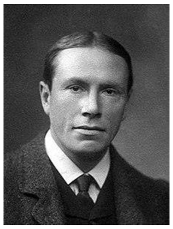
Week 4 Summer Session July 15, 2020

Lecture 7 Humans Are Not Peas: Myths about Genetics-

BEYOND PUNNETT SQUARES ..(4:32) This is the Location Timer on the Computer



Punnett squares were **invented in** the early **1900s by British geneticist Reginald Punnett**. They were a formalized way to understand observations made by Austrian friar and scientist Gregor Mendel, who did experiments with pea plants. He would breed them and look at properties such as height, pod shape and color, seed shape and color, and the position and color of flowers. (5:03)

In one test, Mendel studied pea color using yellow and green peas. True breeding yellow peas always had yellow offspring, and true-breeding green peas always had offspring with green peas. .

	Yellow Peas Male	Yellow Peas Male
Yellow peas Female	Yellow peas	Yellow peas
Yellow Peas Female	Yellow Peas	Yellow Peas

	Green Peas Male	Green Peas Male
Green peas Female	Green peas	Green peas
Green Peas Female	Green Peas	Green Peas

(5:17)

When he crossbred yellow and green peas, they always produced offspring with yellow peas.

	Yellow Peas Male	Yellow Peas Male
Green peas Female	Yellow peas	Yellow peas
Green Peas Female	Yellow Peas	Yellow Peas

(5:19)

However, when he looked at the next generation, he found that the second-generation plants— essentially the grandchildren of the pure plants—had seed colors that appeared with the ratio of one green to 3 yellow. .. (1:3 Green: Yellow)

	Yellow Peas Male	Yellow Peas Male
Yellow peas Female	Yellow peas	Yellow peas
Yellow Peas Female	Yellow Peas	Yellow Peas

(5:27)

We now know that **the color of this particular breed of peas is set by a single gene**. **Genes are a set of instructions held in the center of each cell**. When plants or animals reproduce, the offspring get a copy of each gene from their parents. In animals, one copy is from the mother and the other is from the father(6:03). It's similar, although not as obvious, in plants, because implants it's really just to parents. But the mother\father terminology can be used for simplification purposes. So, a single individual has a copy of the gene from their mother and another from their father.

In the case of the true-breeding green-seed pea plants, both copies are green.

	y	y
y	yy	yy
y	yy	yy

(6:24) In the case of the true-breeding yellow-seed plants, both copies are yellow.

	Y	Y
Y	YY	YY
Y	YY	YY

And if you breed green with green, the offspring will have 2 greens as well—that's what true breeding means. (6:30)

However, if you crossbreed a green and a yellow pea plant, the offspring will have one copy of the green gene and one copy of the yellow gene.

	Y	Y
y	Yy	Yy
y	Yy	Yy

(6:34) They will no longer be genetically pure. But Mendel discovered that these plants had only yellow seeds. **He coined the term dominant to indicate that if an organism had any of that trait, it would win.** .. (6:49)

In modern terms, a plant with any yellow genetic seed material will yield yellow seeds. The green seed genetic material isn't strong enough to "win." Thus, the green seed genetic material is called recessive. Only plants with exclusively green genetic material end up with green seeds. .. (7:16)

If the **peas have a phenotype—what an organism looks like**—that is green, we can be sure that the **genotype—the organism's genetic makeup** (7:30**)** —

Y= dominant Yellow YY y'= recessive Green y'y'

	Y	Y
y	Yy	Yy
y	Yy	Yy

(7:55) With One yellow gene the plant look yellow

	Y	y'
Y	YY	Yy'
y	Yy'	yy'

The offspring has a 3:1 appearance(8:38)

	Y	y'
Y	YY	Yy'
y	Yy'	yy'

The offspring has a 1:2:1 Genetic make-up

Punnett squares clearly demonstrate what is going on. ..

Suppose you have 2 parent plants that are purely green. That means that both of their genes are green. The Punnett square has one parent on the top and one parent on the left of a 2-by-2 grid, and the possible genetic outcomes of the offspring are entered into the grid.

When the plants are crossbred, the offspring get a green gene from the top parent and a green gene from the bottom one.

	y'	y'
y'	y'y'	y'y'
y'	y'y'	y'y'

Pure Green→Pure Green

The same thing happens for pure yellow-gene parents. ..

	Y	Y
Y	YY	YY
Y	YY	YY

Pure yellow →Pure yellow

But what happens if you cross a purely green plant with a purely yellow plant? The green plant gives a green gene to the offspring, while the yellow plant gives a yellow gene. In this case, the Punnett squares that represent the offspring are all a mixture, with one green gene and one yellow gene. ..

However, **Mendel found that yellow genes are dominant**, which means that if you have at least one yellow gene, the plant looks yellow. In fact, visually, you can't tell apart a plant with all yellow genes and a plant with a mix of yellow and green genes. They both have the same phenotype. ..

	Y	Y
'y	Yy'	Yy'
'y	Yy'	Yy'

Appear →Yellow

Punnett squares can also help you understand why Mendel saw that if you bred plants that were crossbreeds themselves, their offspring were 3 times more likely to be yellow than to be green.

Plant Appears 3 yellow : 1 Green

If you set up the Punnett square, you have a plant on the top with one yellow and one green gene and you do the same on the left. You can then take either a green or a yellow gene from one plant and combine it with the other plant. ..

One option is an offspring with 2 yellow genes. Another option is an offspring with 2 green genes. And there are 2 options with one green and one yellow gene. ..

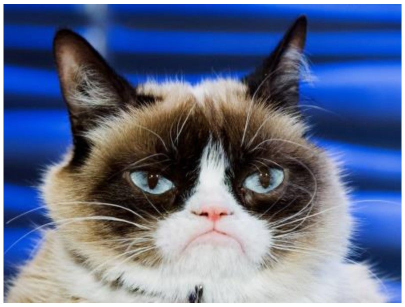
	Y	y'
Y	YY	Yy'
y'	Yy'	y'y'

Remember that only plants with 2 green genes actually produce green seeds. Ones that are purely yellow or a yellow/green mix look yellow. So, this is the genetic explanation for Mendel's observation. Yellow-looking peas can occur 3 times more often than green ones. ..

Punnett squares are very useful and have been introduced in high school biology classes for a long time. They are a great way to teach students the connection between genetics and what people actually see. But unfortunately, this does not have much to do with humans.

A human characteristic that is governed by a single gene is a horrible disease called Huntington's chorea, which is deadly and dominant. If you have it and you give it to your offspring, they will get it. 10:18

It turns out that most human characteristics aren't governed by a single gene. For the characteristic of height, for example, this might be obvious, because there aren't just short and tall people. If there were a single gene, you'd expect 2 classes of people: short and tall. But researchers have identified more than 700 genes that go into determining a person's height. And in order for a person to be very tall, he or she needs to have many of the tall variants of these 700 genes. .. (11:07)



Cats have about a 90% genetic overlap with humans. (This is not a catty remark.)

There is one genetic variation that you often see in textbooks as being a human trait that has a single gene governing it, and that is eye color. According to many textbooks, eyes are blue or brown. Brown eyes are dominant, and blue eyes are recessive. .(11:37).

If you follow the logic of the yellow and blue peas and make a Punnett square, it should be impossible for 2 blue-eyed parents to have a brown-eyed child. It would be possible for brown-eyed parents to have a blue-eyed child if both parents were a genetic mixture of one blue-eye and one brown-eye gene. Then, they would have blue-eyed children 1/4 of the time. (12:00).

But in this single-gene paradigm, 2 blue-eyed parents have only blue-eye genes and can therefore make only blue-eyed children. (12:13) But this is not true. (12:30)

For one thing, human eyes aren't just blue or brown. There is a myriad of colors, including gray, green, violet, and hazel. So, that already makes the idea of 2 genes not very probable. .. (12:47)

Modern research has clarified the situation: It appears that there are 2 important genes dealing with eye color. These are located near one another on one of the chromosomes in the human genome. There are 10 other genes that play a more minor role. Plus, there are complex interactions between the genes themselves. It is entirely possible for 2 blue-eyed parents to produce a brown-eyed child. It's rare, but it can happen. (13:23)

Here is more data to confound the point…..

> Your eyes aren't blue (or green) because they contain pigmented cells.
>
> *As Paul Van Slembrouck writes for Medium, their colour is actually structural - and it involves some pretty interesting physics. The coloured part of your eye is called the iris, and it's made up of two layers - the epithelium at the back and the stroma at the front.*
>
> *The epithelium is only two cells thick and contains black-brown pigments - the dark specks that some people have in their eye is, in fact, the epithelium peeking through.*
>
> *The stroma, in contrast, is made up of colourless collagen fibres. Sometimes the stroma contains a dark pigment called melanin, and sometimes it contains excess collagen deposits.*
>
> *And, fascinatingly, it's these two factors that control your eye colour.*
>
> *Brown eyes, for example, contain a high concentration of melanin in their stroma, which absorbs most of the light entering the eye regardless of collagen deposits, giving them their dark colour.*
>
> *Green eyes don't have much melanin in them, but they also have no collagen deposits.*
>
> *This means that while some of the light entering them is absorbed by the pigment, the particles in the stroma also scatter light as a result of something called the Tyndall effect, which creates a blue hue (it's similar to Rayleigh scattering which makes the sky look blue).*

Back to the topic…

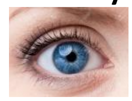
DOMINANT DOESN'T MEAN COMMON . (13:25)

Another myth that the Punnett square mindset perpetuates is that dominant genes become more common over time. ..

Part of the problem is that the word dominant has a meaning in ordinary English that implies that dominant will win. **So, if you have a population of mixed genes, then over time the dominant population will win. (13:46)**

Taking the simple (and, we now know, wrong) idea <u>that brown eyes are dominant</u> in the simplest Mendelian sense, then **<u>blue eyes are destined for extinction in the long term</u>**. But this just isn't true. And we can do a thought experiment to illustrate this. (14:02)

To simplify things, **let's use B for brown eyes and b for not-brown eyes.** ..



A person will have brown eyes if he or she is BB or Bb……….(14:34) and blue or green eyes if he or she is bb. This is because brown is dominant over blue and green.(b) .. (14:44)

Imagine we start out with 11 bb people and 1 Bb person. The Bb person has 4 children with one of the bb people, and each bb couple also has 4 children. (14:53)

11 bb

X

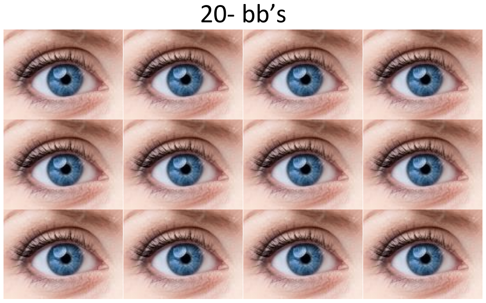
1 Bb

→

Using Mendelian genetics, we'll have 20 bb people from the 5 bb couples and 2 Bb and 2 bb from the mixed couple.(15:02) This is 2 people with brown eyes and 22 people with blue or green eyes—the same ratio as we started with. Brown did not become more common. ..(15:07)

(I'm Sorry I Picked this topic!!!!!)

20- bb's



All Blue eyes

Bb + bb

Brown Blue

All Blue eyes

Now these people all pair up randomly and have 4 children each. Because we aren't going to allow incest, the Bb folks will find a bb for a mate. If they have 4 children each, then we have 44 bb and 4 Bb—which is, again, the same 11-to-1 blue-brown ratio. Whether a gene is dominant or not does not affect how common a trait is—at least not on its own (15:28) bb

All blue

Bb x bb

Brown blue

The bottom line is that even though blue eyes are recessive and brown eyes are dominant, it is likely that blue-eyed people will exist on Earth for many generations. ..(19:09)

Examples of dominant traits that are rare include Huntington's disease and dimples. Whether a trait is rare or not depends on both whether it is dominant and what the surrounding population looks like. ..

Actually, a dominant trait will only become more common if there is a selection for it. Dimples, for example, are dominant, but they don't give the person who has them any sort of survival advantage; dimples don't make it easier to survive long periods of time without food, for example. That's why they stay rare, even though they're dominant. (20:45)..

Selection pressures are not just for survival traits. Sexual selection is another way to increase the existence of a trait in a population. Take peacocks, for example. The male peacock has a huge and beautiful tail that it uses to preen and strut for females. The ones with the biggest and most luxurious tales have more offspring. But from a survival point of view, the tail is silly. It's just long, extra feathers that take a lot of energy to grow and make the peacock vulnerable to predators. (21:44)

But the bottom line is that the idea that dominant traits will necessarily be the most common and recessive traits will be rare is just wrong. (22:13)

ARE GMOS HARMFUL?

- Since it has become possible to edit the genetic code of plants and animals, companies have been doing just that. Plants and animals that have been genetically modified are called genetically modified organisms (GMOs). (23:22)
- More than 2000 studies have found that GMOs are safe. Specifically, the National Academies of Sciences, Engineering, and Medicine—perhaps one of the most trustworthy scientific institutions in America—found that there was no evidence that GMOs were dangerous. (26:08)
- However, there are reasons to be cautious. For example, it is possible to engineer existing diseases in ways that make them deadlier. (28:56)
- Genetic engineering is a tremendously important new technology with the power to revolutionize the world in terms of improving food production, editing human genomes to get rid of unwanted diseases, and ridding the world of pests. But like any powerful technology, it can be abused, so we need to insist that the technology is only permitted under critical and independent scrutiny.(32:06)

Week 4 Summer Session July 15, 2020

Lecture 8 Getting smarter about intelligence.

THE MYTH OF 10%(3:38)

The myth that we use only 10% of our brain is very pervasive, but it's not true. How do we know this? ..

The simplest response is a bit morbid. If there were a distinct 10% of the brain that we used and someone experienced a serious, but not fatal, brain injury, then there would only be a 10% chance that that person would experience some sort of bad outcome.(6:19)

Basically, 9 out of 10 brain injuries would have no impact on a person's life. But that's not true. Even modest damage anywhere in the brain has a negative consequence. . (6:30).

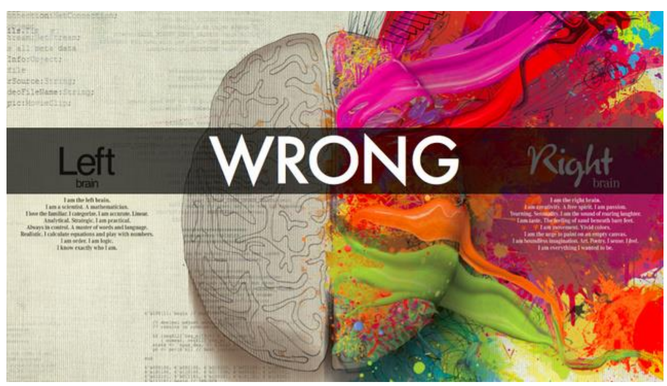
This assumes that there are distinct parts of the brain that are used. Maybe we only use 10% of the brain but that 10% is spread all through the skull. After all, we know that the neurons in the brain are a complex mesh, interlocking with one another. However, scientists have embedded microelectrodes in patients' brains and can see that it's not that just 10% of the neurons are firing. (6:58)

There are many other reasons we know this myth to be not true, but a big one comes from human evolution. The brain takes a lot of energy to run. It takes about 20% of the energy consumed by human metabolism, in spite of being only about 2% of the body's mass. If 90% of the brain were not used, there would be a huge evolutionary pressure to reduce the size of brains and skulls. (7:26)

.

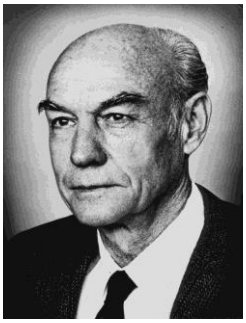
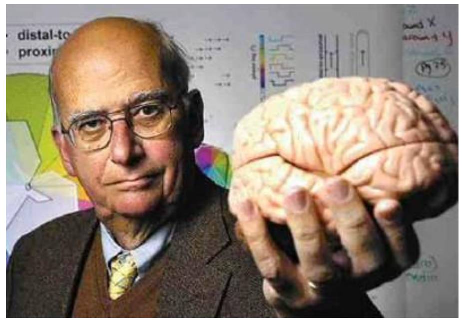
THE LEFT BRAIN VERSUS THE RIGHT BRAIN (8:03)

Another fascinating and recurring myth in modern culture about the brain is the idea of people being right-brained or left-brained. But there is a grain of truth to this myth. For example, the brain really does have 2 hemispheres— one left and one right—so that part is correct. But when brain function is studied, it quickly becomes complicated.(8:34)



Scientists have known for many decades that the brain isn't monolithic and that different parts of the brain have different purposes. The earliest reported data was in the 1800s, when brain scientists took note of the fact that when people experienced different types of brain trauma, this often led to a specific loss of abilities. For example, spatial abilities seemed to reside more in the right side of the brain while language seemed to be preferentially located in the left. (9:07)

These initial observations exploded both into the scientific literature and in the public sphere in the 1960s. It was during this decade that researchers including Roger Sperry and Michael Gazzaniga were experimenting to find ways to treat severe epilepsy. .(9:29).

Roger Sperry   Michael Gazzaniga

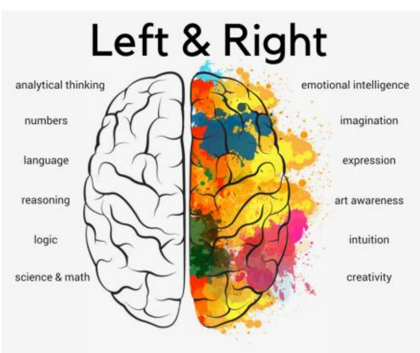
There was a class of patients whose frequent and debilitating seizures resisted treatments like psychotherapy and psychotherapeutic drugs. .(9:35).

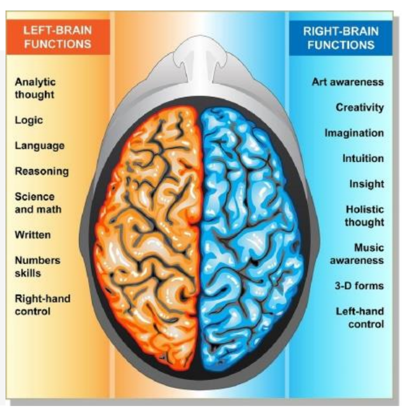
Gazzaniga and Sperry and others explored additional treatments. One treatment was to sever the part of the brain that connected the right and left hemispheres. The part of the body that connects the 2 sides of a healthy brain is called the Corpus Callosum. In these surgeries, surgeons cut the corpus callosum, turning what was once a single operating brain essentially into 2 separate ones.(10:10)

It was from studies like this that scientists became aware of some of the regional differences of brain function. .(10:29).

These studies found differences in the left and right sides of the brain. Popularizers and marketers and others grabbed onto these very early studies and ran with them. **Society was told that the left brain is the analytical, logical, verbal half** while the **right brain is the creative, emotional, visual, and spatial half.** Taking this to the next step, people were told that if they were dispassionate and cerebral scientific whizzes that they used the left side of the brain, while the artsy, creative, caring people used the right side of their brain. (11:30)

But it was just too easy an explanation. People are rarely so dichotomous— either thinking or feeling.
12 Getting Smarter about Intelligence

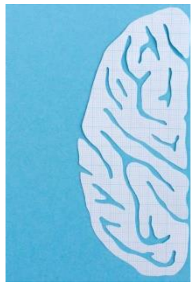




It is true that there are differences between the right and left sides of the brain. The left side of the brain controls the right side of the body, and vice versa. (12:13) And handedness, meaning being left-handed versus right-handed, seems to arise in individual differences in the right and left brain and the development of the fine muscle control centers of the hand. (12:26) But thinking occurs all over the brain. ..

There is some defensible merit in bits of the ideas about the left brain versus the right brain. For example, language processing, once believed to reside only in the left hemisphere, is now understood to take place in both: The left side processes grammar and pronunciation while the right side processes intonation. (12:52)

Similarly, experiments have shown that the right hemisphere is not only responsible for spatial ability: The right hemisphere seems to deal with a general sense of space while the left hemisphere deals with objects in specific locations. (13:02)



LEFT	RIGHT
Language Processing	Language processing
Grammar and Pronunciation	Intonation
Objects in specific Locations	Sense of Space

Learning styles. (13:51)

For perhaps the last 30 or 40 years, the idea of learning styles, or different ways in which different students learn, has been percolating around the education departments of schools and universities. There are at least 70 different models, or ways that researchers break up learning types. While actual models are often more specific, some researchers claim that learners can be distinguished into visual, auditory, and kinesthetic methodologies—see-ers, hearers, and doers. (14:37)

The basic idea is that different people learn better when information is presented to them in a specific way. ..Some learners are better at taking in information when they can see it, such as on a blackboard or computer screen. The idea goes on to further state that when visual learners are told information, they are at a disadvantage compared to auditory learners. .(15:06).

Following that logic, people who prefer to hear information will do well in a class in which information is spoken and not written. ..

And kinesthetic learners are the types that like to work with their hands. You can tell them all you want about the right way to do things or have them read books, but until they do it themselves, with their own hands, they can't internalize the information. .(15:31).

> If you're interested in learning more about the brain, check out Richard Haier's Great Course The Intelligent Brain or Thad Polk's Great Course The Learning Brain.

But the data says that learning styles aren't real.(17:19)

Studies of learning styles start out with a mixed population of different types of people who are given a test to classify them as a visual, auditory, or kinesthetic learner, for example. Next, they are broken up into the different learning styles that the researcher's model requires. Then, those people are randomly assigned to different classrooms, each of which emphasizes one style over the other. So, in one classroom, it's mostly reading; in another classroom, it's mostly listening. And in the third classroom, it's all hands-on. (18:07)

Before the subjects enter the classroom, their mastery of the subject being taught in the classroom is tested. Then, they are taught in predominantly one way and are tested when they leave the classroom to determine how well they learned the material. (18:27)

Studies like this find that no matter what type of learner a subject was identified as, there is no connection between how much the person learned and in what type of classroom he or she learned it. (18:42).

If learning style were a real thing, presumably the type of classroom would matter. Visual learners would learn more and better in visual classrooms, and so on. But that doesn't happen. ..(18:56)

These studies don't necessarily mean that learning styles are wrong. They only test whether specific ways of breaking up the learners helps. But it certainly does make it look like learning styles are a fad that won't survive into the future. (19:13)

IQ

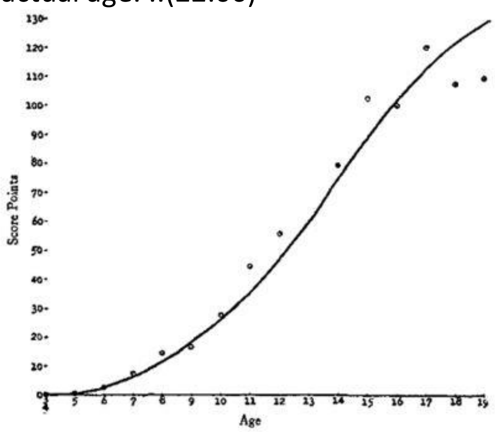
Intelligence quotient (IQ) is one of the most misused concepts in discussions of intelligence and the human brain. ..(19:28)

IQ is a score that is purported to test the intelligence of an individual. The range is from 0 on the bottom with no end on the top—although, realistically, everyone is in the 50 to 150 range, with what might be called the “normal” range to be 85 to 115. A person with average intelligence has an IQ of 100. (20:37)

Although people thought about intelligence and intelligence testing in the 1800s, the modern IQ test was first invented in 1904 by French psychologists Alfred Binet and Théodore Simon. The Binet-Simon IQ test measured a number of components, such as reasoning, naming objects, and wordplay. ..(21:49)

Alfred Binet   Thèodore Simon

The original meaning of the IQ score was a measure of the ratio of a person’s mental age to his or her actual age. ..(22:06)



Graph I. Mental Age Equivalents of Score Points.

IQ = 11/8 x 100 = 138
A ratio of their mental age to the actual age

(22:36)

The test migrated to America in the early part of the 20th century, and Lewis Terman, a psychologist at Stanford University, adapted it to English and made some improvements. The American version is now called the Stanford-Binet test, named after Terman’s employer (Stanford) and Alfred Binet. There are several different intelligence tests used these days, all with different strengths and weaknesses. .(23;14).

Nowadays, the IQ test is simply a measure of how an individual compares to other people in his or her culture and age group. (24:01)

Different tests use different numbers of questions and all manners of different ways to assess people, so it’s important to not use a test score. Instead, researchers convert their test to a bell curve, also called a normal curve or a Gaussian distribution. ..(25:07)

A Gaussian distribution is named after German mathematician and physicist Carl Gauss, who worked out a lot of the curve’s mathematics.

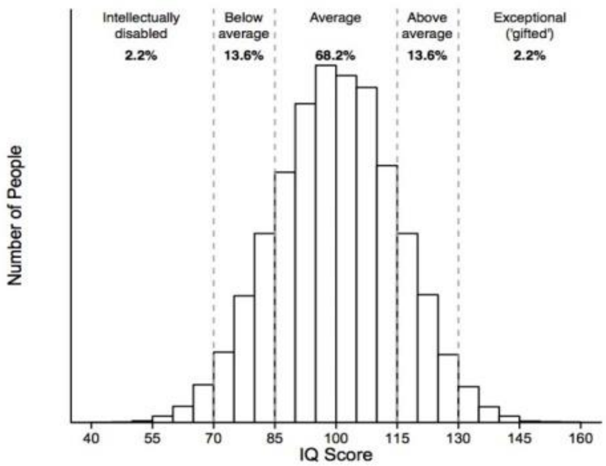
A bell curve looks a bit like a bell, with a distinct shape and width. For IQ, researchers picked an average of 100 and a width of 15. ..(25:20)

In the case of IQ, the total area under the bell curve represents all people. How far away from the center do you have to go to get 68% of the area? That turns out to be 15, meaning ranging from 85 to 115.

If you then double that distance to 30, going from 70 to 130, you get 95% of the area. And if we go another 15, from 55 to 145, you get 99.7% of the area. ..(25;47)

An IQ of 100 is normal. Half of the world is higher than that, and half is lower. Furthermore, pretty much any IQ in the range of 90 to 110 is normal. People scoring in the range of 110 to 119 are a little above average, while those in the 80 to 89 range are a little below average, and so on. The geniuses are in the IQ range of 130 and higher.(25:58)

Mensa, an organization of people with IQs in the top 2% of the population, requires a Stanford Binet test score of 130 or higher. {Oh well}...(26;12)



Classification	IQ Range	%
highly gifted	140+	0.4%
Mensa membership	130+	2%
gifted	130+	2%
International High IQ Society membership	124	5%
high	115-129	15%
high average	110-115	25%
average	90-109	50%
low average	85-89	23%
borderline	70-79	8%

This graph separates university students into their respective majors and then plots each major's average IQ on the vertical axis against the percentage of women studying that subject, given on the horizontal axis.
There is a trend where majors with a low percentage of females have women with higher IQs than ones with a high percentage of females. An obvious interpretation—but a wrong one—is that the lower IQs are because there are more women, and therefore men are smarter than women.
In fact, results of IQ tests for men and women are identical; there is no meaningful difference.
The underlying cause of this graph is that women tend not to be as interested in the hard sciences as men are. The cause of this is not known, but it's not because men are intrinsically smarter.

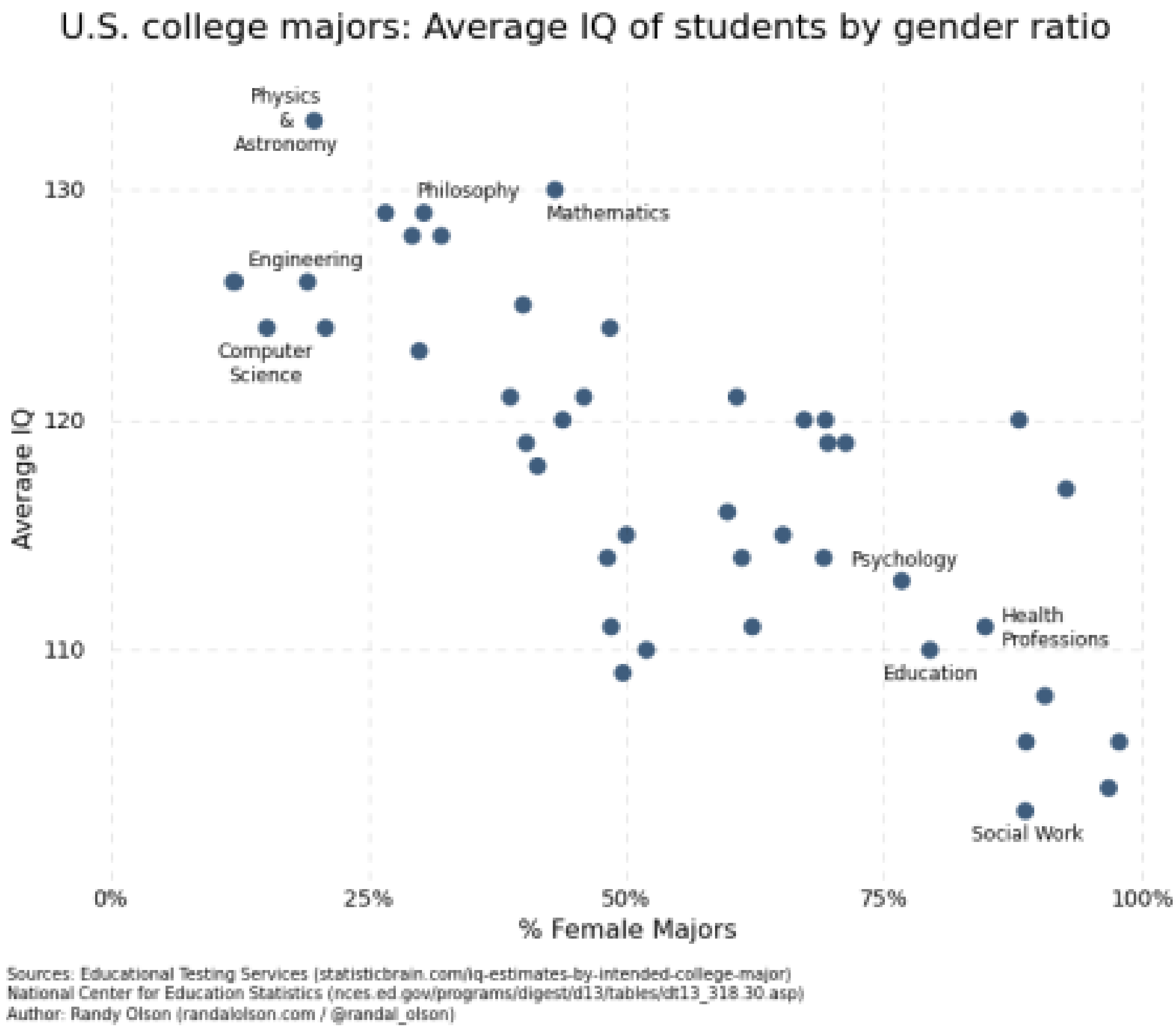
Graph Average IQ vs % female majors

There are many misconceptions and misuses regarding IQ, but the following are three common ones.

1. A person who has an IQ of the hundred and 140 is twice as smart as a person with an IQ of 70. This is false. The IQ is simply a measure of where people stand compared to their peers.(26:33)

2. A person can change your IQ by studying and taking tests. This is false. IQ isn't innate property held by an individual that is well teste (27:03)

3. IQ tests are culturally biased against groups who have historically been economically, socially, and politically disenfranchised. This is false. It once was true, when the tests were entirely based on language in the early 1900s, but psychometricians (experts in measuring intelligence) have beaten that problem into submission. English IQ test are validated for any native English speaker.(27:55)



In 1994, a group of 52 distinguished psychometricians made a statement that was published in The Wall Street Journal on what we do and don't know about intelligence. In summary, they claim that IQ is a good—although incomplete— measure of intelligence and that modern tests are reproducible and accurate. They claim that the brain processes that underlie intelligence are not well understood. They state that it is true that different ethnic groups will, on average, score differently on the test. They also state that success in life is not determined by IQ, but IQ gives an advantage in a complex and changing environment in which decisions are required. (31:05)

<u>Readings</u>

Eagleman, The Brain”

Gottfredson, “Mainstream Science on Intelligence

Haier, The Neuroscience of intelligence.

Heron Stein and Murray, The Bell Curve

Demo video

The Physics IQ Test - PhysPort

www.physport.org › nfw › berg

The Effects of Aging and IQ on Item and Associative Memory

www.ncbi.nlm.nih.gov › pmc › articles › PMC3149731