



Library podcast

Mario Livio discusses "Why?"

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[00:00:35] Hi everybody. I'm Stesha Brandon. I'm the Literature and Humanities Program Manager here at The Seattle Public Library and welcome to the central library and to tonight's event with Dr. Mario Livio. We would like to thank our authors series sponsor Gary Kunis and the Seattle Times for their generous support for library programs. We are also grateful to The Seattle Public Library Foundation private gifts to the foundation from thousands of donors help the library provide free programs and services that touch the lives of everyone in our community. So if any of you are donors to the Library Foundation thank you so much for your support. Now I am delighted to introduce Mario Livio, an internationally known astrophysicist a best selling author and a popular speaker. Dr. Livio has appeared on The Daily Show 60 Minutes and Nova. He's a Fellow of the American Association for the Advancement of Science. He is the author of many books including the Golden Ratio a highly acclaimed book for which he received the International Pythagoras prize and the Pino prize. He's also the author of the equation that couldn't be solved. Is God a Mathematician which was the basis for the 2016 Emmy nominated Nova program the great math mystery and the national bestseller Brilliant Blunders as well as the accelerating universe. Dr. Livio is going to give a presentation and then he'll take questions from the audience and then he's going to sign books right over at this table here. So here tonight to talk about his new book Why what makes us curious. Please help me welcome Dr. Mario Livio

[00:02:13] Thank you very much. Always a pleasure to be in Seattle although I must say that traffic has become horrendous since the last time I have been here which was four years ago with my previous book. So I'm gonna talk about curiosity tonight and you know I'm an astrophysicist neither a psychologist nor a news neuroscientist. So why did I decide to write a book about curiosity. The answer is actually very very simple. I'm a very very curious person myself. And so I became very curious about curiosity and so I spent almost five years now you know looking at all the research that has been done on Curiosity. And I interviewed many people I interviewed many researchers. I visited labs and so on so I'm going to tell you a little bit about what I'd do by the way I walk a lot because I have ADHD so I am not standing at the podium. So don't be alarmed. I would also ask for the lights to be somewhat lowered at the risk. This raises the melatonin level but you will see better the screen.

You see how it brings out the red colors. Now in case you're just wondering about this particular abstract painting well inside it hides the question mark that is on the cover of the book. So this is the question mark that comes after why.

[00:03:43] So let's start and I will start. The way I start the actual book with this author is is very appropriate because we are inside the library.

[00:03:54] Kate Chopin is an American author from the 19th century she lived in Louisiana. Much of her life. She wrote mostly short stories but also a couple of novels. She married the Frenchman Oskar Chopin and the reason that I started with her is that because I encountered this short story by her

[00:04:16] Just called the story of an hour and you see this this story is so short in fact that it could fit on less than one page in Vogue when it was published in 1894. This by the way is her husband. That's the house in which you live.

[00:04:34] Why did I like these short stories so much. Well it's a wonderful short story but I was especially taken aback by the opening sentence. The first sentence in these short stories says knowing that Mrs. Mallard was afflicted with a heart trouble great care was taken to break to her as gently as possible. The news of her husband's death you can hardly start a short story with a better sentence than this.

[00:05:03] I mean this is you know there is death here and human frailty or packed into this one punchy sentence. So and this is really her great gift of Kate pen she is able with every sentence to produce some sort of an intellectual cliffhanger that you know you want to continue to read and so on. So I really like this by the way that's her in the background with four or four children. Oddly enough I found one biography of her that said that she had six children and another one did say seven children. I'm convinced that she knew exactly how many children she had. But apparently some of the broad biographers didn't know. Okay let's start.

[00:05:50] So there was this psychologist Daniel Berlin who was a British Canadian psychologist too at some point decided that he wants to map curiosity on a two dimensional plane. And he gave names to various types of curiosity in particular. He gave these names perceptual curiosity epistemic diversity and specific. I will explain what each one of these means but his goal in doing this was that he then thought that every type of curiosity you have can somehow be placed on this map. You know that it belongs in that quiet quadrant or that quadrant and so on. Now what are these things. What is perceptual curiosity. I mean he defined them. Yes but what did he mean by that perceptual curiosity is that curiosity you feel when you see something that surprises you something that does not agree with thinks you thought you knew before or something that's ambiguous in some way. I mean look at this these Asian children have seen for the first time in their life a white girl before that they didn't even know that such a thing exists. And look at their faces look at their eyes. That's perceptual or curiosity. What is epistemic curiosity was the opposite of that epistemic curiosity is our true love of knowledge that that's what drives scientific research that what drives the greatest artist that that drives the

question why. Which is the title of this book that's epistemic curiosity. Look at these children you know trying to see a scientific experiment and how it works and what does he do how these plans grow why they grow and things like that.

[00:07:38] That's epistemic curios then on the other axis I remind you there was diversity in specific. What is diversity of curiosity. Diversity of curiosity is this. Look at these Dutch children.

[00:07:53] These Dutch children sit next to one of the greatest masterpieces of Western art. This is Rembrandt's The Night Watch in the Reich's Museum in Amsterdam. Not one of them looks at the painting. They are all searching for text messages. That's diversity of curiosity. OK. This is basically the things you do to ward off boredom and you know to to find all the time things. This is also the type of thing that people do in you know they wait for the new smartphone model to to appear and wonder what is going to be in it and so on. Oddly enough believe it or not these same very same painting at the rights museum the Ninth Ward was also actually the subject for very strong perceptual curiosity that surprise and so on. Under other circumstances. And I want to show you now that. Look here. Shoppers in the Dutch city of Breda get more than they bargained for after ACTA stormed the shopping center dressed in 17th century outfit. Seven feet. From a shopping mall

[00:09:09] Inside the shopping mall. You should look at the faces of the people who watch this. Look at all the older faces of the people who were. Given this kid

[00:09:27] Sailing from ropes and jumping from balconies. The group was staging a reconstruction of Rembrandt's painting the night watch to promote the reopening of the rights museum. So. You see

[00:09:48] The same painting the night watch. In this case was stage a strong perceptual curiosity. OK finally there is specific curiosity specific your rusty is just that thing when you are curious about a very specific piece of information like you know. What was the name of the actor in that film you know. You go like this or like Who is this. Does anybody know. Yeah. Ernest Hemingway. That's right. So. But that's that type of course. Who is this person. OK.

[00:10:19] But here he is in 2018 in Milan. So these are the types of curiosity that have been identified. There are others but these are kind of major things. Now before I go into the actual research into curiosity as I was writing this I was thinking to myself there are two people that to me stand out as being so exceptionally curious that I had to kind of look more deeply into them and see what was it that was driving them and so on. And this is one of them. I do dove into you of course. So not I mean she was called by Kenneth Clark the most relentlessly curious man in history and indeed you know of course he did lots of works of art. He did many drawings for many inventions for war for peace and so on.

[00:11:14] But what is most amazing are his notebooks his notebooks. We have now today about sixty five hundred pages or so it is thought that there were fifteen thousand or so pages that you feel all of them were filled with drawings and writing all kinds of notes.

[00:11:33] The notes are all written with the left hand from right to left and in mirror image. So to read it you actually need to hold a mirror to the page. Now when you look at these two pages for example you at first get the impression that this is all a collection of unrelated doodles but if you look a little bit more carefully you start to see some sort of guiding principles here. So first of all there are a variety of geometrical curves. Then there are things that have to do with water flows. There are these clouds that have these curves in them. There is the hair of this old gentleman that has the hair the curve these curves in there

[00:12:16] And then there is also the phenomenon of branching like hearing this kind of plant and in this tree here. And I don't know if you can see it but the branches of the tree transform into the veins of the person here. So there are curves and branching. So one can speculate that the way his mind worked with something like these you would start thinking about one phenomenon. Let's say you know water waves and things like that but then he was very visually a visual person. So immediately it transformed that into a curve a geometrical curve.

[00:12:54] Once he did that he started thinking in what other phenomena do I see curves like this. And then he you know went to clouds and then he went through this and so on.

[00:13:05] So you can almost follow his curiosity through these different subjects. Now you're in on what was Leonardo curious about about everything it was just unbelievable.

[00:13:19] You know we know actually which books he had at one point in his life. They cover every almost discipline that was known at that time there if there was one thing he wasn't interested in. It was politics. And that was very very clever of him because you know who were the rulers at this time the Borgias. They just killed everybody who got into politics. On the other hand they funded Leonardo. So it was great. So. So that's that. He was also very very interested in anatomy and in particular in the human heart. He discovered new things about the human heart unlike other people in his time that were they sexting only to prove that Galen from ancient Greece was correct. He didn't dissect it to find out what's going on. And he discovered the A3 out of the heart in their role and discovered what caused this heat you know for the body and things like that just look at these. It's amazing both the drawings in the in the text that goes with him. He did not discover that there is a circulatory system because he could never see it never dissected the life person so he never saw it. That was left for William Harvey to discover the second person I looked at that was incredibly curious was Richard Feynman.

[00:14:39] He was a legendary physicist a person who has been sometimes called the Sherlock Holmes of physics because you know Sherlock Holmes you know he would look at me and you would say Oh you were born in so-and-so and your wife likes that and these are all of these you could see from my elbows from the middle I don't know the way I dress things like that Feynman could see clues like this in physics that nobody else could see.

[00:15:04] It was amazing. He of course besides the physique he was a bongo drummer he was cracking safes. He was. And he started to learn how to draw from his friend Dorothea. He was a painter. He started to learn how to draw.

[00:15:20] If you take a page from Feynman's notebook it looks something like this. Just look at this. Now look the mathematics is of course much more complicated than in Leonardo's. The drawings are much worse than in Leonardo's

[00:15:37] But overall it gives you the same feeling.

[00:15:41] These these pages could have almost been taken from the same notebooks you know both of them basically said everything is interesting. If you get into it deeply enough. OK.

[00:15:56] Now what about these researchers and curiosity so this there is this psychology. George Lowenstein is is very much active and alive from Carnegie Mellon University. And he published this model of Curiosity which was called the information gap model. The idea was the following that. When you encounter something that kind of disagrees with things you know or at least think you know a gap is somehow formed and that gap

[00:16:28] Is felt as an aversive state is an unpleasant state. And that Curiosity's role is simply to take you out of that unpleasantness. That's this model. OK. So curiosity in this sense is a bit like an itch that you need to scratch to get rid of now together with that comes this property that if you look at curiosity as a function of knowledge then it generates this inverted U shaped type curve meaning when you know about something very very little you are not curious about it because you don't know what to be curious about when you know about something a lot. You're also not curious about it because you feel that you already know everything that needs to be known. When do you really get curious when you know something about the subject. But you know or feel that there is more to be known. That's when you are really curious. OK. So that was his model for curiosity. Now believe it or not something very bizarre happened. A former secretary of defense of ours Donald Rumsfeld in one particular press conference without knowing about curiosity and not referring to curiosity and nothing like this sort of kept certain this property of curiosity but talking about something completely different namely he was specifically asked in that press conference. What about the fact

[00:18:03] That there they did not find any evidence that Iraq was transferring weapons of mass destruction to terrorist organizations.

[00:18:13] And this was is there are known knowns scary things we know we know. We also know there are known unknowns that is to say we know there are some things we do not know. But there are also unknown unknowns the ones we don't know. We don't know.

[00:18:30] That was his answer. OK. Now he was given there is a British organization that gives a foot in the mouth a word and they give gave him in 2012 the foot in the mouth the word for this or for

being the most baffling statement by a politician. They say we think we know what he wants to say but we're not sure we know we know. They say

[00:18:57] Now I wouldn't tell you after all of this that. OK. This was a baffling statement as an answer to that particular question. But the statement itself is actually perfectly logical. There are things we know we know there are things that we don't know we don't know.

[00:19:17] And there are things that we know that we don't know. I mean the statement itself is logical or they didn't quite answer the question there. But it actually captured very nicely this U shaped curve

[00:19:33] Because you see the things we know we know are when we know everything about it. We're not curious the things we don't know we don't know our win we really don't know almost anything and we're also not curious. We're curious about the known unknowns namely about those things that we know that we don't know.

[00:19:53] But by the way I just mentioned that the runner up for that year for the foot in the mouth award was Arnold Schwarzenegger who said that I think that gay marriage is something between a man and his wife.

[00:20:13] And actually I think he should have gotten the first prize because Rumsfeld's statement for security at least logical one was a bit bizarre anyhow. People now can do also experiments in neuroscience and people have done experiments to test these ideas of information gap and this experiment was done by a Dutch neuroscientist Mary Kay. And the way they did this now they tested specifically perceptual curiosity namely that curiosity when you see something ambiguous or possibly in the way they did this is they showed the subject's blurred images of known objects to make them curious about what those things were and then they showed them later what the object was. But they did this while the people were stuck into a functional MRI machine so that they could tell which regions of their brains were activated when they were curious.

[00:21:17] And when their curiosity was relieved.

[00:21:20] And the interesting thing is that they discovered that the parts of the brains that were activated under perceptual curiosity these very particular curiosity were indeed the parts of the brain that are associated with conflict or with hunger or with thirst. So indeed in the case of perceptual curiosity it appears that it is indeed associated with an unpleasant state and the brain regions that are activated are those that are activated when we experience these type of unpleasant state. Now a different experiment by a woman named Kanga and her collaborator right to taste epistemic curiosity namely this love of knowledge wanting to learn and the way they did that is by presenting the subjects with trivia questions a series of 40 trivia questions for example you know they would ask the subjects which musical instrument was invented in order to sound like a human voice you know which one made the violin. So anyhow so we made people epistemic could be curious this way and look to what parts of the brain when then were then activated in the parts that were activated in this case where different parts were the parts that are activated in anticipation of reward. These are the parts that are

activated when you know I'm I say that I'm going to give you a piece of chocolate or when you sit in the theater you know in a play that you wanted to see for a long time just before the curtain goes up things like that. So that's epistemic curiosity and it is associated with a pleasurable state it activates parts of the brain that are in anticipation of reward. In other words perceptual curiosity and epistemic curiosity appear to be rather different things one is associated with an unpleasant state the other with a pleasurable state. And they even activate. Brain regions accordingly. It's almost like. I'm almost tempted to say that had we known these things in advance we might have even not called the two things curiosity we might have given them different names but you know that's how things work.

[00:23:51] Ok I have shown you all kinds of things here. I do want to also leave quite a bit of time for questions so I'm going to skip now quite a few slides. No no look we will stay here way too long. If I would go through this whole thing I'm going to skip quite a few things but I will go to a place where I want to say something first of all about curiosity and fear while writing this book.

[00:24:19] I coined the phrase which I'm truly very proud of. I'm serious about this. I coined the phrase Curiosity is the best remedy for fear. Curiosity is the best remedy for fear. Now why do I say that. You see we very often fear things that we don't know or don't understand and in order to overcome those what do we need to do is learn more about those things and be curious about them.

[00:24:52] Ok. Now throughout history there have been regimes rulers. Sometimes the church unfortunately that tried to build a wall around certain types of knowledge and try to actually suppress curiosity. And even in fairy tales I mean this is Hansel and Gretel. You know there are some fairy tales that don't exactly encourage curiosity.

[00:25:22] You see. I greatly went to exploring the forest fire found the house made of candy. Wanted to taste it you know and so on. What happened. They fell into the hands of a cannibalistic witch.

[00:25:35] So this is not strong encouragement for curiosity or exploration right. But it's more than these look on medieval times

[00:25:46] Corresponded to a suppression of curiosity but not only medieval times. In 1937 the Nazis organized the degenerate art exhibit in Munich which basically was supposed to convince the people that all modern art was just some conspiracy by communist Jews against the German people. This is Gorbachev's visiting that exhibit the Taliban

[00:26:13] Was the risk they dynamited all statues last March as this document. You see this hearing to a dynamite dome Buddha's car. These are these are does seem to me.

[00:26:23] Actually it's not a single parents cheering Muslim hundreds of feet tall dog statues they dynamited them. Why. You of course know that you know ISIS destroyed artworks in Palmyra and things like this. And of course worst of all the Taliban attacked Malala Yousafzai because she advocated education for young Pakistani girl. Luckily you know they shot her in the head. Luckily she survived went on to win the Nobel Peace Prize in just about four weeks ago she actually finished her

studies. So it's amazing that you know what she did. But all of these wars against curiosity now finally what I want to tell you is I have also interviewed nine people that I see as extraordinarily curious in the book and I just want to run through them very very quickly so I'll tell you their names and then I tell you about a few of them who they are.

[00:27:21] So here they are. So this is Freeman Dyson a very famous phrases these Noam Chomsky. This is astronaut Story Musgrave. This is fabulous.

[00:27:31] Joe naughty. This is Marilyn. Both Von. This is Jack Horner. Martin Rees Lord American research would say Brian May and Vic mornings These are the people that we let me just tell you who they are.

[00:27:47] So for example Vik Muniz is a Brazilian artist who is one of the most imaginative artist that I've ever seen. What he does is he takes very well-known works of art. Let's say the Mona Lisa and reproduces it but extremely accurately let's say from ketchup mustard and diamonds you know things like that. And he does this with all kinds of works of art. You know you just cannot imagine. He used garbage. You know near real you know to do reproduce incredible works of art. I showed you Fabiola generosity. She's the director general of CERN the Center for Nuclear Research in Europe you know where the Large Hadron Collider is and she led one of the two teams that discovered the Higgs boson. But her first degree was in music. She's an accomplished pianist though not just physics. I showed you Brian May. Brian May was the lead is still there because they sometimes have still appear. The lead Queen guitarist for the rock band Queen but he's also Paige Dean astrophysics. He was the chancellor of a university is a big big activist for the rights of animals. Is that true expert in Victorian stereo photography Victorian stereo photography. These two images which you look with a viewer and you sitting in in three dimensions so these are these. Marilyn vos Savant they showed you. She writes the column Ask barreling in in Parade magazine but you know she never finished even an undergrad to a degree but she has the highest ever recorded IQ of any person 228 IQ. I just want to remind you that one hundred forty is considered a genius. OK now to be fair the tests are completely useless when you reach those types of scales but it sure is very very up there. OK. So these are these people. OK. Let me finish with coming back to my friend Leonardo who said once blinding ignorance does mislead us. Oh Richard mortals.

[00:30:11] Open your eyes and indeed my scientific icon Albert Einstein kept opening his eyes. Here he is. Do does it once and twice and thrice. Thank you very much.

[00:30:28] Can I have the lights please.

[00:30:34] So I'll be happy to answer questions and then we'll sign books. So are there any questions. Yes. If somebody is naturally curious what would be acting to suppress their curiosity. That's what you're asking.

[00:30:47] So first of all indeed curiosity is largely genetic. It is not only genetic but like all psychological traits it has a large genetic component. That is well known. Now what would be us

doing to suppress that curiosity. So you know in the Middle Ages for example church orthodoxy assumed that. The doll make model of the solar system which had the earth in the center was the correct model and nobody was allowed to talk against Giordano Bruno was burnt at the stake for it

[00:31:27] You know. So that act to suppress your curiosity. You know Galileo was tortured by the Inquisition. That is a big suppression of curiosity. But what is x to separate to suppress curiosity not just for an individual but even for a society. I'll tell you what. Eliminating funding for the endowment for the Arts act to suppress curiosity. And limiting funding for NPR. Suppress this curiosity cutting budgets for the NIH suppresses curiosity. OK so there are many things that can be done by individuals or. Atmospherically or governments or things like that that suppress curiosity. Other questions yes. Is is is curiosity contagious. Yes. So it is very interesting. You didn't read my book you write the sentence before last. The book by the way just appeared last week. Yes it's it's it's hot off the press. Literally it appeared last Tuesday. So nine days ago.

[00:32:40] The sentence before last I say they say that curiosity is contagious. In that case I say let's turn it into an epidemic. How do you how can you encourage curiosity yes and nourish curiosity. And so on. So there are a number of ways. So you know you start first of all with small children. Yes they ask any questions you encourage them to ask me any questions you don't say or stop asking me all these days. Yes. Not only that what you do is suppose they ask you why is that and that yes something.

[00:33:18] Why is it don't give immediately the answer. Say why do you think is that in and let them say something and then say oh well if that's the case then if I do this that should happen. And let them see it for themselves. So that's one thing.

[00:33:37] Second thing follow their curiosity. I'll give you an example. You see we all want our kids to learn science and things like this anything right. But sometimes. The curriculum is a bit silly to be honest because the curriculum lets say the curriculum says that all children need to know about the freefall acceleration on Earth.

[00:34:05] Ok let's see. Here's like most kids are not interested. Goodbye. But most kids at least most American kids are. Fascinated by dinosaurs right. Yes.

[00:34:20] So start with dinosaurs start your science lessons with dinosaurs and talk about dinosaurs and teach them about dinosaurs. And then you can say. You know what. The dinosaurs or became extinct and you know why they became extinct. Because an asteroid came from space and hit the Earth.

[00:34:41] It accelerated towards the earth. You know and so you can bring in what you thought was important through the curiosity that they already have.

[00:34:52] It just reminds me there is a phrase in German the home of whom is the banana coon. Why is the banana curved. Yes there are two. There are two. There are two questions here. So one

curiosity killed the cat. The original phrase which comes from the 16th century say the care killed the cat. In care meant grief.

[00:35:14] And somewhere at the end of the 19th century that turned into curiosity killed the cat. And I'm not sure why it turned into that but that's part of that thing that tries to suppress curiosity. Now you asked about what. Yes. Whether animal Curiosity is about animal curiosity. Yes. OK so animals are curious. But humans are the only ones who are capable of asking why and I actually describe experiments that shows that demonstrate that that humans are the only ones who are able to ask why.

[00:35:50] And that's why the book is called Why. Because that's really unique to humans. Yes. You know for people who are interested in many things. Is there a point where it becomes a distraction perhaps at the very extreme edge of that

[00:36:05] May be ADHD.

[00:36:08] You know where people just cannot focus on one thing and they have attention deficit disorder where do they all the time are attracted to something that may be. I'm not sure but I talked to some experts on this and they said that one one could regard this as an extreme is curiosity sort of stuck on spinning gears if you like. So that that is possible now it is absolutely true that for people to make genuine contributions they must have at least one area in which they actually are able to focus and do something about it. Yes. Leonardo for example was famous for not finishing most of his projects. I actually speculate in the book that he may have had ADHD it almost never finished anything but still when he was very curious about something he was able to focus and finish it and it didn't happen often. But but it did happen. So yes I think one does needs to at some level you know say OK but if you want to really do something then please focus on these for it. It has it has a genetic component. It's not 100 percent genetic but but it has a genetic component. Is it also tied to intelligence. Yes there is a correlation. Exactly. How does one influence the other. I don't exactly know. Maybe it has to do with the fact

[00:37:36] That the mechanisms that drive curiosity first of all are based in this dry out which is underneath the cerebral cerebral cortex and some components of intelligence also reside in you know in those general areas that that is one possibility. And there are other connections that may be between the two in terms of if you are very curious it means that you are also able to process information very very well and that may be in itself related to intelligence because you know you look if you want to be you have to assign value to knowledge and if you assign value to knowledge then you have to be able to process a lot of information.

[00:38:18] But by the way I should make one one clarifying statement my writing style is very concise. I've always known that it's true even in when I write scientific papers. I mean where somebody might write five paragraphs I write one sentence this sometimes is it's sometimes not so good. Yes but look as a result of these. The book is not very thick and and no and the thing is you see that about a third of it actually is the end notes that they put in the bibliography which is enormous. My feeling is

actually that this is not bad for a modern reader who you know on one hand wants to finish the book and if they get really really interested in the more things then you know they can read all the notes and all the bibliography associated with it.

[00:39:18] But sometimes this is taken by some people in the wrong way they say that you know what.

[00:39:24] Ok maybe this I wrote about this superficially if you will just look the number of bibliography here he would see that there is nothing superficial about this it's just that I really have a very concise style up and there is no question I think you heard her writing that if we didn't have curiosity would we become extinct where there is no question about this that curiosity evolved largely because of survival Yes I mean of course we had to understand our environment we had to understand cause and effect in order to actually be able to survive there is no question about this we had to at some point you know know that if you walk off the cliff we notice things are not so good happen. So so so of course it was important in that however. This is the skin would be the whole story because we as humans have always been curious in many more things than those needed for survival you see I can say that especially because I work in theoretical astrophysics most of my work. You know may become one day with applications but certainly when I DOING THESE TWO WORK I already do it for curiosity. It's not. It does not have any direct immediate applications. If I will understand the cosmic expansion is accelerating or not.

[00:40:53] Yes. So maybe we'll take a couple of more questions. Do we understand you know what turns the mind into various types of curiosity and so on. Of course we don't. I mean this is one of the thing. I mean. What you are asking is do we fully understand consciousness and we don't really know. So you know we can look at various things but no you know Einsteins brain is being analyzed to death. To find

[00:41:22] To find all kinds of things in it because especially that was this pathologist that kept his brain in a jar for years without telling anybody. But at the end he told you know the cause took some concern.

[00:41:34] They really have shown nothing convincing about what was special about his brain for example was was smaller than the average. So you know so no we really don't know these things with a mirror. So I discussed this in the book too. So there is a conspiratorial theory but there is a very simple explanation.

[00:41:57] He was left handed and for left handed had returned from left to right. Normally his wife is and would have smeared the ink so it was much easier for him to write like I am not an expert in the psychology of fans but I believe. But I believe that that and basically are interested in two things in preserving their queen in building their house and then getting food so all they do is towards that thing. Now how would they sense how they sense the food so quickly is to me it's a mystery but I am sure that it has been studied by many other researchers. I mean because sometimes you know you just leave something there for

[00:42:45] You know an hour and already the ants know and they come. So clearly these days they smell worse you know in some sense where you are. They sometimes stop and look as if they are exchanging some form of information. I'm sure they are not talking about the weather. Thank you all very much. I would sign the

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