

Lise Eliot, PhD Associate Professor Neuroscience Chicago Medical School of Rosalind Franklin University



Transforming Culture in Engineering Education

Pink Brain, Blue Brain?

Neurobehavioral sex differences and implications for developing talent in STEM

May 23, 2013 1:00 pm (Eastern)

WEPAN 2012-2013 Webinar Series



Host: Diane Matt, Executive Director, WEPAN, Women in Engineering ProActive Network



Speaker: Lise Eliot, Associate Professor Neuroscience, Chicago Medical School of Rosalind Franklin University



Moderator: Shawna Fletcher, Interim Director, Women in Engineering Program, The Ohio State University and WEPAN Professional Development Committee Chair



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 To propel higher education to increase the number and advance the prominence of diverse communities of women in engineering.





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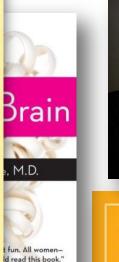
The popular zeitgeist...

OVERSIAL NATIONAL BEST SELLER NOME THE REAL DIFFERENCE BETWEEN DANIEL G. AMEN unleash the wer female R REMEM a n d FR FOR

MEN ARE FROM MARS, Women Are From Venus

A Practical Guide for Improving Communication and Getting What You Want in Your Relationships

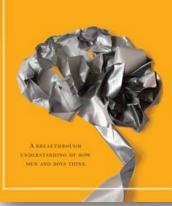
JOHN GRAY, Ph.D.



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THE MALE BRAIN



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CINE AND SCIENCE

MARIANNE J. LEGATO MD. FACP

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Bad neuroscience on CBS Early Show

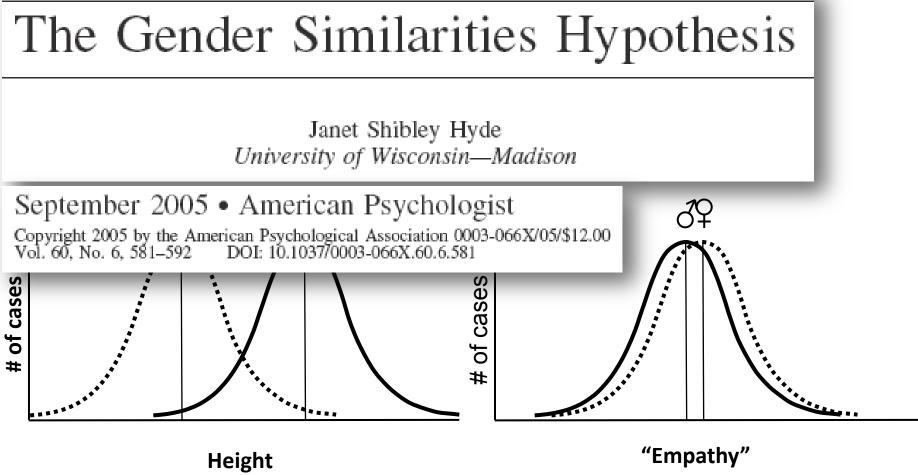
By CBSNEWS / CBS / September 22, 2010, 5:44 PM

Size Matters: How Male, Female Brains Compare



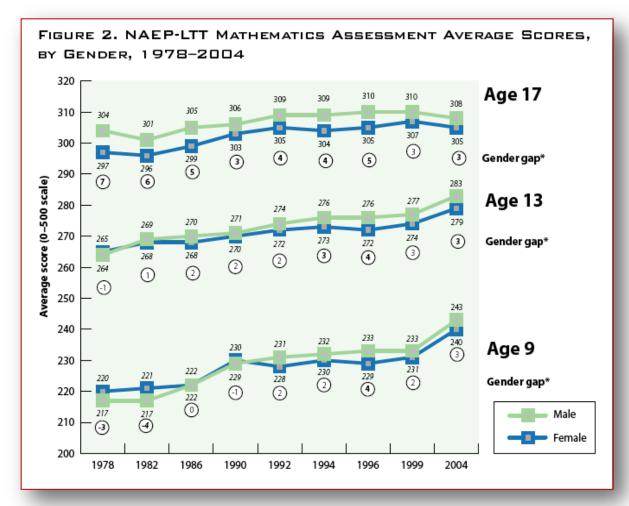


http://www.cbsnews.com/2100-500165_162-6890474.html





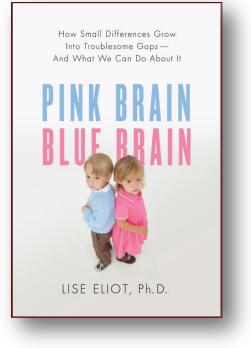
NAEP math data





C. Corbett et al., Where the Girls Are: The Facts about Gender Equity in Education. AAUW (2008).

Take home message



- Sex differences in behavior are real, but much subtler than Mars/Venus stereotypes and largely acquired through learning.
- There is no such thing as a "male brain," or a "female brain." Brain sex differences are small and statistical, not large & categorical.
- A better understanding of <u>how</u> sex differences develop is crucial for helping raise both boys' and girls' achievement.

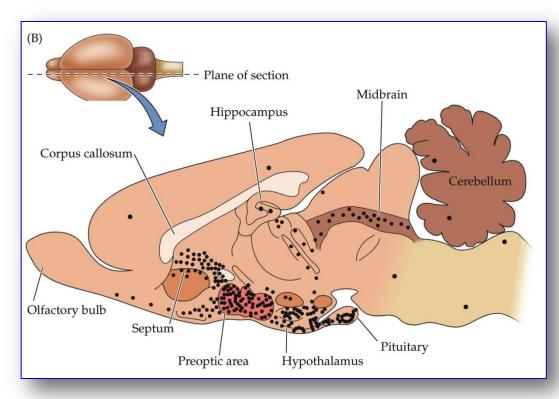
VERSITY

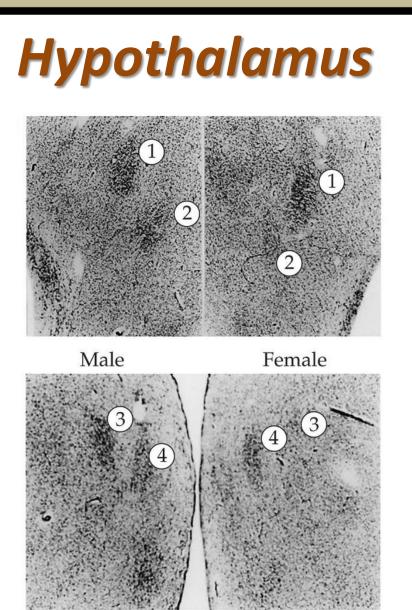
SEX DIFFERENCES (AND SIMILARITIES) IN THE BRAIN

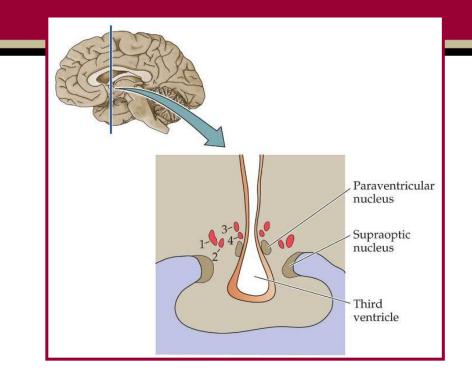


Sex differences in the brain

- Psychological differences tell us there must be differences in brain structure or function.
- But small magnitude of behavioral differences makes it hard to identify reliable brain differences in humans.
- In rodents, differences are most dramatic in areas of the brain involved in reproduction itself.

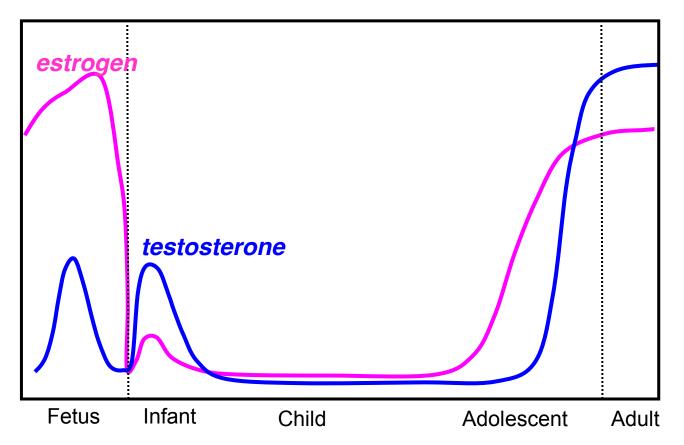






- The preoptic area (POA) is important in reproduction.
- In rats, perinatal testosterone expands the male SDN-POA by 5X.
- The human homologue, INAH-3, is 2X larger in men.

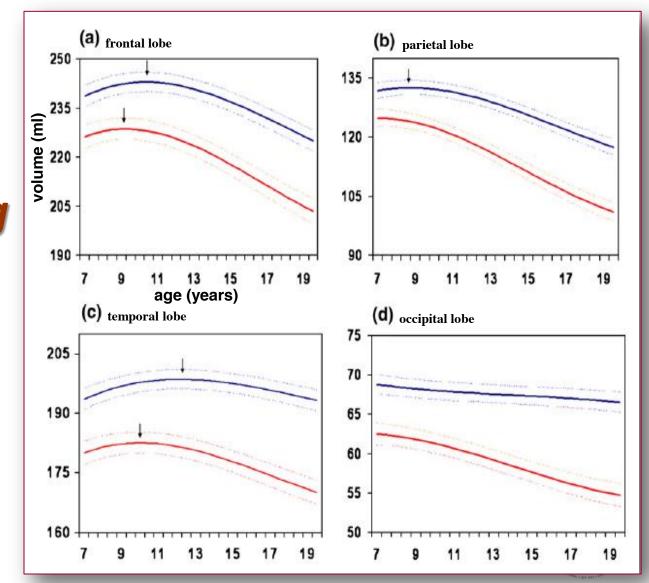
Gonadal hormones



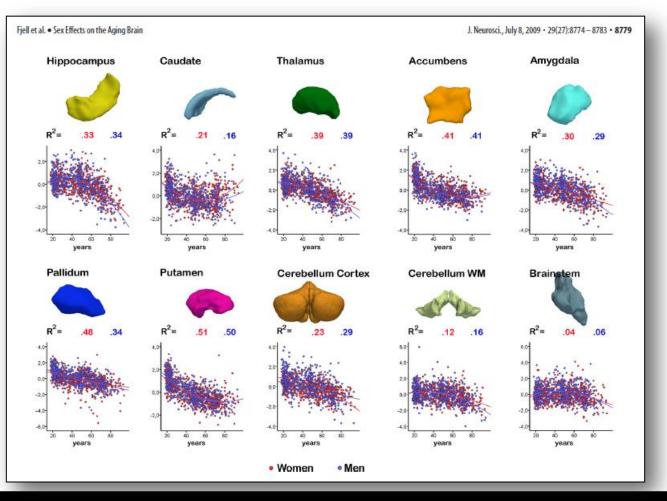
Prenatal T (**organizational phase**) affects toy preference, sexual orientation, activity level. By contrast, post-pubertal hormones (**activational phase**) have negligible effects on cognition or emotion (menstrual fluctuations; WHI; transsexuals; delayed puberty)

Females' brains are smaller and finish growing earlier

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



But sex differences in specific structures are "minute" when corrected for overall brain size





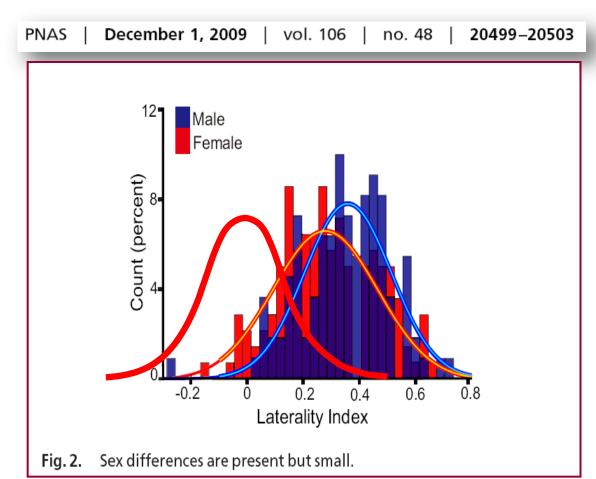
"Men tend to use only one brain hemisphere at a time, but women employ 'whole brain' thinking."

www.girlslearndifferently.com



Wrong: Both men and women are left

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



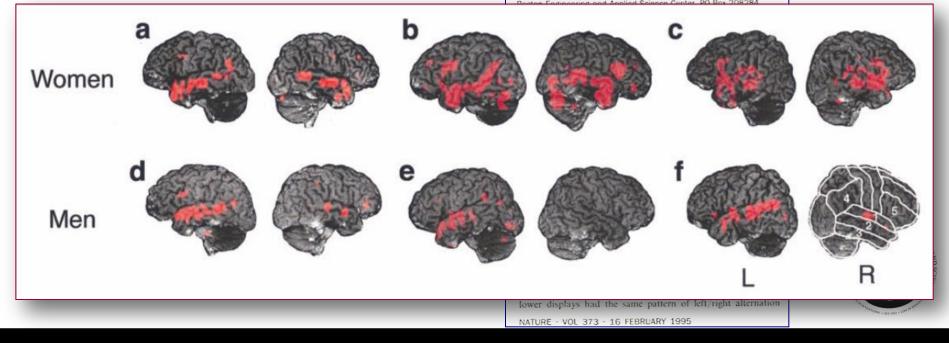
- Merrill Hiscock: 4 exhaustive surveys, 1994-2001, in *J. Clin. Exp. Neuropsychology* asking "Is there a sex difference in human laterality?"
- Found a "weak populationlevel sex difference in hemispheric specialization" for auditory, visual, tactile & dual-task assays, accounting for <u>1-2 percent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

Is language processing more lateralized in men?

Sex differences in the functional organization of the brain for language

Bennett A. Shaywitz^{*†}, Sally E. Shaywitz^{*}, Kenneth R. Pugh^{*‡}, R. Todd Constable[§], Pawel Skudlarski[§], Robert K. Fulbright[§], Richard A. Bronen[§], Jack M. Fletcher^{||}, Donald P. Shankweiler[‡], Leonard Katz[‡] & John C. Gore[§]

Departments of * Pediatrics and † Neurology, Yale University School of Medicine, PO Box 208064, New Haven, Connecticut 06510-8064, USA ‡ Haskins Laboratories, 270 Crown Street, New Haven, Connecticut 06511, USA § Department of Diagnostic Radiology, Yale University School of Medicine, PO Box 208042, New Haven, Connecticut 06520-8042, USA] Department of Pediatrics, University of Texas Medical School, 6431 Fannin, Houston, Texas 77030, USA 6 Department of Applied Physics, Yale University,



BRAIN RESEARCH 1206 (2008) 76-88

"NO" according to meta-analysis

I.E. Sommer et al. (2008) Sex differences in handedness, asymmetry of the planum temporale and functional language lateralization. *Brain Res.*, 1206:76-88.

Sex difference in language lateralization measured with functional imaging

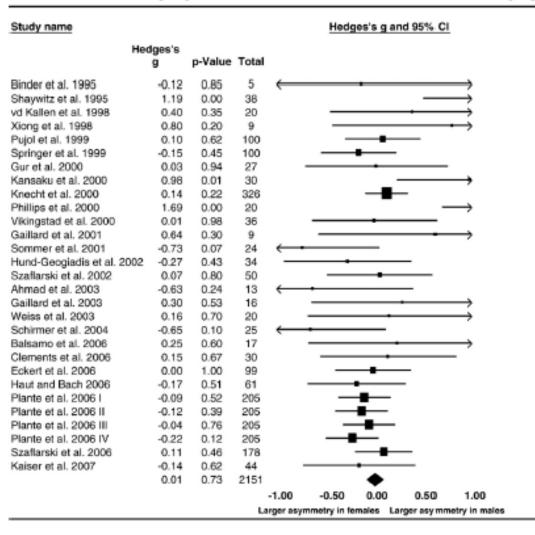


Fig. 4 – Sex differences in asymmetry of language activation.

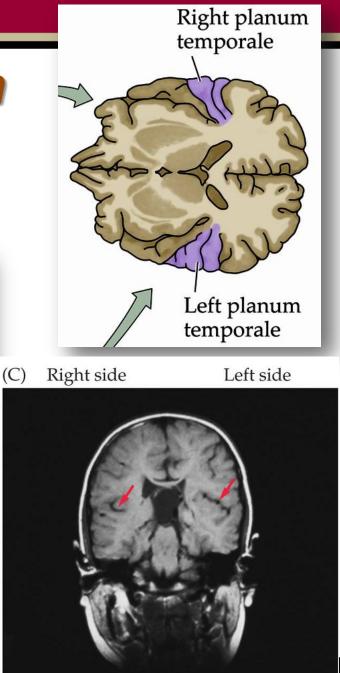
No difference in planum temporale asymmetry Sommer et al. (2008)

Sex differences in Planum Temporale asymmetry

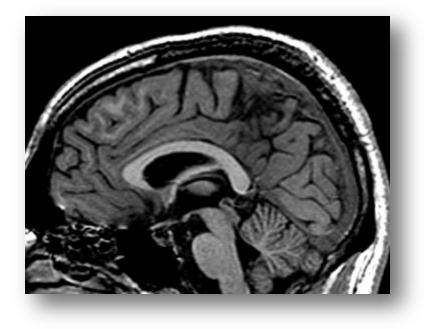
Hedges's g and 95% Cl

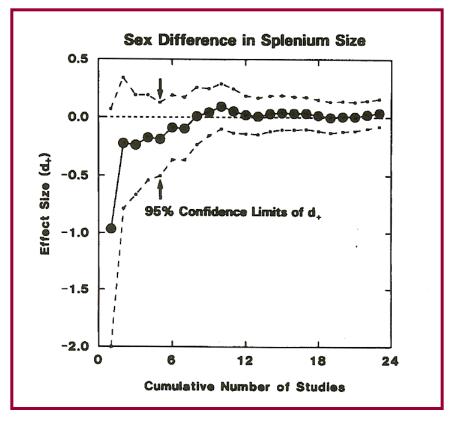
Study name

	Hedges's g	p-Value	,				
Wada et al. 1975	0.42	0.04			_		-
DeLisi et al. 1994	-0.23	0.47	_			_	
Kulynych et al. 1994	3.13	0.00					>
Preis et al. 1999	-3.04	0.00	<				
Watkins et al. 2001	0.56	0.00			-	_	_
Foundas et al. 2002	0.19	0.44		-			
Knaus et al. 2004	-2.47	0.00	<				
Chance et al. 2006	0.89	0.07					
Eckert et al. 2006	-0.22	0.27		_			
Dos Santos Sequira et al.	2006 -0.48	0.02	_	-	_		
Takahashi et al. 2006	-0.13	0.56				_	
Vadlamudi et al. 2006	-0.44	0.15	\leftarrow	_			
Walder et al. 2007	0.83	0.11					\rightarrow
	-0.11	0.68					
			-1.00 More a	-0.50 symmetry in	0.00 females Me	0.50 re asymmetr	1.00 y in males



Also, no difference in corpus callosum

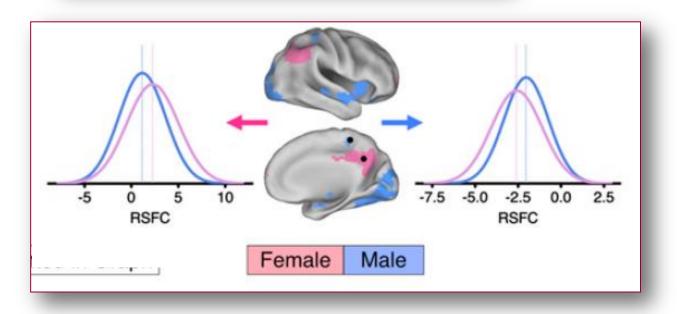




Bishop & Wahlsten (1997) Sex differences in the human corpus callosum: Myth or Reality? *Neurosci. & Biobehav. Revs.* 21:581-601.

Small difference in adult connectivity

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



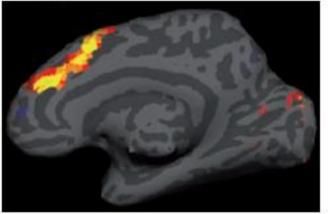
- Resting fMRI activity from 1,414 participants, 35 sites.
- However, a similar study of 238 adolescents found no sex difference in functional connectivity (Dosenbach et al., <u>Science</u>, 329:1358-61, 2010).



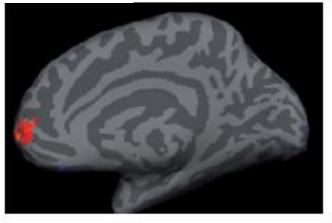
Brain Fallacy

- 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 selfjudgment task.
- Gender learning is at least as potent as other cultural experience in shaping brain function.

Subject X



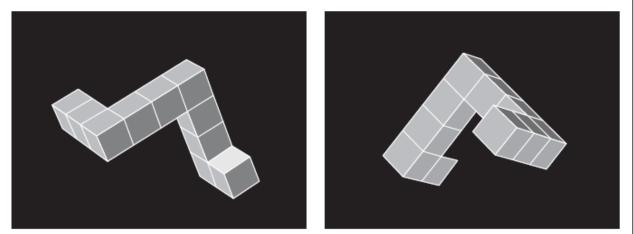
Subject Y



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

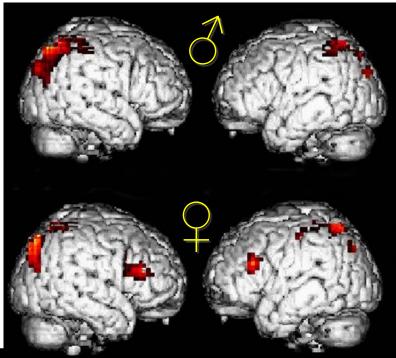
Are these objects the same except for their orientation?

Mental rotation



- Stronger in males, from infancy onward, but difference widens through childhood.
- The one imaging study of children found no difference between boys and girls, using same MR task that revealed a difference between adults: Kucian et al. (2007) <u>J. Neural</u> <u>Transmission</u>, 114: 675-686.





THE NURTURE SIDE



 ${\it Rosalind franklin university} \textit{ of medicine and science}$

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.



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 risktaking and visual-spatial skills, while "girl play" promotes relational and literacy skills.



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



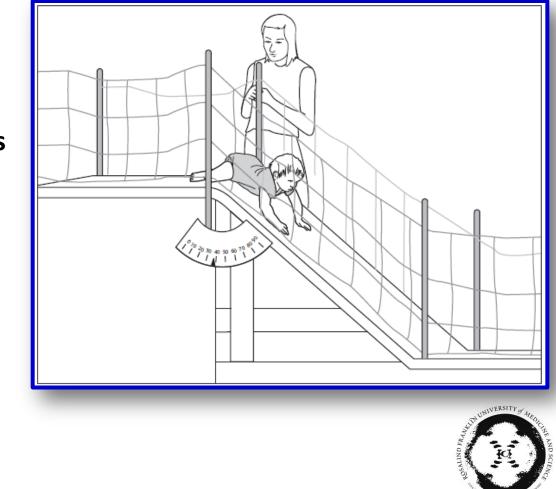


Cards from a British designer



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.



Toys 'R Us



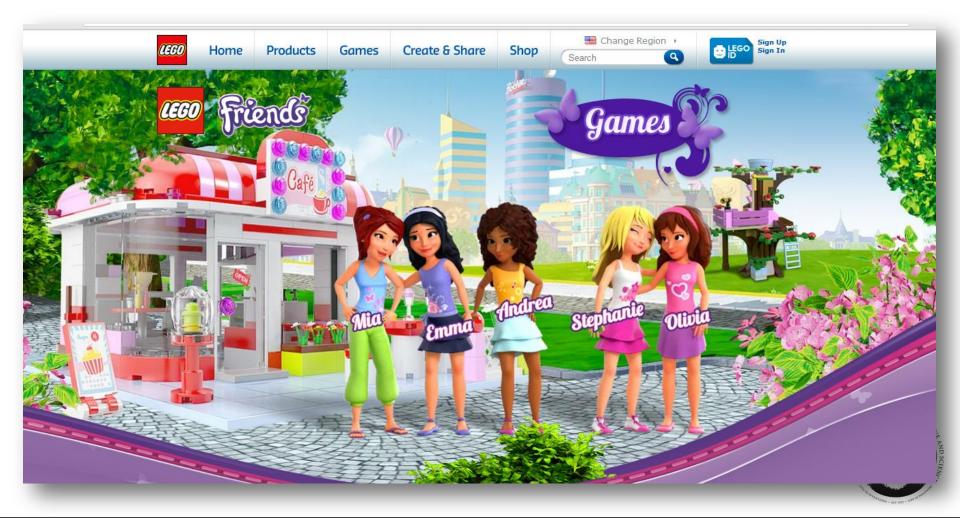


In 1981, LEGOs were for girls too





but today's girls get "girly" LEGOs



Gendered crayons





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Pink crappy science toys



AND SCIENCE

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Teacher bias

- Teachers' expectations shape student outcomes, known as the "Pygmalion effect" and their implicit biases about gender are the same as everyone's.
- Girls are especially vulnerable to female teacher's math anxiety (Beilock et al., PNAS, 107:1860-63, 2010).
- Boys learn differently. They need hands-on activities and motor breaks" (6th 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." (3rd grade teacher, *Daytona Beach News Journal*, 9/15/11)



Understanding current causes of women's underrepresentation in science

Stephen J. Ceci and Wendy M. Williams¹

www.pnas.org/cgi/doi/10.1073/pnas.1014871108

"Women's current underrepresentation in mathintensive fields is not caused by discrimination in these domains, but rather to sex differences in resources, abilities, and choices (whether free or constrained). Thus, current initiatives direct energy toward solving past problems rather than current ones."





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

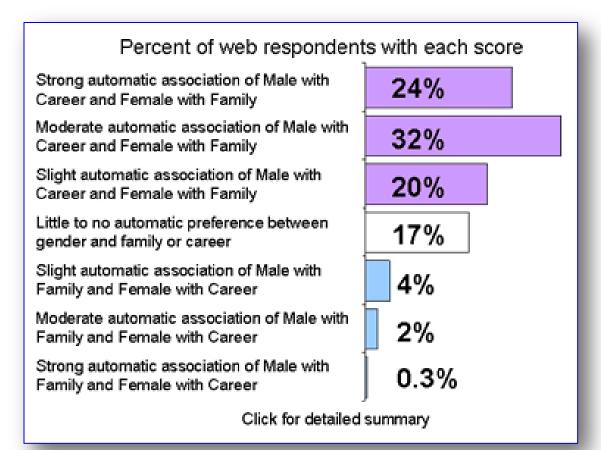
Keep in mind

- Keep your index fingers on the 'e' and 'i' 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

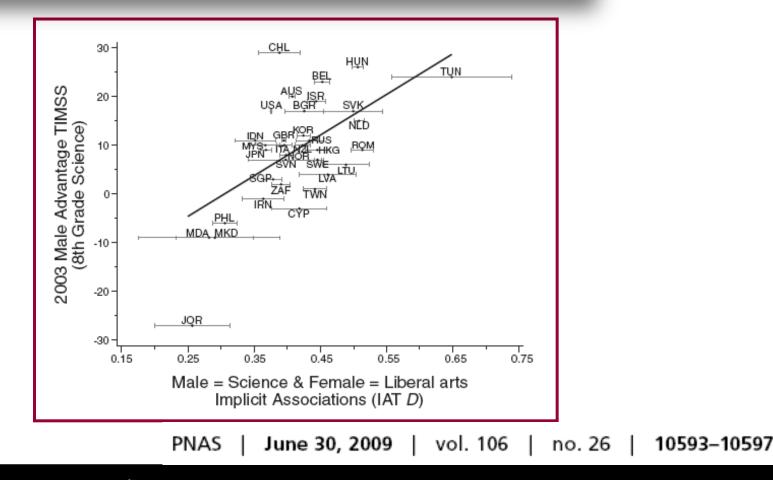
IAT: Results



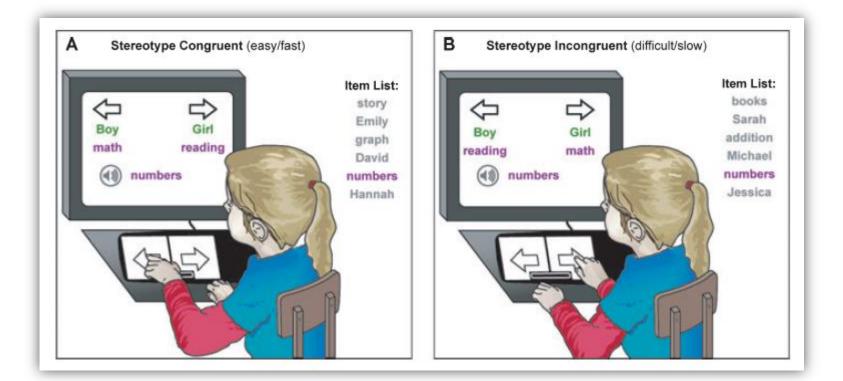


National differences in gender–science stereotypes predict national sex differences in science and math achievement

Brian A. Nosek^{a,1}, Frederick L. Smyth^a, N. Sriram^a, Nicole M. Lindner^a, Thierry Devos^b, Alfonso Ayala^c, Yoav Bar-Anan^{a,2}, Robin Bergh^d, Huajian Cai^e, Karen Gonsalkorale^f, Selin Kesebir^a, Norbert Maliszewski^g, Félix Neto^h, Eero Olliⁱ, Jaihyun Parkⁱ, Konrad Schnabel^k, Kimihiro Shiomura^I, Bogdan Tudor Tulbure^m, Reinout W. Wiersⁿ, Mónika Somogyi^o, Nazar Akrami^d, Bo Ekehammar^d, Michelangelo Vianello^p, Mahzarin R. Banaji^q, and Anthony G. Greenwald^r



Child implicit association test





"The math–gender stereotype is acquired early and influences emerging math selfconcepts prior to ages at which there are actual differences in math achievement." --Cvencek, Meltzoff & Greenwald (2011) *Child Dev.*, 82:766–779. Psychological Bulletin 2011, Vol. 137, No. 4, 616-642

Are Leader Stereotypes Masculine? A Meta-Analysis of Three Research Paradigms

Anne M. Koenig University of San Diego Alice H. Eagly Northwestern University

Abigail A. Mitchell Nebraska Wesleyan University Tiina Ristikari University of Tampere

This meta-analysis examined the extent to which stereotypes of leaders are culturally masculine. The primary studies fit into 1 of 3 paradigms: (a) In Schein's (1973) think manager-think male paradigm, 40 studies with 51 effect sizes compared the similarity of male and leader stereotypes and the similarity of female and leader stereotypes; (b) in Powell and Butterfield's (1979) agency-communion paradigm, 22 studies with 47 effect sizes compared stereotypes of leaders' agency and communion; and (c) in Shinar's (1975) masculinity-femininity paradigm, 7 studies with 101 effect sizes represented stereotypes of leadership-related occupations on a single masculinity-femininity dimension. Analyses implemented appropriate random and mixed effects models. All 3 paradigms demonstrated overall masculinity of leader stereotypes: (a) In the think manager-think male paradigm, intraclass correlation = .25 for the women-leaders similarity and intraclass correlation = .62 for the men-leaders similarity; (b) in the agency-communion paradigm, g = 1.55, indicating greater agency than communion; and (c) in the masculinity-femininity paradigm, g = 0.92, indicating greater masculinity than the androgynous scale midpoint. Subgroup and meta-regression analyses indicated that this masculine construal of leadership has decreased over time and was greater for male than female research participants. In addition, stereotypes portrayed leaders as less masculine in educational organizations than in other domains and in moderate- than in high-status leader roles. This article considers the relation of these findings to Eagly and Karau's (2002) role congruity theory, which proposed contextual influences on the incongruity between stereotypes of women and leaders. The implications for prejudice against women leaders are also considered.



What to do

- Teach spatial skills & computer programming early.
- Train students in "Growth Mindset."
- Foster positive risk-taking & competition.
- Evaluate teachers for gender bias.
- Discourage gender segregation and encourage gender interaction in classroom settings: respect, collaboration & mutual leadership.

Teach "Math = Money" and salary negotiation: <u>Kate Farrar, 23-Apr-13 WEPAN webinar</u>



Teach spatial skills (from pre-K to college)!!

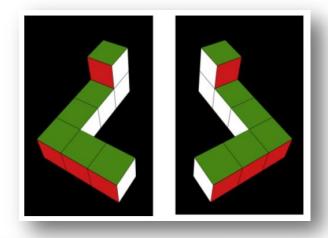


Table 11. Engineering retention rates for subjects										
	Males		Females		Males		Females			
	EG1	CG1	EG1	CG1	EG2	CG2	EG2	CG2		
Enrolled	13	40	11	32	85	200	90	161		
Retained in Engineering	9	25	7	17	52	104	69	77		
Engineering retention rate (%)	69.2	62.5	63.6	53.1	61.2	52.0	76.7	47.8		

randomized sample

Sorby, Sheryl A. (2009) "Educational Research in Developing 3-D Spatial Skills for Engineering Students," International Journal of Science Education, 31: 459-480.

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Asking Questions and Discussion

- Participant microphones are muted for webinar quality.
- Undock and expand the "Questions" pane in the webinar control panel and type in your question.
- If time permits, "live" questions may be asked at end of webinar.



Questions & Discussion



Host: Diane Matt, Executive Director, WEPAN, Women in Engineering ProActive Network



Speaker: Lise Eliot, Associate Professor Neuroscience, Chicago Medical School of Rosalind Franklin University



Moderator: Shawna Fletcher, Interim Director, Women in Engineering Program, The Ohio State University and WEPAN Professional Development Committee Chair



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- Survey following the webinar—please respond!
- Support WEPAN—make a donation at <u>www.wepan.org</u> > Donate
- Pay a personal tribute to someone who has made a difference to women in engineering
- Thank you for attending today!

