#### Disclaimer: Math is my field.

There is emphasis in women because this is the group I know better. Many of the statements apply to other underrepresented groups (for instance, African American, LGTB, Latinos, ...)

### Women in math

Undergraduate math majors: 43% are women

New PhDs in math: 28% are women

Postdocs in math: 21% are women

Tenured math faculty at PhD-granting universities: **12%** are women

AMS prizes awarded at JMM 2014: 0% given to women

From AWM President Ruth Charney's column in the Sept-Oct 2014 AWM Newsletter.







After her husband death, in **1710**, Maria Winckelmann Kirch asked the Royal Berlin Academy of Sciences if she could fill her husband's position as Royal Astronomer (she had been doing the job herself since her husband There were obvious became ill). The Academy refused.



In 1870, Sofia Kovalevskaya took private lessons with Karl Weierstrass, since the university would not even allow her to audit classes.

### Why there is very little diversity in math? Possible explications.

- \* Gender schemas (Stereotypes)
- \* Implicit bias (self and from outside)
- \* Lack of role models (a vicious circle)
- \* Negative messages (expectations of brilliance...)
- \* Lack of mentors
- \* "Equal calls equal"
- \* Impostor feeling
- \* Isolation, feeling of not belonging.
- \* Accumulation of disadvantage.
- \* "Invisibility" of women











### THE NO SO DISTANT PAST



1893 New Zealand 1902 Australia (except aboriginal) 1906 Finland 1913 Norway 1915 Denmark 1917 Canada (except Indian) 1918 Austria, Germany, Poland, Russia 1919 Netherlands **1920 United States** (with exceptions) 1921 Sweden 1928 Britain, Ireland

1930 South Africa (except black people) 1931 Spain 1934 Turkey 1944 France 1945 Italy 1947 Argentina, Japan, Mexico, Pakistan 1949 China 1950 India 1954 Colombia 1957 Malaysia, Zimbabwe 1962 Algeria 1963 Iran, Morocco



1964 Libya 1967 Ecuador 1971 Switzerland 1972 Bangladesh 1974 Jordan 1976 Portugal 1989 Namibia 1990 Western Samoa 1993 Kazakhstan, Moldova 2005 Kuwait 2006 United Arab Emirates 2011 Saudi Arabia

### Most men ask

#### not "Is she clever?"

Freshness, Charm-the Enticement of a Skin More Previous than Personality or One Week Follow this Simple Beauty

> Often we marve, it her-the pull whose pupily. Then repeat both assisting and runs-only agent is her baruty. She knows at hitle ing Apply a basif or oils ervart - that is all and says so attact yet screnchy attracts everyone to her ade. Too often ver close risel site in a corner alone.

#### 4 4 4

Brains or beruty? - but why theread 4 lawshise beauty with deversess charar with scisdow. Develop poor two ty to taking out the sweetness of your personality. Time's oftat throws als of girls have done-and frand new hoppeness as a result.

The memory are simple. Have a poetry slim — remember preserve, if poetry. Coolly issuely treatments are an reasonary — not cally use of palm and ouve oth as embodied in Palmo.tvz.

It is south toping for this choice then sould have, the clean, fissh skin you want—do this one work, then note the change. given above. Do not think any green coop. Use provder and rouge if you wish. But never have them on over right. They ske the ports, often en arge them. Blockhendsand disigurements ofter follow. They must be is the same as Polmolive. Polmolive is a sum emollizat in coap form.

washed away Wash your face with soothing Palmolive. Then massings softly into the chin. Rinse thor-

> Note carefully the name can tempter Palandin Para i more rold wante hour

Do this regularly, and particularly in the twaing. The us dPs set liefs becay irea and

Thus, in a single manner, million since the class of Clasparra taxe found beauty, chann-mic youth prolonged. Nonedications are decessary. Just music

nexture. Your color will be good. Wrinkles will not be your problem as the years advance. d traild this marshe

Do not use ordinary seaps in the treatment

represented to made of pain and day; oils,

And it costs but too the calse - so little

that millione let it do for their bodies what

does for their facts. Obtain a cake today,

Then note what an amining

difference one week makes.

melling circ-gue naiserd's gross actor to Patraphine Scap. the day's eccanolations of dust and off an perspiration, channes the power, and Nature will be lengt to you. Your skin will be of fire

Pales and alive sile

"dame c.ui mainer pretros 2% geally for cuty

10c

1924 : Most men ask "Is she pretty?" not "Is she clever?"

# "Is she pretty?"

Cleverness-do you seek it? Then for Method which is Bringing it to Thousands.

Grawiald Bill-The Balandire Da.







We overheard that plaint ... 'If my hair looks such a mess *one more* night, I'll kill myself!'"

## If your husband ever finds out

you're not "store-testing" for fresher coffee ...



... if he discovers you're still taking chances on getting flat, stale coffee ... wee be unto you! For today there's a sure and certain way to test for freshness <u>before</u> you buy





EARS FROM NOW? 1934 THE SCIENTIFIC & EASY WAY TO When tempted to over-indulge "Reach for a Lucky instead" Issues that contribute to the accumulation of disadvantage. AND INCHES HUTETH. SENSIBLE! SURE! **ARE YOU BEACH BODY** Comple ely Illustra NO. PHOTOGRAPHS . DIAGRA 14 THE Another Bonomo Handy WEIGHTLOSS COLLECTION A BOLL REPLACED A FAIT & RUNNIE AND AND 1965 1.2 2015 EXCLUSIVELY AVAILABLE ONLINE AT PROTEINWORLD.COM



#### SIMPLE ENOUGH FOR A Woman to drive. Phew.







Used BMW's You know you are not the first. But do you really care? You dad will have to chase the boys away when you are older

Issues that contribute to the accumulation of disadvantage.

like a girl

You'd be really pretty if you just made an effort.

Aren't you cute?

"You'll want kids one day."

prude

You're such a bitch.

You are asking for it

He picks on you because she likes you

You won't like that job; you'll have to be focused on technology.

man up!

### slut

Is it that time of the month?

You'd be much prettier if you smile.

Can't you take a joke? You're bossy.

"Calm down."

"Nice [insert objectified body part here]."

"Your body/clothing/appearance is 'distracting.'" Can M

You must have been beautiful when you were

younger.

" Can women have it all?

don't wear that to school you are going to distract the boys



- On the Physiological Feeble-Mindedness of Woman, P.J.
  Möbius Published in 1900, by 1906, eight editions had appeared.
- (Irrelevant Coincidence: P.J. Möbius was the grandson of Augustus Möbius Band.)

#### NUMBERPLAY

### **The Princess Problem**

BY GARY ANTONICK JANUARY 27, 2014 12:00 PM

A princess lives in a row of seventeen adjacent rooms, each connected by a door to each room next to it. Each room also has a door to the outside. The princess enjoys the rooms but never stays in the same room two days in a row: at the end of each day she moves from the room she occupied to one of the rooms next to it (she chooses randomly).

On the first of June a **prince arrives from a faraway kingdom to woo the princess**. The princess's guardian explains the habits of the princess and the rules he must follow: Each day he may knock on a single outside door. If the princess is behind it she will open it and meet the prince. If not, the prince gets another chance the next day. Unfortunately the prince must return to his kingdom on July 1. Can he devise a strategy to make sure he meets the princess before then?

#### "Math class is tough. Want to go shopping? Okay, meet me at the mall.



Issues that contribute to the accumulation of disadvantage.

While preparing a talk, I wanted to emphasize and idea. So search in Google for the classical cartoon with a person and floating lightbulb

# For illustrating something in a talk, I googled images of "Idea clipart"



Human beings in "idea clipart" are male with one exception and white, with no exceptions.

### THE STATUS QUO IN MATH

I'm too pretty to do math

### Aphorism attributed to mathematician Hermann Weyl

There are only two females in the history of math, Sofia Kovalevskaya and Emmy Noether:

the former wasn't a mathematician, the latter wasn't a woman.







 $b^{2} = H^{2} - (Y_{4})R^{2}$  $a^{2} = (Y_{3})H^{2} - (Y_{4})R^{2}$  Issues that contribute to the accumulation of disadvantage.



### G. H. Hardy, 1940, A Mathematician's Apology,

No mathematician should ever allow himself to forget that **mathematics**, more than any other art or science, is a young **man's** game.



Marilyn vos Savant is a magazine columnist (with the highest recorded IQ according to the Guinness Book of Records) . She writes column where she solves puzzles and answers questions on various subjects. The most famous of them was the Monty Hall problem.





On a game show, you're given the choice of three doors:

Behind one door is a car; behind the other two, goats.

You pick a door, say No. 1, and the host, who knows what's behind the doors, opens another door, say No. 3, which has a goat.

Then the host says to you, "Do you want to pick door No. 2?" Is it to your advantage to switch your choice?

Player choice before door is open Of the letters from the general public, 92% are against my answer, and of the letters from universities, 65% are against my answer.

SINCE YOU SEEM TO ENJOY COMING STRAIGHT To the point, i'll do the same. You blew it!

#### MAYBE WOMEN LOOK AT MATH PROBLEMS DIFFERENTLY THAN MEN.

#### ING STRAIGHT E YOU BLEW IT! show question, .... How many irate mathematicians are needed to get you to change your mind? "Our math department had a good, self-righteous

#### You are the goat!

"Our math department had a go laugh at your expense,"

I am sure you will receive many letters on this topic from high school and college students. Perhaps you should keep a few addresses for help with future columns.

I am in shock that after being corrected by at least three mathematicians, you still do not see your mistake.

MAY I SUGGEST THAT YOU OBTAIN AND REFER TO A STANDARD TEXTBOOK ON PROBABILITY BEFORE YOU TRY TO ANSWER A QUESTION OF THIS TYPE AGAIN?

You blew it, and you blew it big! Since you seem to have difficulty grasping the basic principle at work here, I'll explain. There is enough mathematical illiteracy in this country, and we don't need the world's highest IQ propagating more. Shame!

This is a call to math classes all across the country. Set up a probability trial exactly as outlined below and send me a chart of all the games Play "not switching" two hundred times and keep track of how often the contestant wins. Play "switching" two hundred times



## Ranks of men and women in academia

- •(...) men and women [in academia] start out on roughly equal footing.
- •(...) several years down the line, the men are earning more, and they are being promoted at a faster rate than the women are.
- •(...) in a group of people with outstanding early promise, will the men and women advance equally in academia? (...) After 10 to 12 years, the men were almost a full rank ahead of the women.

Virginia Valian

#### Stony Brook Math Department Composition

Origin	Total %	
US	16	45.7
Russia	8	22.9
British	2	5.7
China	2	5.7
Israel	2	5.7
Argentina	1	2.9
Germany	1	2.9
Netherlands	1	2.9
Romania	1	2.9
Italy	1	2.9
	35	100.0

## Equal calls equal

#### Applicants to SB Math Dept. 2015

Applicant Race (for 5 jobs out 5	Total Appl		Asian or Pacific Islander		Black		Hispanic		Other		White		Unknown		Int'l Appl	
posted)	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Male	1008	80.51%	329	79.66%	10	100%	<b>3</b> 3	86.84%	27	81.82%	602	83.03%	7	21.21%	302	82.74%
Female	216	17.25%	83	20.10%			5	13.16%	6	18.18%	121	16.69%	1	3.03%	54	14.79%
Unknown	28	2.24%		0.24%							2	0.28%	25	75.76%	9	2.47%
Total Appl	1252	100%	415	32.99%	10	0.80%	38	3.04%	33	2.64%	725	57.91%	33	2.64%	365	29.15%



- In 2014-2015, 1214 Ph.D.s in pure math were granted in the US
- 26% of those were from women.

## Women disqualify themselves

# Imposter Syndrome or Feeling

Two American psychologists, Pauline Clance and Suzanne Imes, coined the term in 1978

They described it as a feeling of "phoniness in people who believe that they are not intelligent, capable or creative despite evidence of high achievement." While these people "are highly motivated to achieve," they also "live in fear of being 'found out' or exposed as frauds."

# Implicit bias

- Implicit bias manifests in expectations or assumptions about physical or social characteristics dictated by stereotypes that are based on a person's race, gender, age, or ethnicity.
- People who intend to be fair, and believe they are egalitarian, **apply biases unintentionally**.
- Some behaviors that result from implicit bias (...) can either can reduce the quality of the workforce or create an unfair and destructive environment.

Jo Handelsman and Natasha Sakraney (President Obama's)White House Office of Science and Technology Policy

# Publishing in academia

- \* (...) men in academia publish more than women do,
  - Even when you control for productivity, men still advance more rapidly than women do.
  - Although men publish comparatively more papers, women's papers have a higher citation rate

### POSSIBLE EXPLANATIONS, MODELS

#### Don't You Worry Your Pretty Little Head Words and Music by AARON SCHROEDER and BEN WEISMAN

21

MAX BYGRAVES



ABERBACH (LONDON) LTD

# Averages and standard deviation

0.3

0.2

0.1

This discussion is about a issues affecting certain groups of people,

- Not all members of these group will be affected in the same way.
- \* Non-members of these groups might be affected by the same or similar issues.
- \* Outliers exists.
- Problematic situations occur with certain frequency but not all the time, and not only to members of underrepresented groups.

## Accumulation of disadvantage

- nothing seems overtly wrong in most work situations, especially in academia and science, where the meritocratic ethos is so prominent.
- People are often unable to perceive or assess
   how small imbalances can really add up.
- Any single instance of bias is likely to be tiny, and someone might say, you're making a mountain out of a molehill.



Mountains are molehills piled one on top of the other



## Accumulation of disadvantage

- Members of a simulated organization were assigned a score with a normal distribution.
- 1% of bias points were added to men.
- At the lowest level of the pyramid there were as many women as there were men.
- At the end of the simulation, top of the pyramid, the highest career level, the distribution was 65% men, 35% women.

Martell, David, Emrich, 1996

The cause for such distribution is the repeated disadvantage of 1%.



### We tend to believe,

What is, is what ought to be... (Naturalization of the status quo)





A typlical math department from a research university

...nothing seems overtly wrong in most work situations, especially in academia and science, where the meritocratic ethos is so prominent. (Valian)

## Lack of self-confidence

...**students who were not going on to Calculus II** choose from a list of potential **reasons**,

'I do not believe I understand the ideas of Calculus I well enough to take Calculus II.'

- Roughly twice as many women as men chose this as one of their reasons.
- Previous research suggests that the perceived lack of understanding among women is not because women do not actually understand the material as well as men;

Martell, David, Emrich, 1996

# Stereotype Threat

An instance: Women taking a math test will perform worse when reminded that women aren't expected to do well in math.

Stereotype threat refers to a situation in which people are or feel themselves to be at risk of conforming to stereotypes about their social group..

If negative stereotypes are presented regarding a specific group, group members are likely to become anxious about their performance, which may hinder their ability to perform at their maximum level"



Stereotype threat and test performance

The effect of stereotype threat (ST) on math test scores for girls and boys. Data from Osborne (2007)

Claude Steele and Joshua Aronson

#### Expectations of brilliance underlie gender distributions across academic disciplines

Sarah-Jane Leslie,<sup>1+</sup>† Andrei Cimpian,<sup>2+</sup>† Meredith Meyer,<sup>3</sup> Edward Freeland<sup>+</sup> We hypothesize that, across the academic spectrum, women are

underrepresented in fields whose practitioners believe that raw, innate talent is the main requirement for success, because women are stereotyped as not possessing such talent. This hypothesis extends to African Americans'

underrepresentation as well, as this group is subject to similar stereotypes.

Expectations of Brilliance



#### Lea Kenigsberg (extract from her essay for an NSF grant proposal)





One of the initial difficulties I faced as a woman in math was the lack of a role model. Despite having kind and encouraging professors here at Stony Brook, (often) being the only woman in the class, and not having a single female math professor resulted is self doubt. I found it hard to believe that women are good enough for math, or that I am good enough for math. I blamed all my accomplishments on affirmative action. This all changed once I met Professor Moira Chas. Her passion for the subject, the vividness and enthusiasm with which she taught, dispelled every doubt I had with regard to the competence of women in math. Not only that, Moira helped, supported, and encouraged me through difficult times. I don't think I would have been where I am if not for Moira, and I want to pay forward what she has given me.

Apologies for the praise to Moira Chas, which is not the point of this slide.

Thao Do (who scored highest from the SB team on the Putnam the year we finished 4th in the country)



An excerpt from an email she sent me when she was a Freshman at Stony Brook

"Interestingly, when I searched your email on gmail, I found out that you are the person who takes care of math club in our school, which I attend every week. Also, I think I met you once in the talk of Prof John Milnor. I math profee dels (my dow that it is not easy." Role models (experience) dow that it is not easy." Role models (experience) dow that it is not easy." Apologies for the praise to It is not it. se I want to become a female admire you a lot

Apologies for the praise to Moira Chas. It is not the point of this paragraph

Thao Do (who scored highest from the SB team on the Putnam the year we finished 4th in the country)



An excerpt from a recent email.

I find it very important to have women mathematicians around. At MIT we have a strong female community; each year there's a nice party, and several talks per semester where we invite successful female mathematicians come to share about their career path. Most of my friends at MIT now are female; I live with 2 other female grad students which is great because we often share our insecurities, how we feel stupid in math, how uncertain the future is and how hard it must be to find a tenure job nowadays.

Having a community

## Gender schemas

- Women may fear or suspect that their work will not be evaluated in same way a man's is, so they need more documentation to back up what they are saying. Men may be **more willing to take a flier**, to come up with some intriguing hypothesis for which they have relatively meager data and just put it out there to be proven true or false. Women may believe, perhaps correctly, that they are less likely to be given the benefit of the doubt, and that their off-the-cuff ideas will be dismissed as foolish. We associate risk-taking behavior with men, and we may be less tolerant of intellectual risk-taking in women.
- In many professional situations, our gender schemas have the effect of making a man seem slightly more qualified and competent than he is, and a woman slightly less Virginia Valian



### WHY DIVERSITY?

# Why diversity? (my take on it)

- We do not want to lose good mathematicians (by being biased)
- \* We should be fair, as fair as we can.
- Diversity helps to achieve excellence (by studying problems from different points of view)
- \* We want to attract and retain a diverse body of (grad and undergraduate) students, and a diverse faculty.
- \* To make High Authorities happy



## IDEAS FOR INDIVIDUAL CHANGE

- Offer real support to someone else who feels wracked by doubt.
- Find a community. For some, simply following a Twitter feed such as #BLACKandSTEM or #womenandSTEM can serve as reassurance that they really do belong in science. His message? "You're not here because you ticked some box. You're here because you bring a lot to the department."
- \* Fake it until you make it

- Emphasize the "growth mentality" as opposed to the "fixed mentality".
- Remember and remind people that mistakes are valuable. They help in the learning process and produce brain growth. (Jo Boaler)

Martell, David, Emrich, 1996

 My own private mantra: "It's not about me, it is about math".

## Ideas for individual change

**Imagine, in detail, people who violate expected stereotypes in a positive way** and practice thinking about these positive examples.





Possibles strategies for individual change: A list found in internet (unidentified source)

What Can I. Say To Myself? Instead of ... Try thinking .. . I'm not good at this. · What am I missing? · I'm awesome at this. · I'm on the right track I give up. · I'll use some of the strategies we've learned This is too hard. This may take some time and effort. · I can't make this any better. · I can always improve, so I'll keep trying. · I just can't do math · I'm going to train my brain in Math. · Mistakes help me to · I made a mistake. learn better. ·She's so smart. I will never be that smart. · I'm going to figure out how she does it so I can try it! · Is it really my best work? · It's good enough. · Plan A didn't work. · Good thing the alpha bet has 25 more letters

## Ideas for individual change

### Learn about gender schemas.

- \* Advocate for yourself. This includes
  - avoiding words such as 'just' and 'only' when describing your work,
  - not apologizing for every mistake, whether real or perceived.
  - not interpreting every failure as "I am not good enough at this".
  - use the 'elevator talk' to mention to your colleagues about your achievements.



#### IDEAS FOR CHANGE IN HIRING PRACTICES

- \* Stop and and question our schemas regularly
- Implicit bias makes us forget people who belong to certain groups. Thus, it may be useful to make a conscious effort to bring those people "to the table" when organizing lists (of conferences, of candidates for a position...)

# Hiring



- In fact, widening the pool of female candidates does help. Women progress faster through the ranks in those law schools with a high percentage of female faculty members than they do in schools where there are few female professors.
- Studies have shown that when people are asked to rate a female candidate for a managerial job, they rate her more positively if she is one of several women in the candidate pool than if she is the only woman.



When assessing the behavior or performance of someone from a stigmatized group, try to focus on concrete positive and negative factors and your memory of what actually happened, rather than relying on overall "gut" feelings.

# Writing adds

Instead of

"We particularly encourage applications from minorities and under-represented groups." write

"We aim to be a diverse and inclusive department."

(unless you really have a diverse and inclusive department)

 Consider placing this sentence right after the sentence near the top, to make clear that it is not a pro forma interest.



### ADVISING

Ideas for advising: A list found in internet (unidentified source)

What Can I. Say To Myself? Instead of ... Try thinking. · I'm not good at this. · What am I missing? · I'm awesome at this. · I'm on the right track I give up. · I'll use some of the strategies we've learned This is too hard. This may take some time and effort. · I can't make this · I can always improve, so I'll keep trying. any better. · I just can't do math · I'm going to train my brain in Math. · I made a mistake. · Mistakes help me to learn betler. ·She's so smart. I will never be that smart. · I'm going to figure out how she alles it so I can try it! · Is it really my best work? · It's good enough. · Plan A didn't work. · Good thing the alpha bet has 25 more letters

The mentee/student's expectations:

- \* I don't belong
- I'm not good at this
- People like me can't do this
- You aren't like me
- You can't help me/you won't help me



- Surface-level differences (like gender, race, age...) will decrease "interpersonal comfort".
- Find deep level similarities (like values, tastes, experiences). Interpersonal comfort decreases anxiety and improves performance.
- \* Seek out ways to collaborate or be on the same footing
- Consider creating interdependent "jigsaw" conditions
- Be aware that most likely, you will have a certain degree of anxiety in presence of a member of an underrepresented group.
   Based on a talk by Abigail Stewart

A mentor gives students access to an interpersonal relationship with a "role model" in an area where they are trying out a "possible self".

This identification becomes more **difficult if you seem impossibly skilled**.

How can implicit biases to affect the mentor-mentee relationship? The mentor can

- have lower expectations than student can meet
- overly positive feedback (because of low expectations)
- create a patronizing environment

It is important to be aware of our own implicit biases and how could these biases enter into mentoring experiences

Advising students

### Good mentoring practices

- Communicate high and reasonable expectations.
   Express confidence student can meet them
- Provide accurate and fair feedback
- Provide encouragement



## THANKS

## Thanks

- \* Many people (including Benson Farb, Amie Wilkinson, Helen Grundman, Jean Taylor, Dennis Sullivan, Katrin Wehrheim, Virginia Valian) gave me suggestions for this presentation. The final product is of course my responsibility.
- The section about mentoring owes a great deal to a talk by Abigail Stewart. <u>https://www.drp-network.org/</u> workshop-2018.html

## References

- Ellis, Jessica, Bailey K. Fosdick, and Chris Rasmussen. "<u>Women 1.5 times more</u> <u>likely to leave STEM pipeline after calculus compared to men: Lack of</u> <u>mathematical confidence a potential culprit</u>." PloS one 11.7 (2016): e0157447.
- <u>A Conversation: With Virginia Valian; Exploring the Gender Gap and the</u> <u>Absence of Equality</u>, NYTimes, Aug 25 1998.
- Valian, Virginia. "<u>Why so slow</u>." The advancement of women 280 (1998).
- Hyde, Janet S., and Janet E. Mertz. "<u>Gender, culture, and mathematics</u> <u>performance</u>." Proceedings of the National Academy of Sciences 106.22 (2009): 8801-8807.
- Martell, Richard F., David M. Lane, and Cynthia Emrich. "<u>Male-female</u> <u>differences: a computer simulation</u>." (1996): 157.
- <u>Dealing With Impostor Syndrome When You're Treated as an Impostor</u>, June 12, 2018, by Kristin Wong, NYTimes
- Implicit bias Jo Handelsman and Natasha Sakraney https://www.whitehouse.gov/ sites/default/files/microsites/ostp/bias\_9-14-15\_final.pdf
- Why Are There Still So Few Women in Science? NYTimes, http:// www.nytimes.com/2013/10/06/magazine/why-are-there-still-so-few-women-inscience.html?\_r=0
- Jo Boaler https://www.youcubed.org/

## The end