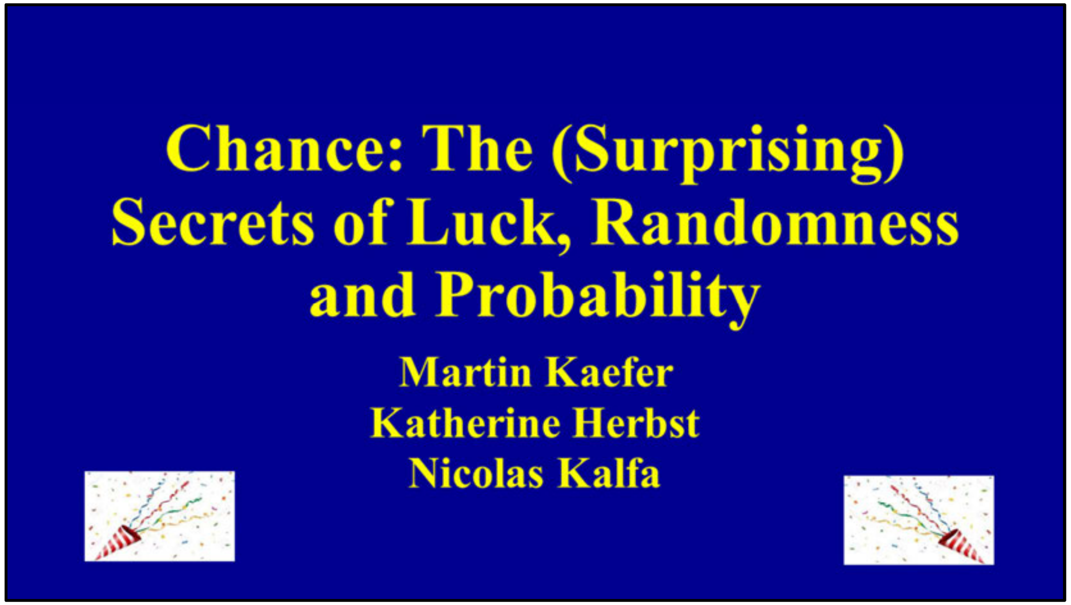
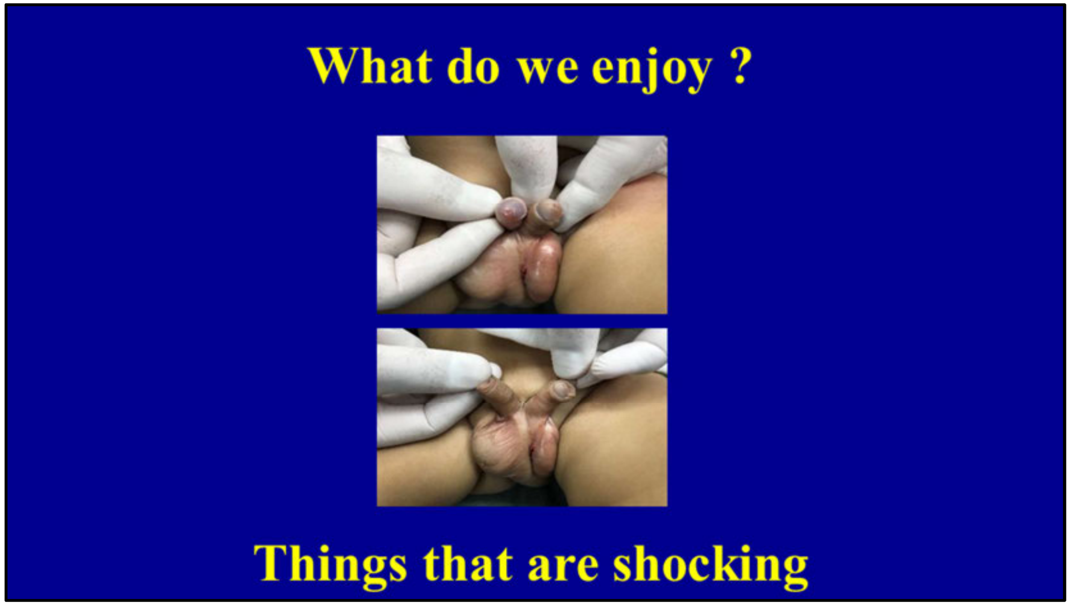


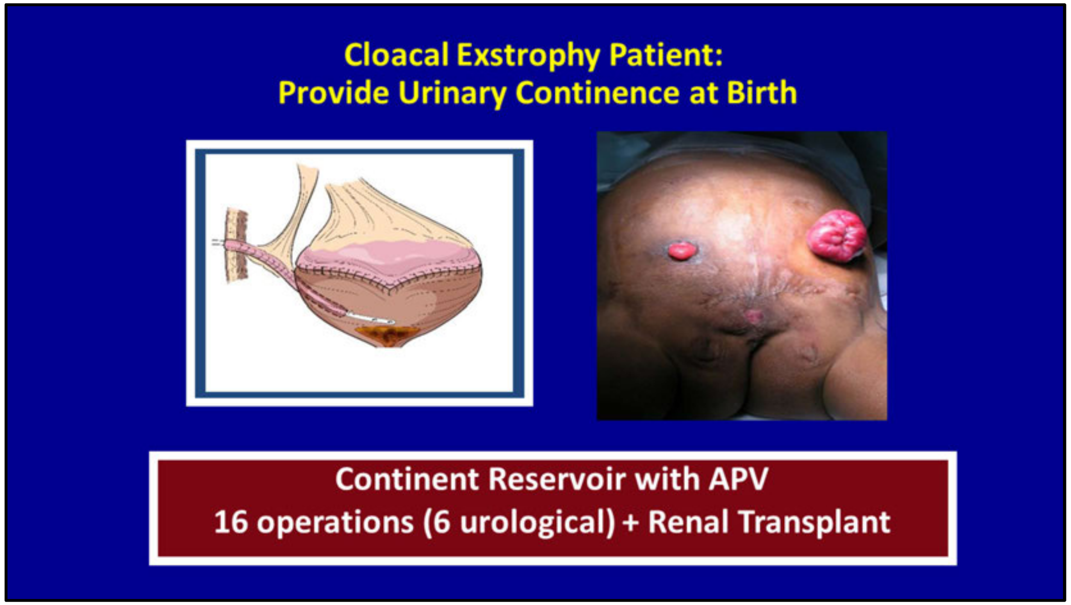
Thank you for getting up so early to be with us this morning.. We will be your hosts for the next 45 minutes… and we hope to have some fun. To start us off, lets begin with what the three of us enjoy.

……– these may be some of the things that you also enjoy. First, we like things that are beautiful. Second…

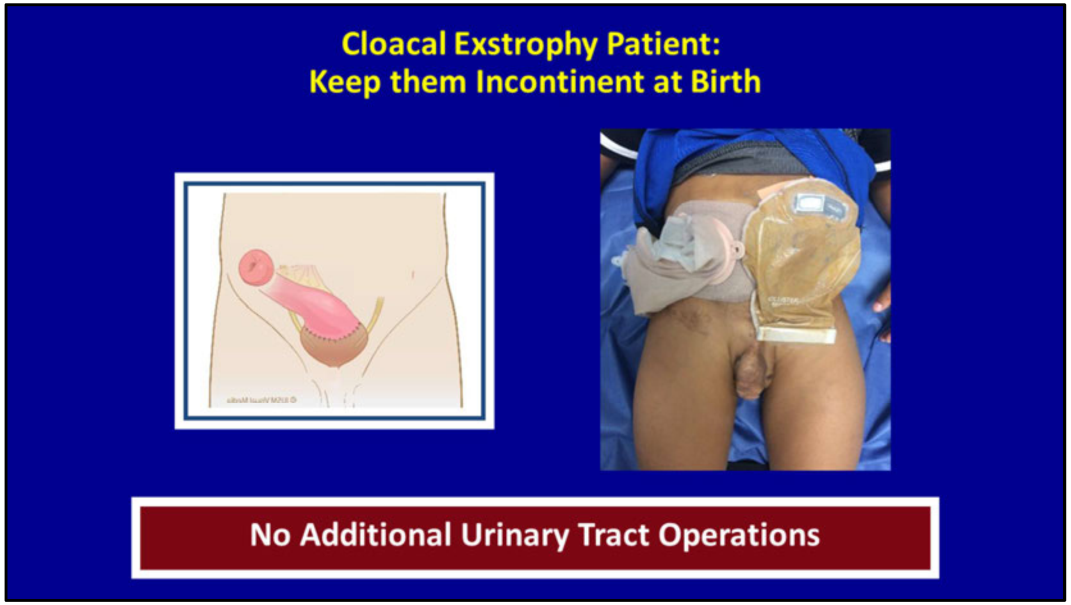


We enjoy things that are shocking. They move us to think of things in a different way.

We enjoy questioning paradigms and learning new truths



The standard paradigm in cloacal exstrophy has been to create a continent urinary reservoir in a patient who is going to have a lifelong colostomy and is likely to have many other physical and social challenges. Is this a just and correct goal for these individuals in all cases? (Especially when it means having a much larger need for surgery and a significant risk of renal failure?)



After critically looking at our data, we felt it might be good to question this paradigm of treatment in certain patients. We now recommend considering an incontinent option at birth with the option of converting to a continent reservoir at a future date if the patient so wishes. And many of our patients are happy and healthy.

What do we enjoy ?

Experiencing and understanding things that are counterintuitive

And we like understanding things that are counterintuitive, that cause us to go ah-ha. We essentially enjoy seeing the world more clearly for what it is. For understanding reality and some of its secrets.

At first you may think you know what this is…but it is in fact

Green Apple (+ Helium)

a green apple, processed into a taffy paste
and then inflated with helium to make…

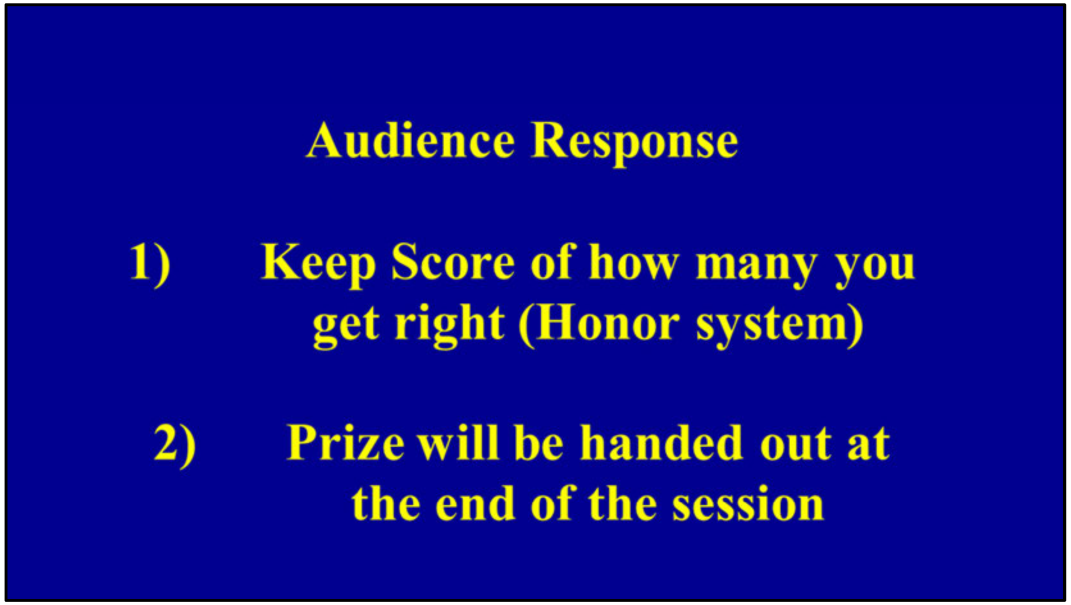
A dessert

All of these enjoyable things allow us to do one thing…..see the world more clearly.

Oh, And one final thing we all like….

winning

A lot………. So in this spirit we are going to do the following



We are going to spend the next 45 minutes playing a game. And the winner will get a prize. Don't over think your choices.

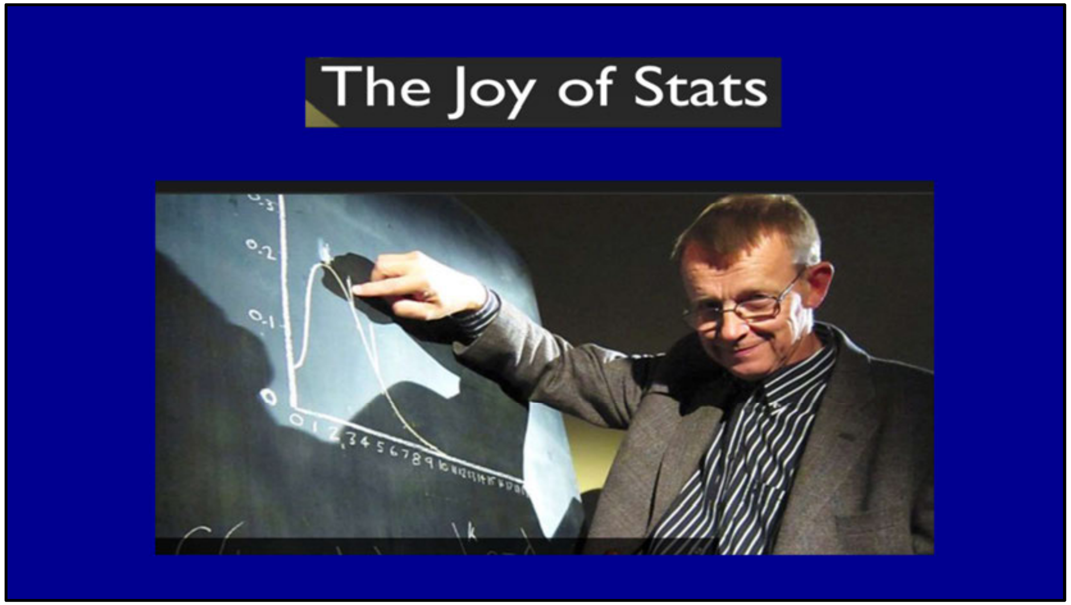
So again, we want to see the world more clearly. Well, what are some reasons we might we not see it so clearly?

Why might we not see the world clearly ?

Swedish Doctor

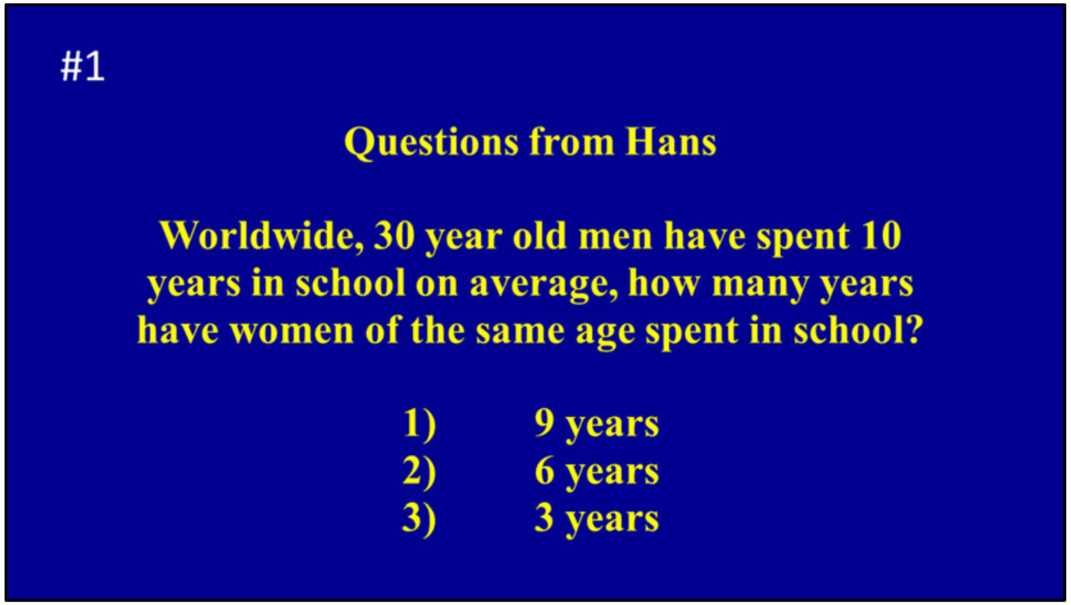
Hans Rosling

Lets start by asking a doctor. Maybe even a Swedish doctor. They seem to be pretty smart.
Hans Rosling was a very engaging man. He is known for making even statistics……

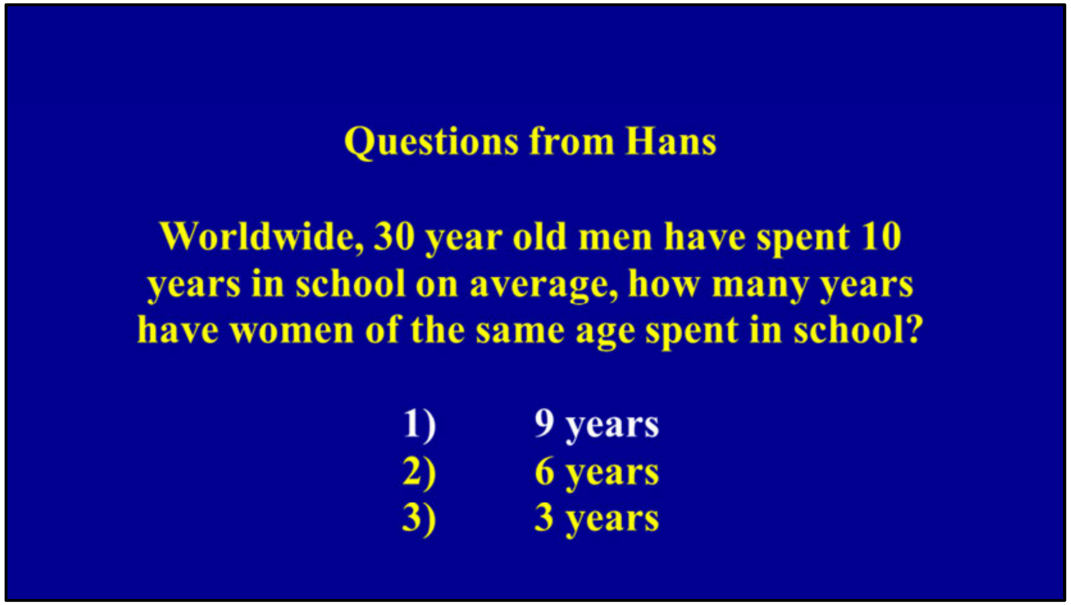


Interesting. Here he is in a TV special he helped produce a few years ago. He also has a bestselling book…

In Factfulness he asks the following questions …



Please write down you answer to the following.



And here is the answer. Surprising is it not?

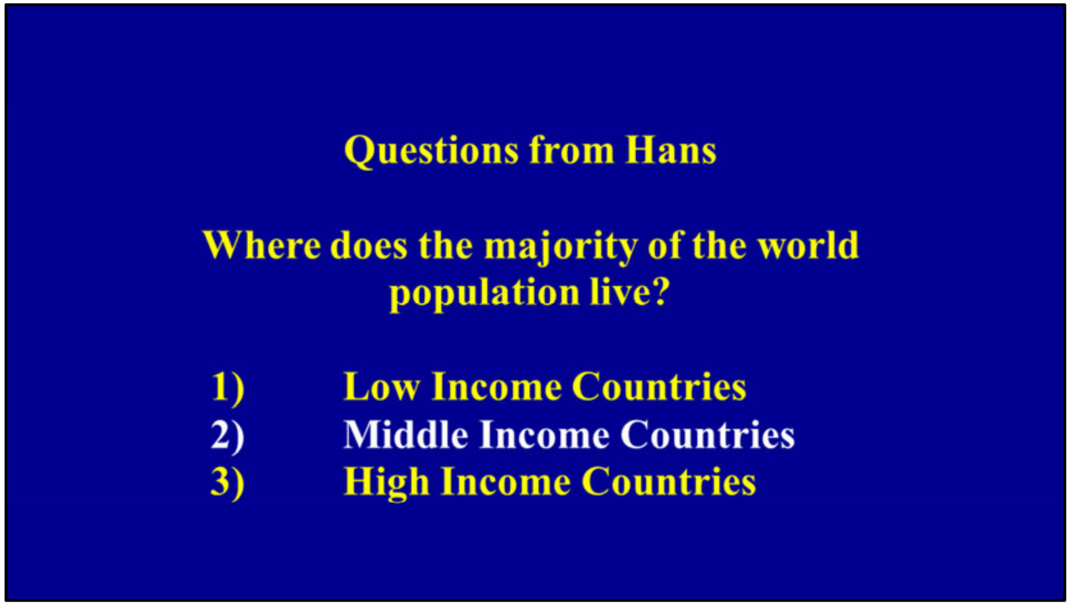
#2

Questions from Hans

Where does the majority of the world population live?

1) **Low Income Countries**
2) **Middle Income Countries**
3) **High Income Countries**

Read question



I for my part thought it was number one.

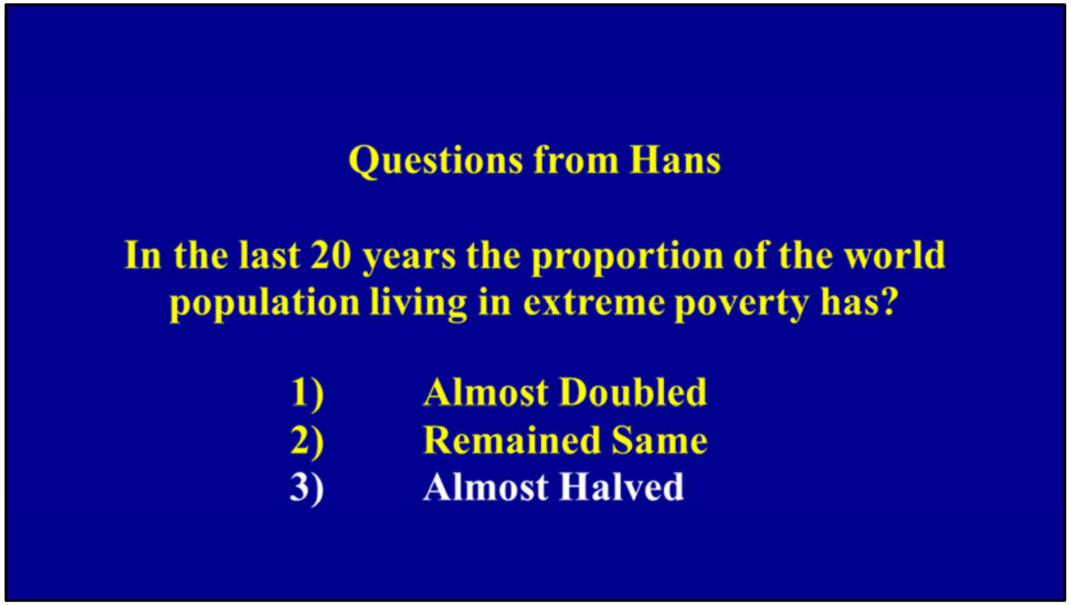
#3

Questions from Hans

In the last 20 years the proportion of the world population living in extreme poverty has?

1) Almost Doubled
2) Remained Same
3) Almost Halved

Read it…. Got your answer?



Hard to believe isn’t it?

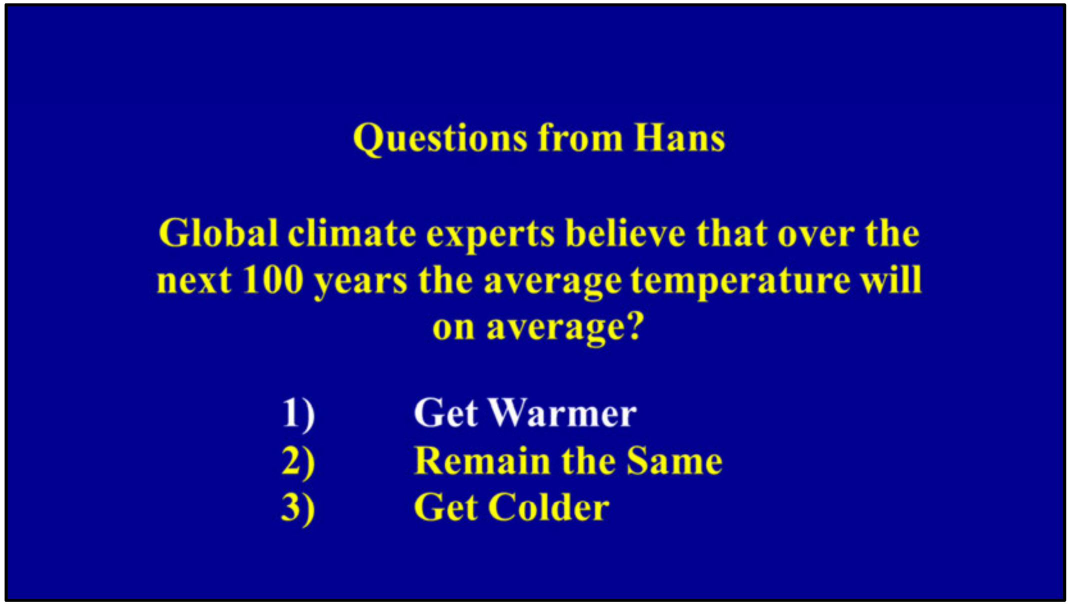
#4

Questions from Hans

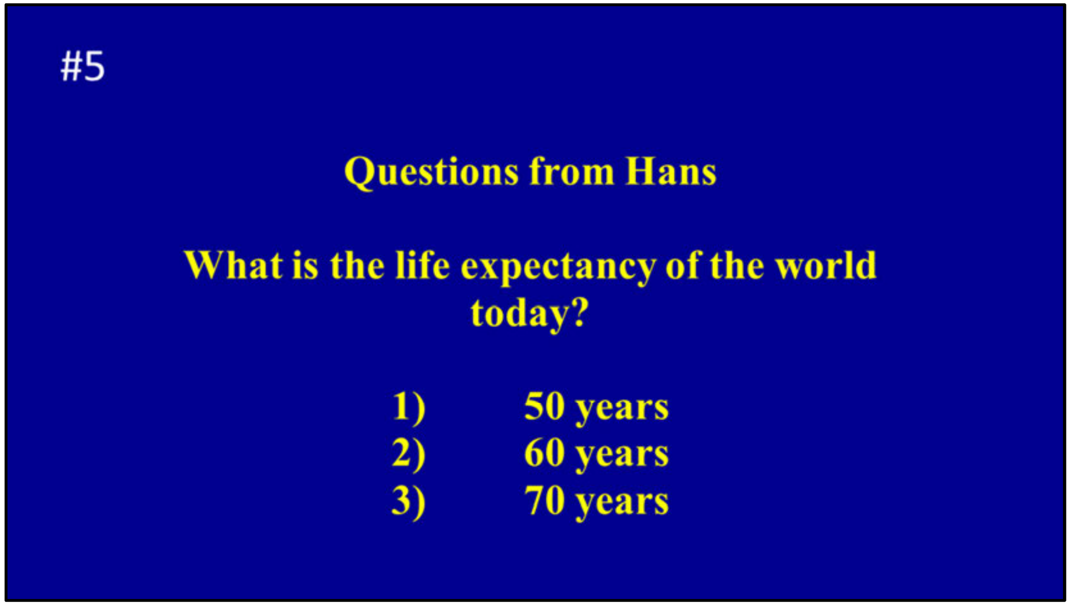
Global climate experts believe that over the next 100 years the average temperature will on average?

1) **Get Warmer**
2) **Remain the Same**
3) **Get Colder**

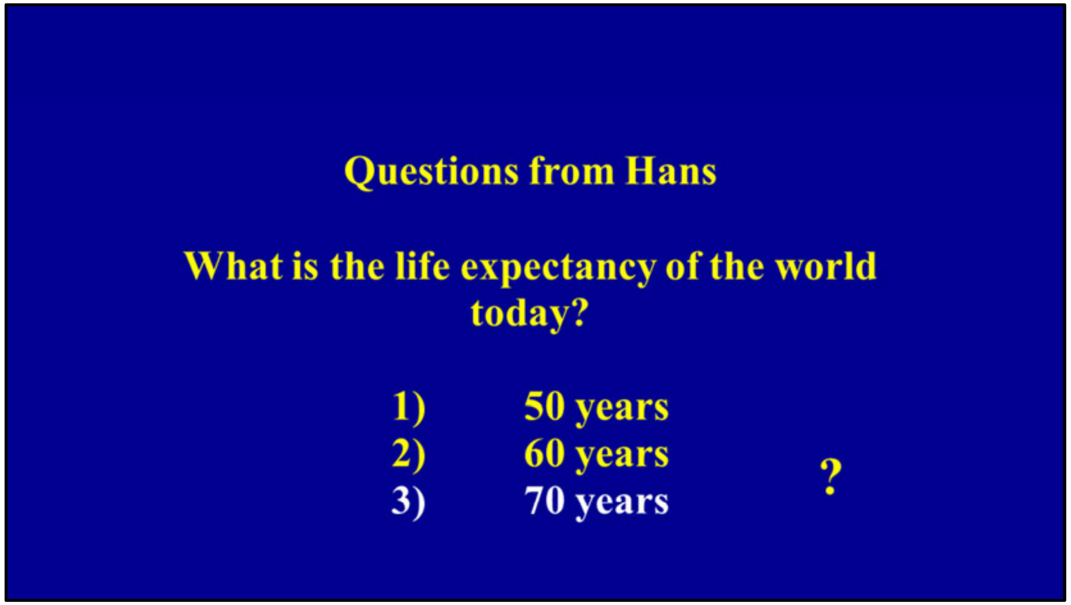
Well finally an easy one….ready?



Well maybe in this situation you should have trusted your intuition ☺



And lastly, what is the average life expectancy today?

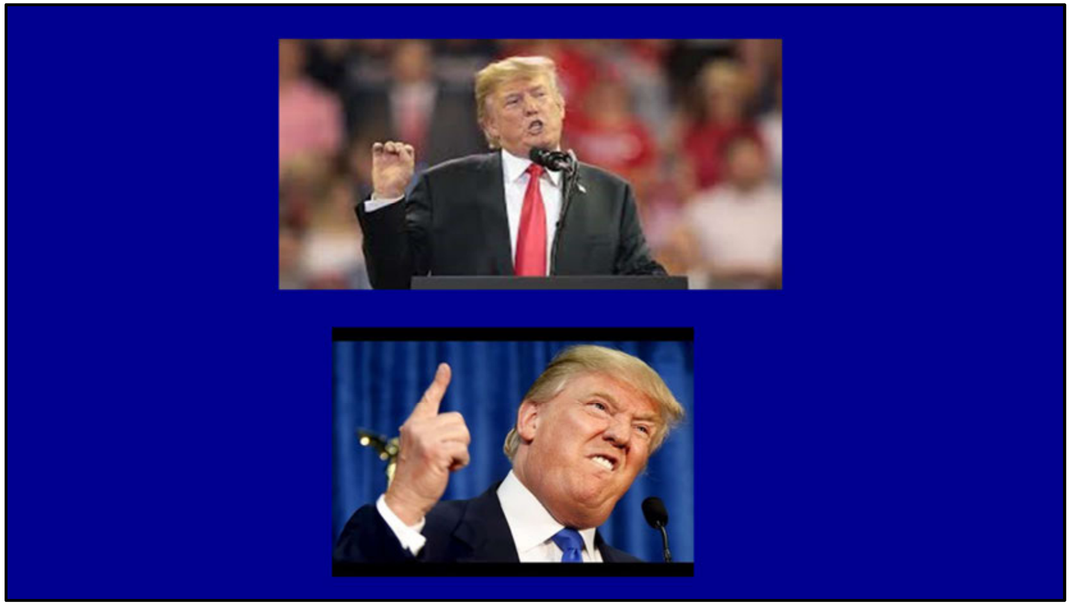


Astounding. Now why is it that we get so many of these wrong . Well Goedele, Darius and another Swedish Doctor told us yesterday.

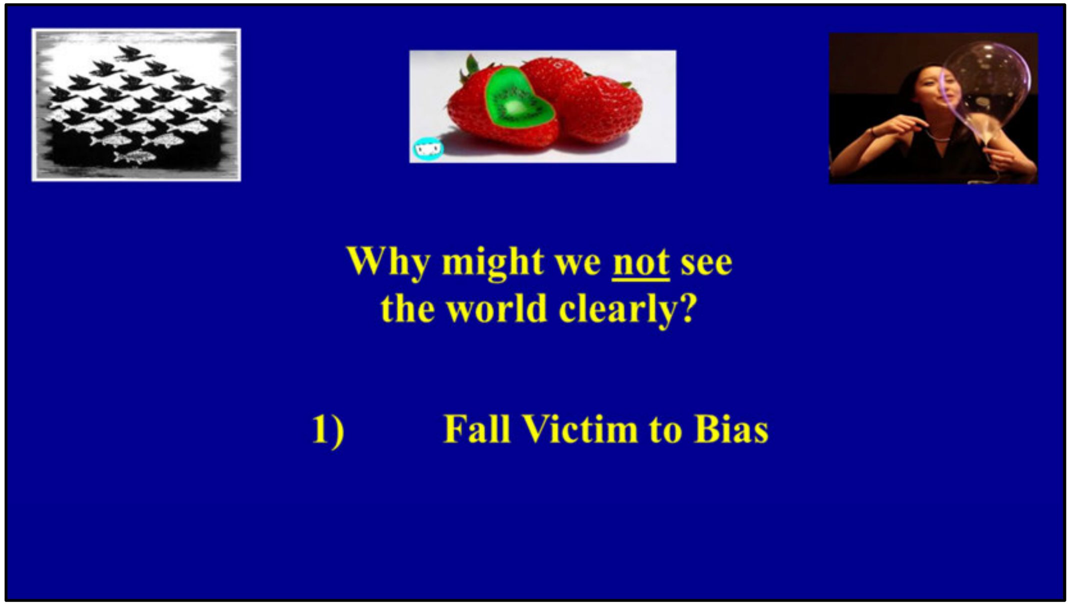
Its Bias.   I just happened to look this up on Wikipedia. And guess how many forms of recognized bias there are?

Hans stresses that it is the instinct to generalize that effects us the most.

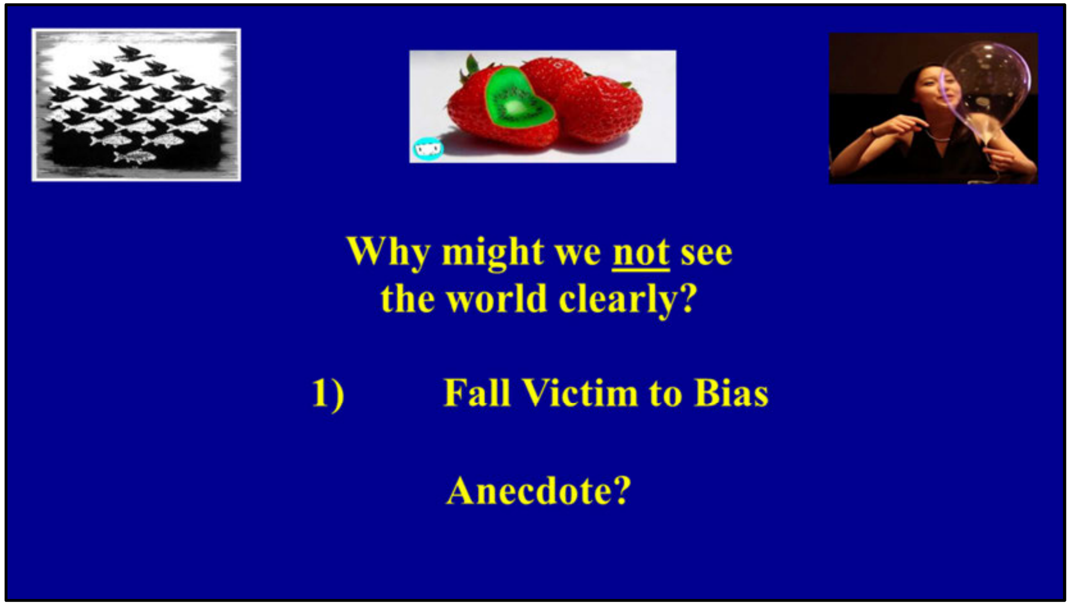
You see the world based on your own personal last experience, the quantity of information that you experience and yes….



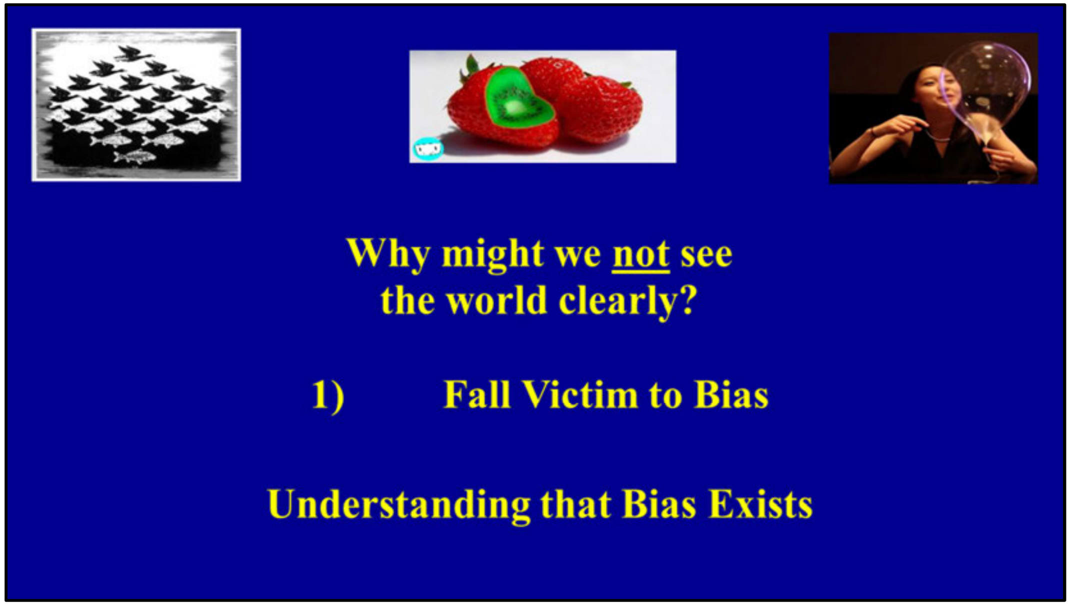
Propaganda.



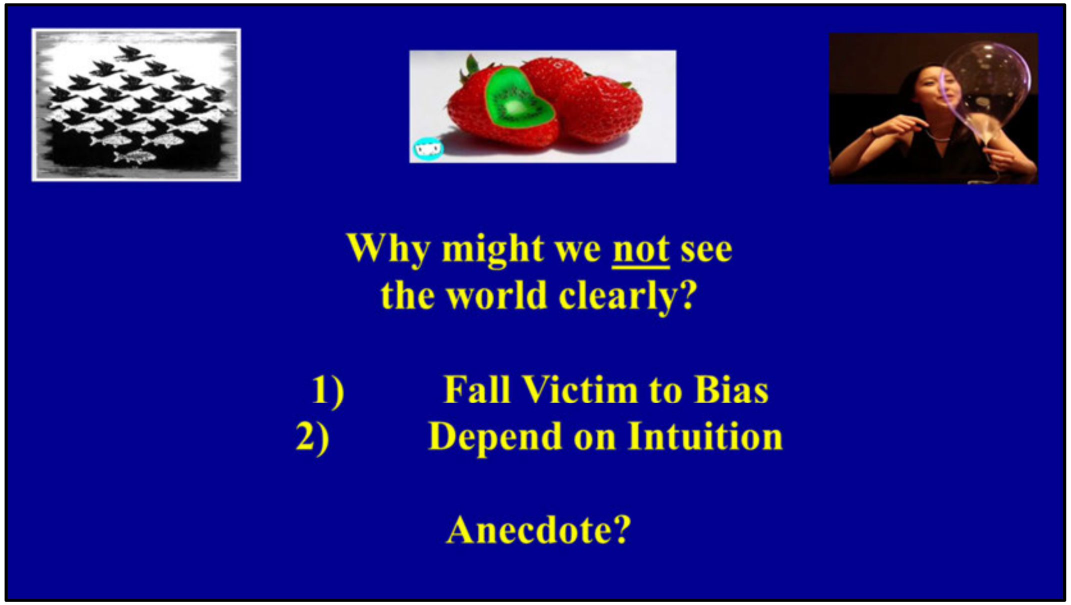
So, first reason we may <u>not</u> see the world clearly s that we fall victim to bias.



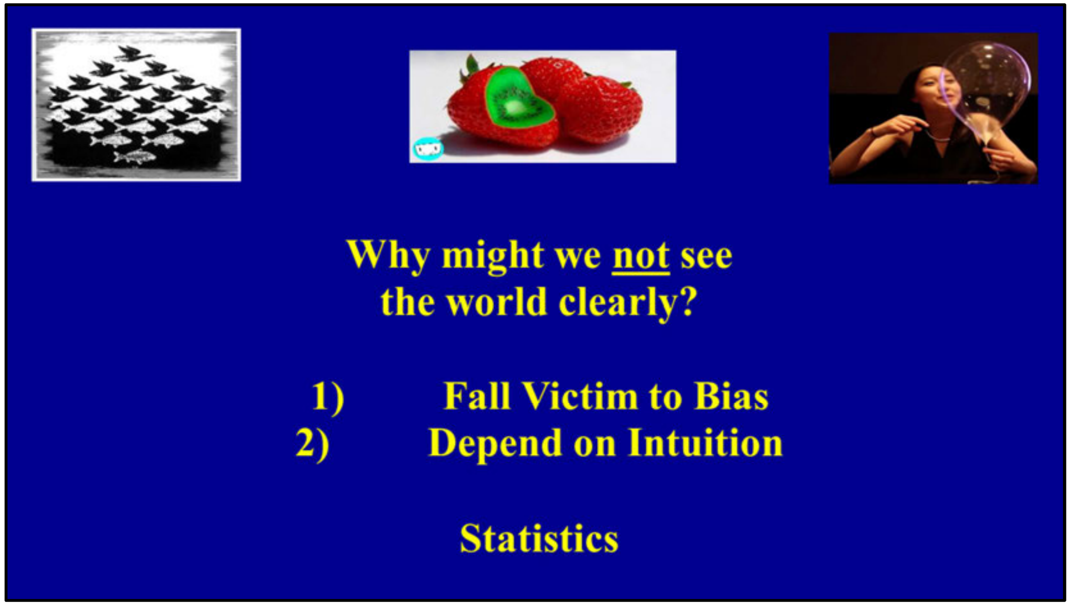
What is the Anecdote…. ?



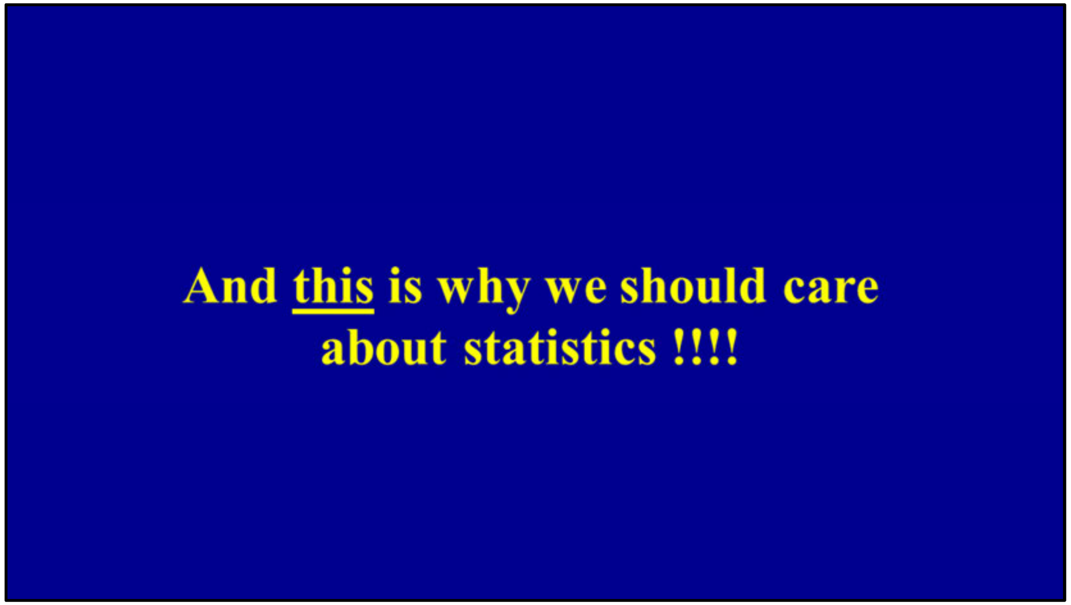
- Understanding that it exists



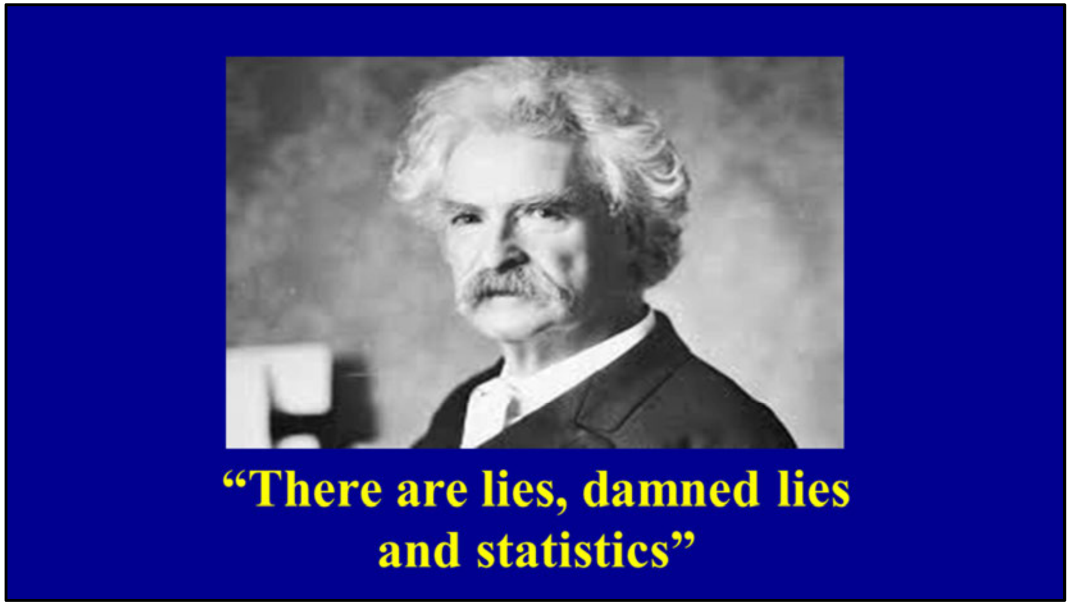
A second reason why we are likely not to see the world clearly is that we depend too much on intuition. And as you will see, this can be misleading. What is at least the partial anecdote or cure to this – if used properly? …


Why might we not see
the world clearly?
1) Fall Victim to Bias
2) Depend on Intuition
Statistics

……Statistics



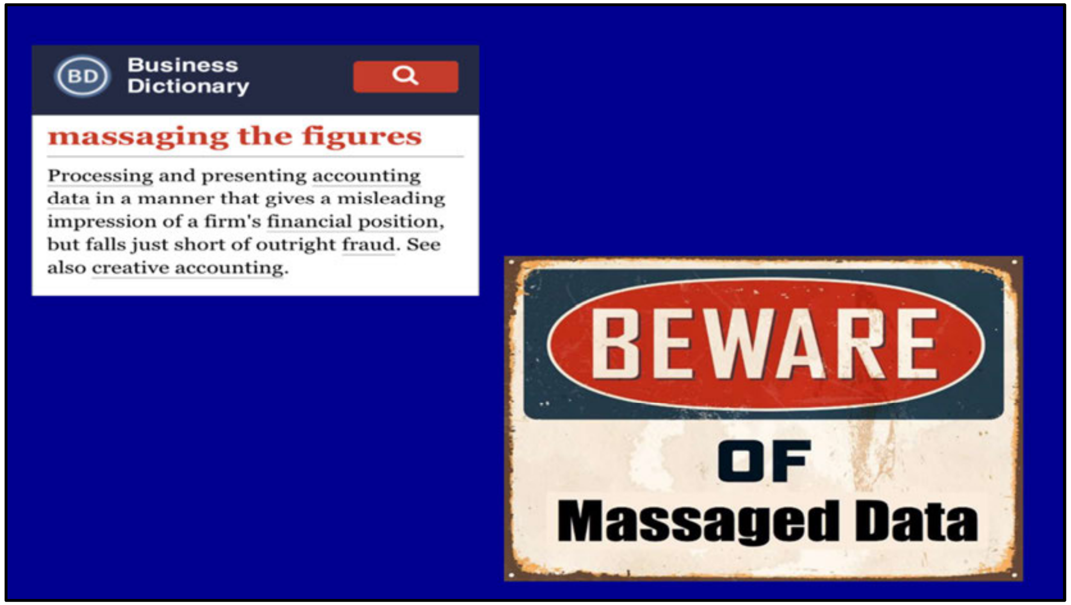
And this is why we should care about statistics. Now, many would contend that statistics have their own problems. This guy did…



You may not recognize his face, but you surely have heard Mark Twain’s sentiments about this topic. And even if you don’t think that they are lies…

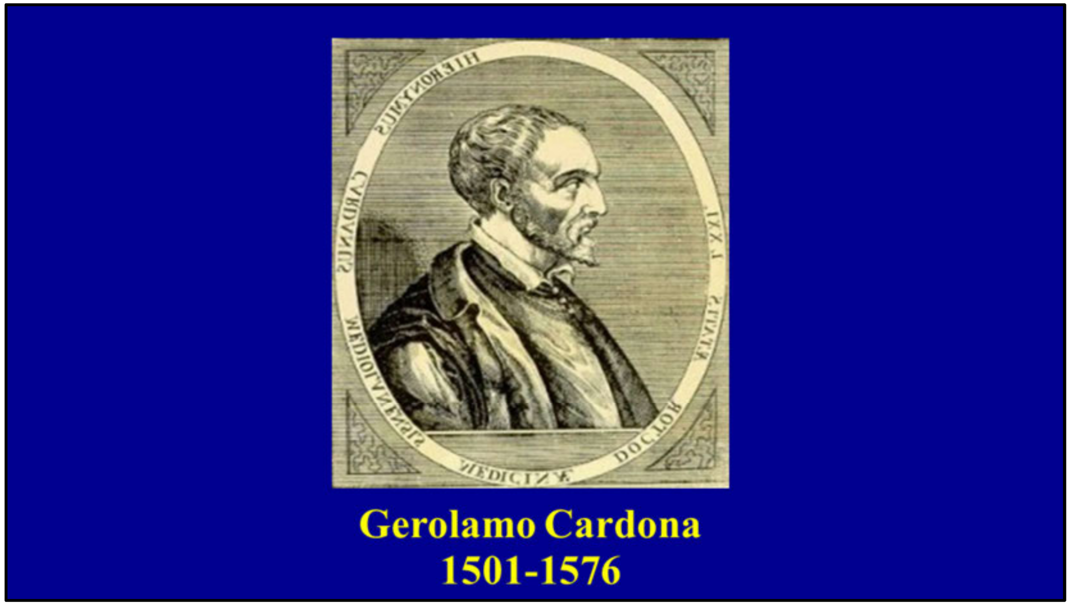
We may be extremely skeptical because…. of

our concern that data can be gently changed through statistical manipulation. However….



this makes it even more important to use statistics <u>appropriately</u> to aid in understanding the world around us.

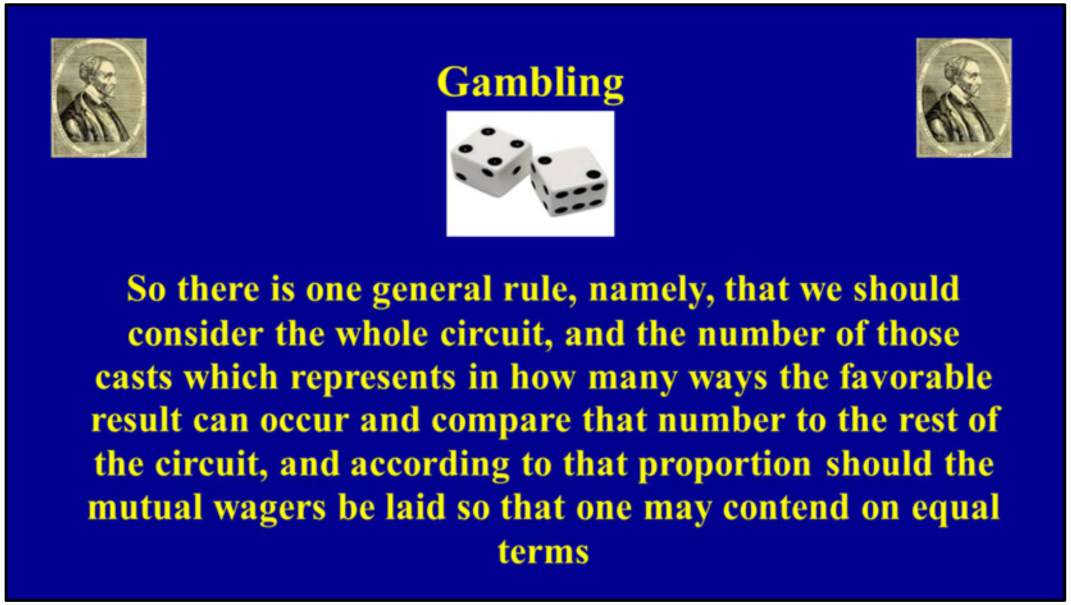
Lets take a brief look at how a very bright Italian man came to help us put our <u>trust</u> in statistics



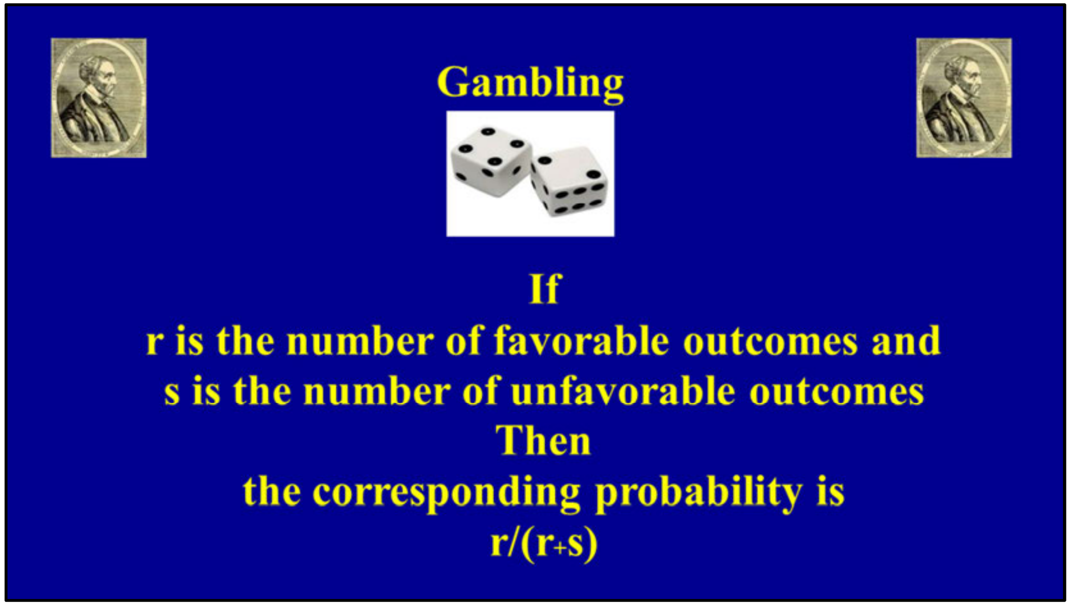
Its this guy – an Italian you may have never heard of.

He was the true Renaissance Man, First he lived in the renaissance , so that helped. He was another doctor….. But he didn't stop there….He became an expert in nearly every important topic of the day. He was also a prolific inventor.

But what most interested him, and most nearly all of the elite at that time was…..gambling. And, like us, they most enjoyed winning.

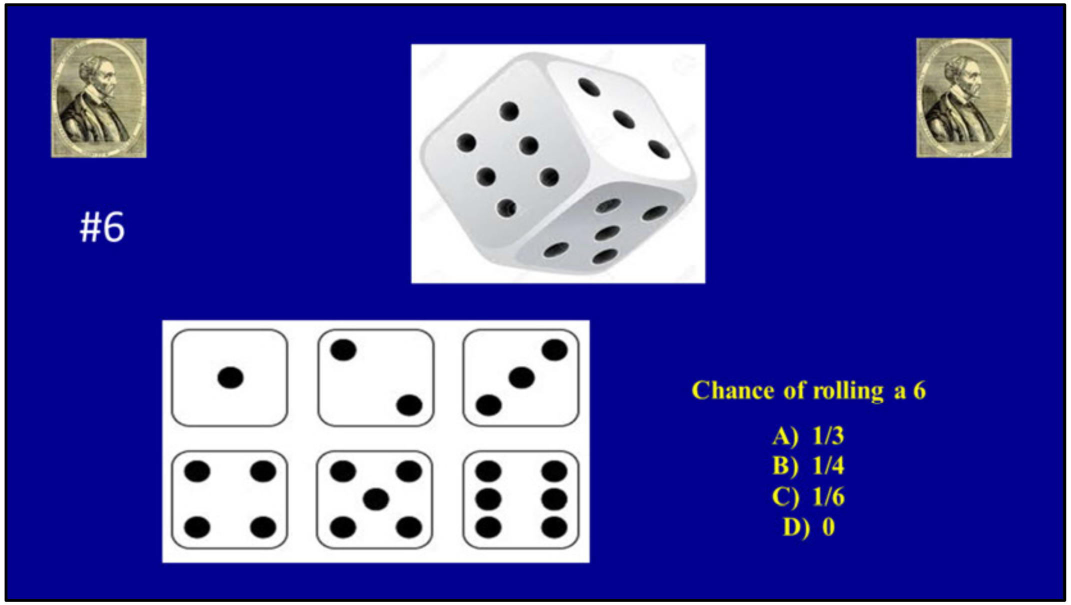


They didn’t bet on soccer scores or horses, they bet on dice.   This was one of the famous quotes from his master work. Don’t even try and read it.

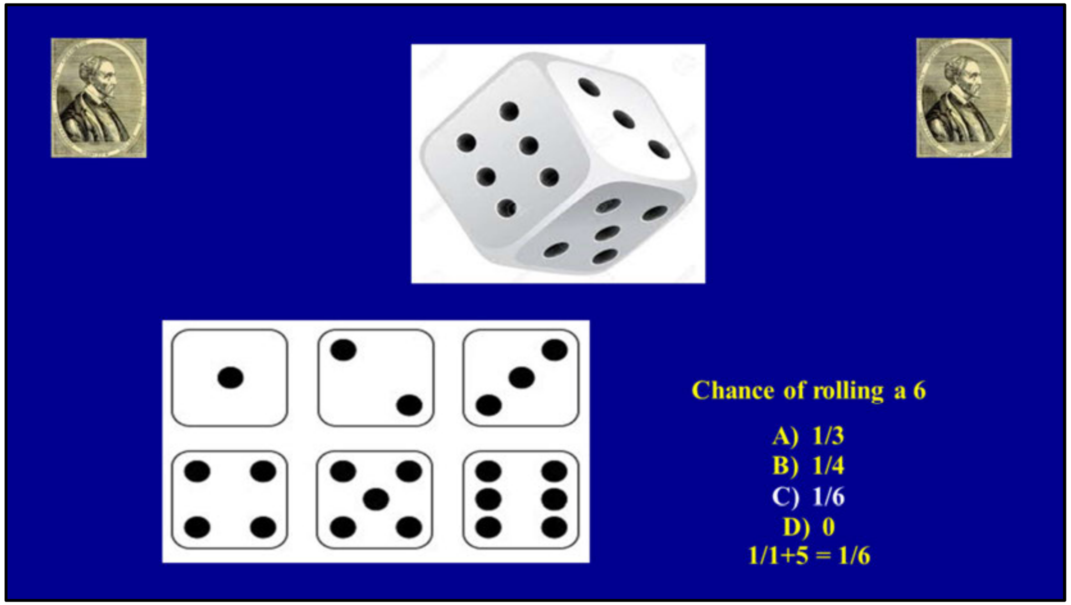


Here are his words in a format that we can perhaps better understand.

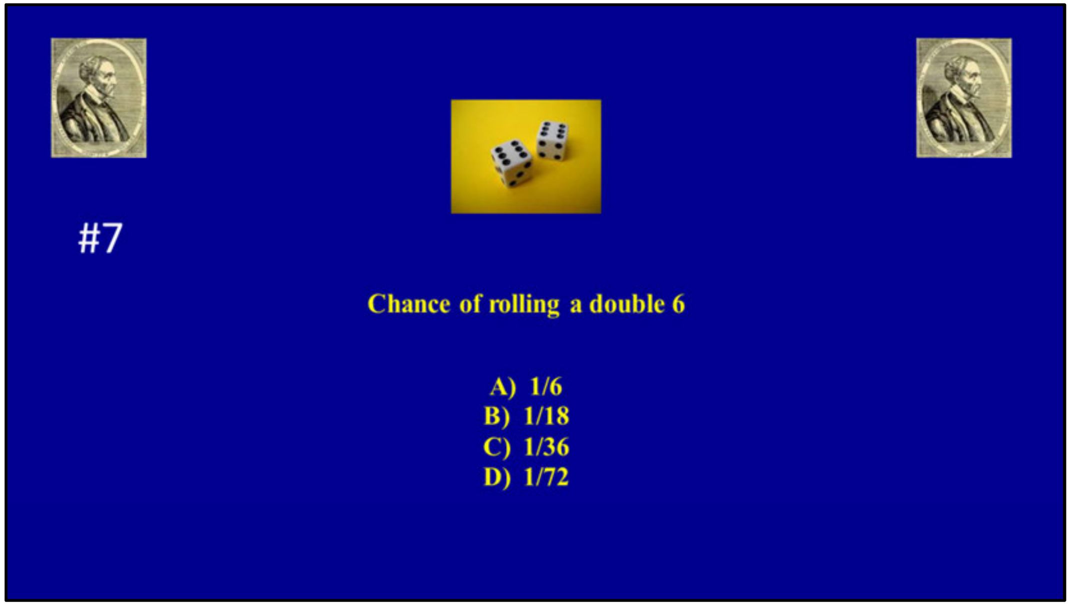
Here is how it pertains to dice



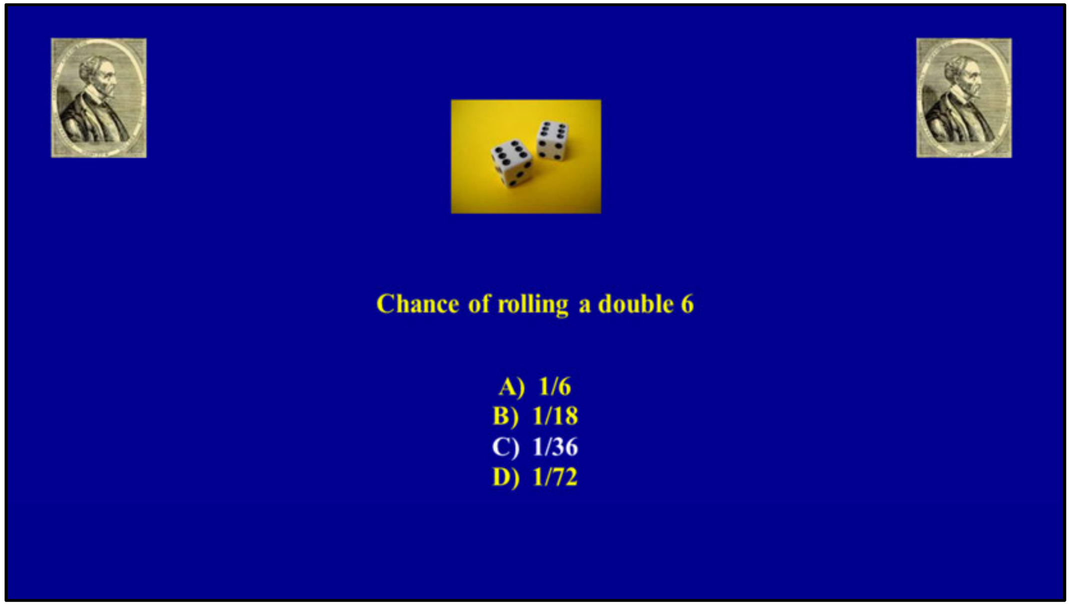
Which leads us to question #6. what is the probability that you will roll a 6 if you roll the dice once? Write down your answer.



It is of course 1/1+5 or 1/6

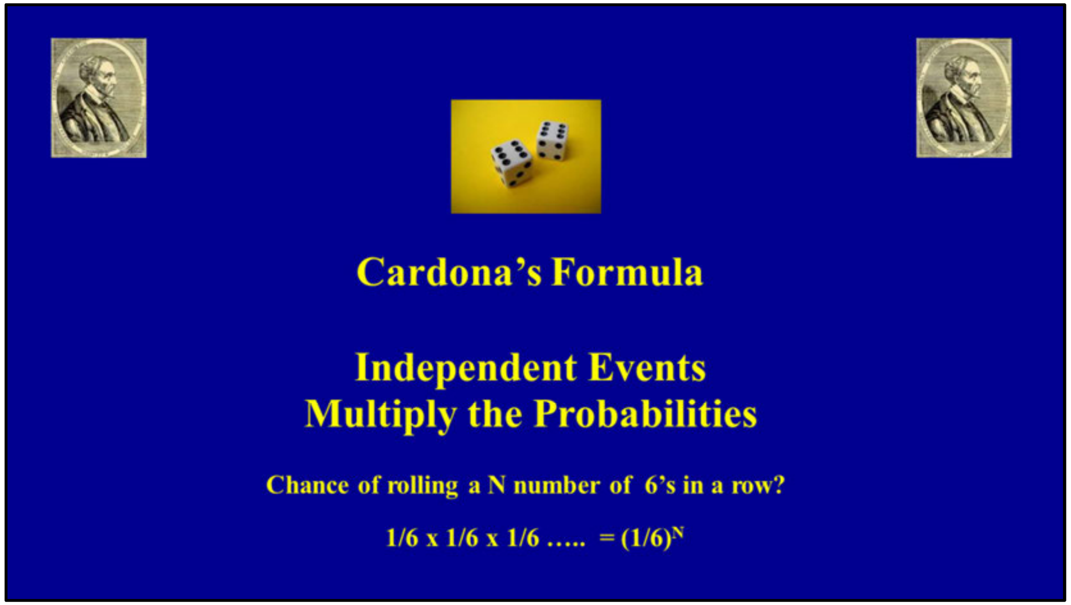


Now what is the probability that you will roll two sixes with one throw of two dice?

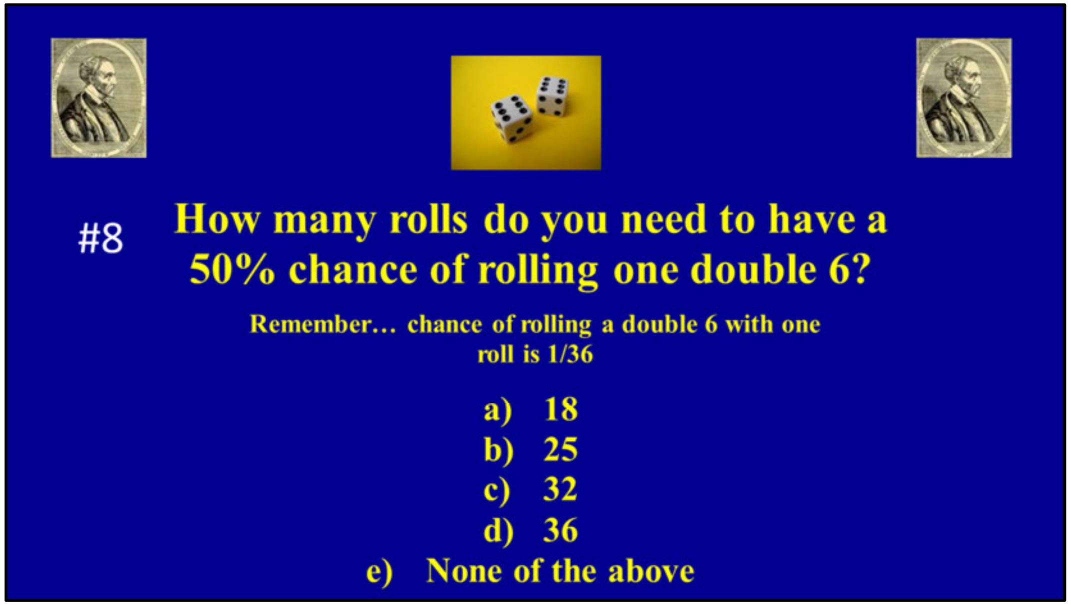


Again, many of you probably found this easy.

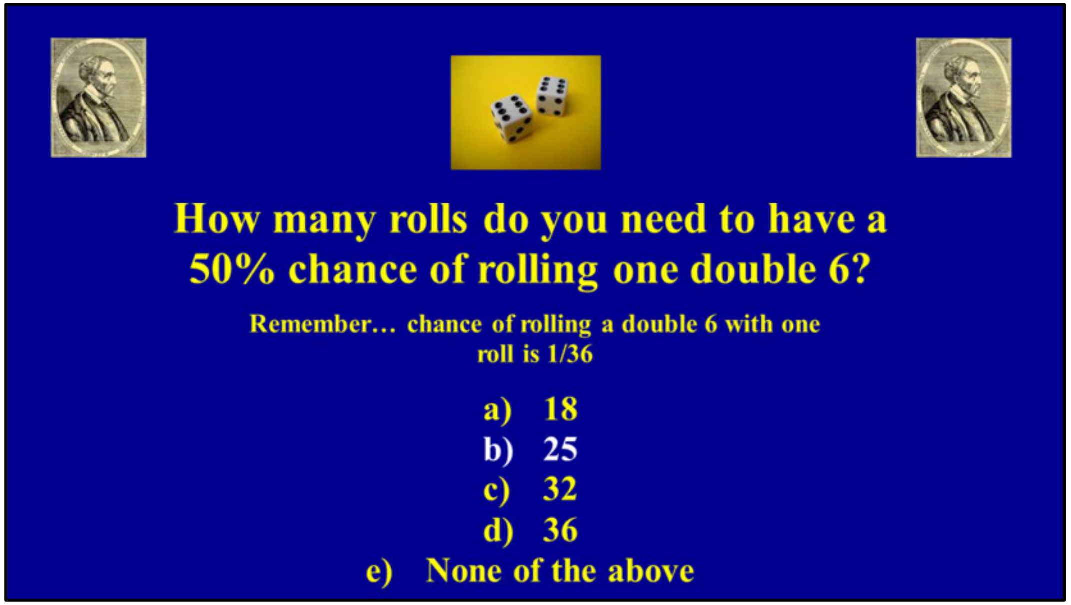
You multiply the two probabilities – everyone has learned this at some point. - This has been termed by some to be Cardona’s Rule.
Interestingly, when he came up with the idea he initially claimed that one should multiply the odds – but he quickly realized his mistake.



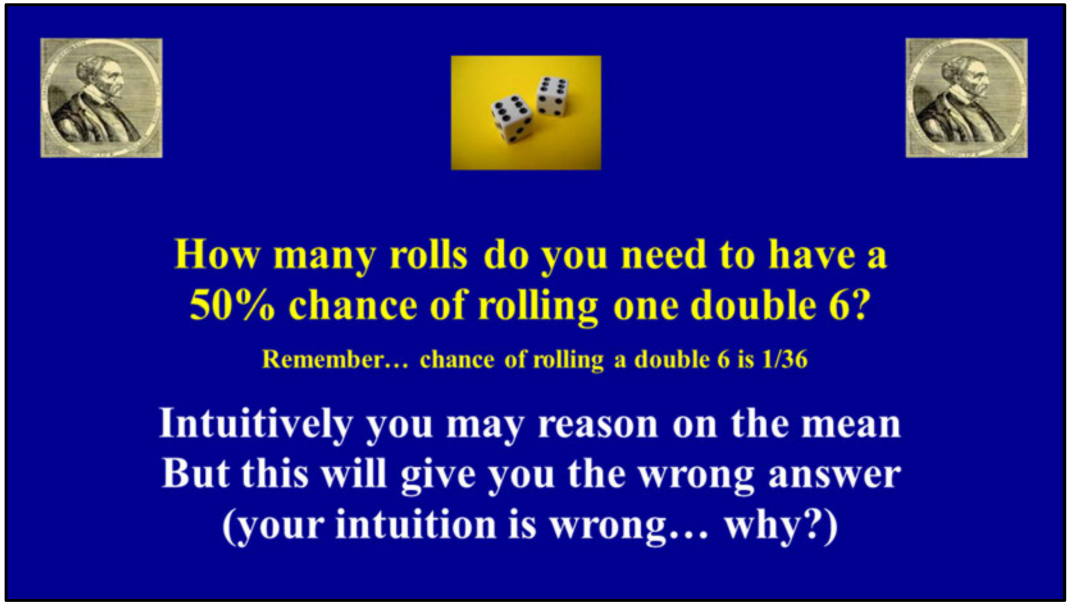
And if we take this further we realize that if we have N independent events then the probability will be that of an individual event to the Nth power.
So far so good, right?



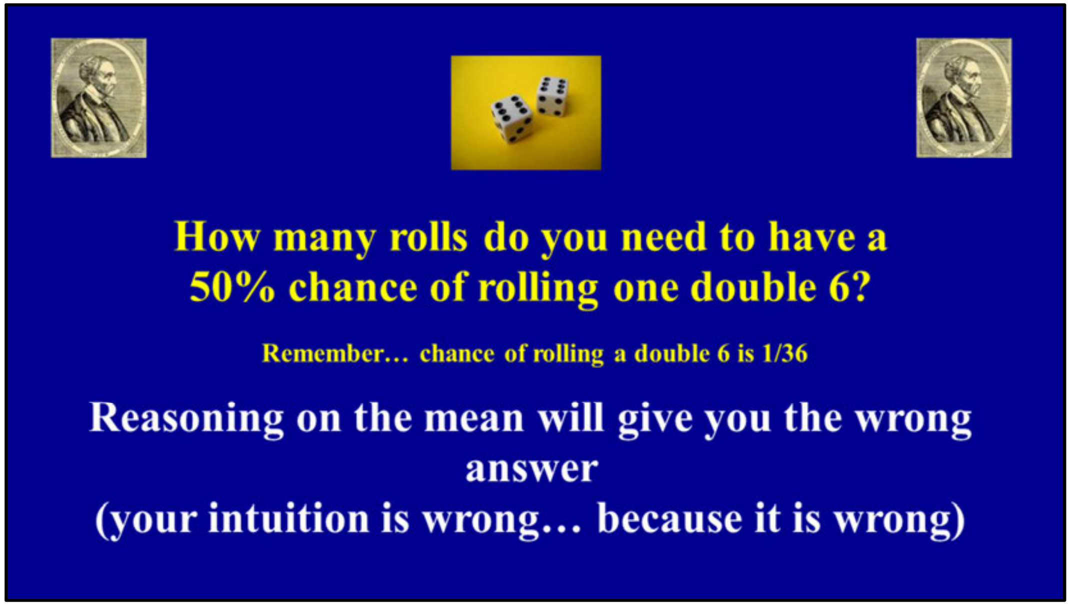
This is easy. Now let us examine the problem that was posed to Cardona by some of the wealthy gamblers of his time….. How many rolls do you need to have a 50% chance of rolling one double 6…… Remember that the chance of rolling a single double six is 1/36 .



Guess what……. Its not 18.



Now, intuitively you may reason on the mean. But this will give you the wrong answer. Why?



Because it does. So here was his secret….   In order to figure out the probability of it happening you have to first….

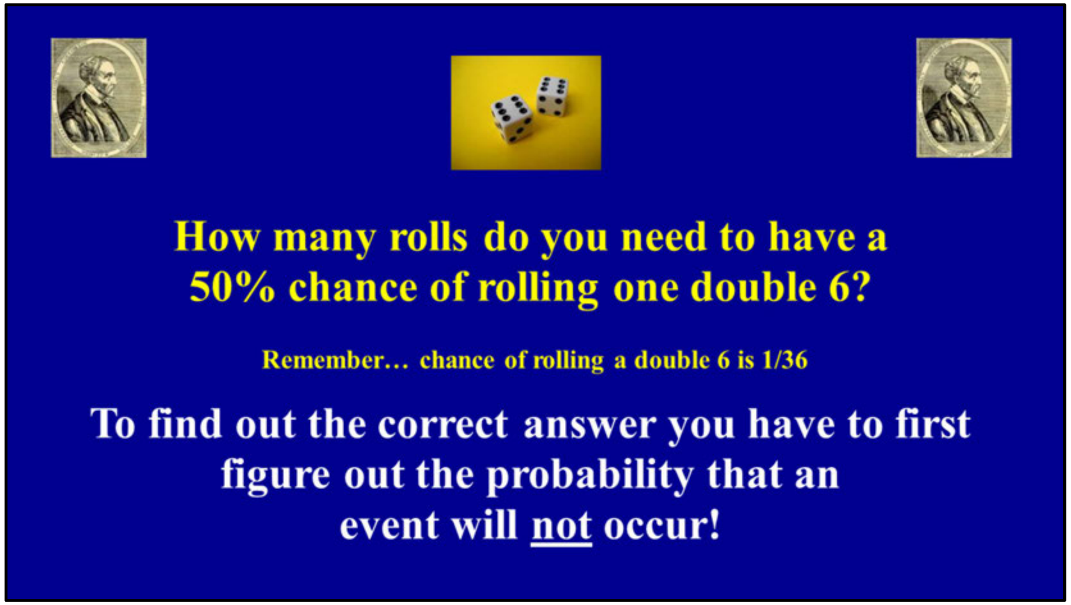
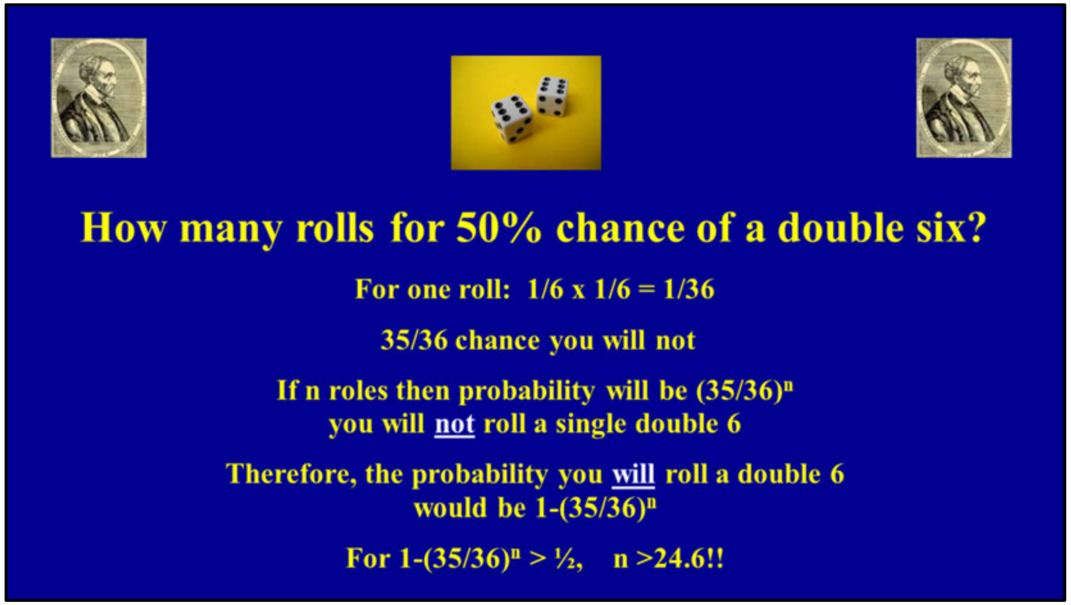
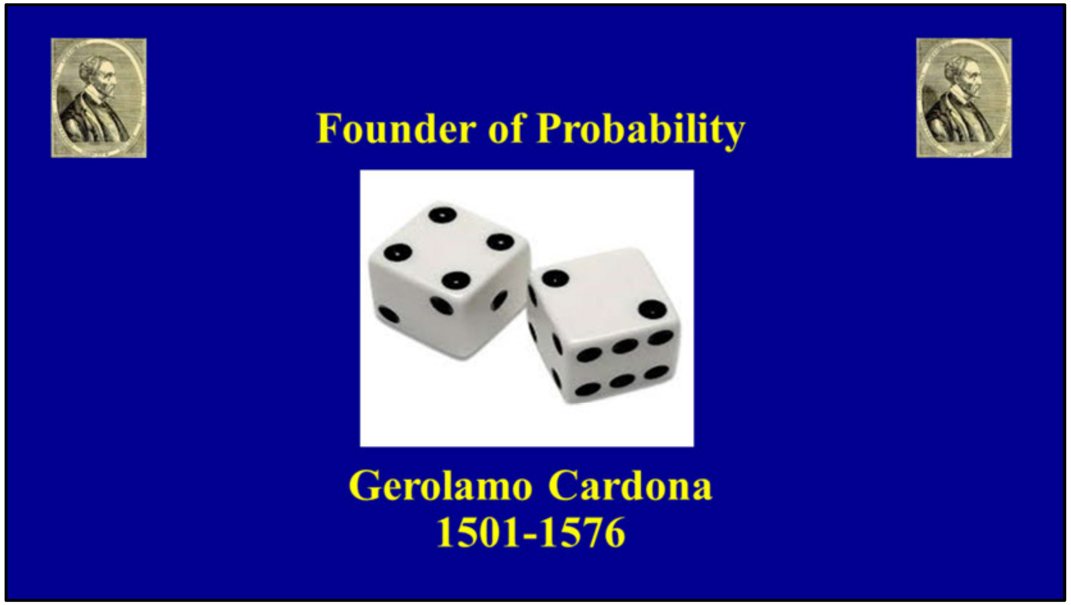


Figure out the probability that it will not occur….. And then subtract from 100%

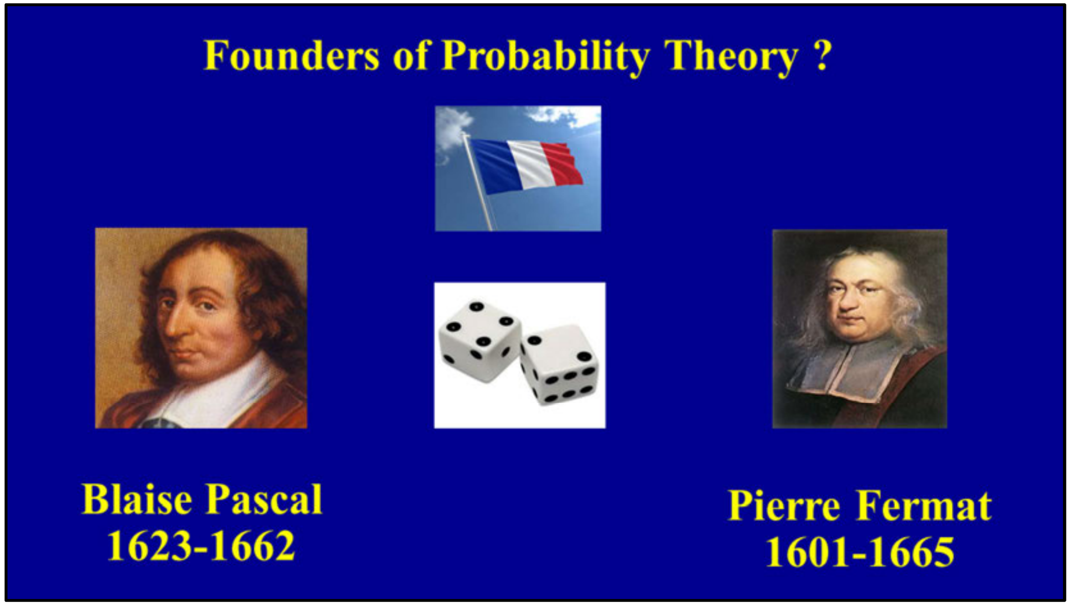


Here it is explained

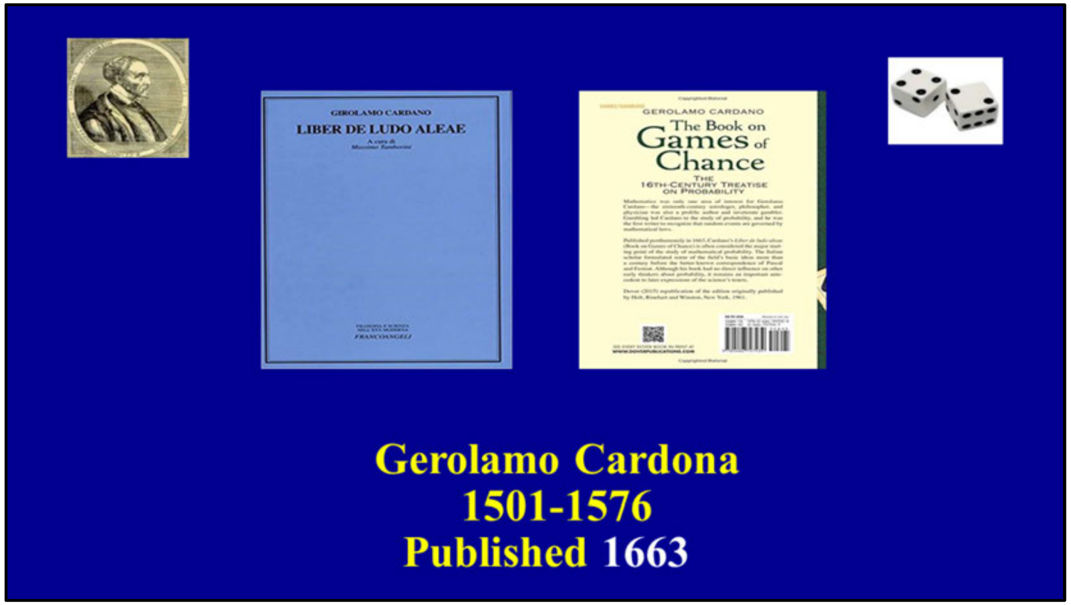
Strange? Yes
Reality? Yes
Pretty amazing. We cannot fully depend on our intuition.!



And for this work Cardona should rightly be called the Founder of Probability…. But he usually is not.   Who takes credit instead? Well…..



The French!!! Somehow they got the credit. Does anyone know why…?



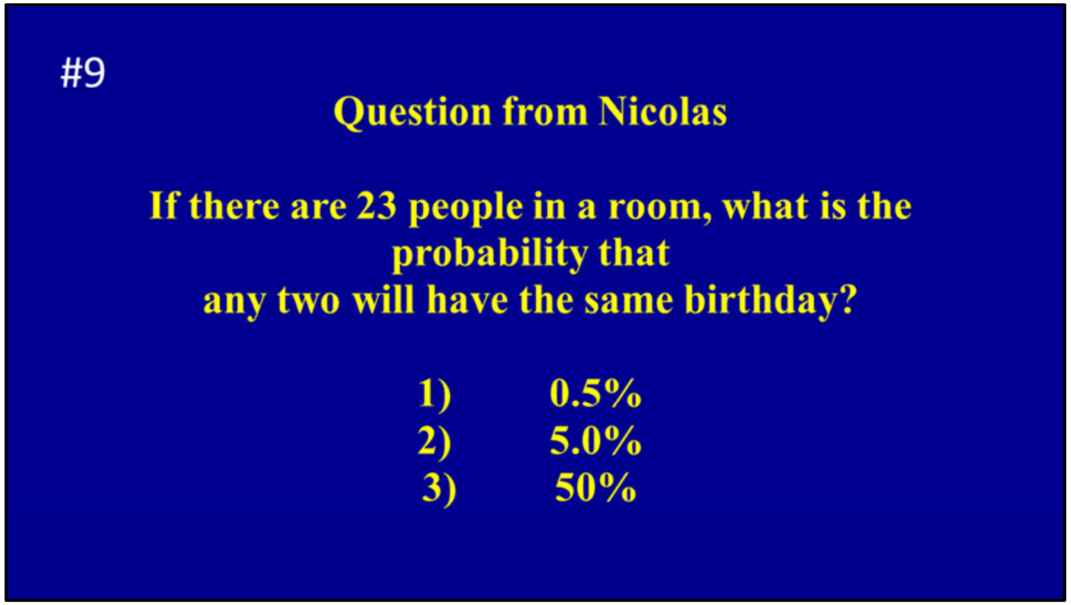
Because this book which included all of his early ideas including a section on effective cheating methods, …….translated into English as the Book on Games of Chance……. was published in 1663, Which leads us to an Important lesson….

Important Lesson #1

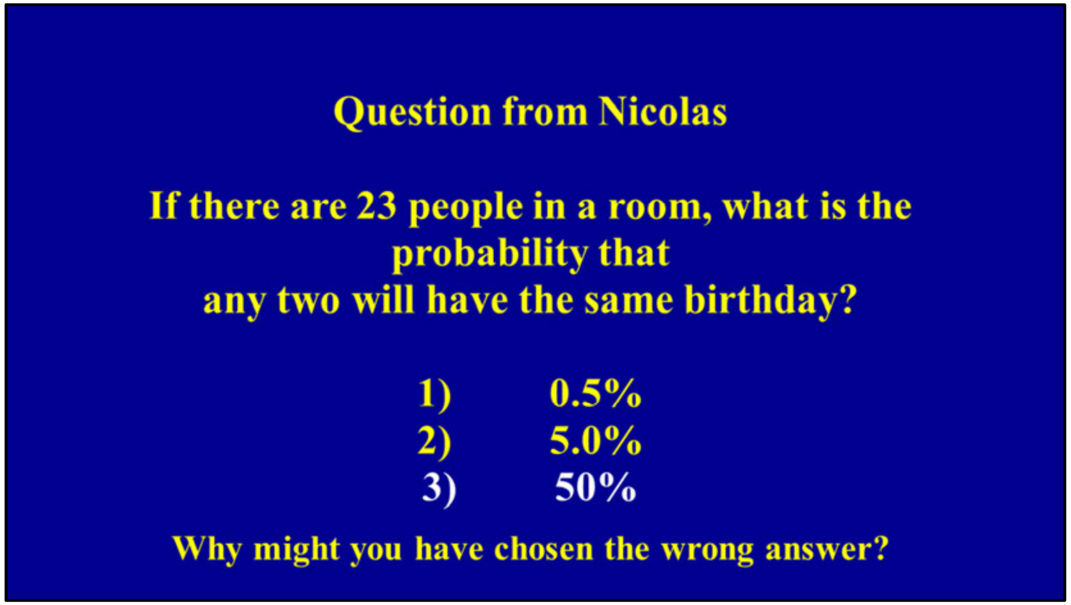
Don’t Delay in Publishing !

#1. Don’t delay in publishing!

At this point, we would like to have a well spoken Frenchman come to the podium to explain another entertaining example..



By birthday we mean march 3rd or September 16th or the like. Does everyone have their answer?



Shocking, isn't it ? In fact its <u>more</u> than 50%.

If there are 23 people in a room, what is the probability that you will have the same birthday as someone else?

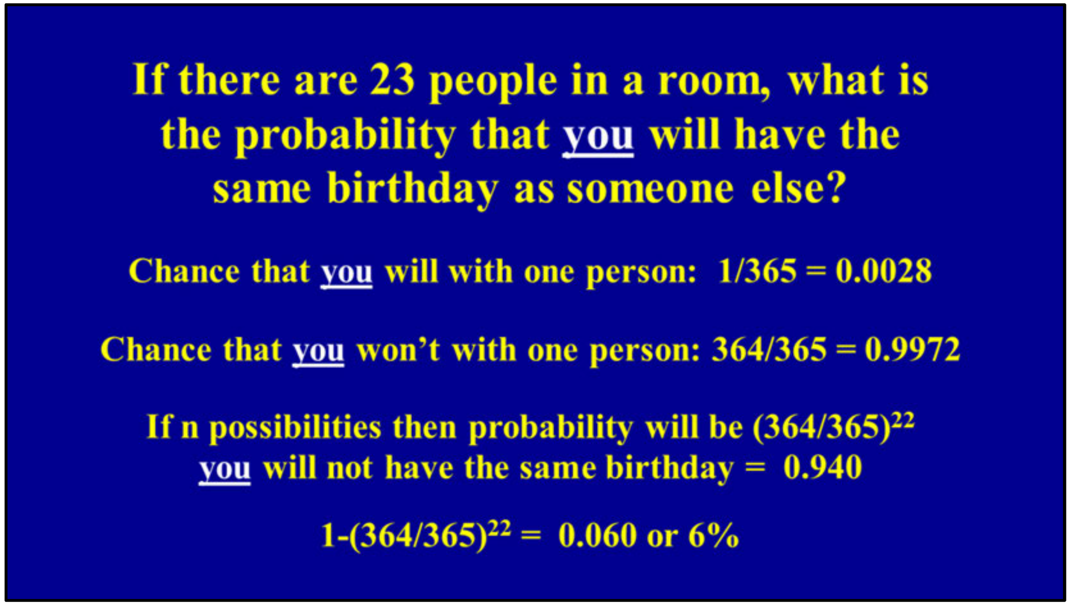
Chance that you will with one person: 1/365 = 0.0028

Chance that you won't with one person: 364/365 = 0.9972

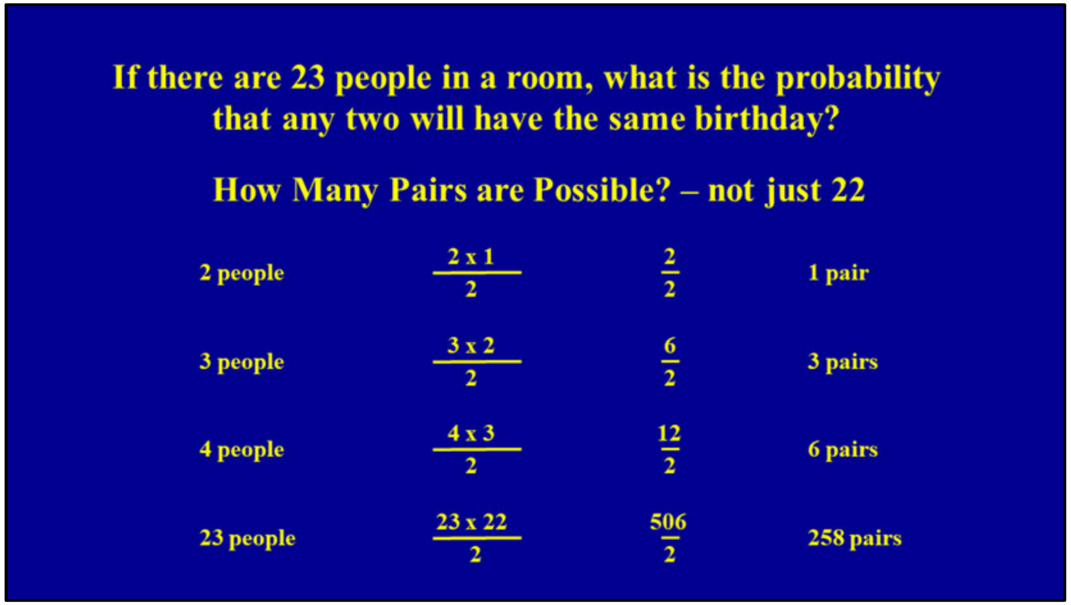
If n possibilities then probability will be $(364/365)^{22}$ you will not have the same birthday = 0.940

$1-(364/365)^{22}$ = 0.060 or 6%

Here is what you may have thought was going on. But…

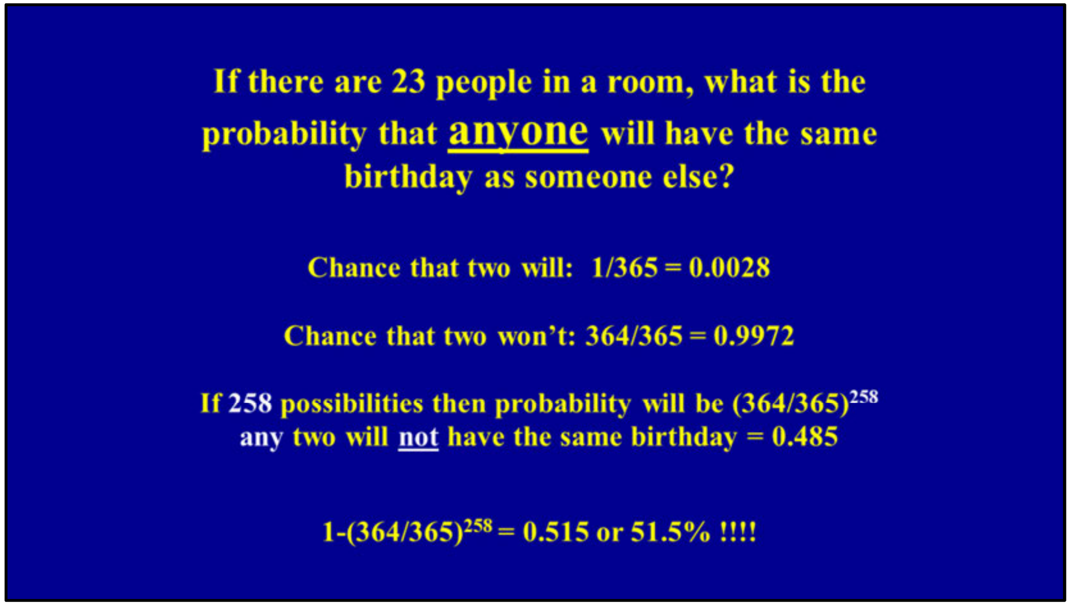


this is a very egocentric way of looking at the problem. Its not just about you!

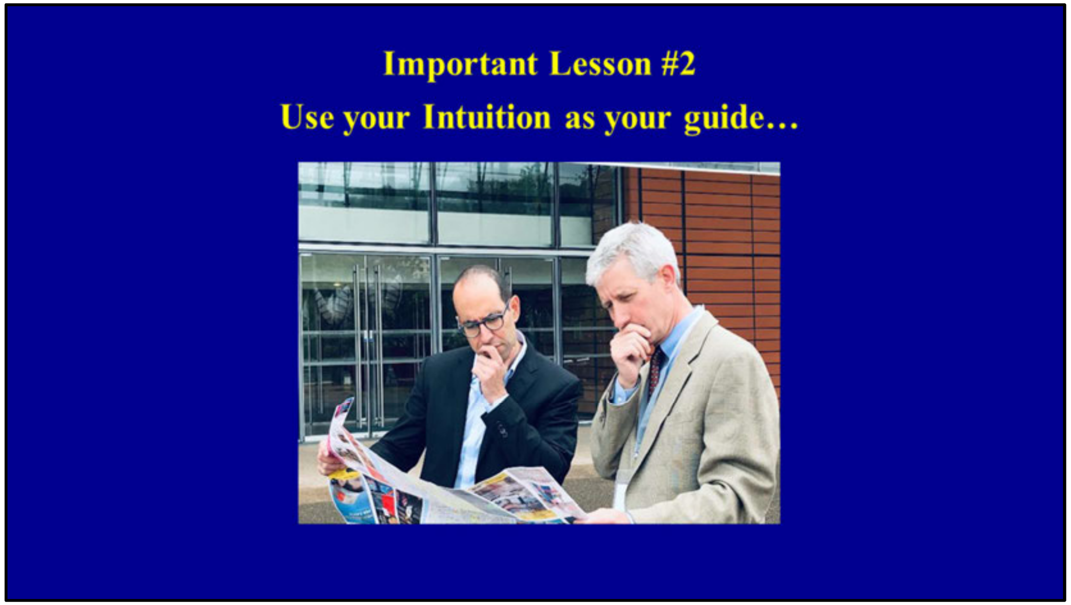


In fact, there are quite a few more possible pairs of individuals that can have the same birthday.
It follows from the law of permutations, that if there are two people, there can be one pair.
If there are 3 people there are three possible pairs and so on.

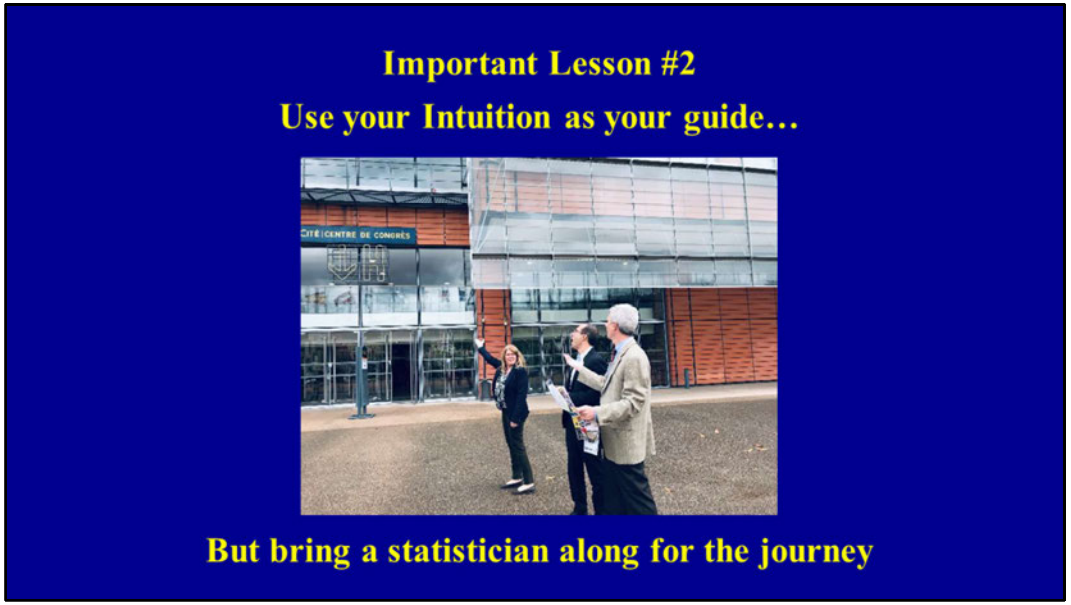
So for 23 people there are a total of 258 possible pairs



And so to have a condition in which none of the 258 total possible pairs have the same birthday, you need to raise it to the 258th power. So in the room, there is a 48.5% chance of there not being any individual pair with the same birthday…….. Or a 51.5% chance that there is!!



So lesson number 2 is what? Use your intuition as your guide, but…..



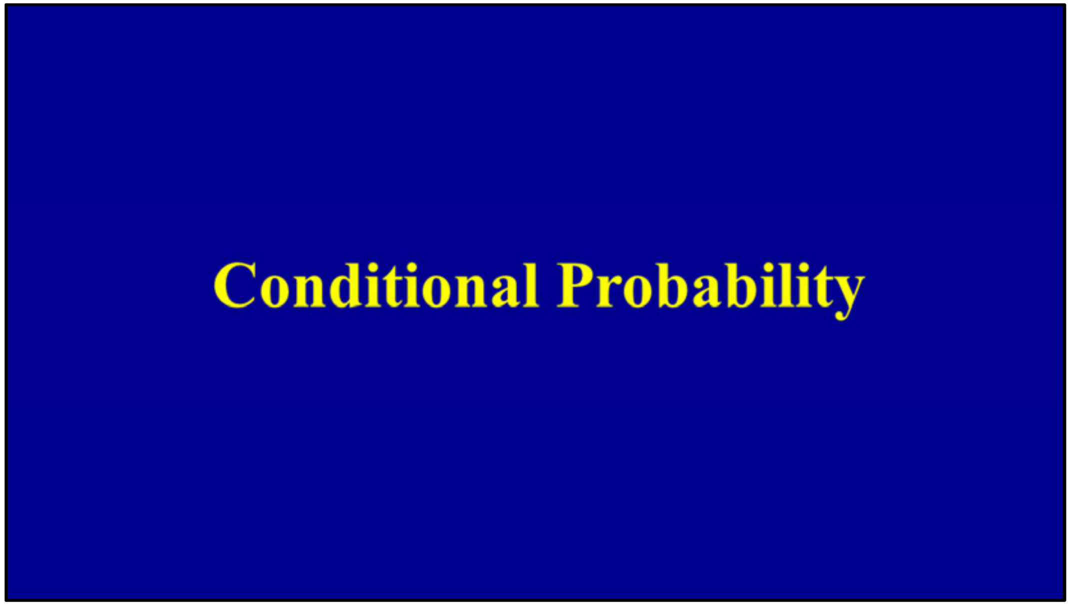
bring a statistician along for the journey.

Parallel programme: Thursday 25, April 2019

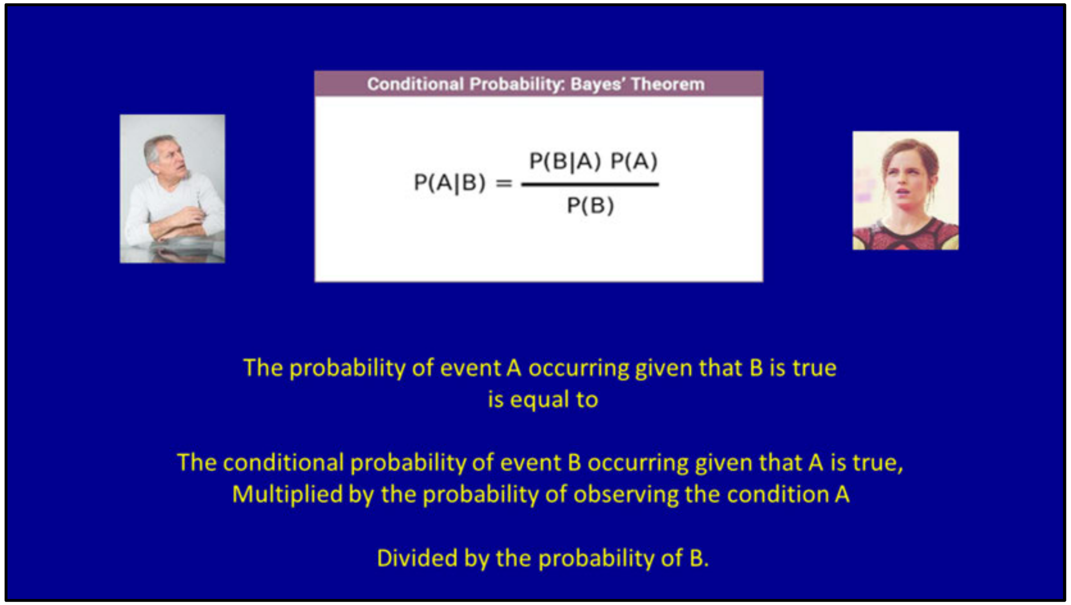
16:45 - 17:30	**Research Committee Session: "Everything you should know about statistics in 45 terrifying minutes"** *Katherine Herbst (USA), Martin Kaefer (USA), Magdalena Fossum (Sweden), Goedele Beckers (Netherlands)*

And this Journey continues this afternoon at 4:45!

The next highly entertaining area of probability brings us to this relatively serious looking fellow. An Englishman. Bayes was the individual who gave us incredible insight into this arena of probability. And this was in respect to our understanding of



Conditional Probability. This is Bayes Formula….



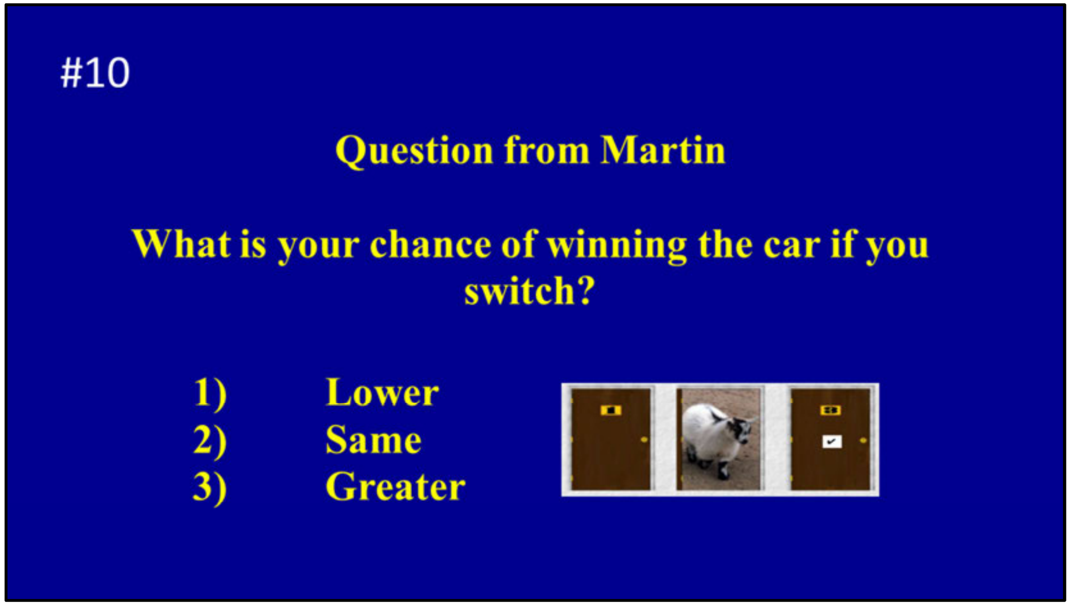
Confused? , scared?

….. Its actually a truly amazing formula that explains a lot of really cool stuff. For example this helps explain the Monty Hall Problem. What is the Monty Hall Problem you may ask?

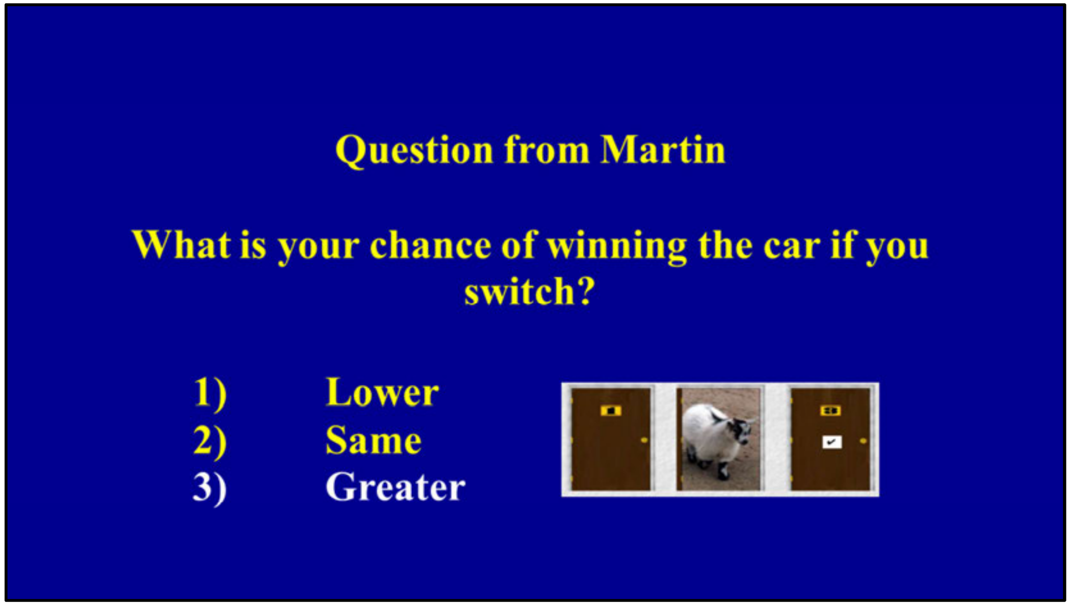
Well, it’s a game. Lets play. Behind one of these doors is a car, while behind the other two are goats. Lets assume for arguments sake that you prefer cars. You get to choose one of the doors. Which one will it be?

You pick three. So now in this game I am going to open one of the other doors to show you what is behind it. Remember, that I know what is behind the other doors, so I am going to open one that has a goat.

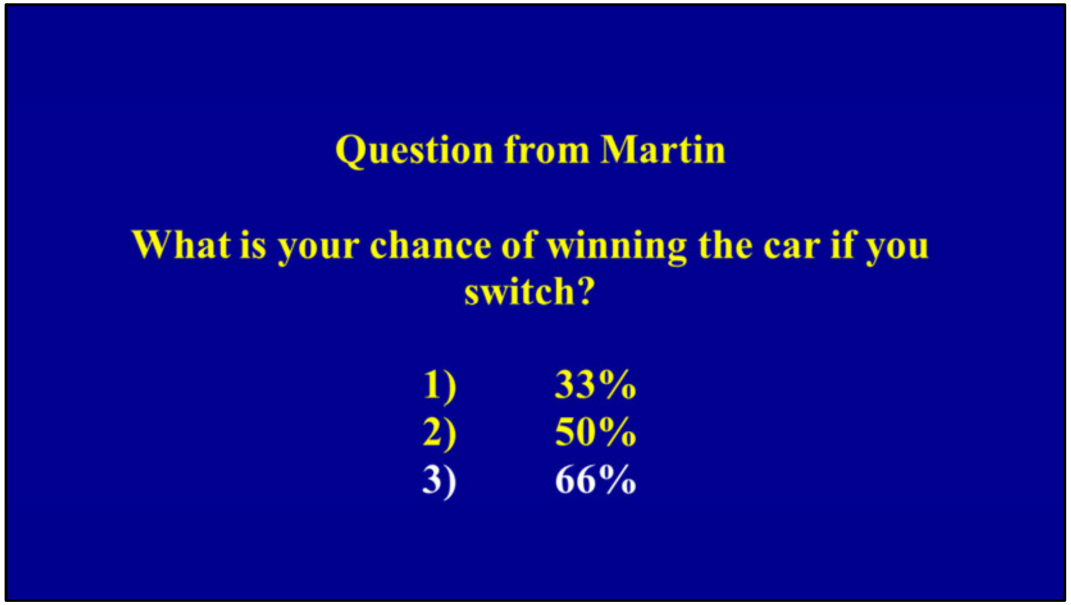
Behind door number 2 is a goat. So now comes the interesting part of the game - -- I offer you the option of switching to door one, or keeping number 3? What do you want to do?



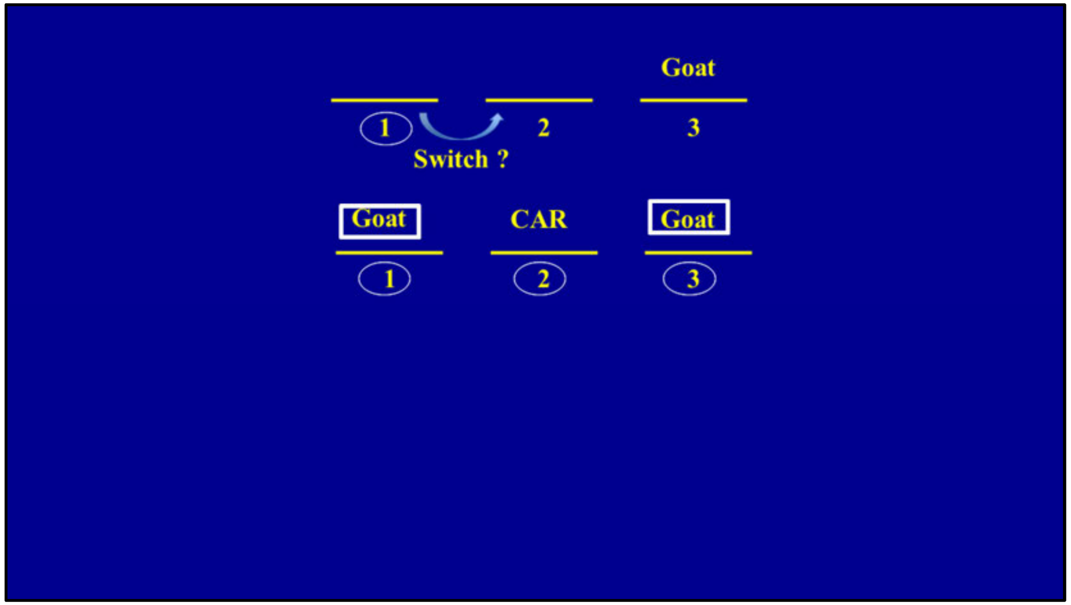
It basically boils down to this? Have you written down your answer?



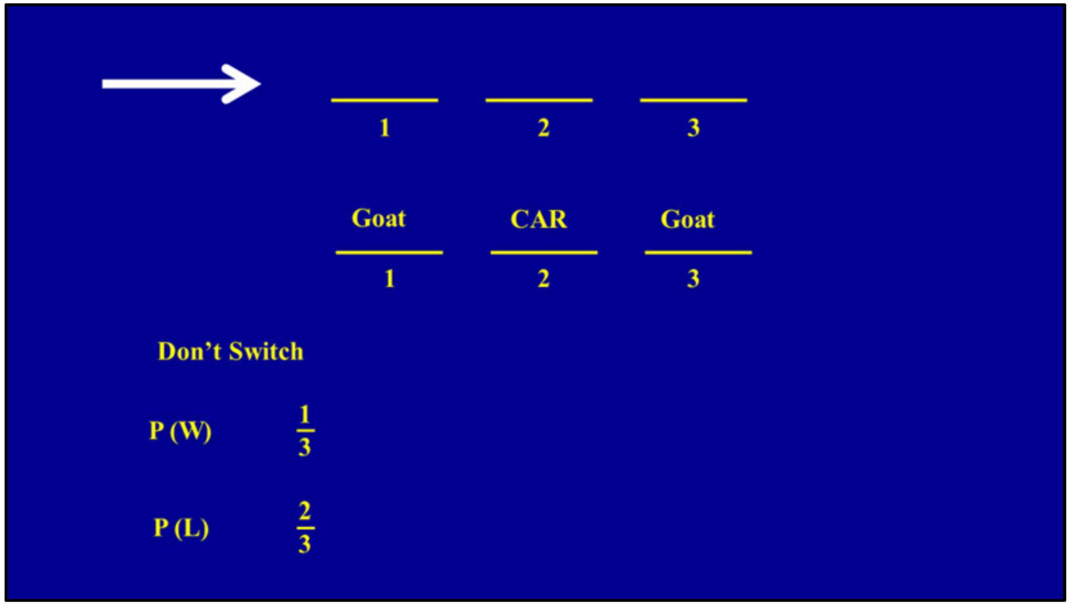
And its actually Greater. In fact…



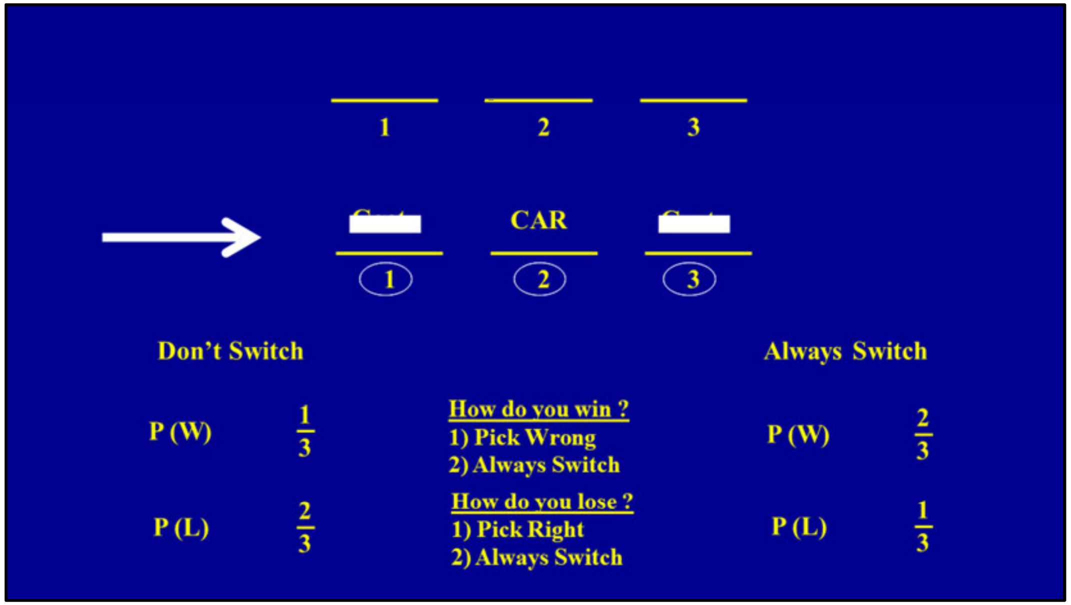
Your chances are twice as good of winning if you switch. How can this be ???



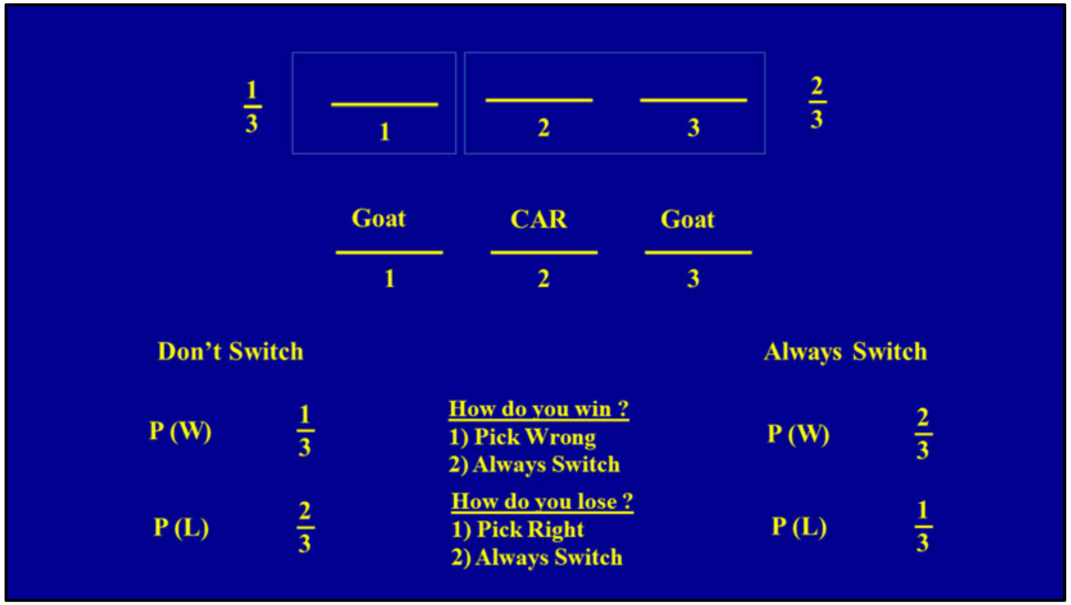
Well. And this is worth paying attention to……….
Here is the problem again.
Do you Switch?
Well lets say this is how they are arranged.
If you pick door 1, then I show you door 3
If you pick door two, then I can show you either one
If you pick door 3, then I show you door 1
So what is the probability If you….



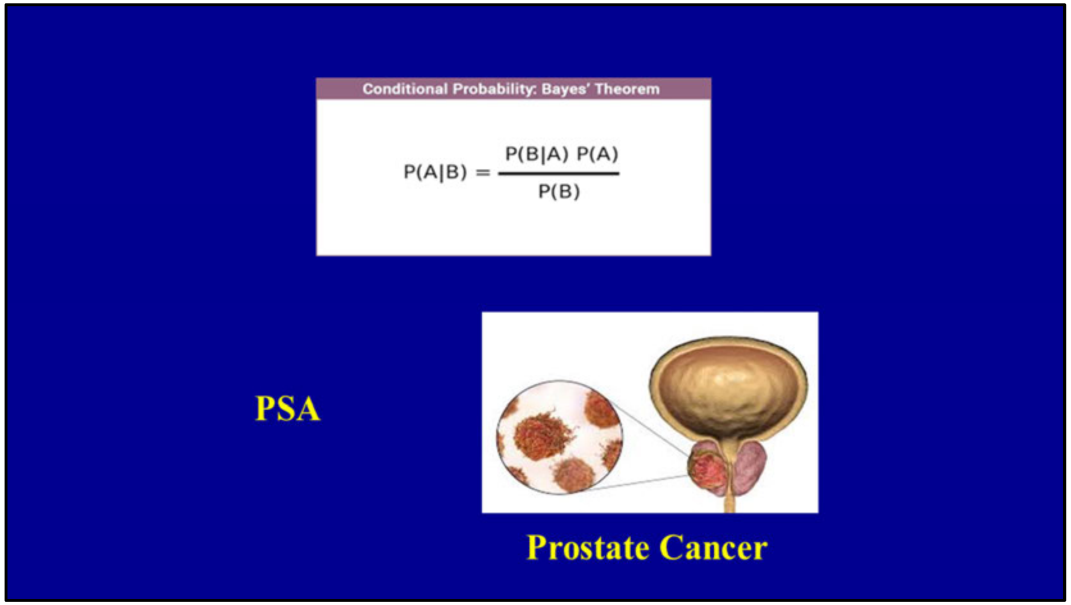
……. don't switch? Well…the probability of you winning is 1/3 rd and the probability of you losing is 2/3rds



Now what if you always switch? Well lets think of the scenerios…..
When would you win? You would have to first pick wrong – what is the chance of picking wrong? 2/3rds
And what is the chance of initially picking right and then switching? 1/3rd. And there you have it !!



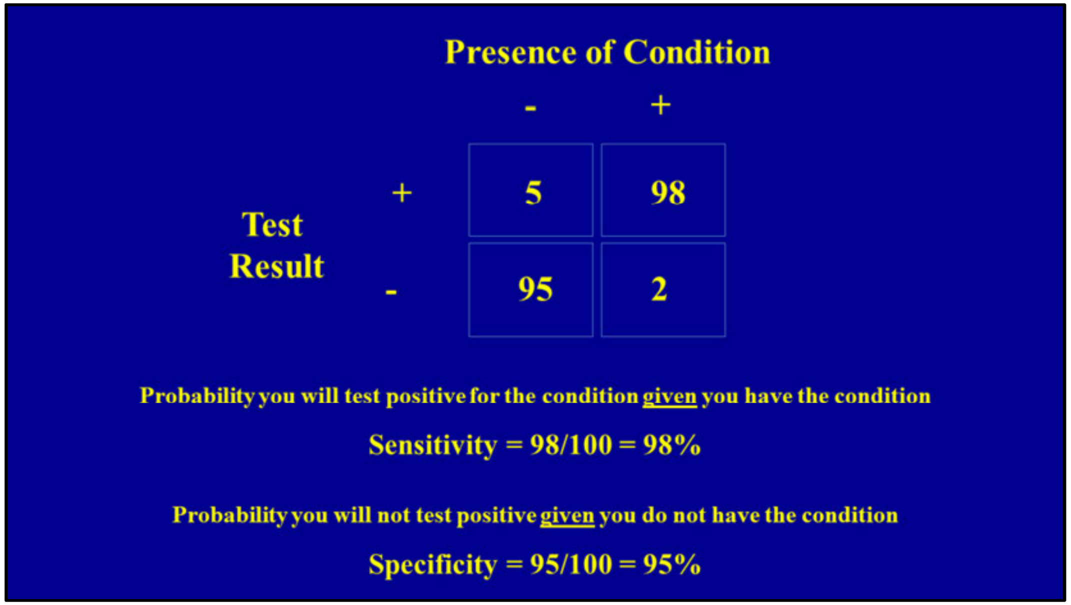
Perhaps an even easier way to think of it would be like this…..
In the beginning you have a 1/3rd chance of winning leaving 2/3rds chance of winning remaining.
Would you rather have 2/3rds of the choices or 1/3rd?



The Bayes formula can be used to actually prove this. But lets look at something more relevant than cars and goats. Lets look at a clinical situation. The Bayes Conditional Probability formula helps us with real life clinical problems. Lets say for example that you have a patient with an elevated test for cancer. If we focus on simple parameters like sensitivity and specificity we can make some very interesting predictions.

		Presence of Condition	
		-	+
Test Result	+	5	98
	-	95	2

Here is a table that we should all be familiar with. It shows us the number of subjects that test positive or negative and whether or not the disease is present or absent.



We have some commonly understood definitions. For example Sensitivity. Read the definition. Which in this case would be 98 over a total of 100 (one can say there are 98% true positives) And Specificity…… (one could say there are 95% true negatives)

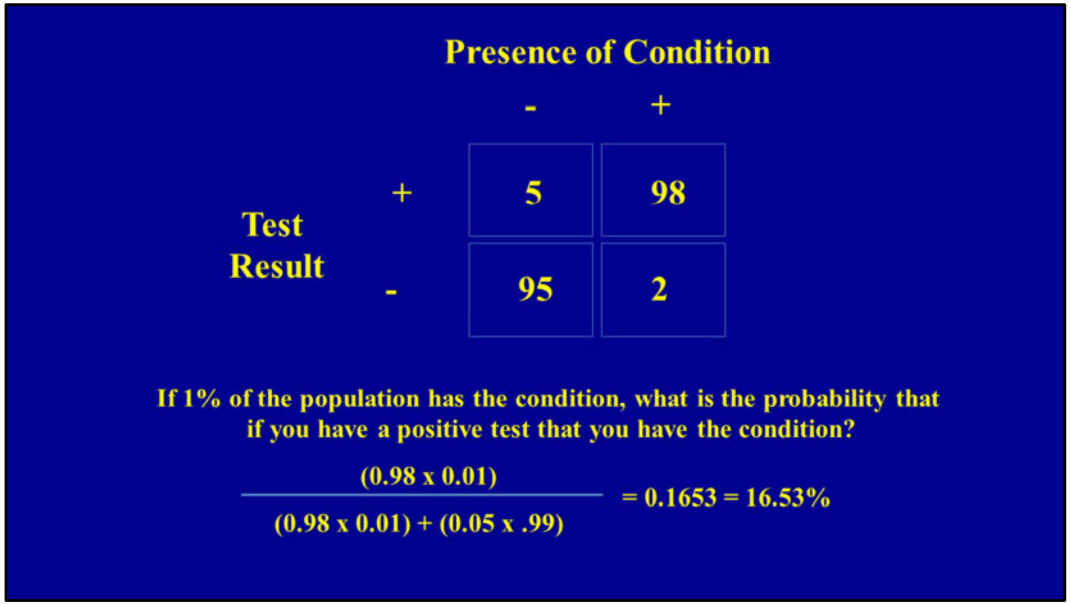
Presence of Condition

Test Result	-	+
+	5	98
-	95	2

If 1% of the population has the condition, what is the probability that if you have a positive test that you have the condition?

$$\frac{\text{Sensitivity} \times \text{Incidence}}{(\text{Sensitivity} \times \text{Incidence}) + (\text{Complement of Specificity} \times \text{Complement of Incidence})}$$

Now if only 1% of the population has this condition,
We simply plug the data in to the Bayes formula…. And get



For a low probability event with a high sensitivity and less than ideal specificity, the probability that someone who tests positive has the disease is relatively low.
(This is because the disease incidence is low, and due to less than perfect specificity there are more healthy people with a positive test than there are people with the disorder that have a positive test)
Raise the specificity of the test and this phenomenon is not as profound)

However, what if the test is done twice?

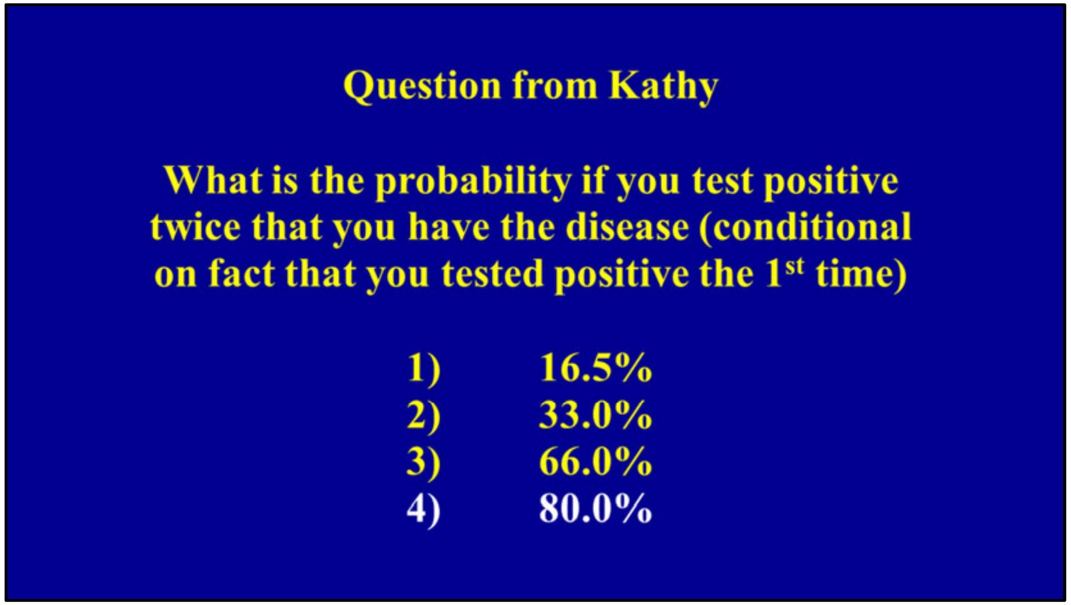
#11

Question from Kathy

What is the probability if you test positive twice that you have the disease (conditional on fact that you tested positive the 1st time)

1) 16.5%
2) 33.0%
3) 66.0%
4) 80.0%

So now what is truly fascinating… What ….



It goes up to almost 80%.

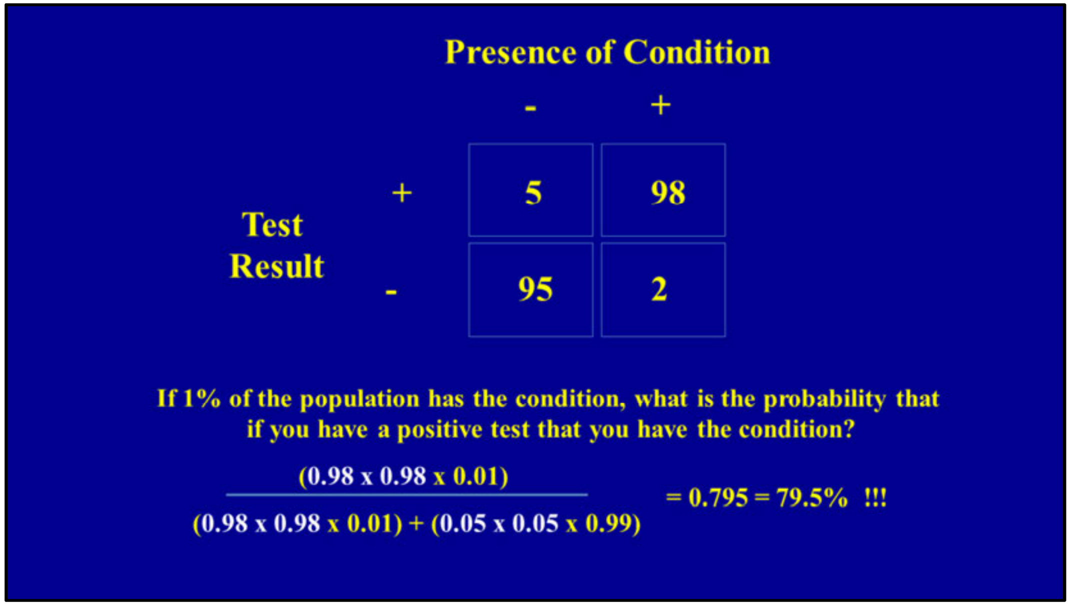
Presence of Condition

		-	+
Test Result	+	5	98
	-	95	2

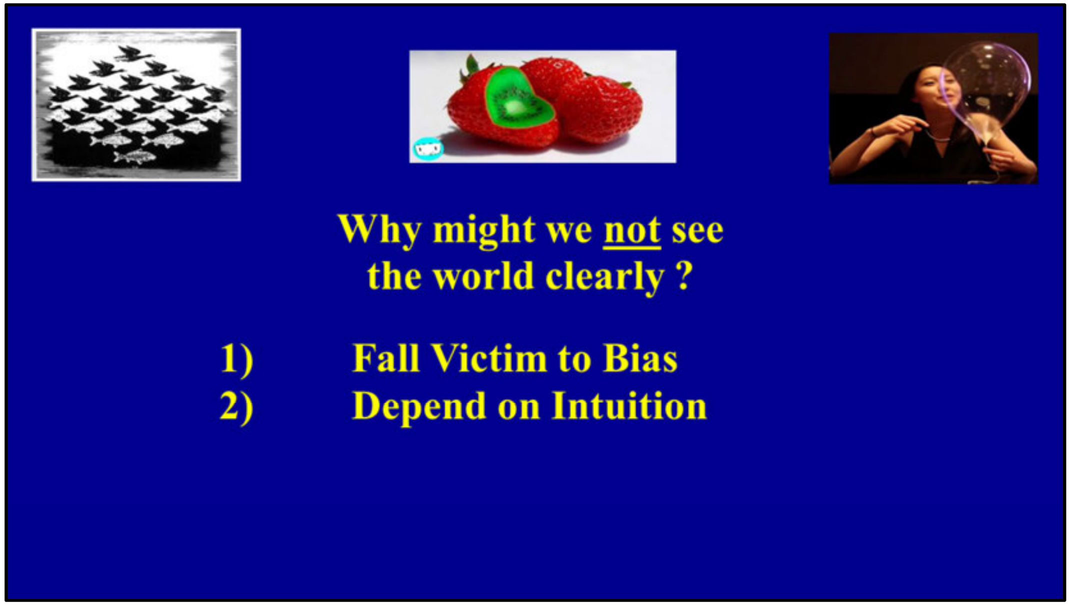
If 1% of the population has the condition, what is the probability that if you have a positive test that you have the condition?

$$\frac{(0.98 \times 0.98 \times 0.01)}{(0.98 \times 0.98 \times 0.01) + (0.05 \times 0.05 \times 0.99)} = 0.795 = 79.5\% \ \ !!!$$

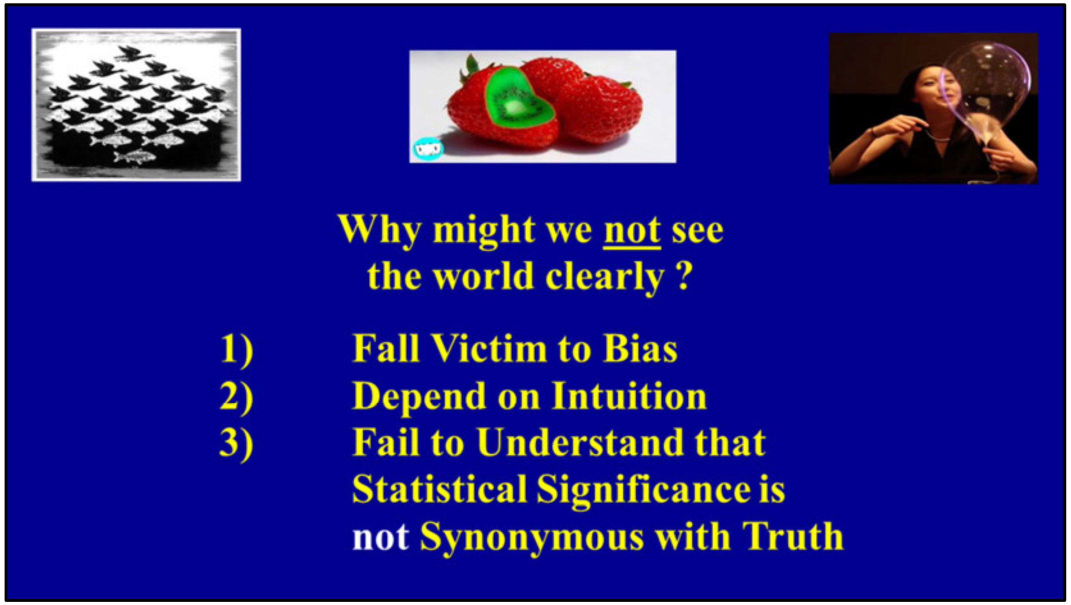
Here is the math – with cardona’s rule nestled inside



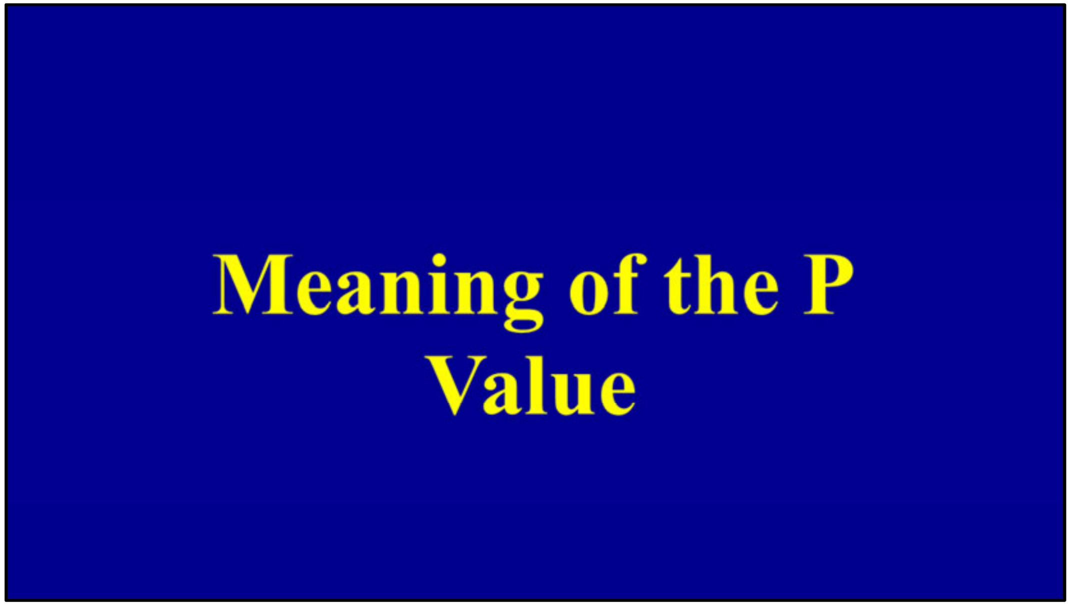
Here is the math – with cardona's rule nestled inside



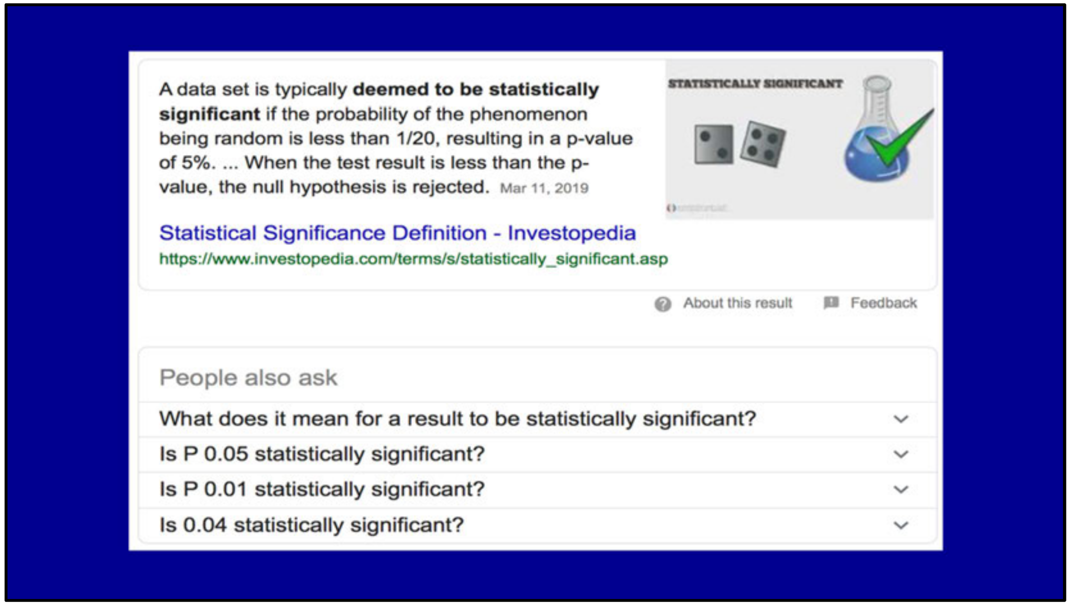
A third reason we may not see the world so clearly is because…



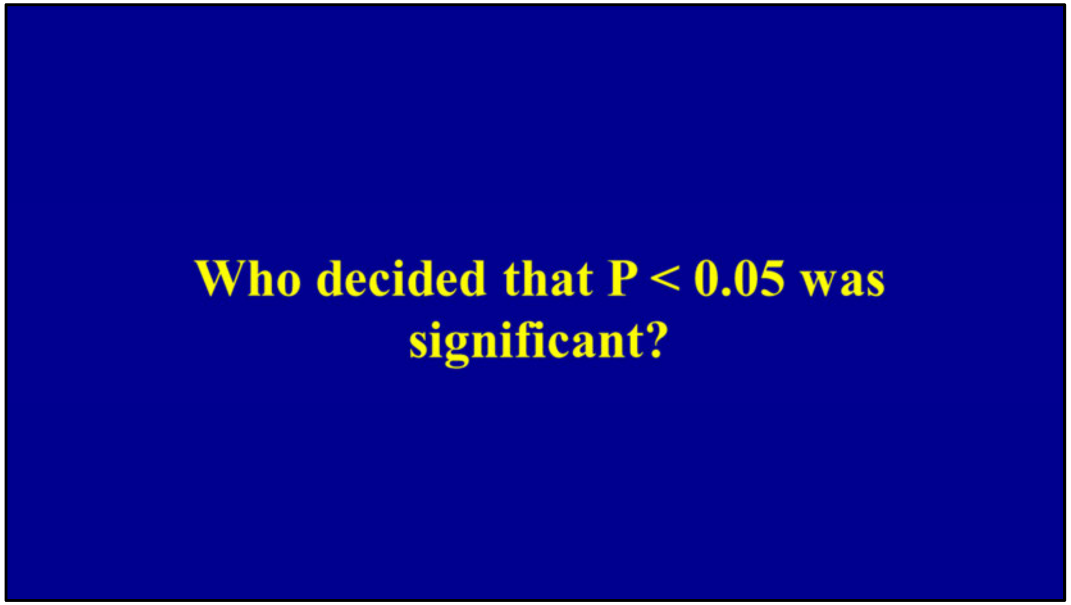
… we equate statistical significance with truth.



Which brings us to the meaning of the P value. What is statistically significant? Well. If we go to google…



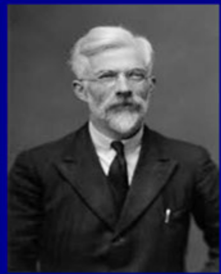
We find the following. Most commonly a p value of less than 0.05 is used. What does this mean? This means that…it is deemed to be statistically significant if the probability of the phenomenon being random is less than one in twenty or less than 5%. Interesting



Who decided that this 0.05 was the mark for something being statistically significant? Well… it was

In 1925, Ronald Fisher advanced the idea of statistical hypothesis testing, which he called "tests of significance", in his publication *Statistical Methods for Research Workers*.[25][26][27] Fisher suggested a probability of one in twenty (0.05) as a convenient cutoff level to reject the null hypothesis.[28] In a 1933 paper, Jerzy Neyman and Egon Pearson called this cutoff the *significance level*, which they named α. They recommended that α be set ahead of time, prior to any data collection.[28][29]

Despite his initial suggestion of 0.05 as a significance level, Fisher did not intend this cutoff value to be fixed. In his 1956 publication *Statistical methods and scientific inference*, he recommended that significance levels be set according to specific circumstances.[28]



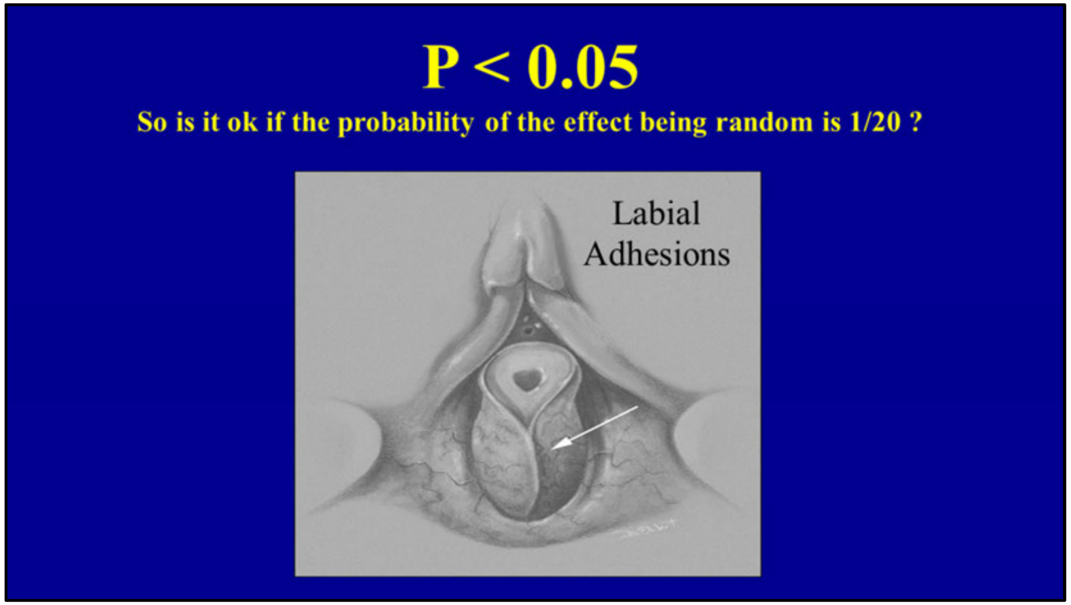
Ronald Fisher
British Statistician
1890-1962

Ronald Fisher. But he never really intended for this value to be fixed.

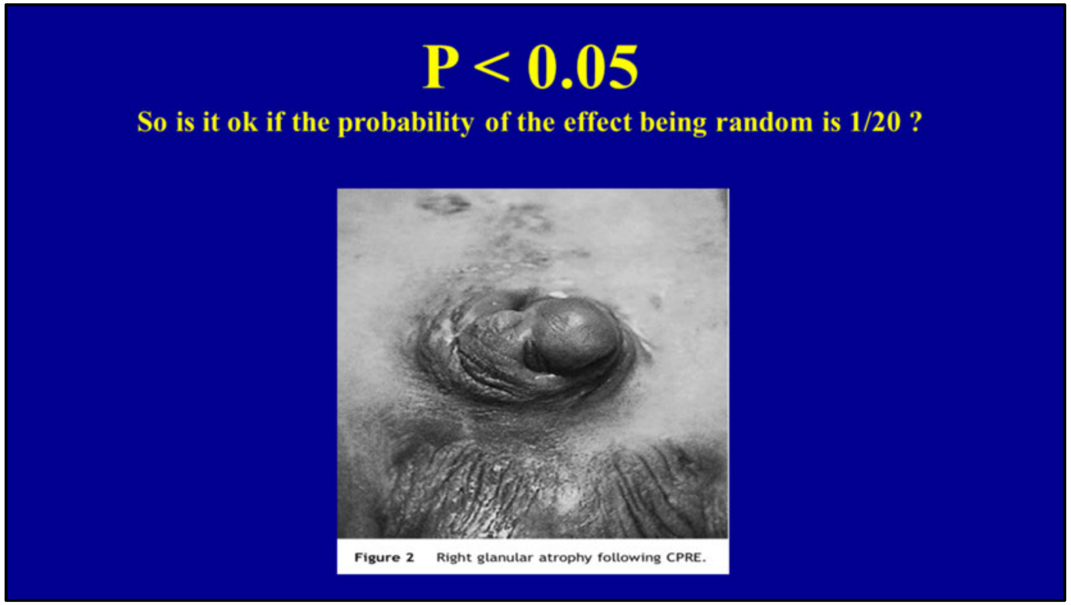
$P < 0.05$

So is it ok if the probability of the effect being random is 1/20 ?

So is it ok if the probability of the result being random is 1/20? Maybe. But Maybe not. For example….



Many of us would accept the probability of the effect being random 1/20 times if it concerns labial adhesions being treated with steroids.
However,….



if it pertains to the risk of losing half a penis during an exstrophy closure, is 5% chance of the finding being random good enough? Or to push this argument even farther…

…is is adequate when utilizing new softwear in a Boeing Airplane. Or should we demand more!

What is Significant Enough?

$P < 0.05$	$\frac{1}{20}$	5%
$P < 0.01$	$\frac{1}{100}$	1%
$P < 0.001$	$\frac{1}{1000}$	0.1%
$P < 0.0001$	$\frac{1}{10000}$	0.01%

So here is what the various P values mean.   So you might ask?

Who decides were the threshold is placed?

Well, We do. It is our job to discuss, debate and decide what standard we need to have before we think the evidence is adequate. This is why we come to meetings.

What is Significant Enough?

P < 0.1	1/10	10%
P < 0.05	1/20	5%
P < 0.01	1/100	1%
P < 0.001	1/1000	0.1%
P < 0.0001	1/10000	0.01%

On the flipside, one might ask what makes P<0.1 lack importance? Nothing actually. If there is a groundbreaking finding with huge import and you find that there is a 90% chance that your results were not due to random chance….. Should you report them?   I for one at would be willing to listen.

Important Lesson #3

Statistical Significance does not Equal Truth

Ask not what is statistically significant, but what is important (the degree of randomness you would be willing to accept) in the context of what is being considered.

So important lesson #3 follows

And finally, what is the final reason we may not see the world clearly? Because the information we re receiving is false.

To hear more about this you should come to tomorrows presentation. Thank you for your attention. !