

# Tell Me A Story: Transcript

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*Thanks to Choi Hyoungsoon for transcribing this podcast. Choi also created a [Korean translation, available here](#).*

RADIOLAB INTRO: Aight, shh, quiet. You're listening to Radio-Radiolab. The podcast. From New York Public Radio. From Public Radio. W. W. N. Y. C. And NPR.

ROBERT KRULWICH: Hi, I'm Robert Krulwich. Jad's...I'm not exactly sure where Jad is. I know he's at a meeting that I should be at too, so, not being exactly America's number one meeting person, I got out of it so I could be here with you, for which I thank you very, very much. So. This podcast, today's podcast is one of our in-between occasionals where we share with you, our regular listeners, an idea, a compelling conversation, a thought. In this case, what you're about to hear is a big thought, from me anyway. I put it together for the graduating class at Caltech. I was invited to be the commencement speaker there, this past June, and I wanted to make a case for talking about science to folks who may not be all that well-versed, or even all that interested, in sciencey things. Because talking about this stuff, I argued, has very powerful consequences. So, take a listen...

Thank you, Kent Kresa, and thank you, Jean Chameau. And thank you, Judy Campbell, and thank you Congressman Schiff, and thank you Mayor Bogaard, and especially thank you to all 205 members of the Caltech Class of 2008, plus the extra 14 who are getting pretty close to be allowed to sit here. Congratulations to all of you. It's a great, great honor to be here. Normally, if you're a science reporter at NPR or ABC, a trip to Caltech means that you call ahead and you ask for a few precious moments with a world class intellectual whatever, and you're ushered in, and you furiously take notes, all the time thinking, 'Do I have any idea what this man is saying? this woman?' I'm sure you know the feeling.

And, uh, when I got my invitation asking me to give you guys a lecture, I thought, 'Come on, what can I tell you?' But I thought of something, so... And it's something that's gonna happen to you, you sitting here with the black hats. Uh, in the next hour or two, there you'll be in your cap and gown surrounded by your family and by friends, and by friends of friends, and somebody, you know, maybe an uncle or a buddy, somebody, is gonna turn to you and say, "So, like, what were you doing at Caltech? I mean what were you working on?" Not that they really wanna know, you know. But after all you've been here for four years, so you know, or a different

number if you're a grad student, you must have been doing something here. So it's only polite to ask.

And I know that a lot of you have scientifically illiterate dads and moms, some brothers and some sisters, not all of them, of course, but some. And let's assume that one of these people, say make it a relative, let's say, make it a he, he's not a scientist, he's not an engineer, and the last time he had thought, a complex thought about biology or math was back in eleventh grade, when he got a C- in both subjects and vowed ever never to think about biology or math ever again. But because this is your day, and because this person loves you, or because he can't really think of anything to say after 'Hey!', he asks you about your work.

And to make it still more interesting, let's assume that if you explain to this person, what you've been working on, you might have to use certain words like protein or quark, or differential or maybe hypotenuse, and if you do, they're gonna listen to you very, very politely, but upstairs those words are gonna mean not a whole lot to them, you know. Cause science is not their thing. They can lip-sync every words to 'N Sync's "Bye, Bye, Bye," but you know hypotenuse is hard.

So here's my question. When you are asked, 'What are you working on?', should you think, 'There's no way I can talk about my science with this guy, cause I don't have the talent, I don't have the words, I don't have the patience to do it. It's too hard. And anyway what's the point?', which is, by the way, not an unusual position. No less than Isaac Newton, and I mean Sir Isaac Newton, that one, when asked, 'Why did you make your Principia Mathematica, your earthshaking book about gravity and laws of motion so impossibly hard to read?', he said, 'Well, I considered writing a popular version that people might understand, but', and I am quoting Newton here, 'To avoid being baited by little smatterers in mathematics,' that was his phrase "little smatterers," he intentionally wrote a book in dense scholarly Latin with lots of maths so that only scholars could follow. In other words, Isaac Newton didn't care to be understood by average folks. But here is the argument I wanna make to you guys this morning. And you're not gonna hear this advice often, I suggest you may never hear it again. When asked about your work, do not do what Isaac Newton did. No, no, no.

When a cousin or an uncle or a buddy comes up and asks you, "So what are you working on?", even if it's hard to explain, even if you know they don't really wanna hear it, not really, I urge you to give it a try. Because talking about science, telling stories to regular folks is not a trivial thing. Scientists need to tell stories to non-scientists, because science stories, you know this, have to compete with other stories about how the universe works and how the universe came to be. And some of those other stories, bible stories, movie stories, myths can be very beautiful and very compelling. But to protect science and scientists, this is not a gentle competition. So you've got to get in there and tell yours, your version of how things are and why things came to be.

We all know about creationist science movement in America, but what you may not know is that movements are spreading all over the world. In Turkey, there's a group led by a man named Adnan Oktar, he's a Muslim creationist, and his group produced a picture packed 768 page "Biology" textbook that's priced very, very cheaply so schools can have it for next to nothing and that textbook is now used all over Turkey. It's written in clear and simple language using fabulous pictures, and the pictures are designed to prove that fossils show no evidence of evolution.

And this group's books and their CD-ROMs and their grocery store magazines, they have grocery store magazines, their websites are so wide spread and so inexpensive and so provocative with titles like "The Bloody Ideology of Darwinism" or "The Evolution Deceit" that in Turkey's high schools, which are not religious schools, they have a long secular tradition there, evolution and Darwin are disappearing from the curriculum in high schools of that country. In 2006, when Turks were polled and asked, 'I want you to listen to this statement and tell us if it's true or false or you don't know', here's the statement: 'Human beings as we know them developed from an earlier species of animals', in 2006, only 25% of the Turkish public said 'Yes' to that. That's a very low number. In Japan, 78% say humans evolved from predecessor species, in the US it's 40%. But that's above Turkey.

In Turkey, there was a debate of course. And there's still one, sort of, except Mr. Oktar sued people who opposed his views, sued them for slander, managed to shut down their blogs in Turkey, his followers attacked biology professors as Maoists. Maoists? As Maoists for teaching evolution, which they called 'Nothing but a deception imposed upon us by the dominators of the world system.' High school teachers in Istanbul were fired because they taught evolution, not creation science. And while Mr. Oktar was recently arrested for his role in sex-ring operation, so he may be taking a break, creation science is now taught all over Turkey, and while Turkey may seem an ocean or more away, it is not.

There are always Mr. Oktars, who aim their stories right at you, right at the heart of a place like this, at the values Caltech has always honored from the beginning. I know you spent long nights cramming and sweating under the weight of too many assignments and too many a tests, and too many papers from too many professors who didn't realize there're other professors that are making you do the same tests ... and so forth. But somewhere in that nightmare of work, you may have noticed that your teachers were giving you more than tension-headaches, they were giving you values. A deep respect for curiosity, for doubt, always doubt, for open-mindedness, for going wherever data leads no matter how uncomfortable, for honesty, for discipline, and most of all, the belief that anybody no matter where they're from, no matter what their language, no matter what their religion, no matter what their politics, no matter what their age or their temperament, I mean this place has seen monstrous egos and bongo players and people who dress in viking hats, but if you can learn, had a sit down in a laboratory and think in an orderly

way and if you have the patience to stare and stare and stare and stare, looking for a pattern in nature, you're welcome here.

It may be boring, it may be sometimes very exhausting, but there's a freedom, a freedom in this way of looking that is precious in the world. And that freedom can be attacked or defended with stories. Stories matter. After all what is a science experiment? You make up a story that may or may not be true, and then you test that story in the real world to see what happens. So for example, let's say you're in Pisa, it's 1590, and a guy named Galileo comes up to you and says, 'Hello, there!.' Actually, he probably wouldn't say it that way, 'You see I have a canon ball in my right hand. It's a very, very heavy thing to be sure. But in my left hand, sir, I have a golf ball.' Oh, it wouldn't be a golf ball, it's a little old, before golf. 'On my left hand, I have a musket ball which is lighter than the canon ball. Now, sir, if I told you that these two balls, if dropped from the same high place at the same time, in spite of their five or ten fold difference in weight, that they would hit the ground simultaneously, the light one and the heavy one, dropping, landing at the exact same time, would you like to see me try?' Whether Galileo actually did this or not, if a guy named Galileo propose this to you, wouldn't you stick around just to see how it comes out?

Galileo, for my purposes, is the great un-Newton. Unlike Newton, he had a flair for narrative, a story teller's sense. Unlike Newton, he wanted to tell people what was on his mind. Unlike Newton, he thought that people could understand him. That's why he got into so much trouble. In his famous book "The Dialogues", about the sun being the center of the solar system, he didn't write it in Latin. He wrote it in Italian, for a mass audience. And the writing was gorgeous. It was poetic, it was combative, it was funny, it was a running conversation between three good friends who spend four days together arguing and eating and boating through Venice in gondolas, the argument being: 'Is the earth the center of the solar system or might it be the sun?' And the text of that book has little pictures, line drawings that he made, he put in marginal headings to break up the text so he wouldn't have big sheet of writing, and while there are numbers in his book, he doesn't get to them till two-thirds through the book. And if you skip the numbers you don't miss that much. So, because Galileo's book was so easy to read and such a page turner, it so threatened the established order that Galileo, as you know, was put under a house arrest. And it wasn't just his science that was alarming. I think it was the power of his story telling. That's what made him extra dangerous. Because stories have this power. People like them.

E. O. Wilson, the great scientist and the great story teller, writes that, 'Science like the rest of culture is based on the manufacture of narrative. We all live by narrative.' He doesn't know the half of it. I work on radio and TV, and I've learned that I can go on primetime TV, and I have, and do an hour on string theory and talk about multiple dimensions and space-time curvature and super-symmetries. This is very odd, and very hard stuff for grandma, for your brother, the cousin that I was talking about before and yet a whole lot of people, a few million people sit

there the whole time, I mean, ABC clocks this kind of thing, and they sit and they watch, and apparently, I have to assume, they're pretty fascinated. But the program ends, and then you have a bunch of ads like seven commercials in one network ID and three and a half to five minutes pass. And the next program comes up on the very same channel. And it's about extraterrestrials landing in antigravity machines to examine the breasts of innocent cocktail waitresses. And the same people who were watching the previous hour sit there with the same sense of awe and the same sense of fascination and they think 'Wow!' and they kind of believe it too. People are not scrupulous about stories.

Truth, fiction, eh, it's like this endless back and forth between Ross and Phoebe on the TV show "Friends", you know the show? Ross's a paleontologist, he studies dinosaurs, Phoebe is his masseuse friend, she doesn't study anything but she knows everything. And in a typical episode, Ross sits down and very carefully explains how opposable thumbs evolve slowly over time, and Phoebe listens very respectfully, and Ross finishes, 'So,' he says, "You see how evolution explains opposable thumbs?" 'Or,' says Phoebe, 'Maybe the overlords need them to steer their spacecrafts.' So people can slip very easily from reason to fantasy, and they believe both and they don't feel the need to be consistent. They just wanna feel like they're absorbed, like they're swept away. And when you tell stories, boy, this hat is driving me nuts, I'm just gonna..., you can't do it, only me! Uh, and I don't know what's wrong with my hair, uh, just forgive me here.

When you tell stories to Americans, to really anybody in the world, you have to remember there are lots of Phobes. Stories with gripping visuals and good punchlines and stories that make intuitive sense, that make sensual sense to your eyes, and to your ears, and to your touch, they can convince, they have power. You may not believe that two balls, one heavy and one light, dropped from the same high place will drop together, but if you see it with your own eyes, THAT you remember. And as science gets harder, the metaphor becomes more useful and even necessary. I mean more and more what science teaches about the world is not intuitive that way. It makes no sensual sense. This starts early in high school that if you slap your hand on a hard surface like, like that, the outer electrons of my hand and electron on the wood here are repelling each other, this is the electromagnetic forces, you know. The electrons just don't like being around other electrons. So the reason my hand didn't go through the surface, then, is that two platoons of electrons, mine and the table's, on a line of scrimmage, got in each other's face, OK?

That's harder though to add faces, and motives, and football analogies to electrons. So there are some of you sitting here, probably here, who say, 'You can't talk about nature that way. It distorts what's true. What's true is what you see in equations, in the math that points to these laws.' But I go back to my man Galileo, who was maybe the first, in Western tradition anyway, to honor mathematics as the primal force of knowledge. 'The logic of the universe,' he said in his

book "The Esseyer", 'is written in the language of mathematics without which one is wandering around in a dark labyrinth.' But having honored math, Galileo was very happy to create beautiful metaphors to invent marvelous characters, to draw pictures. He knew how to light that labyrinth so the rest of us could see inside. Because the more abstract and mathematical science gets, the more we need to imagine something concrete as the physicist Alan Lightman has said, 'We are blind people inventing what we don't see.' And yet 400 years later many scientists have become very weary of metaphors, of adjectives, of the active tense. "It was observed that" is much nicer for these people for some reason than "I saw." And I can tell you from personal experience, they do not like talking to reporters because they think whatever they say, this journalist person is gonna turn it into something stupid and cartoony and wrong. And, yeah, you're applauding. And maybe that's true.

But I was happy to learn that these people were just as nasty about each other. My favorite example is a pair of letters from Werner Heisenberg and Erwin Schrodinger, two of the 20th century's great physicists. Schrodinger liked to think in pictures, his most famous one being the image of a cat in a box, who paradoxically is both alive and dead at the same time, don't ask. The point is Schrodinger loved pictures, and Heisenberg, he loved numbers. And when Schrodinger read Heisenberg's papers, they were so mathematical, he wrote, 'I am repelled', his word, 'I am repelled by the methods of transcendental algebra that so lack visualizability.' And Heisenberg answered back, 'Oh yeah?' Well, I mean he probably didn't say it that way. 'The more I reflect on Schrodinger's work, the more disgusting I find it.' And "disgusting" is a quote, it's a Heisenger's word.

So there is a tension here among scientists between two kinds of truths, math and narrative. But the job that we face, and I should come clean with you and tell you what's really on my mind here, is to put more stories out there about nature that are true and complex, not dumbed down. But still have the power to enthrall, to excite, to remind people there is a deep beauty, a many level beauty in the world. And what scientists say is not their off-hand opinion, it's hard-won information, it's carefully hewn from the world. It's not the bunch of ideas from a tribe of privileged intellectuals who look down on everybody, even though they are indeed up here looking down on you.

But it's my sense that if more scientists wanted to, they could learn how to tell their stories with words and pictures and metaphor and people will hear and remember those stories, and not be as willing to accept the other folks' stories, or at least, there'll be a tug of war. And I think that science stories will surprisingly win. I remember standing on the rim of the Grand Canyon looking down that enormous hole created by running water, endlessly running water fed by distant Colorado rain and I thought, you know, 'How did this beautiful thing happen?' And in my head I heard a line written by Loren Eiseley, a great, great scientist and a writer, a line I read in college which describes "The magnificent violence hidden in a rain drop." And when I looked

back at the canyon, at the roaring river there, that's what I saw, magnificent violence hidden in torrent old rain drops. Now it can't all be that good. And even when we try, we don't always win. Again, I'm thinking of Ross, again poor Ross in the show "Friends." He puts two hundred fossils in front of Phoebe, brings them in his suit case, to show her how over time fossils gradually change and evolve into recognizable forms, and he says, 'I'm gonna lay them all out for you to see and you're gonna see this with your own eyes. Because these fossils are from all over the world.' And Phoebe says, 'Really? You can actually see it?' And Ross says, 'You bet, from the US, China, Africa, all over.' And Phoebe says, 'I didn't know that,' and Ross says, 'There you go!' And Phoebe says, 'Huh! So now the real question is who put those fossils there and why?'

So, yes, science stories don't always win. But at the very least, it should be a tug of war. And if you tell them right, they have power to change minds. On my way here, I read a story in Smithsonian Magazine. It's a good example of what I am talking about. Imagine you're sitting on your porch with a friend, a non-science friend, and as you sit there, a robin, an ordinary robin wanders onto the lawn. And you say to your friend, 'You see that robin? Did you know that robins, in fact all birds are directly descended from dinosaurs.. And in a way that robin is a small feathery modern dinosaur.' Heh? If your friends are like my friends, she would say, 'What? what are y... Go away.' But don't go away. Instead you could tell them a story, which is how I'm gonna conclude.

Eight years ago, Bob Harmon who works for the Museum of the Rockies was having lunch in a canyon somewhere in Montana, and he looked up at a big rock face, and he saw a bone sticking out of the wall, just a bit. The bone turned out to be part of a Tyrannosaurus Rex, one of the best preserved examples of a T-Rex found anywhere. And after three years of carefully, carefully, carefully chipping away, they got a two thousand pound skeleton out of the wall. And it was removed from the canyon, and the dinosaurs was named Bob in honor of Mr. Harmon. And on the way out, for various logistical reasons, they had to break a leg bone, and some of the fragments were sent to laboratory scientists around the world including to a scientist in North Carolina named Mary Schweitzer.

So Mary Schweitzer gets a bone, a bone fragment in the mail, and she opens it up and she looks at it. And although Bob the dinosaur was 68 million years old, almost immediately she said, as soon as she looked, 'This is not a Bob. This dinosaur is a girl, and she's a pregnant girl.' And what Mary knew is that when women get pregnant, they use calcium from their bones to build the skeletons of their developing fetuses. And if the mother is a bird mother, well, birds form a very distinct structure in their bones when they're pregnant, and they need calcium to build eggs, or egg shells. So Mary had studied birds, and when she looked at the dinosaur bone fragment, she saw just what pregnant birds have.

But, you know, just to be sure, she looked up the most primitive birds, the emu and the ostrich. And she called a bunch of ostrich breeders in North Carolina, and said 'Does anybody have a dead female? I need a leg bone here.' And a few months passed, and the phone rings and it's a farmer saying, 'Y'all need that lady ostrich?' And Mary and her two assistants drove to this farm to collect the dead ostrich, which was in a farmer's backhoe bucket, drove it back to Raleigh. And what do you know, the former ostrich had been a pregnant former ostrich, and the next year, Mary publishes a paper in Science which shows the dinosaur bone right next to the ostrich bone showing nearly identical features. And since then another T-Rex, this one in Argentina, was found to have the same calcium structure. So there's more evidence here that when you look deep inside dinosaurs, and deep inside birds, what you see is very, very similar. Which gives us yet another reason to think that the robin in your front yard is an itty-bitty dinosaur.

And then Mary went on to do many more interesting things about dinosaurs, but, if your non-science friend come listen to that story and lean in a little and hear how scientists work with bones, dead birds and buckets, patiently looking for patterns, you have just placed a sword in the hand of your friend. So the next time somebody tells her that scientists are know-it-alls who toss off opinions, that science is an elitists' plot, she would think, 'Well, but I did hear this story.' And the scientific method gets a little more defense, a little protection. But better than that, the next time your friend sees a robin, she'll see, I hope, more than a robin. She'll glance at a little bird pecking for worms on the lawn and she'll travel 60 million years back in time to a place which creationists say did not exist, but now because of your story, your friend has a pregnant Tyranosaurus in her head with the unfortunate name Bob. Which makes robins and sparrows and chickadees and crows and all birds just a little more amazing and a little more delightful to look at, which means YOU WIN! The creationists can't beat the light, you have smote them with your story.

So ladies and gentlemen of the Class of 2008, mindful of the fact that this place, this institution which is about to confer upon you a Bachelors of Science Degree, and all you others here and there who are getting your masters and your doctorates, knowing as you must that places like this with their culture of intellectual freedom and respect for truth and love of inquiry, not to mention illegal bonfires on city streets, and basketball team that loses 207 games in a row, but not the women's team, I heard of their astonishing two game back to back winning streak, yes, yes!

You know, you know that when you receive your degree today, you are part of and you're celebrating something very rare, and very precious, and very fragile in our world. This place celebrates freedom and because you are now free men and women, you have to protect what you've been given by helping others who haven't been here, who are never coming here to understand the value of what you do and what your teachers do, and what their predecessors have done, which is why an hour or so from now when your brother, or your aunt or your mom



asks you 'So what have you been up to while you've been here?', take a chance, find the words, find the metaphor, share the beauty, and tell them what's on your mind. Tell them a story. Thank you very, very much.

COMMENCEMENT SPEAKER: Thank you very much, Robert, for sharing your stories and your challenges with us. I can't really imagine any more appropriate words for a Caltech commencement. I'd like you all to turn to page 54 in your program to join the Caltech Glee Club. Singing...

ROBERT KRULWICH: So, that's what I told the Caltechies. If you have any beef or any thoughts, any reaction, I'd love to hear what you think. You can write us at our website. And again, we'd like you to hang on till the fall when we have a whole new season... of Radiolab.

JAD ABUMRAD: Wait, wait, wait. The podcast is not over. I'm Jad. I'm back from the meeting. And Robert forgot to read the credits, so here I am to do, to do that for him. Um, thank you to Caltech for providing the audio and for choosing Krully to give the talk. Radiolab is funded by the Alfred P. Sloan Foundation, the Corporation for Public Broadcasting, the National Science Foundation. I'm Jad Abumrad, thanks for listening.