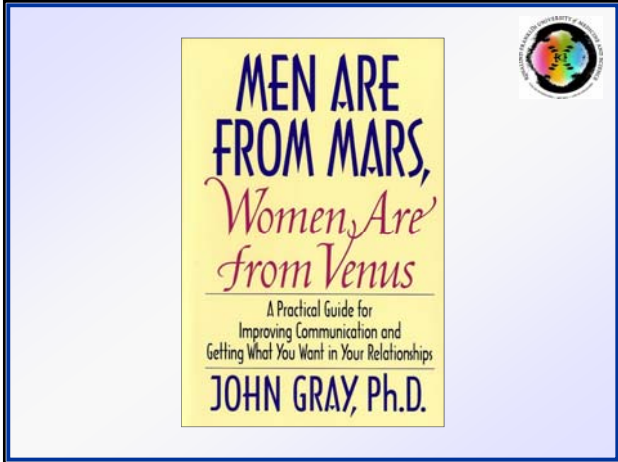
- TIME: Why Are Men and Women Different?
- Newsweek: The Boy Crisis
- Newsweek: The Mystery of GENDER
- TIME: THE MATH MYTH
- Photo of a man in a suit with a Harvard logo.

Study of Mathematically Precocious Youth (SMPY), Benbow et al.

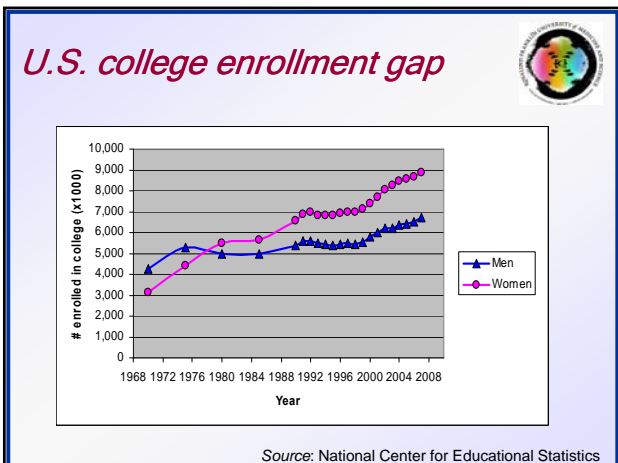


Year	Ratio of boys:girls above 700
1981	13
1988	4
1989	8
1997	4
2005	3

Sources: Association of Women Mathematicians (2006) www.awm-math.org/benbow_petition/background.html; R. Monastersky, "Primed for Numbers?" Chronicle of Higher Education, 51, no. 26 (2005): A1, <http://chronicle.com/tree/v51/i26/26a00102.htm>







Plasticity in visual development

The diagram shows the visual pathway from the eye through the optic nerve, lateral geniculate body, and visual cortex. Below it, a photograph shows a child with strabismus (crossed eyes). To the right, two brain scans are shown: the top one is labeled 'Normal rearing' and shows a regular pattern of cortical columns; the bottom one is labeled 'One eye shut' and shows a distorted, irregular pattern of cortical columns.

D. Hubel, T. Wiesel

How do boys' and girls' brains differ?

The graph plots 'Median head circumference (in centimeters)' on the y-axis (ranging from 34 to 50) against 'Age (in months)' on the x-axis (ranging from 0 to 36). Two curves are shown: a solid line for 'Boys' and a dashed line for 'Girls'. Both curves show an increase in head circumference over time, with boys' heads being consistently larger than girls' heads.

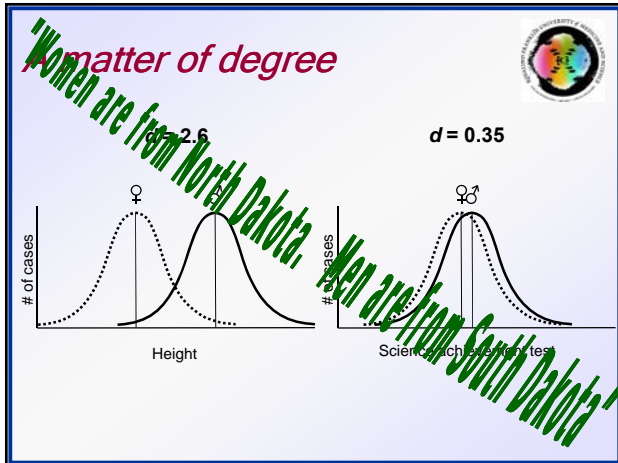
Figure 2-1. Median (50th percentile) head size of boys and girls from birth to age three. Data are from the Centers for Disease Control.

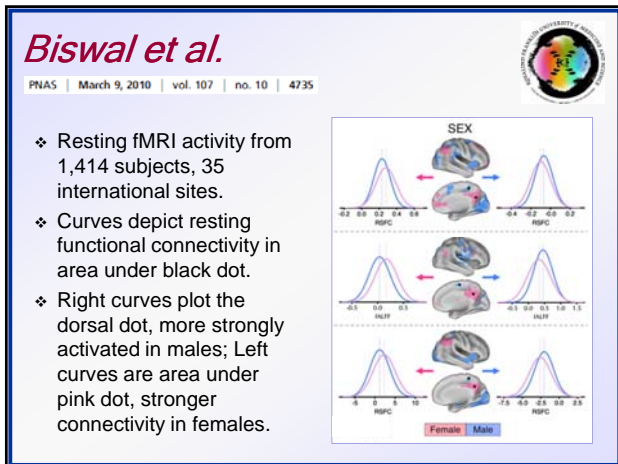
- ❖ The male brain is about 9% larger, throughout the lifespan.
- ❖ But males are also taller (8.6%), heavier (9.4%) & other organs are larger (liver=15%).
- ❖ Scattered reports of other boy-girl differences in brain structure or function, but surprisingly unreliable.

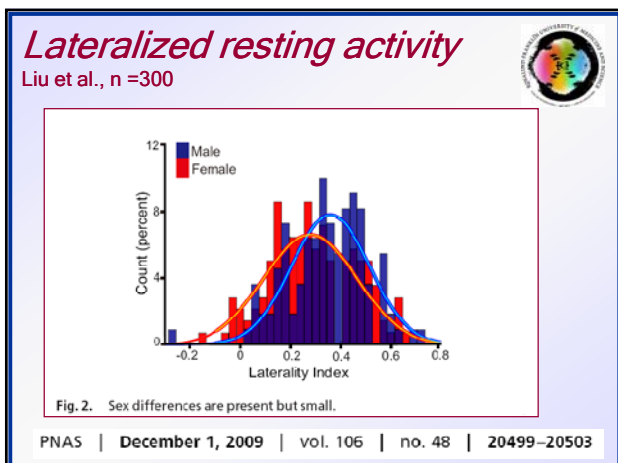
Lobe volumes in adolescence

Lenroot RK et al. 2007. Sexual dimorphism of brain developmental trajectories during childhood and adolescence. *NeuroImage*, 36:1065-73.


The four graphs show lobe volumes (in cm³) on the y-axis against age (7, 9, 11, 13, 15, 17, 19) on the x-axis. Each graph has two lines: a blue line for boys and a red line for girls. (a) Frontal lobe: Boys' volume is higher than girls' and both decrease with age. (b) Parietal lobe: Boys' volume is higher than girls' and both decrease with age. (c) Temporal lobe: Boys' volume is higher than girls' and both decrease with age. (d) Occipital lobe: Boys' volume is higher than girls' and both decrease with age.

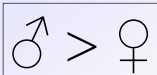







Psychological differences




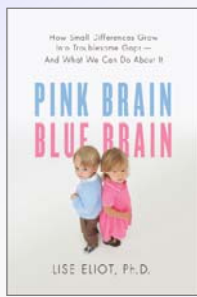


♂ > ♀




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<ul style="list-style-type: none">❖ Spatial ability❖ Math & science tests❖ Mechanical reasoning❖ Activity level❖ Gross motor❖ Physical aggression❖ Competition & risk-taking❖ Throwing & targeting	<ul style="list-style-type: none">❖ Verbal fluency❖ Reading, writing, spelling❖ Most perception❖ Associative memory❖ Fine motor❖ Relational aggression❖ Fear & conscientiousness❖ Social perception
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"Small differences grow into troublesome gaps"

Differences in infancy



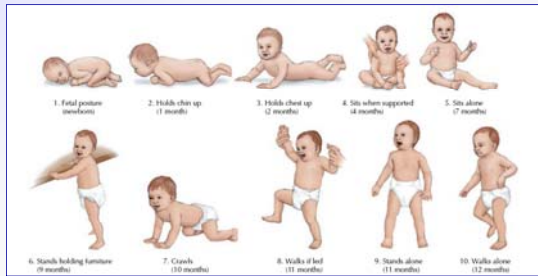
- ❖ Girls talk about one month earlier.
- ❖ Boys more physically active (d=0.2) beginning in infancy and growing through childhood (d=0.5 in school-age)
- ❖ No difference in neonatal eye contact; but girls make greater eye contact after 4 months.
- ❖ Toy choice: differs by 9-12 months; testosterone appears to bias boys towards more active playthings, but parents, peers, marketing and children's own gender identification amplify the difference.
- ❖ Boys have lower inhibitory control beginning as toddlers.

Male vulnerability

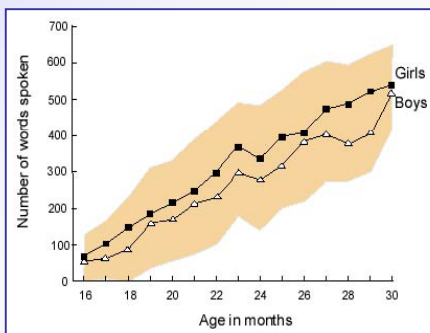


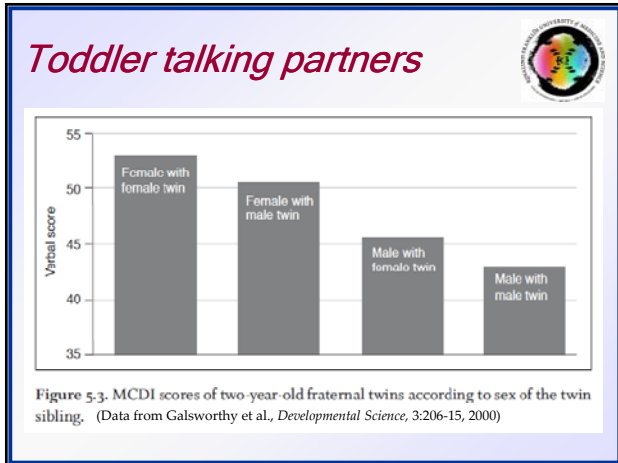
- ❖ Boys 30% more likely to be miscarried
- ❖ 7% more likely to be born prematurely
- ❖ 50% more likely to be born by C-section
- ❖ 30% likelier to receive a low Apgar score
- ❖ 22% higher infant mortality rate

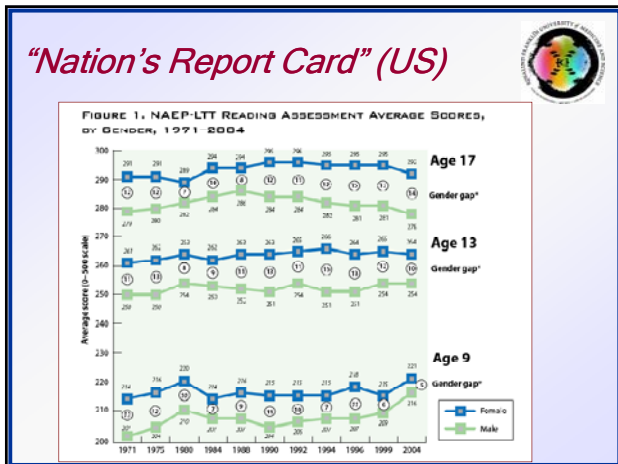
No sex difference in gross motor milestones



Language difference in toddlers







Emergent Literacy

- ❖ Birth-to-school entry a crucial time for acquiring the motivation and skills for independent reading.
- ❖ The more informal reading & writing experiences children have before school entry, the easier their transition to literacy.
- ❖ Pediatrician surveillance of early literacy milestones can be clinically significant for promoting emergent literacy.
- ❖ Girls score ~12% higher on phonological awareness at age 4 to 5.

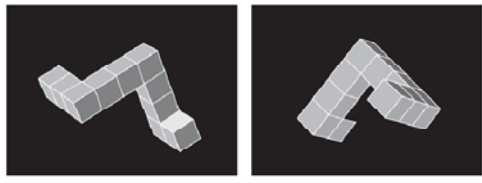
Legend for Brain Diagram:

- [20] (Pink)
- [27] (Blue)
- [28] (Green)
- [29] (Yellow)
- [30] (Orange)
- [34] (Purple)

Mental rotation



Are these objects the same except for their orientation?

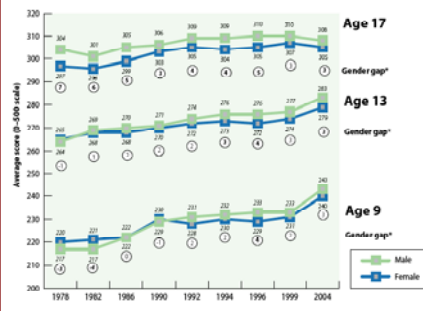


- ❖ Largest cognitive difference between men & women.
- ❖ Appears in infants by 3 months.
- ❖ However, the difference grows through childhood and adolescence, and experiences like **sports** and **video games** have been shown to improve performance in both sexes.

NAEP math data



FIGURE 2. NAEP-LTT MATHEMATICS ASSESSMENT AVERAGE SCORES, BY GENDER, 1978-2004



Sex difference in aggression

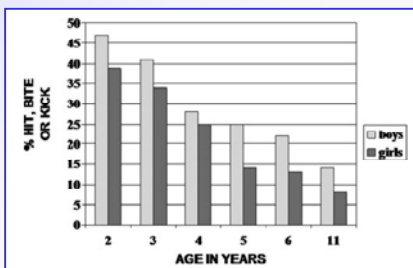


Figure 1. Changes in physical aggression of boys and girls with age (mothers' reports).
 Source: Tremblay et al. (1999).

Empathy

Oops. No significant difference between males and females (U. Child Psychol. & Psychiatry, 42:241, 2001)

"Eyes Test"
 Simon Baron-Cohen (2003)

THE ESSENTIAL DIFFERENCE

Connellan, Baron-Cohen et al. (2000)

Study of 100 newborns, widely cited in recent media and books as evidence for innate sex difference in preference for "people versus objects."

Condition	Boys	Girls
Face	~45%	~40%
Mobile	~55%	~60%

Caveats: Live face vs. jingly mobile; JC not "blind" to sex of newborns; study contradicts nearly 5 decades of prior research; B-C and colleagues have yet to replicate; other research finds no sex difference in infant object perception. (Spelke, *Am Psychol* 2005)

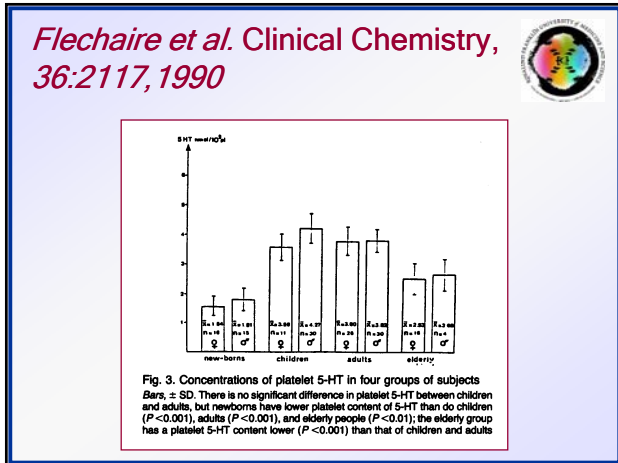
The popular view

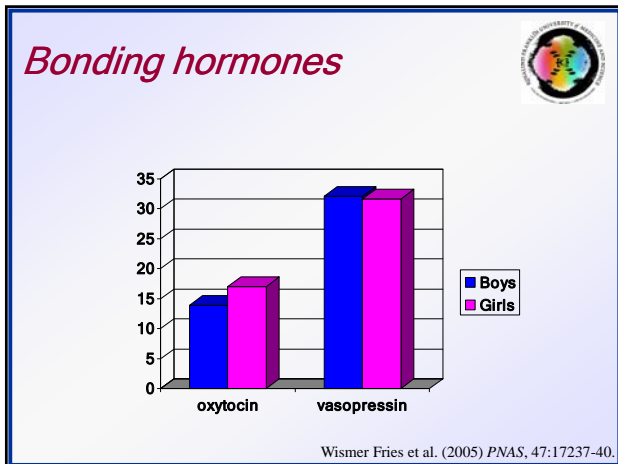
"Anyone who has raised boys and girls or watched them grow up can see that they develop differently, especially that baby girls will connect & that baby girls, not boys, are not for..."

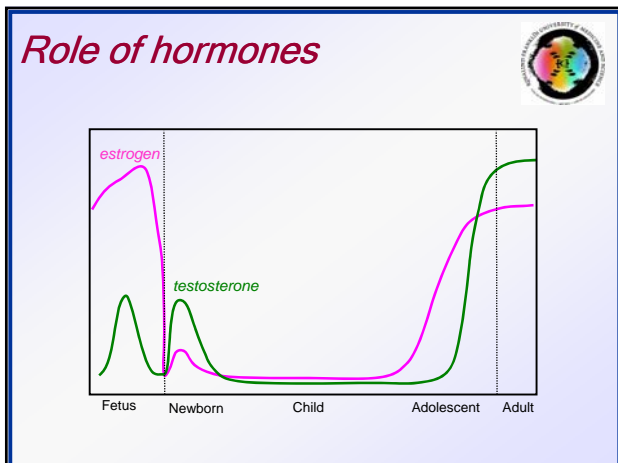
"Psychoneuroendocrinology"
 - Nature book review

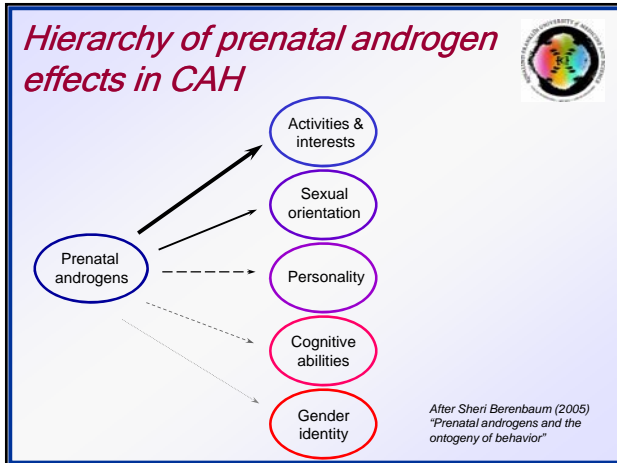
...erone...
 ...nics the centers...
 ...servation, and processing of emotion...

"BOYS FROM THE GET-GO LEARN DIFFERENTLY THAN GIRLS DO"



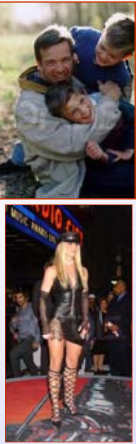




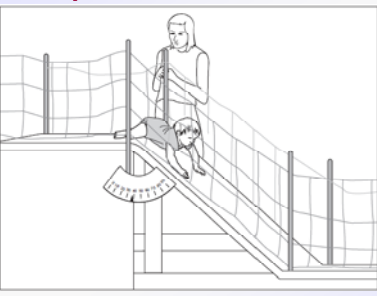


Social Learning

- ❖ **Parents:** in spite of best intentions, different expectations, interactions, and attributions for success of boys and girls.
- ❖ **Peers:** Arguably the strongest influence; gender segregation and conformity create two separate cultures that reinforce different interests, abilities, and relational styles. Even adults avoid careers where strongly outnumbered by opposite sex.
- ❖ **Teachers:** Pygmalion effect well-documented. Teachers' expectations shape student outcomes.
- ❖ **Larger culture (& media):** Babies can categorize "male" versus "female" even before they gender identify. More media exposure associated with stronger stereotyped views in children. Some sex differences (e.g. body image dissatisfaction) have actually increased in recent decades.



Biased expectations



- Mothers of girls underestimated the slope their infants would crawl down, but mothers of boys were accurate.
- There was no difference in the actual slope boys and girls descended.
- Mondschein et al. 2000.

Epigenetic development of sex differences

a Low licking and grooming

b High licking and grooming

- Research by Michael Meaney et al. has shown that differences in maternal care alter DNA to permanently impact the brain and subsequent memory and stress response.
- Earlier research found that rat mothers lick their male pups more than their female pups, which promotes survival of spinal motor neurons that control copulatory ability.

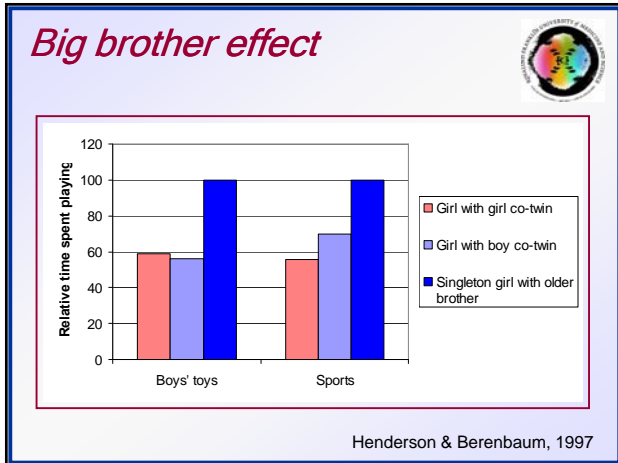
Feder et al. *Nature Revs Neurosci.* (2009)

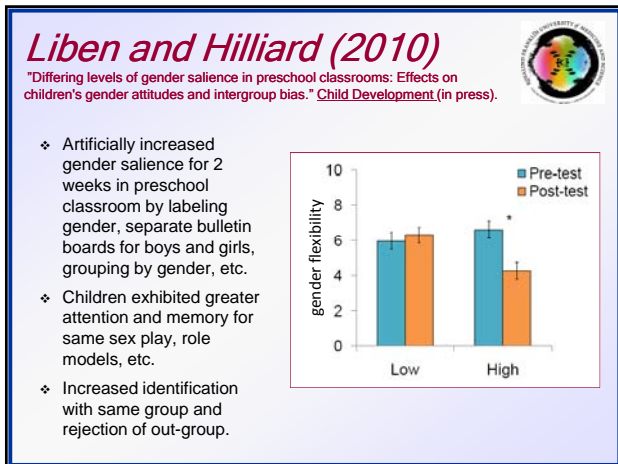
Toys 'R Us

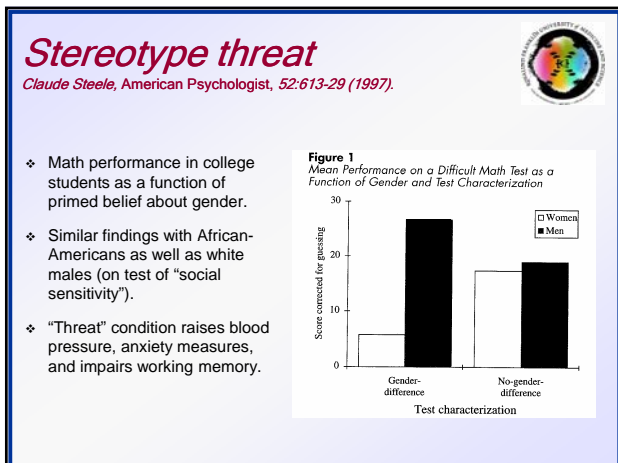
Toy preference

(Servin et al. 1999)

Age	Boys - Trucks	Boys - Dolls	Girls - Trucks	Girls - Dolls
Age 1	180	120	110	280
Age 3	280	70	140	220
Age 5	240	20	150	140








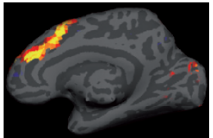
Functional imaging

(Han & Northcutt, 2008)

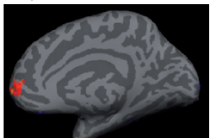


- ❖ Brain activation in two different subjects while performing the same self-judgment task.
- ❖ Gender learning is at least as potent as other cultural experience in shaping brain & mental function.


Subject X



Subject Y



Conclusions



- ❖ Sex differences are real, though mostly modest. They originate as innate (genetic and hormonally-shaped) biases, which are then magnified through learning, practice, and children's own desire to gender identify. So **plasticity** is both the cause and the "cure" for the more troubling differences.
- ❖ With regard to education, gender is not a very accurate way of grouping children who differ in abilities or learning style.
- ❖ The most useful outcome of studying sex differences: being mindful of later gaps and knowing how to challenge boys and girls earlier in their weaker or less stereotypical domains.



Implications for education

1. Watch out for stereotyping



- ❖ Avoid use of "boys and girls" and separate lines, cubbies, etc.
- ❖ Beware of biases, such as "boys are toxic" or Barbie's "Math class is hard!"
- ❖ Remember that differences in verbal, reading, writing, math & science skills are small and statistical, not large & categorical.
- ❖ All academic skills are learned, where plasticity trumps "hardwiring" every time.

2. Promote girls' visual, spatial, math & risk-taking skills



- ❖ In preschool, find building toys that appeal to girls:
 - "pink" or "house-and-garden" Legos; Lincoln logs; wood blocks
- ❖ Tool use and woodworking for all!!
- ❖ Computer programs (mazes, mental rotation, ST Math from MIND Institute)
- ❖ Puzzles (particularly in 3D), checkers, chess
- ❖ Engineering projects (toothpick bridges; egg protectors)
- ❖ Musical keyboard training
- ❖ Maps, globes, and navigational games!!
- ❖ Throwing, sports, and physical challenges

3. Promote verbal, literacy & self-regulatory skills in boys



- ❖ One-on-one dialogue, word play, singing
- ❖ Dramatic play (fireman, astronaut, race car driver, etc.)
- ❖ More movement and tolerance for physicality
- ❖ Non-writing, fine motor activities (painting at easels, Legos, cutting, Play-Doh, bead stringing)
- ❖ "Mark-making" on boxes, paper rolls, clipboards, sticky notes
- ❖ Pet & plant care
- ❖ Pre-reading computer programs (in pairs)
- ❖ Action, humor, non-fiction books (audio too)
- ❖ Dictation and typing to divorce printing from composition
- ❖ "Tools of the mind" to teach executive skills/self-regulation

4. The issue of choice



- ❖ "Best practice" states that children should have a choice of activities.
- ❖ But if the choice is woodworking vs. sewing, or number games vs. writing, the boys and girls will segregate themselves.
- ❖ One solution is to limit choices to one cognitive domain at a time, such as spatial, verbal, math or music.

5. Adult role models



- ❖ In the U.S., men constitute only 4% of the child care workforce and 21% of teachers overall, a 40-year low!
- ❖ In the absence of male teachers, boys look to each other as role models, while girls identify more with their teachers.
- ❖ There is some evidence that teacher gender improves performance in same-sex students (Dee, 2005).
- ❖ Must recruit more young men into teaching and/or bring more men into the classroom providing a model of academic focus. (E.g., Lads and Dads; cops with books).
- ❖ Similarly, girls need models of women in math & science.
