

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

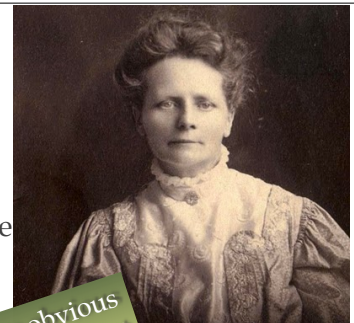
From AWM President Ruth Charney's column in the Sept-Oct 2014 AWM Newsletter.

Why?

Why?

Why?

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 became ill). **The Academy refused.**



There were obvious obstacles in the past

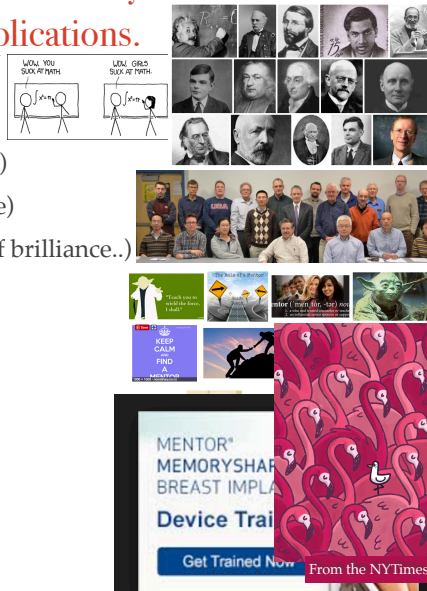


In 1870, **Sofia Kovalevskaya** took private lessons with Karl Weierstrass, since the university would not even allow her to audit classes.

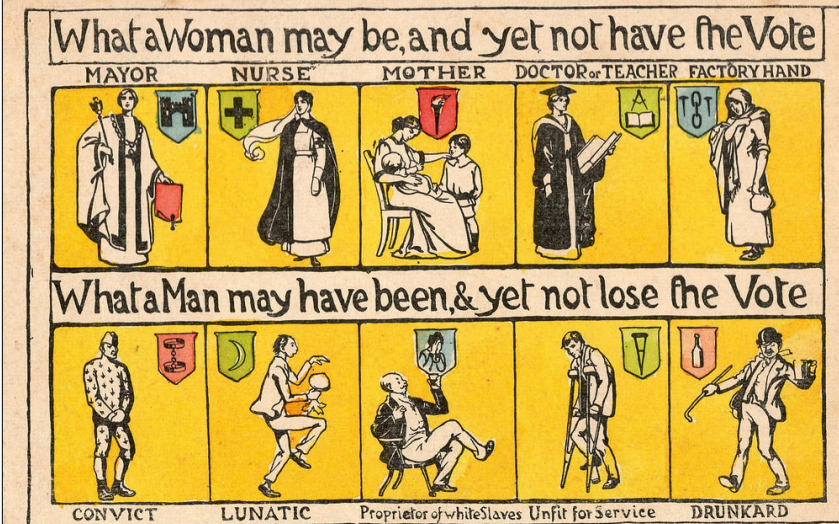
Why there is very little diversity in math ?

Possible explanations.

- ❖ 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	1930 South Africa (except black people)	1964 Libya
1902 Australia (except aboriginal)	1931 Spain	1967 Ecuador
1906 Finland	1934 Turkey	1971 Switzerland
1913 Norway	1944 France	1972 Bangladesh
1915 Denmark	1945 Italy	1974 Jordan
1917 Canada (except Indian)	1947 Argentina, Japan, Mexico, Pakistan	1976 Portugal
1918 Austria, Germany, Poland, Russia	1949 China	1989 Namibia
1919 Netherlands	1950 India	1990 Western Samoa
1920 United States (with exceptions)	1954 Colombia	1993 Kazakhstan, Moldova
1921 Sweden	1957 Malaysia, Zimbabwe	2005 Kuwait
1928 Britain, Ireland	1962 Algeria	2006 United Arab Emirates
	1963 Iran, Morocco	2011 Saudi Arabia



1934

Issues that contribute to the accumulation of disadvantage.

1965

2015

Issues that contribute to the accumulation of disadvantage.

1970

1970

2008

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.

You are asking for it like a girl

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

Aren't you cute? You're such a bitch.

"You'll want kids one day."

He picks on you because she likes you

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

Is it that time of the month?

man up!

slut

You'd be much prettier if you smile.

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

"Nice [insert objectified body part here]."

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

Can women have it all?

You must have been beautiful when you were younger.

prude

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

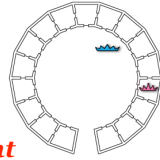
Dr. P. J. Möbius
Über den physiologischen Schwachinn des Weibes
9. AUFLAGE
MIT EINEM ZEICHNUNG VON VERFASSEN
CARL MARHOLD VERLAGSBUCHHANDLUNG
HALLE A. S. 1908

- ❖ 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?

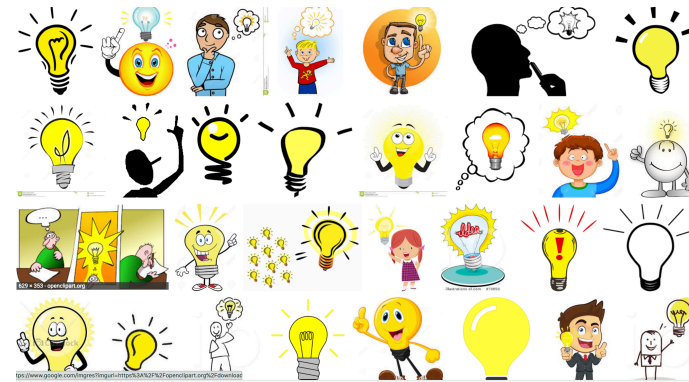
"Math class is tough. Want to go shopping? Okay, meet me at the mall."



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.

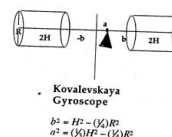
THE STATUS QUO IN MATH



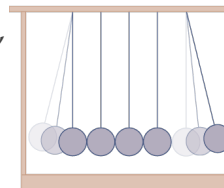
Aphorism attributed to mathematician Hermann Weyl

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.



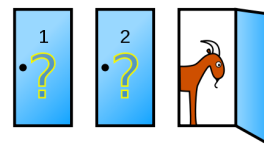
Issues that contribute to the accumulation of disadvantage.



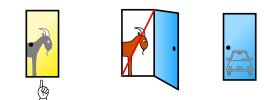
Issues that contribute to the accumulation of disadvantage.

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.



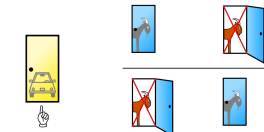
Marilyn vos Savant is a magazine columnist (with the highest recorded IQ according to the Guinness Book of Records). She writes column where she solves puzzles and answers questions on various subjects. The most famous of them was the **Monty Hall problem**.



Switch and win



Switch and win



Stay and win

Player choice before door is open

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?

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.

You are the goat!

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.

"Our math department had a good, self-righteous laugh at your expense,"

You are utterly incorrect about the game show question, How many irate mathematicians are needed to get you to change your mind?

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 of 5 posted)	Total Appl		Asian or Pacific Islander		Black		Hispanic		Other		White		Unknown		Int'l Appl	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Male	1008	80.51%	329	79.66%	10	100%	33	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%	413	32.99%	10	0.80%	38	3.04%	33	2.64%	725	57.91%	33	2.64%	365	29.15%

17.25%

- 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.

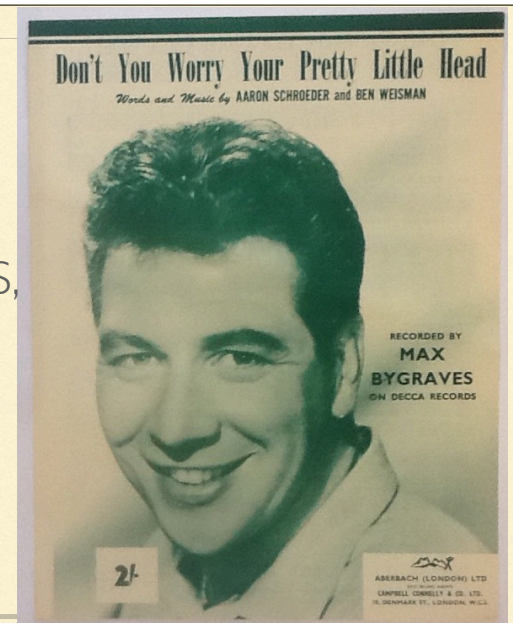
Jo Handelsman and Natasha Sakraney
(President Obama’s) White House Office of Science and Technology Policy

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**

Virginia Valian

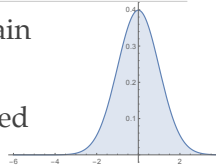
POSSIBLE
EXPLANATIONS,
MODELS



Averages and standard deviation

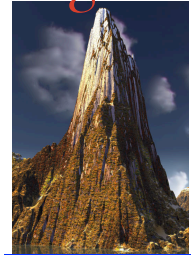
This discussion is about a issues affecting certain groups of people,

- ❖ 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

Virginia Valian

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.

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



Martell, David, Emrich, 1996

We tend to believe,

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



A typical 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;

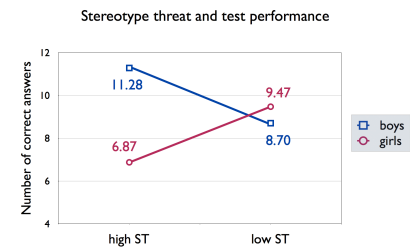
Ellis, Fosdick, and Rasmussen, 2016

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"



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

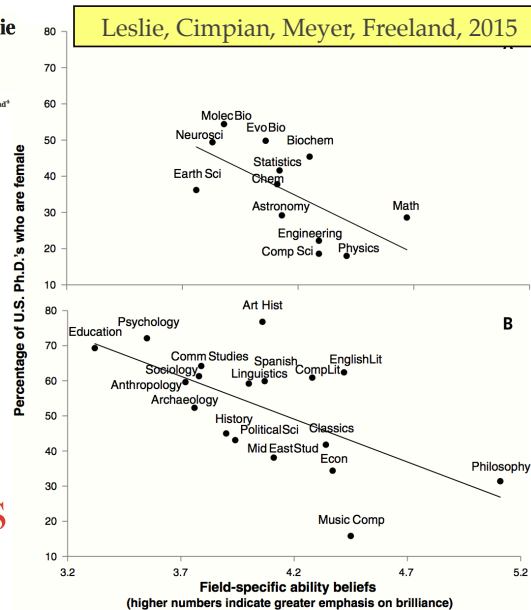
Steele, Aronson, Quinn, 1999

Expectations of brilliance underlie gender distributions across academic disciplines

Sarah-Jane Leslie,^{1,2} André Cimpian,^{1,3} Meredith Meyer,² Edward Freeland⁴

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)



Role models

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 in 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 admire you a lot because I want to become a female math professor. I know that it is not easy.**”

Role models (my personal experience)

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

Ideas for 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**

Ideas for change

- ❖ 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.

Boaler

Ideas for change

- ❖ 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.



Possible 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.
• I made a mistake.	• Mistakes help me to 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!
• It's good enough.	• Is it really my best work?
• Plan A didn't work.	• Good thing the alphabet has 26 more letters!

Ideas for individual change

Learn about gender schemas.

Ideas for change

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

Ideas for change

- ❖ **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

Valian

- ❖ 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.**

Valian

Ideas for change

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.

Virginia Valian

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 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.
• I made a mistake.	• Mistakes help me to 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!
• It's good enough.	• Is it really my best work?
• Plan A didn't work.	• Good thing the alphabet has 25 more letters!

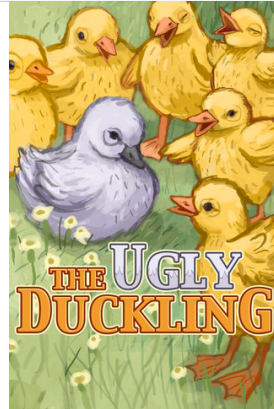
ADVISING



Advising students

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



Based on a talk by Abigail Stewart

Advising students

- ❖ **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

Advising students

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.**

Based on a talk by Abigail Stewart

Advising students

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

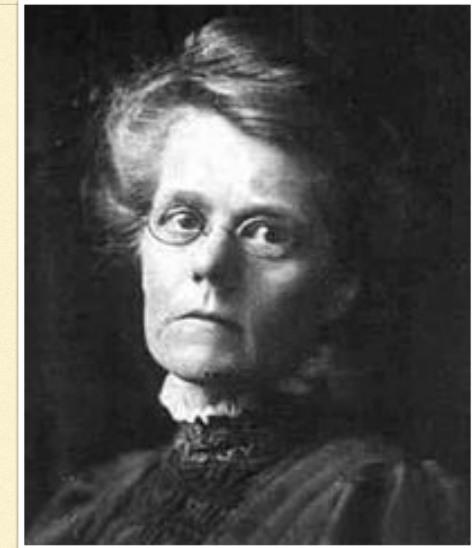
Based on a talk by Abigail Stewart

Advising students

Good mentoring practices

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

Based on a talk by Abigail Stewart



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. <https://www.drp-network.org/workshop-2018.html>

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The end