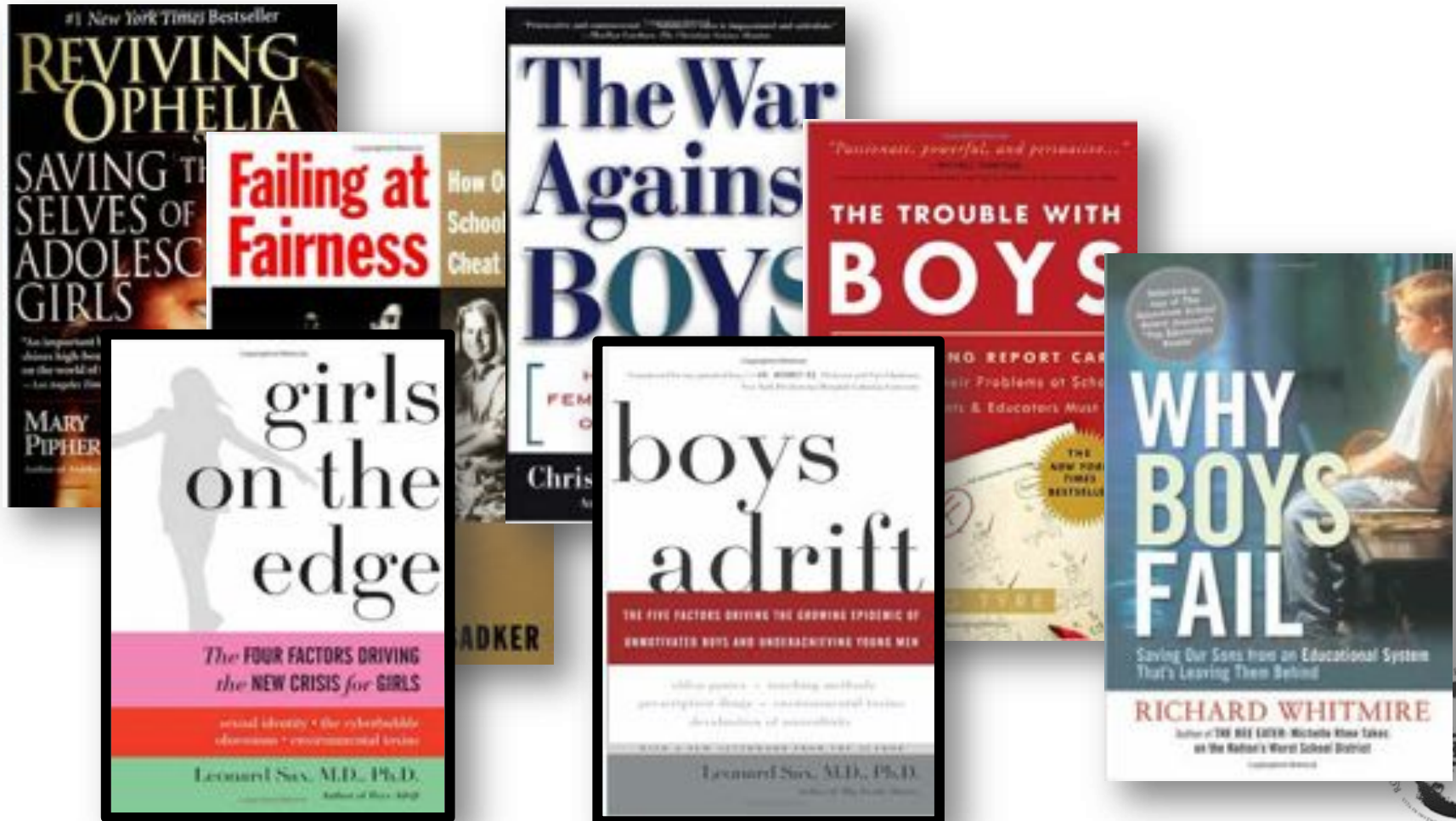


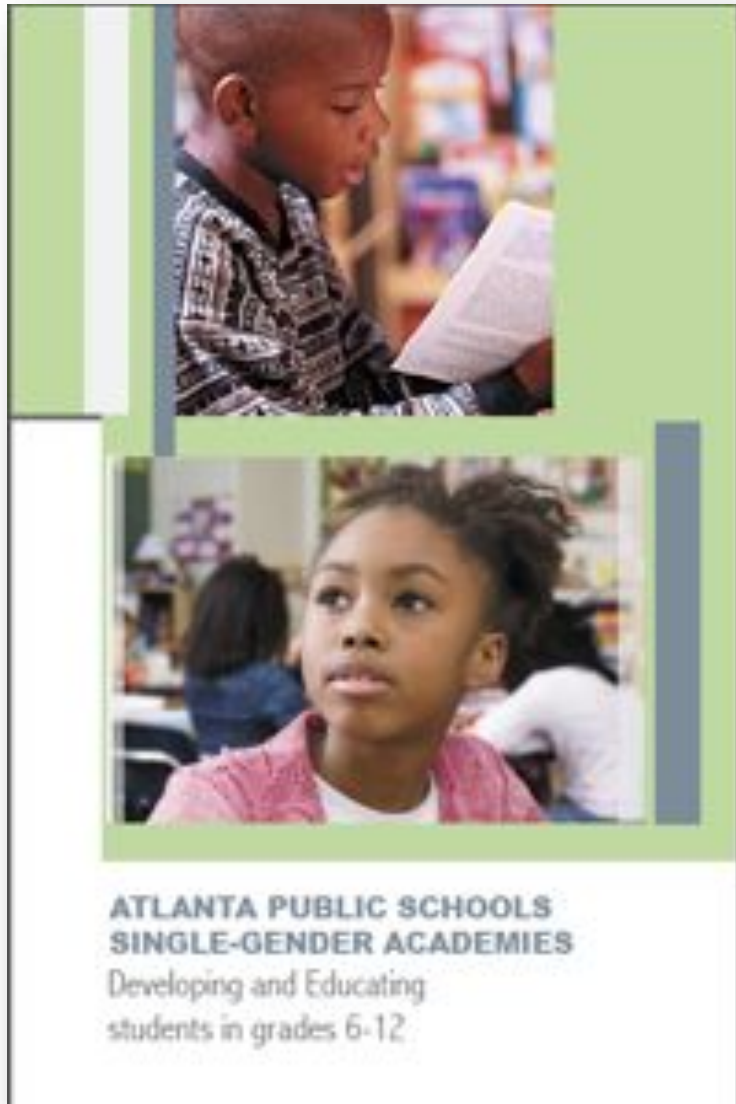
# ***Pink Brain, Blue Brain:*** Preventing small differences from growing into troublesome gaps

**Lise Eliot, PhD**  
*Dept. Neuroscience*  
*Chicago Medical School*  
*Rosalind Franklin University*  
*North Chicago, Illinois*



# Girl crisis or boy crisis?





**“Research solidly indicates that boys and girls learn differently.”**

**Q: What research?**





- Sex differences in behavior are real, but more subtle than the Mars/Venus view and smaller in children than adults.
- Prenatal testosterone biases certain behaviors, but learning & practice play a greater role in all gender gaps.
- There is no such thing as a “male brain,” or a “female brain.”
- A better understanding of how sex differences develop is crucial for helping us raise both boys’ and girls’ achievement.

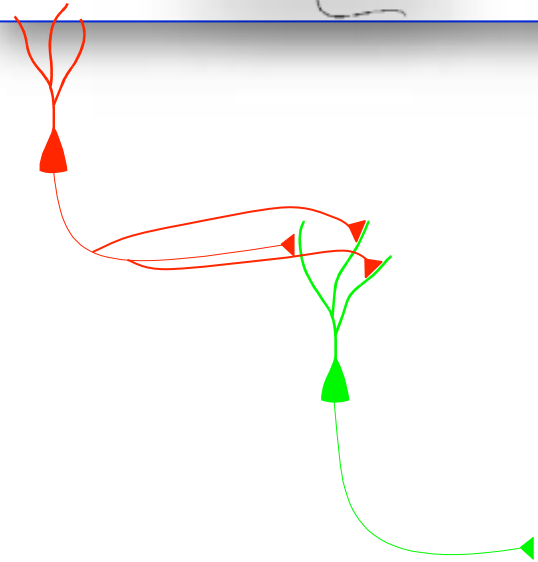


# BRAIN DEVELOPMENT



# How the brain grows up

- ◆ **Nature** (genes & hormones) and **Nurture** (environment & experience) inextricably interwoven from the first cell division.
- ◆ Neuroscientists use the term “**plasticity**” to describe the Nurture effect. Works according to 2 “**activity-dependent**” rules:
  - “Cells that fire together, wire together.”
  - “Use it or lose it.”
- ◆ Synaptic plasticity is far more potent in childhood than later life.

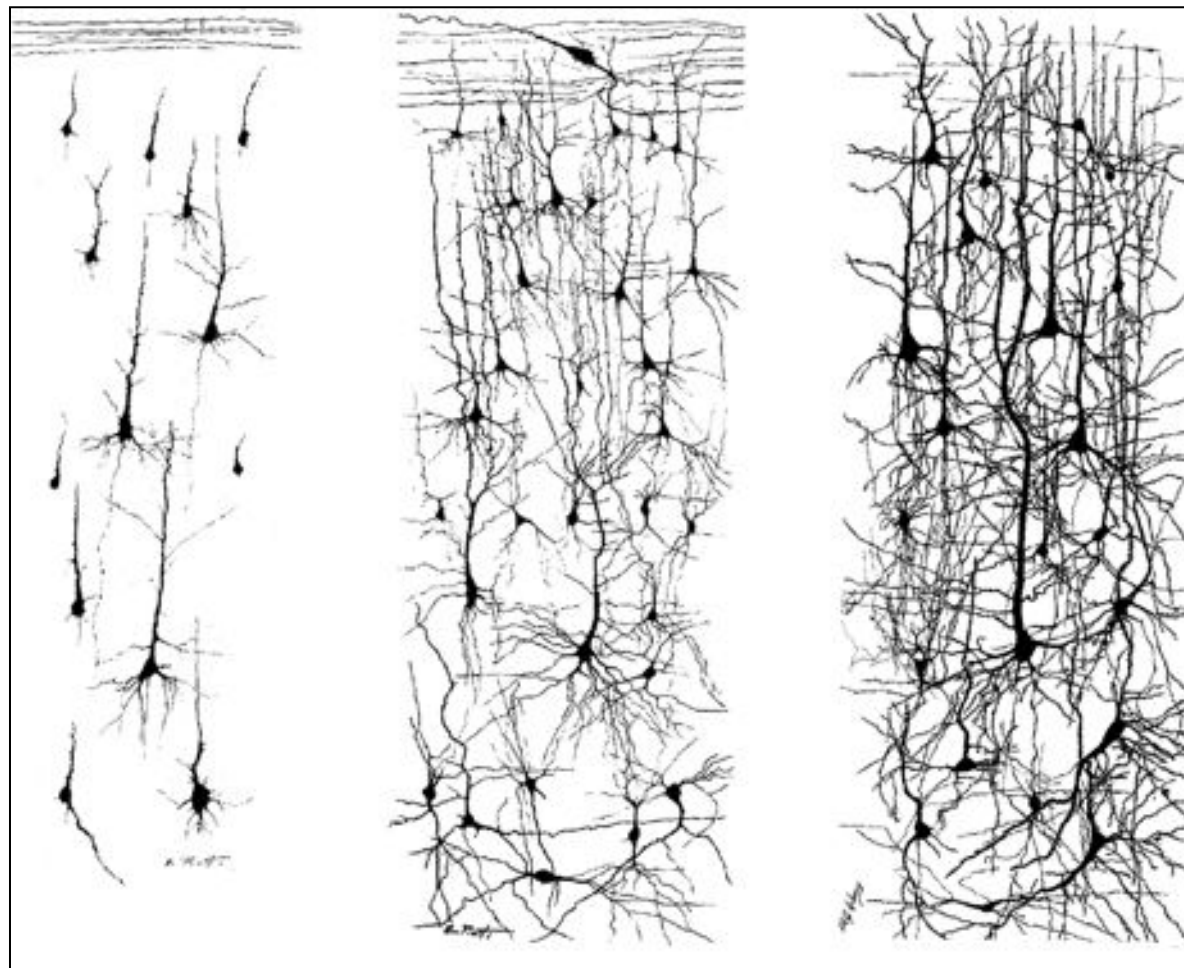


# *“Magic Trees of the Mind”*

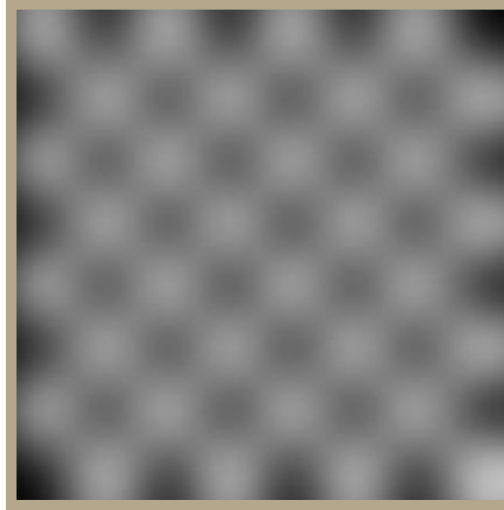
Newborn

3-month-old

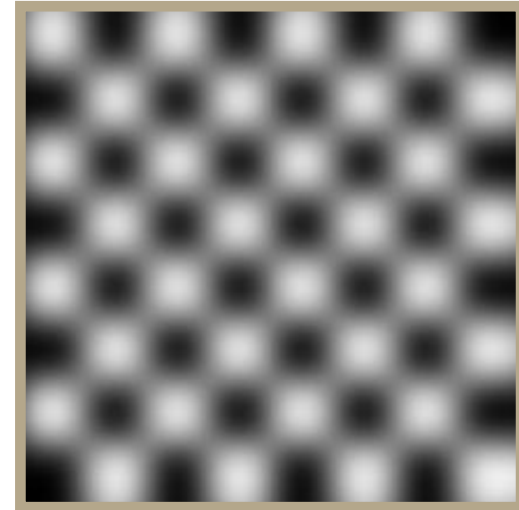
2-year-old



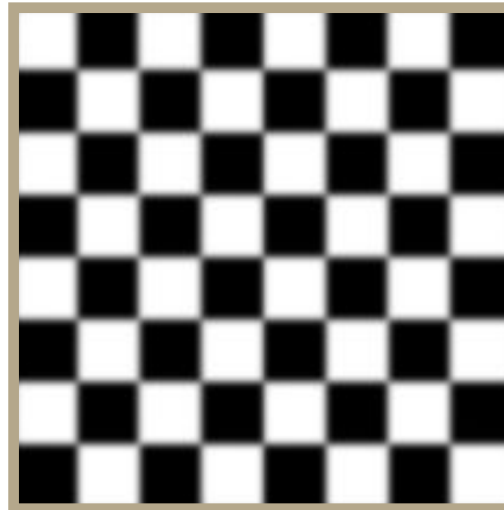
*As synapses form, vision "turns on"*



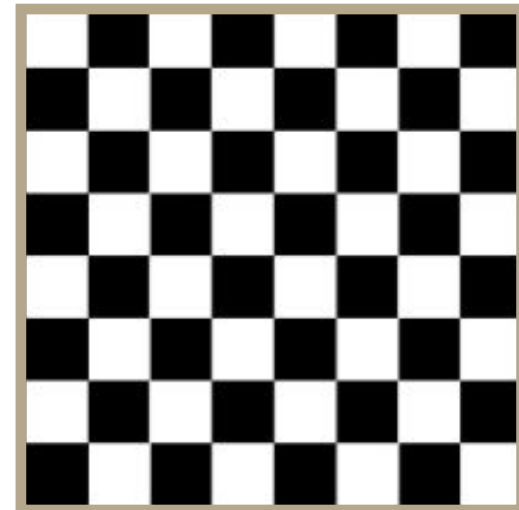
Newborn



2 months



6 months

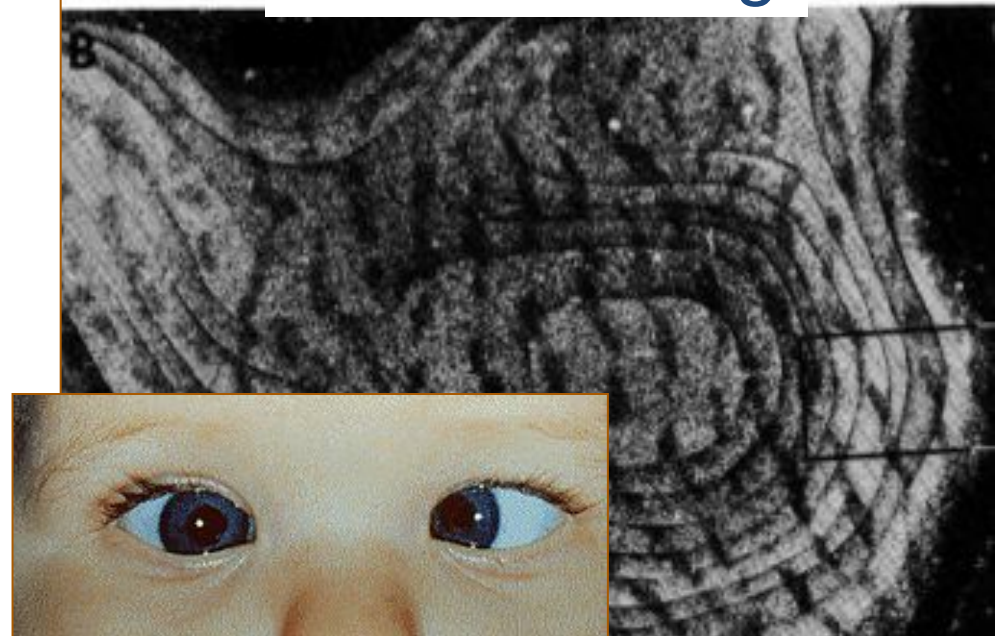
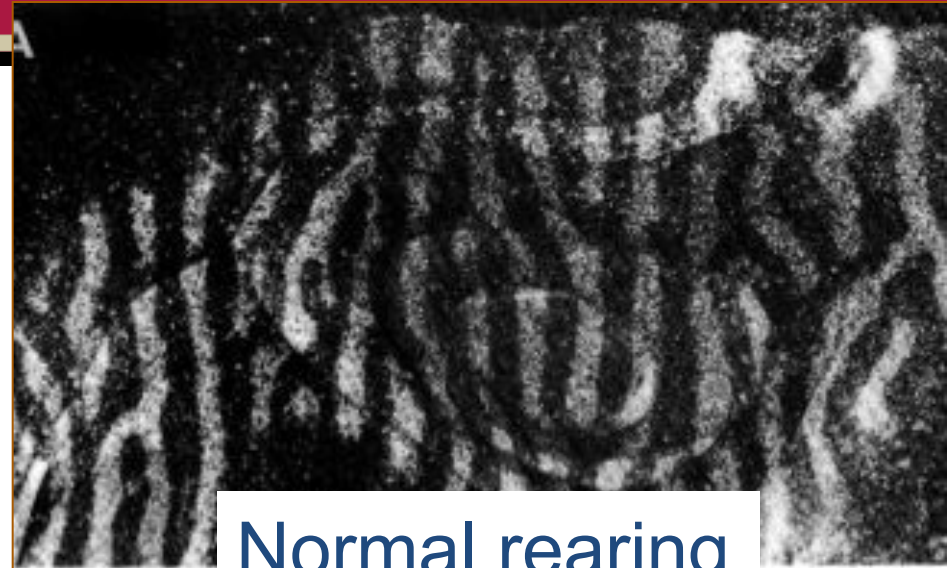
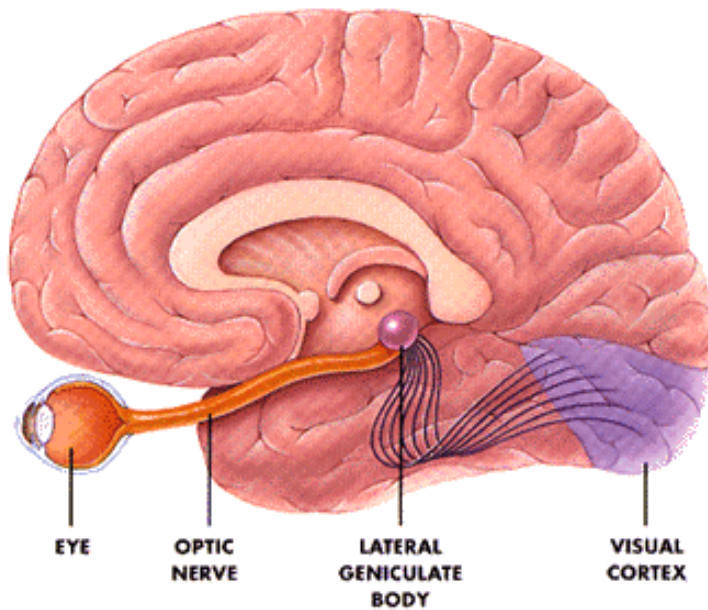


Adult

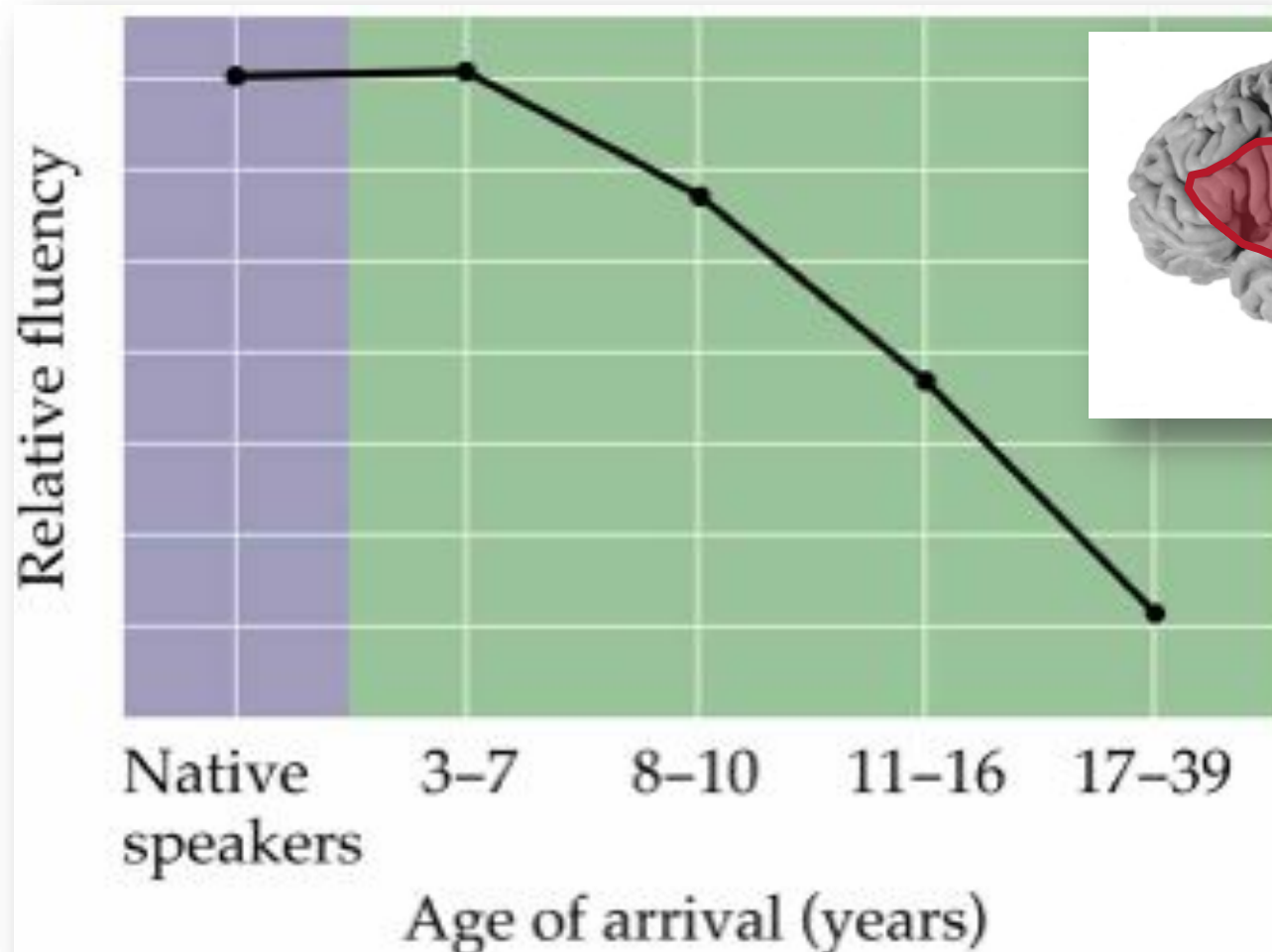


# Effect of early visual experience

Hubel & Wiesel (1981 Nobel Prize)



# Critical period for language



# *Girl culture, boy culture & plasticity*

- **The different ways in which boys and girls are socialized and spend their time wires up their brains differently.**
- **“Boy play” promotes risk-taking and visual-spatial skills, while “girl play” promotes relational and literacy skills.**



# ***Critical period for gender identity?***

- On rare occasions (for serious medical conditions & birth defects) doctors have advised parents to raise genetic boys as girls.
- The largest study of such children found that only 17 of 77 such XY individuals had reverted to male identity by late adolescence.  
***“These data do not support a theory of full biological determinism ... and one must conclude that gender assignment and concomitant social factors have a major influence on gender outcome.”*** H. F. L. Meyer-Bahlburg (2005) *Arch.Sex. Behav.*, 34: 423 - 438.
- Another recent review: ***“In general, data from people with most forms of 46,XY DSDs reveal that gender identity is predominantly influenced by learning and socialization associated with sex of rearing.”*** A.B. Wisniewski (2012) *Scientifica*, doi:10.6064/2012/834967

# SEX DIFFERENCES IN THE BRAIN & BEHAVIOR



# The Gender Similarities Hypothesis

Janet Shibley Hyde  
*University of Wisconsin—Madison*

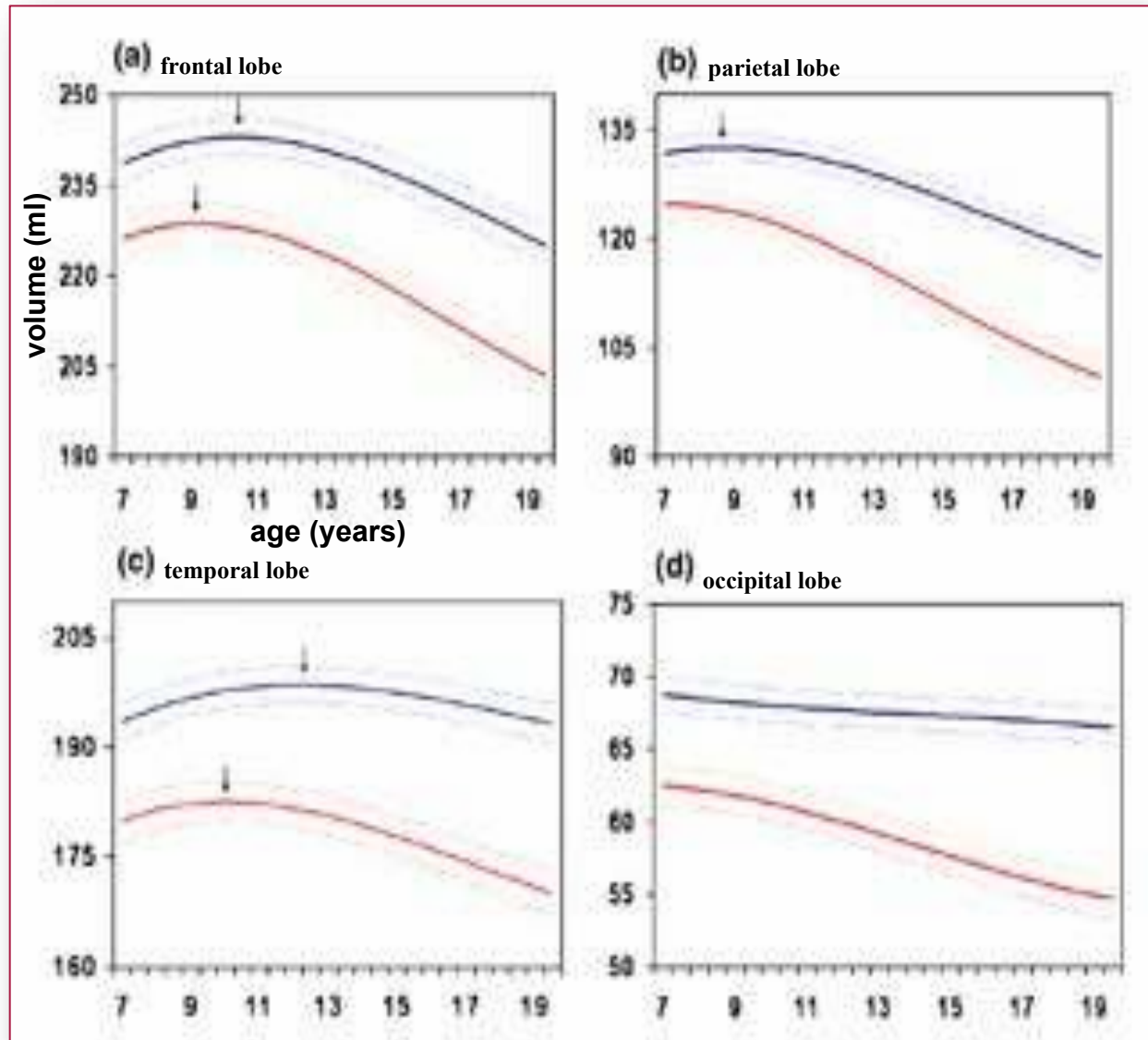
September 2005 • American Psychologist

Copyright 2005 by the American Psychological Association 0007-0024/05/\$12.00  
Vol. 60, No. 6, 581–592 DOI: 10.1037/0003-066X.60.6.581



# Girls' brains are smaller and finish growing earlier

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



***“Men tend to use only one brain hemisphere at a time, but women employ ‘whole brain’ thinking.”***

**[www.girlslearndifferently.com](http://www.girlslearndifferently.com)**





# Wrong: Both men and women are left dominant

(Study of resting brain activity, Liu et al., n =300)

PNAS | December 1, 2009 | vol. 106 | no. 48 | 20499–20503

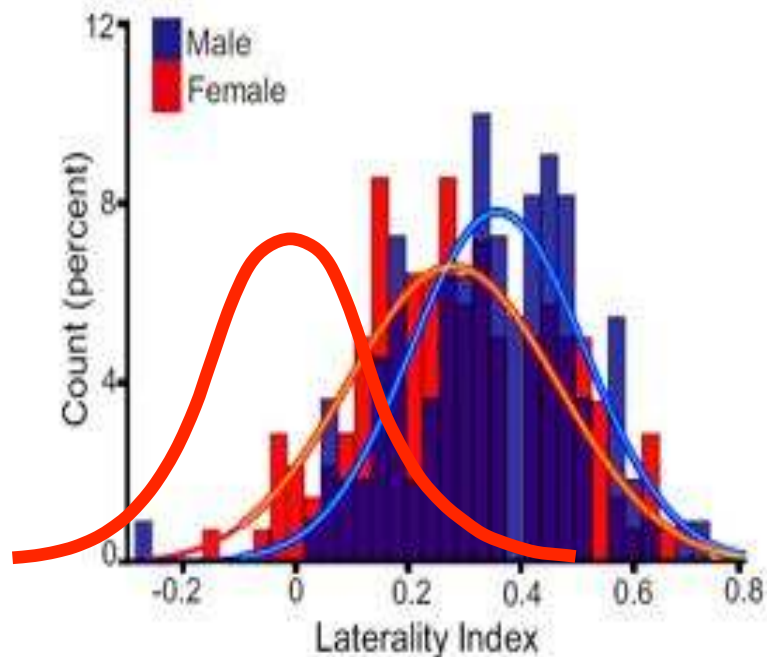
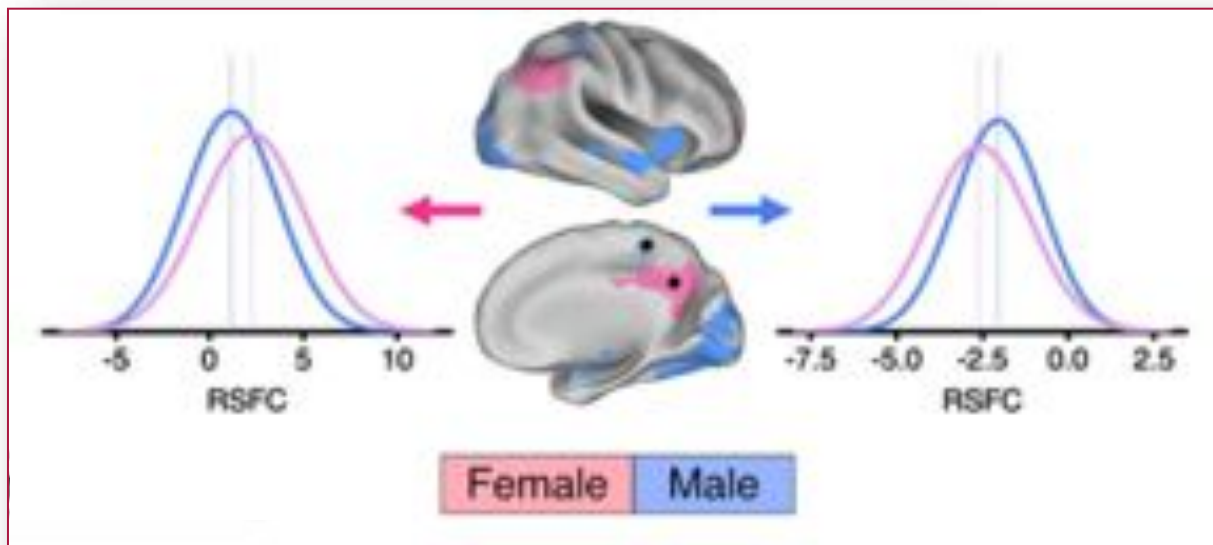


Fig. 2. Sex differences are present but small.

- Merrill Hiscock: 4 exhaustive surveys, 1994-2001, in *J. Clin. Exp. Neuropsychology* asking “Is there a sex difference in human laterality?”
- Found a **“weak population-level sex difference in hemispheric specialization”** for auditory, visual, tactile & dual-task assays, accounting for 1-2 percent of variance.
- Similar findings in meta-analysis by Voyer (1996): 0.1% of variance.

# *Small difference in adult connectivity*

(Biswal et al.) PNAS | March 9, 2010 | vol. 107 | no. 10 | 4735

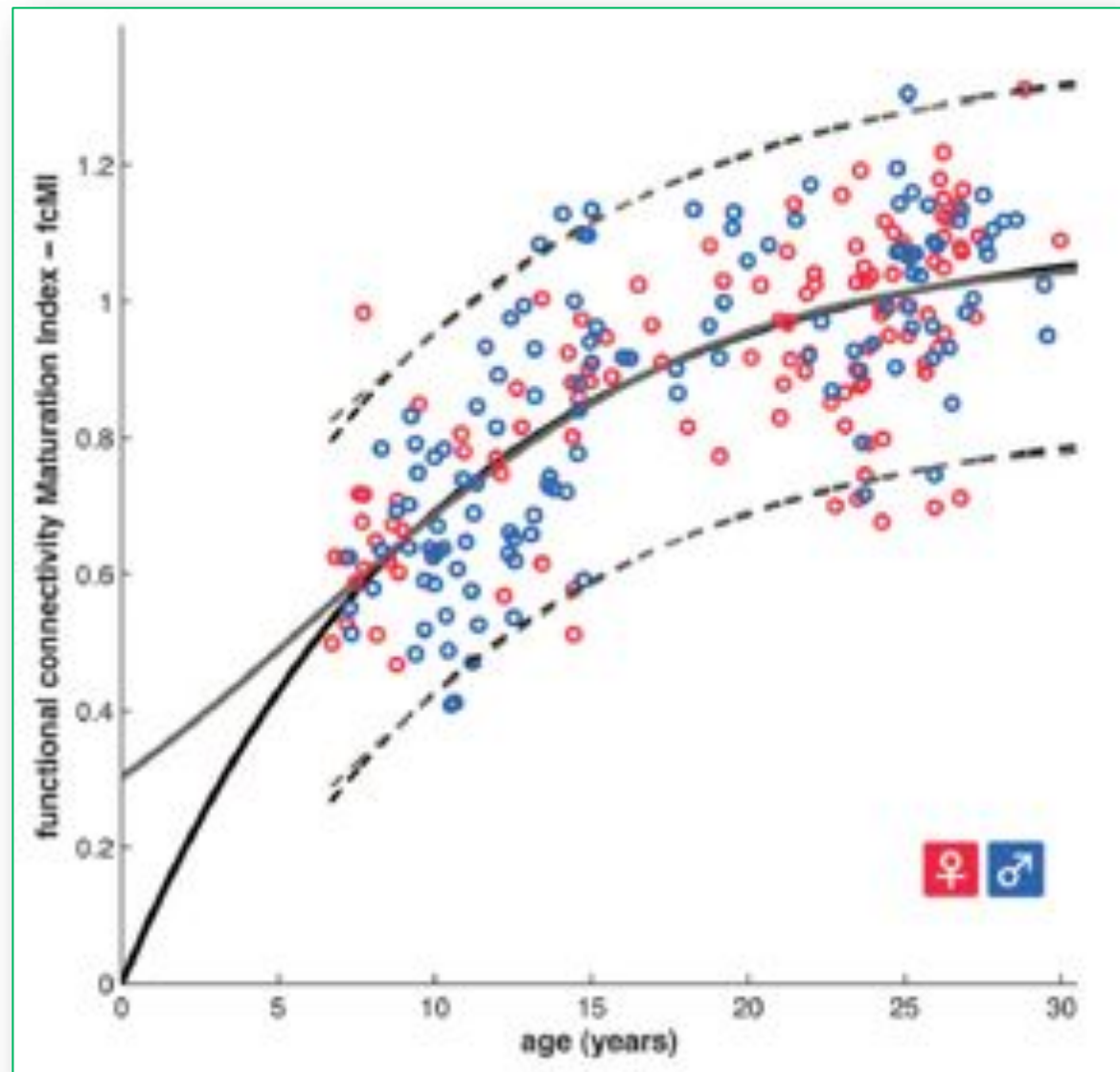


- Resting fMRI activity from 1,414 subjects, 35 sites.
- Right curves plot connectivity in the blue areas, more strongly connected in males. Left curves are pink brain areas, stronger connectivity in females.



# But none in adolescents

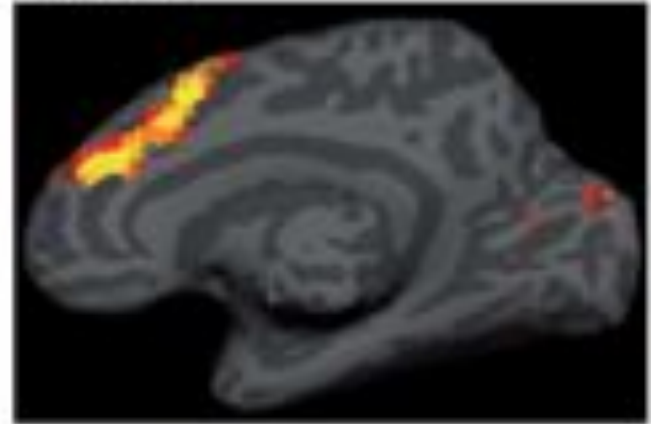
Dosenbach et al. Science,  
329:1358 -61(2010)



# Brain Fallacy

- Just because a sex difference in the brain is “biological” does not mean it is “hardwired.”
- Consider this experiment: 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 function.

Subject X



Subject Y

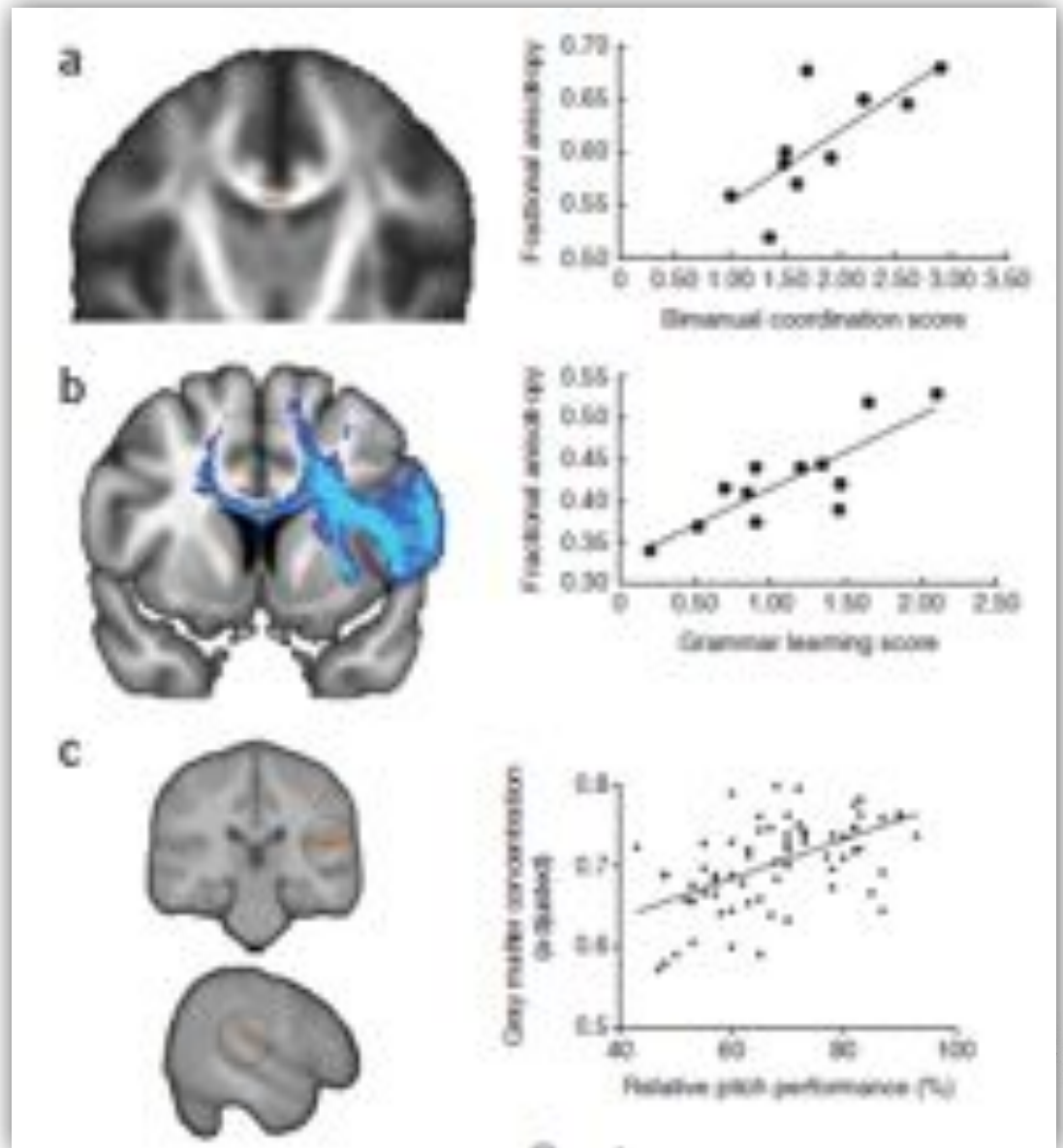


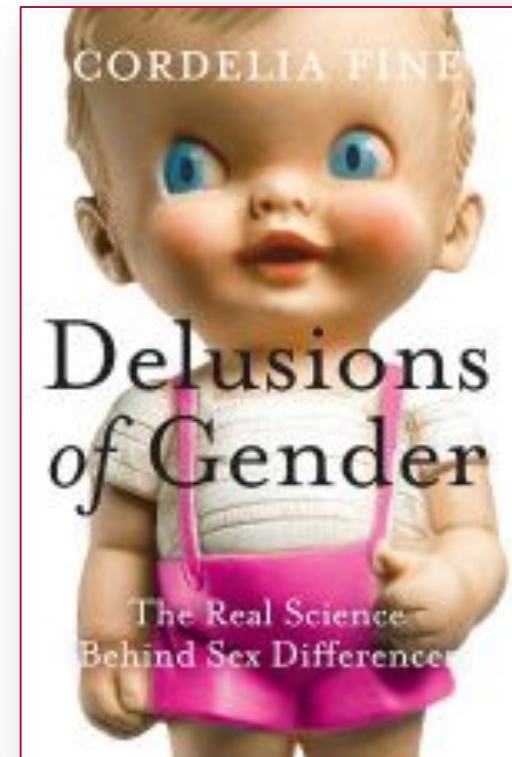
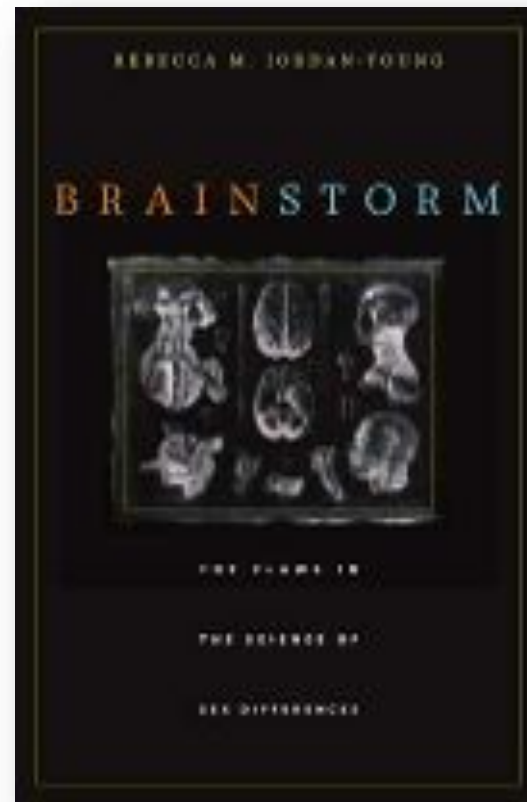
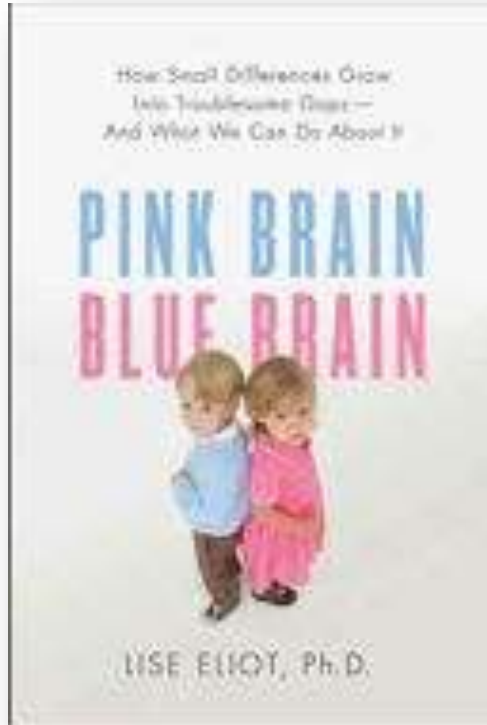
Han & Northoff (2008) Culture-sensitive neural substrates of human cognition: a transcultural neuroimaging approach. *Nature Neuroscience*, 9:646-54.

# Brain plasticity during learning

Zatorre et al (2012) *Nature Neuroscience*, 15:528-36

*Considerable recent research has shown that both gray & white matter grow during learning of all types (motor, language, music).*





# ROLE OF NATURE (HORMONES)



# *What teachers are hearing:*

## **Michael Gurian**

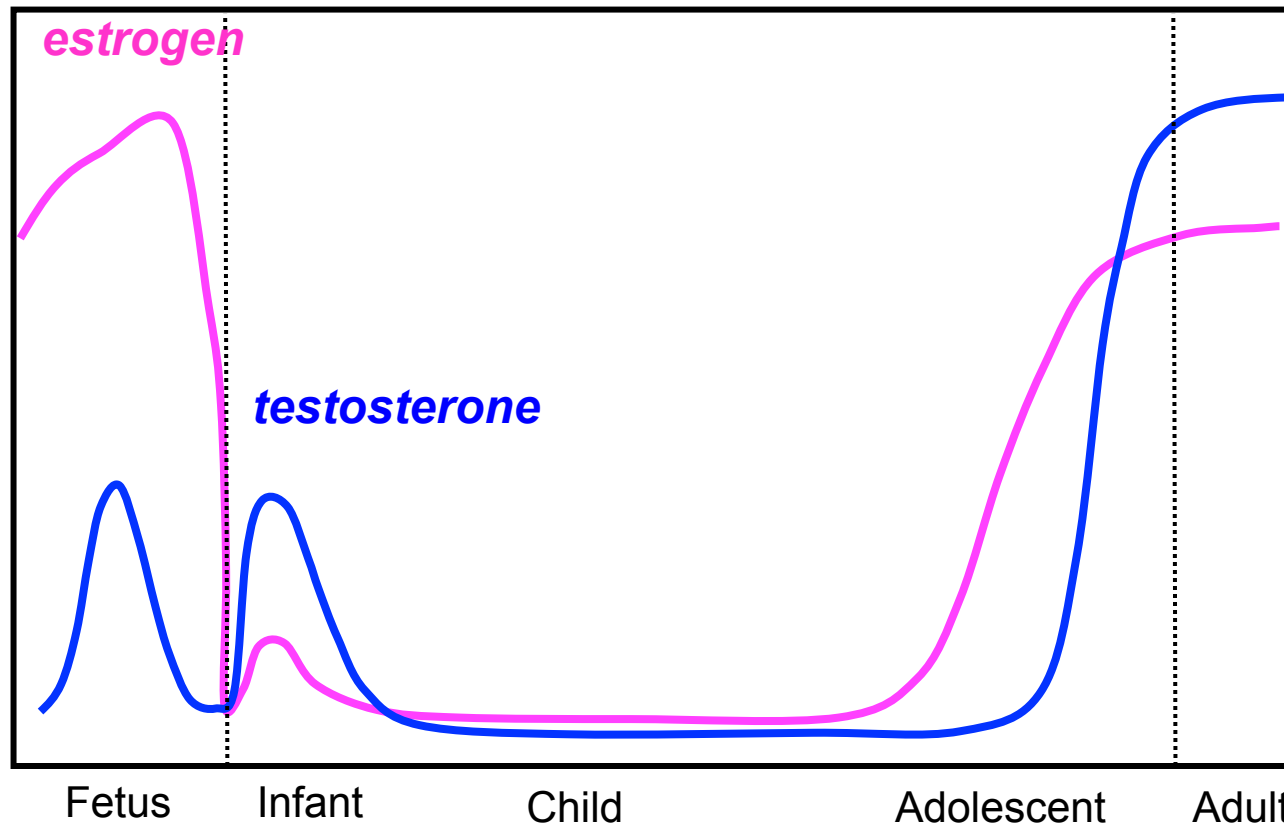


“Girls have great difficulty in learning certain aspects of math [because of] ... testosterone: surges of the hormone, which males receive during adolescence between five and seven times a day, can increase spatial skills. ... The adolescent girl may have a few days a month when





# Gonadal hormones



*Prenatal T (**organizational phase**) biases toy preference, sexual orientation, activity level. By contrast, post-pubertal hormones (**activational phase**) have negligible effects on cognition or emotion (menstrual fluctuations; WHI; transsexuals; delayed puberty)*

# THE NURTURE (PLASTICITY) SIDE



# *Social gender learning*

- Family, peers, teachers & larger culture shape children's gender aspirations
- Such influences have been linked to:
  - Toy preference
  - Mental rotation
  - Math performance
  - Verbal ability
  - Risk-taking
  - Physical aggression
  - Emotional expression





## Cards from a British designer



# Toys 'R Us



# *In 1981, LEGOs were for girls too*



*but today's girls get "girly" LEGOs*



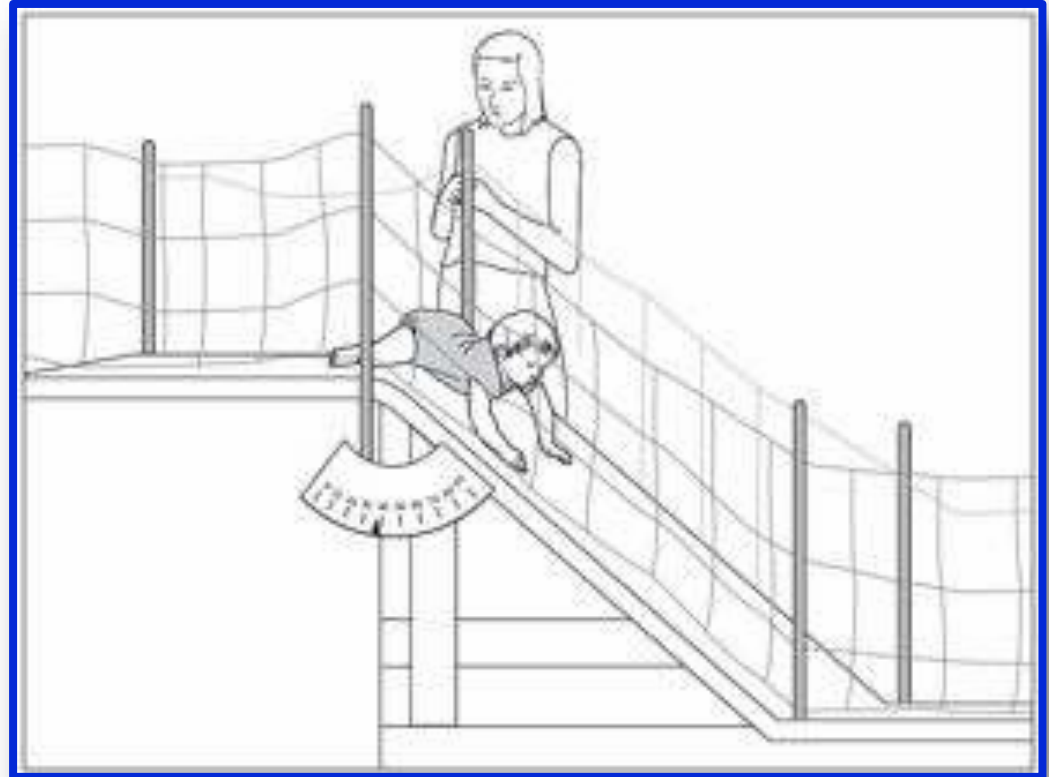
# *Gendered crayons*





# Parental 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, Adolph, & Tamis-LeMonda (2000) Gender bias in mothers' expectations about infant crawling. *Journal of Experimental Child Psychology*, 77, 304-316.



# Teachers

- ❖ Teachers' expectations shape student outcomes:  
"Pygmalion effect"
- ❖ Teachers exhibit the same implicit biases as everyone else (See [www.implicit.harvard.edu](http://www.implicit.harvard.edu) to test yourself on career/homemaker versus gender; STEM/humanities versus gender)
- ❖ "Boys learn differently. They need hands-on activities and motor breaks" (6<sup>th</sup> grade teacher quote, *Portland Press Herald*, 9/9/11)
- ❖ "Girls generally work well with others and talking about a concept with a peer can help them understand it... Social skills seem to come naturally to them." (3<sup>rd</sup> grade teacher, *Daytona Beach News Journal*, 9/15/11)



# Implicit Association Test

<https://implicit.harvard.edu/implicit/Study>

In the next task, you will be presented with a set of words or images to classify into groups. This task requires that you classify items as quickly as you can while making as few mistakes as possible. Going too slow or making too many mistakes will result in an uninterpretable score. This part of the study will take about 5 minutes. The following is a list of category labels and the items that belong to each of those categories.

Category	Items
<b>Male</b>	Man, Boy, Father, Male, Grandpa, Husband, Son, Uncle
<b>Female</b>	Girl, Female, Aunt, Daughter, Wife, Woman, Mother, Grandma
<b>Science</b>	Biology, Physics, Chemistry, Math, Geology, Astronomy, Engineering
<b>Liberal Arts</b>	Philosophy, Humanities, Arts, Literature, English, Music, History

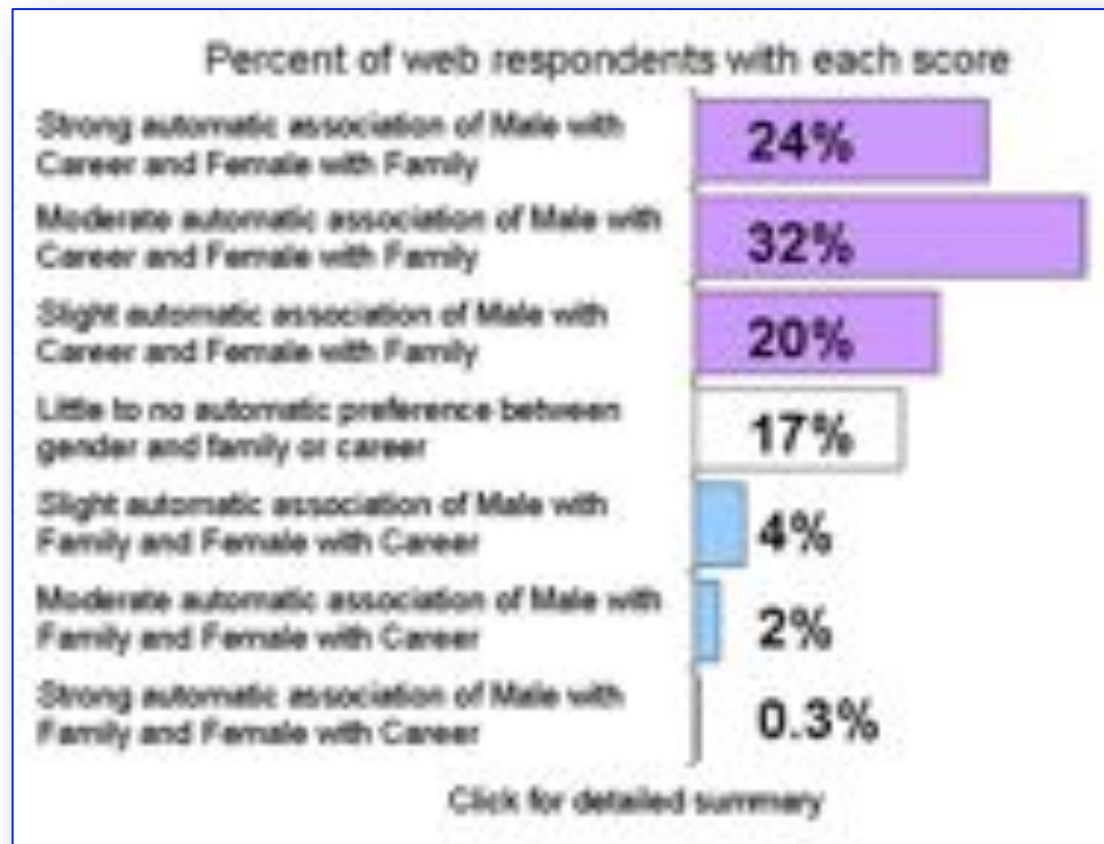
*Keep in mind*

- Keep your index fingers on the 'e' and '?' keys to enable rapid response.
- Two labels at the top will tell you which words or images go with each key.
- Each word or image has a correct classification. Most of these are easy.
- Sort items by their category membership. Words in green should be categorized with the green labels. Words in white should be categorized with the white labels.
- The test gives no results if you go slow -- Please try to go as fast as possible.
- Expect to make a few mistakes because of going fast. That's OK.
- For best results, make sure that your monitor is set to maximum brightness and avoid distractions.

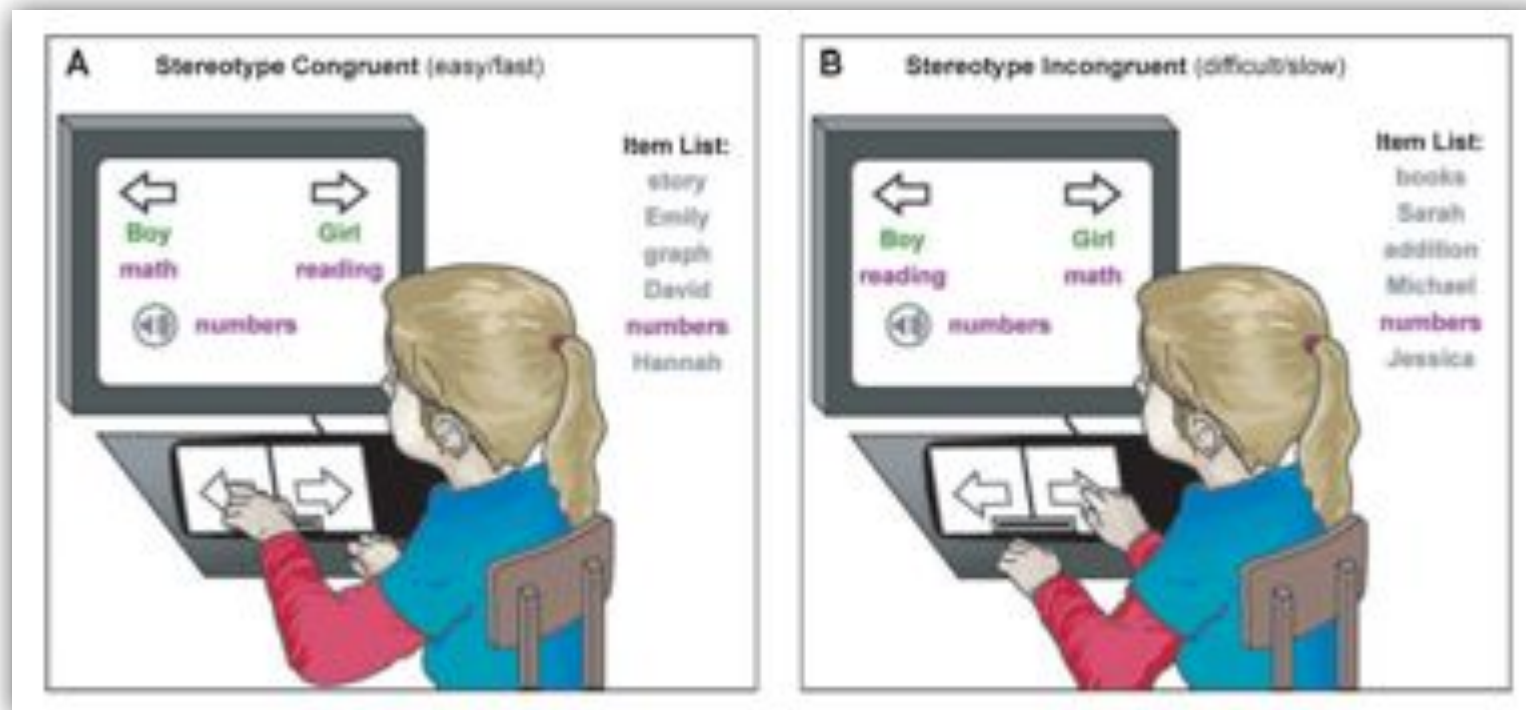
[I am ready to begin](#)



# IAT: Results



# Child implicit association test

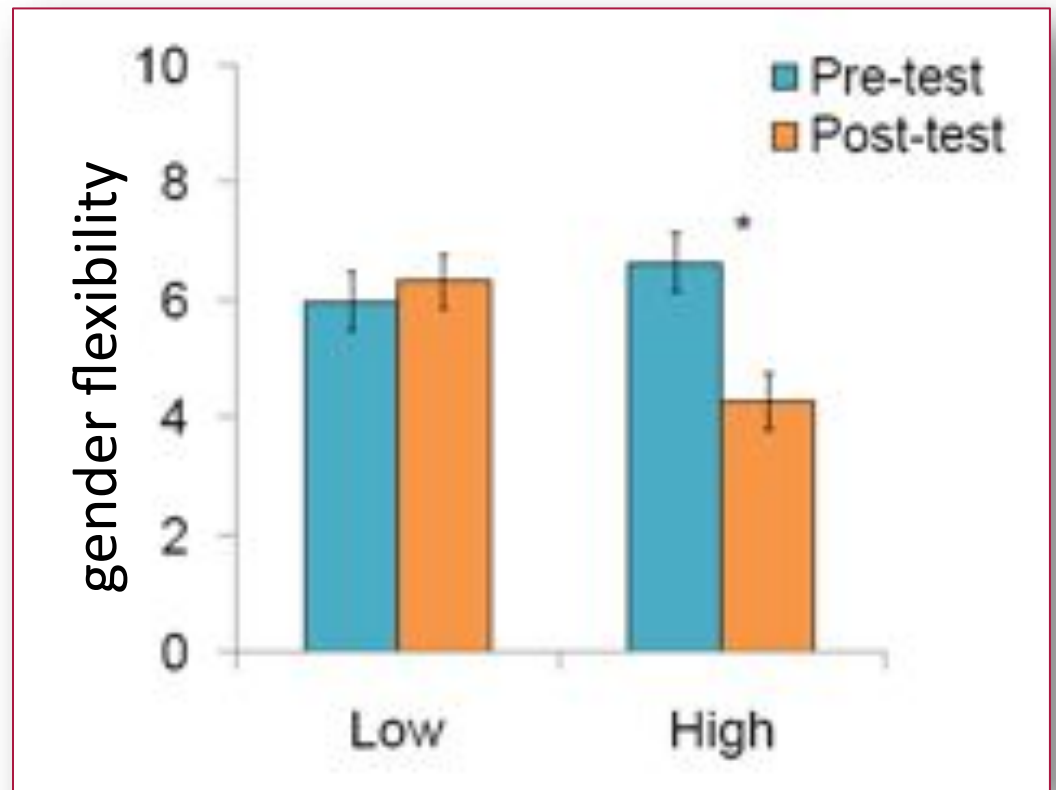


- “The math–gender stereotype is acquired early and influences emerging math self-concepts prior to ages at which there are actual differences in math achievement.”
- Cvencek, Meltzoff & Greenwald (2011)



# ***When teachers emphasize gender, so do kids*** Hilliard & Liben (2010) *Child Dev.* 81:1787-98.

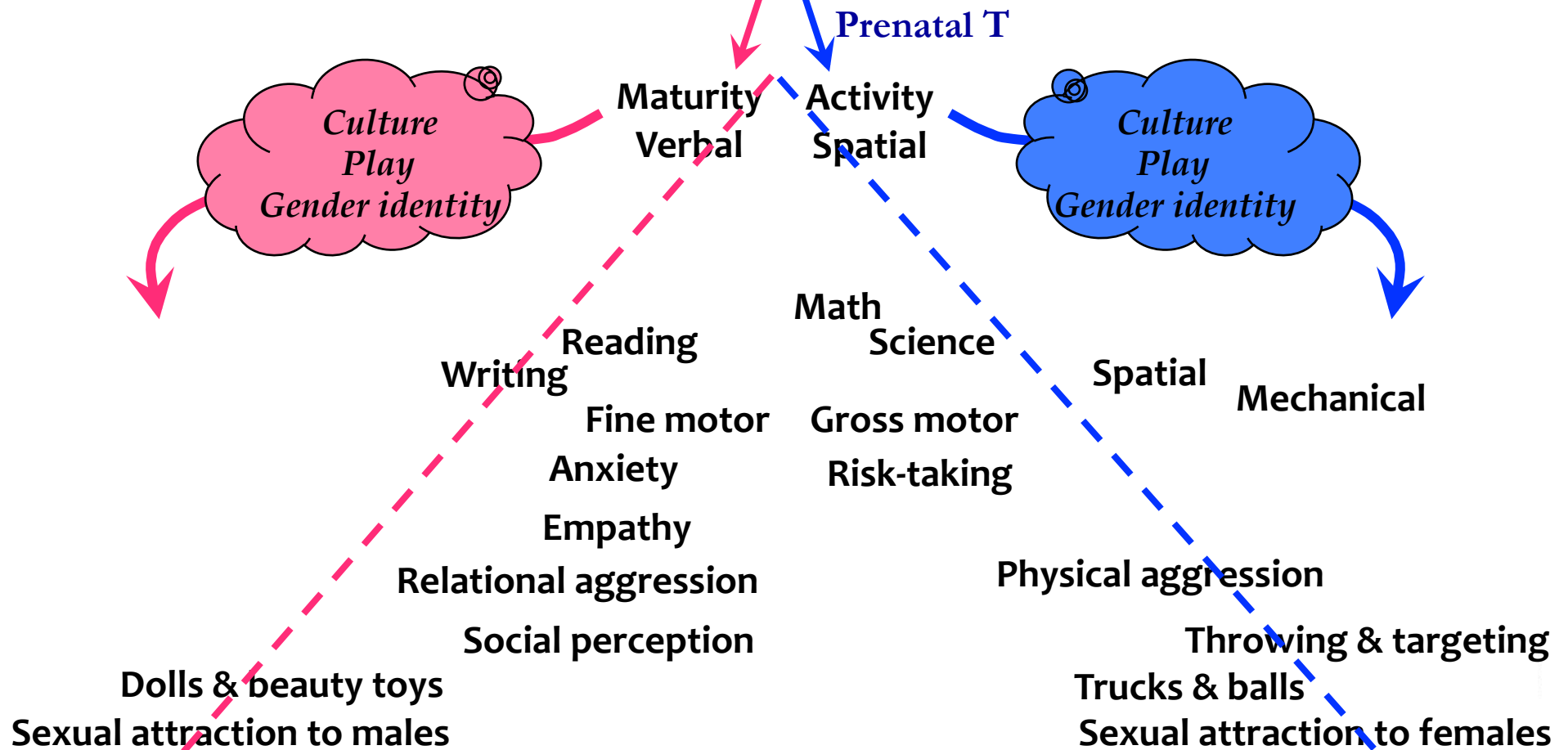
- Artificially increased gender salience for 2 weeks in preschool classroom by labeling gender, separating bulletin boards for boys and girls, grouping by gender, etc.
- Greater attention and memory for same sex play, role models, etc.
- Increased identification with same group and rejection of out-group.



# SMALL DIFFERENCES IN INFANCY, MAGNIFIED THROUGH LEARNING

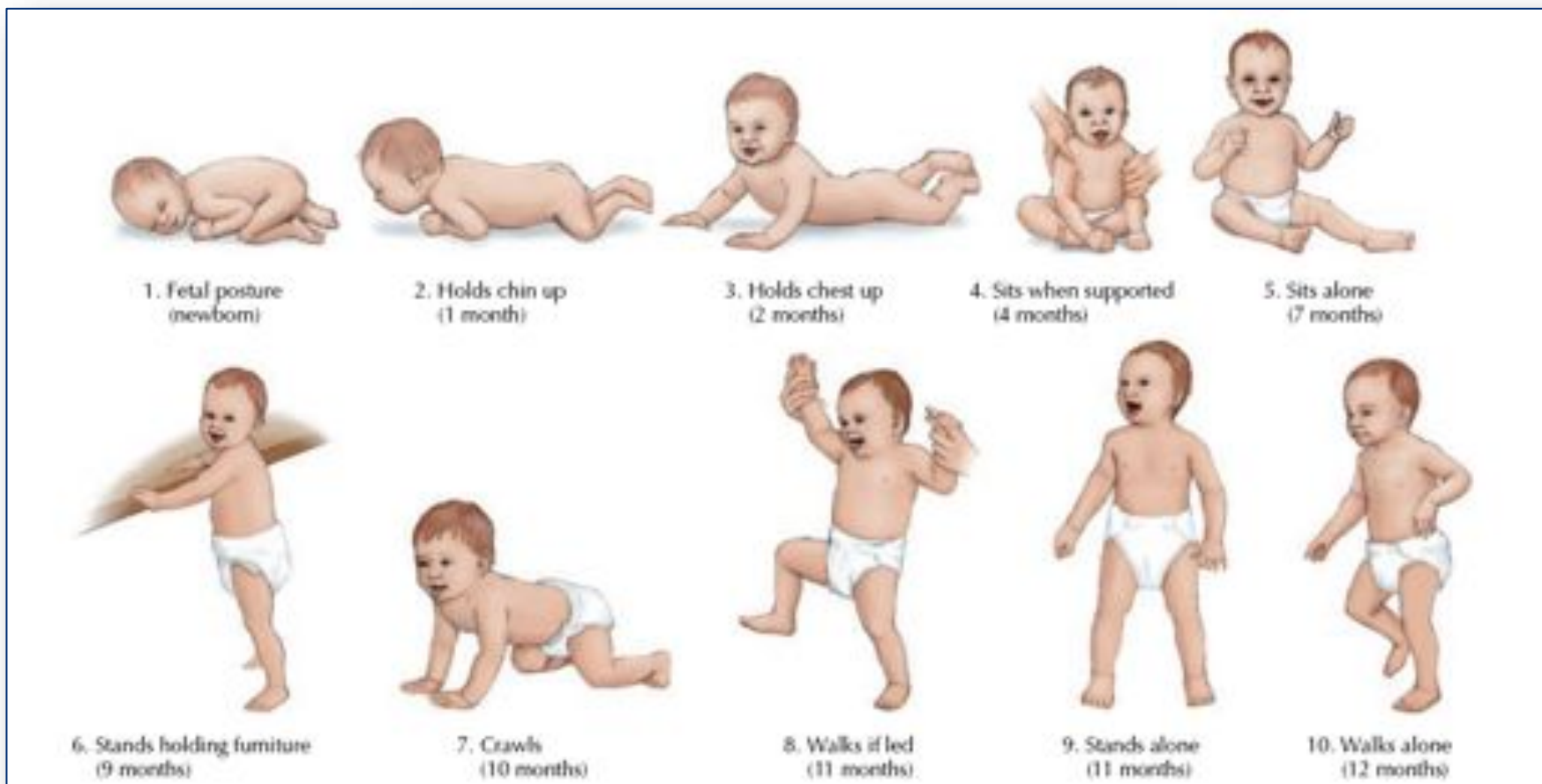


# Nature biases, Nurture magnifies





# *No gender difference in gross motor milestones*



# Activity level

- no clear difference before birth, but boys more active from birth to 12 months ( $d=0.2$ ): Campbell & Eaton (1999) *Inf. Child Dev.* 8: 1-17.
- and even more so by preschool years ( $d=0.5$ ): Eaton & Enns (1986) *Psychol. Bull.* 100:19–28.
- girls with CAH more active ( $d=0.55$  compared to control girls), suggesting this difference is influence by prenatal testosterone ; Pasterski et al. (2007) *Hormones & Behav.*, 52: 368–74.



# Young girls get less outdoor play

[Arch Pediatr Adolesc Med.](#) 2012 Apr 2. [Epub ahead of print]

## Frequency of Parent-Supervised Outdoor Play of US Preschool-Aged Children.

[Tandon PS](#), [Zhou C](#), [Christakis DA](#).

Behavior, and Development, Seattle Children's Research Institute and Department of Pediatrics, University of Washington, Seattle, Washington.

### Abstract

**OBJECTIVE:** To characterize preschoolers' daily parent-supervised outdoor play frequency and associated factors.

**DESIGN:** Cross-sectional using data from the Early Childhood Longitudinal Study-Birth Cohort.

**SETTING:** Nationally representative US sample.

**PARTICIPANTS:** Preschool-aged children. Main Outcome Measure Parent-reported outdoor play frequency.

**RESULTS:** The sample size of 8950 represented approximately 4 million children. Sixty percent of children exercised 0 to 3 days per week, and 93% perceived their neighborhood to be safe. Forty-four percent of children were reported taking their child outside to play at least once per day. Fifty-one percent of children were reported to be supervised by either parent. Fifty-eight percent of children who were not in child care went outside daily. A child with sex (odds ratio [OR] for girls, 0.85; 95% CI, 0.75-0.95), having more regular playmates (OR for mother's race/ethnicity (OR for Asian, 0.51, 95% CI, 0.43-0.61; black, 0.59, 95% CI, 0.49-0.70; Hispanic, 0.62, 95% CI, 0.52-0.73); mother's employment (OR for full time, 0.70; 95% CI, 0.62-0.81), and parent's exercise frequency of 4 days per week (OR, 1.75). We did not find significant association of outdoor play with child's time spent watching television, household income, mother's marital status, or parent's perceptions of neighborhood safety.

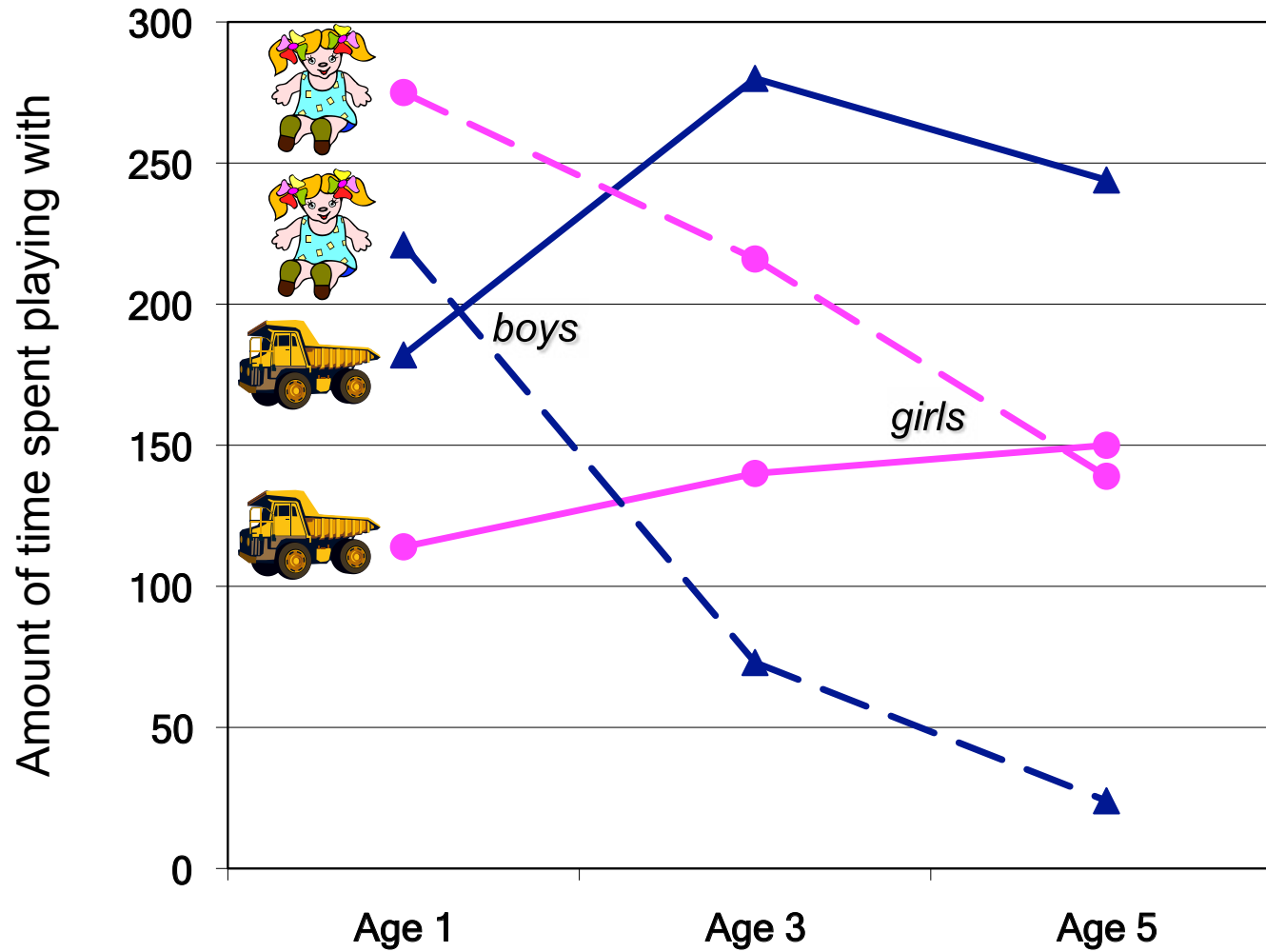
**CONCLUSIONS:** About half the preschoolers in this sample did not have even 1 parent-supervised outdoor play opportunity per day. Efforts to increase active outdoor play should especially target children who are girls and nonwhite. Outdoor play opportunities at child care are critical for children of parents who work outside the home.

PMID: 22473885 [PubMed - as supplied by publisher]

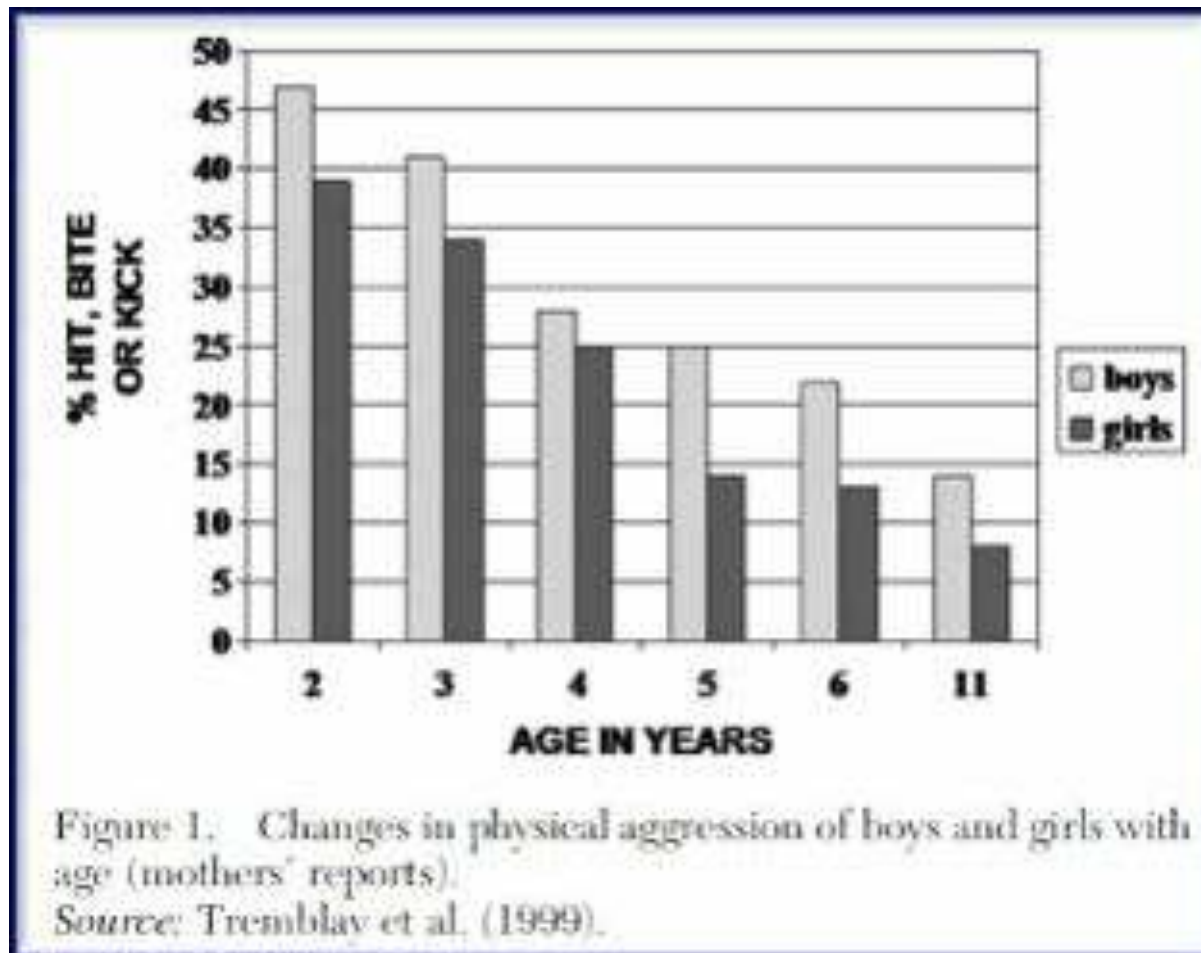
"Young girls get less outdoor play" was published in the Archives of Pediatric & Adolescent Medicine.



# Toy preference ages 1 - 5 (Servin et al. 1999)



# Physical aggression: sex & development

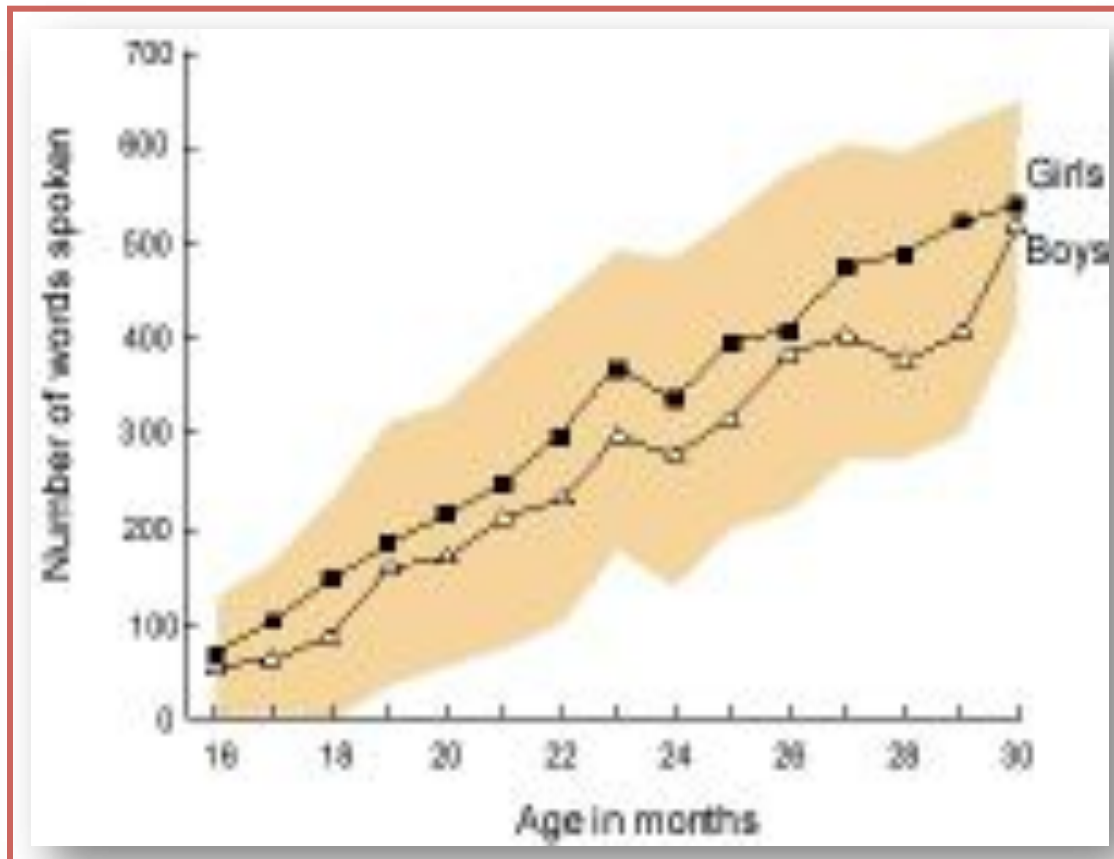


# *Self-regulation & ADHD*

- The sex difference in activity level is the main reason boys diagnosed with ADHD 3:1 over girls. There is NO difference in distractibility.
- On a practical level, however, boys exhibit poorer self control (“self-regulation,” “inhibitory control”) by a fairly wide margin, which is evident in classrooms.
- Parents and preschools need to focus on cultivating this prior to school entry, using gentle, gradually-progressing challenges for self-control & social awareness (e.g., Tools of the Mind, Second Step)



# Girls talk earlier... but only a little bit



- ◆ Similar findings in China and Sweden;  $d = 0.2$ .
- ◆ In behavioral genetic studies, sex accounts for  $< 3\%$  of the total variance in children's language skill (e.g. Kovas et al., 2005).

Fenson et al. (1994) *Monograph. Soc. Res. Child Dev.*



# ***Mothers talk less to sons (after 12 months)***

Dev Psychol. 1998 Jan;34(1):3-27.

## **Moderators of gender effects on parents' talk to their children: a meta-analysis.**

Leaper C, Anderson KJ, Sanders P.

Department of Psychology, University of California, Santa Cruz 95064, USA. cam@cats.ucsc.edu

### **Abstract**

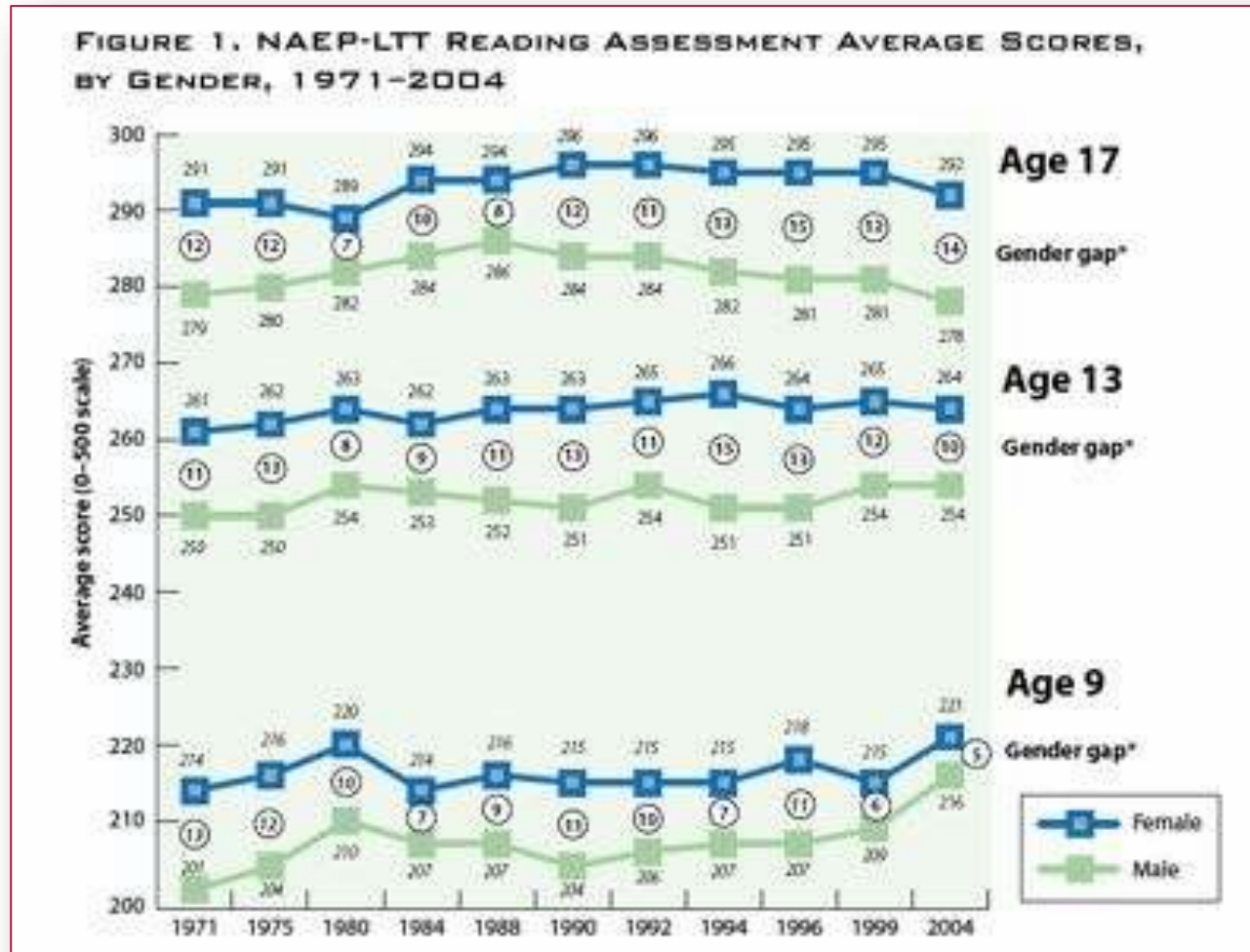
Two sets of meta-analyses of studies examining gender effects on parents' observed language with their children were conducted. One looked at studies comparing mothers and fathers in amount of talking, supportive speech, negative speech, directive speech, informing speech, and questions and requests. The other looked at studies comparing mothers' interactions with daughters versus with sons in amount of talking, supportive speech, and directive speech. Across studies, mothers tended to talk more ( $d = .26$ ), use more supportive ( $d = .23$ ) and negative ( $d = .13$ ) speech, and use less directive ( $d = .19$ ) and informing ( $d = .15$ ) speech than did fathers. Also, mothers tended to talk more ( $d = .29$ ) and use more supportive speech ( $d = .22$ ) with daughters than with sons. Medium or large effect sizes occurred in most analyses when particular moderator variables were taken into account. Effect sizes varied, depending on aspects of the interactive setting, the child's age, sampling and measurement, and publication characteristics. The results are interpreted in relation to a contextual-interactive model of gender typing.

PMID: 9471001 [PubMed - indexed for MEDLINE]





# NAEP reading data



# Toddler talking partners

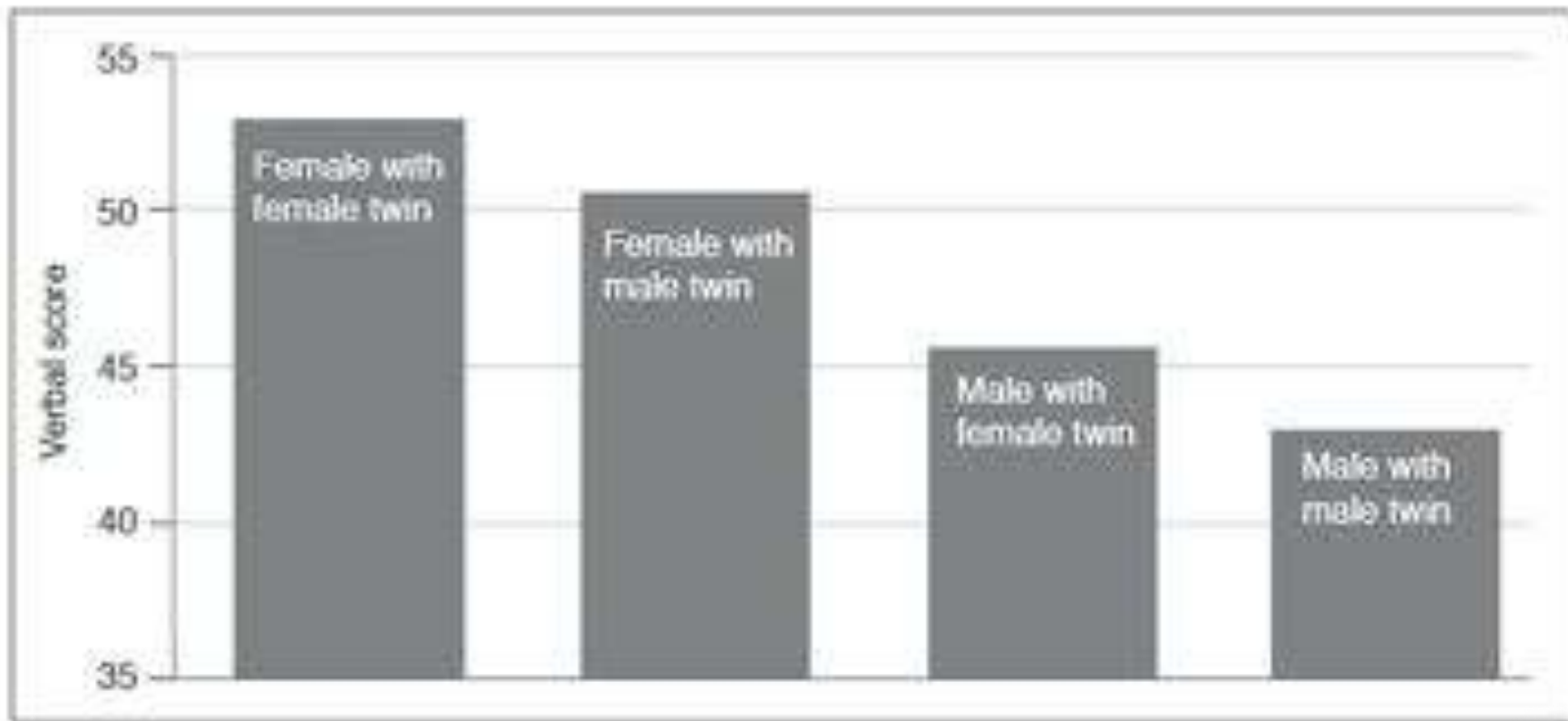


Figure 5.3. MCDI scores of two-year-old fraternal twins according to sex of the twin sibling. (Data from Galsworthy et al., *Developmental Science*, 3:206-15, 2000)



# *Talking twins (boys)*



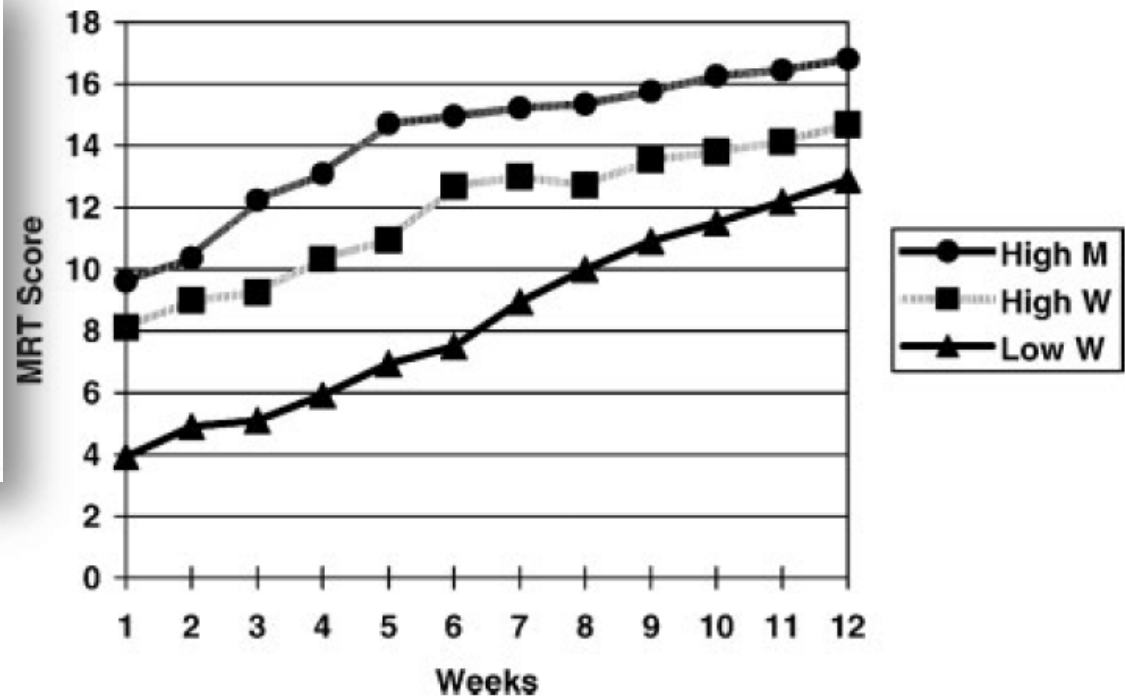
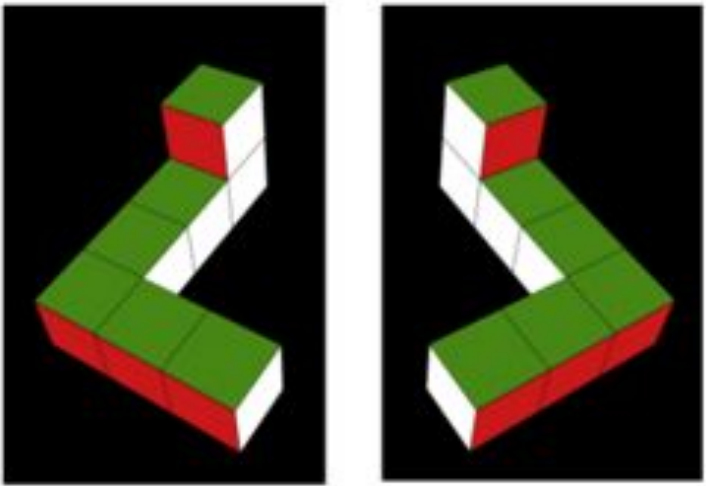
# CLASSROOM & PARENTING IMPLICATIONS



## *For girls (and boys)*

- Teach spatial skills (building, maps, tools, etc.)

Physical challenges and sports



- Teach salary nego
- Require compute

[www.guys.org](http://www.guys.org)

great web site by



The National Strategies  
Early Years



### Mark Making Matters



Young children making meaning in all areas of learning and development

department for  
children, schools and families



- Train executive
- Encourage n

organization)



# *Time to truly integrate our schools*

- Encourage boys and girls to work together, form friendships.
- Alternate seating of boys & girls.
- Create “buddy” time where boys and girls are partnered on projects.
- Reject gender slurs as much as we would reject racial slurs:
  - “Boys are stupid.”
  - “Girls are weak.”
  - “Michael’s a girl.”
  - “No, he’s gay.”



May 11, 2012

## EDUCATION WEEK

LOGIN | REGISTER | SUBSCRIBE

Published Online: May 7, 2012

Published in Print: May 9, 2012, as Researchers Cite Social Benefits in Coed Classes

**Scholars Say Pupils Gain Social Skills in Coed Classes**

Four-year-olds Elijah Reyes and his classmate Alyzandra Lopez work together on a "buddy" activity at Kenilworth Elementary School in Phoenix. The preschool classroom is taking part in the Sanford Harmony Program, an experimental curriculum aimed at reducing children's gender biases.

—Laura Segall for Education Week

By Sarah D. Sparks

- Teacher training in gender bias
- Student emphasis on listening, sharing & cooperation
- Structured (boy + girl) "buddy time" activities each day
- Pilot study of 94 preschool & 199 5<sup>th</sup> graders found greater social competence, less aggression, less exclusionary behavior, and better social skills toward both genders.

**Sanford Harmony Program**

<http://sanford.clas.asu.edu/>





# American Council for CoEducational Schooling

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FOR PARENTS

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and FAMILY DYNAMICS  
ARIZONA STATE UNIVERSITY

[www.coedschools.org](http://www.coedschools.org)

