

# OpenTheo

## Genes, Atoms, or Something Else? | Praveen Sethupathy & Roald Hoffmann

February 24, 2018



### The Veritas Forum

Are we more than our biology? At a Veritas Forum from Cornell, Praveen Sethupathy (Cornell) and Roald Hoffmann (Cornell) explore how genetics influences how we think about personal identity and what, if anything, is beyond the scope of science.

### Transcript

Share with great apes, 98%, or some figure like that. And even with E. coli, we share a very substantial amount. How does that make us like E. coli? Does it make you like me? Does it free us of choices for good and for evil? No more than the original sin.

[Laughs] Somewhere along the line in our science education, we're told that DNA is the building block of human life. The unique genetic code that makes you, you. But is that all we are? A complex blend of biochemical matter, simply following the instruction manual of our genes? At a Veritas Forum from Cornell, Praveen Sethupathy, a genetics professor at Cornell, enrolled Hoffman, a Nobel Prize winning chemist at Cornell, explore how genetics influences how we think about personal identity and what, if anything, is beyond the scope of science.

[Music] Good evening, everybody, and welcome to the Veritas Forum. We've got an absolutely fascinating topic to look at tonight. So we're looking at genes, atoms, and human identity.

So I think I need to make a disclaimer as I start off. I am neither a geneticist nor a chemist. I'm a social scientist.

So I know absolutely nothing about the topic tonight. So there are no stupid questions at all. So before, as I was preparing to moderate this talk, as a social scientist, I did a lot of background reading on the Human Genome Project, which I believe Praveen is actually booked on.

And I became convinced that this was probably the most significant scientific breakthrough of our era. And coming from a public health perspective, I also learned that there are some 1,800 human disease genes that they've uncovered, and just the potential of the Human Genome Project to change our lives and to change our future biological futures is just unbounded. But what fascinated me even more than the public health aspects was the fact that I learned that 99.9% of all the genes that have been uncovered are common to us all.

And only 0.01% of our genes actually determine the diversity between us. And in fact, there's more diversity within races than there is between races. And this is just a sort of fascinating topic.

But as I went further and I was preparing even further, I started to get the feeling we're opening a Pandora's box, and that we're expecting in further investigations into our Human Genome to be uncovered more than there's the potential to do, more than what we're asking it to do. And that is tell us about our ancestry, where we came from, tell us a little bit about who we are right now, and then any biological events that are going to be shaping our lives in the future. So a couple of really important questions I'd like the presenters to talk about tonight that sort of came up in my research.

And these are the sort of three governing questions. Is genetics a valid basis on which anyone can base the understanding of who we are and what we are? Can people choose their identity? And if so, how much can we choose given that we've got 99% of all our genes in common? And how much of identity is non-changeable and how much of that network is given to us and how can we shape our identities as human beings or their choices that we can make in this regard? So I'm hoping that's going to sort of bring our discussion together. Prior to the forum, I asked both Rold and Praveen to prevent some opening statements, and I asked them to include in those statements some sort of background on their cultural ratio, their ethic and also their faith backgrounds, and knowing that both Rold and Praveen currently have faith perspectives that are different from their families of origins and their community of origins, to talk maybe a little bit about that transition of how their identity changed once they changed their faith beliefs.

So I'm going to ask Rold to start off with some brief remarks and then you can sit. Sorry. Can I sit here? So first of all, that would take more than five minutes to say what we need to say, but let me try.

So I come from a Jewish family born in Poland just before World War II. The war, the Holocaust shaped part of my response to Judaism. And it's quite natural to see all that horror result in some emotionally wrenching changes.

I never was an observant Jew. The reason was that my parents were socialists. So this is a thread of Jewish assimilation that anyway pointed away from religion.

Even my name, Rowald, I was named after Rowald Amundsen the Norwegian explorer who first reached the South Pole just 103 years ago. Even that name is a reflection of the structuring of Jewish identity in assimilationist times in Poland. My uncles were named Samuel and Abraham.

There was no way that my parents were going to name me Samuel and Abraham. Neither were they going to give me the name of a Polish saint or a Catholic saint rather. Michael or Thomas were out too.

So one looked for the names of secular heroes. That was part of the culture that I came from. And the name of a polar explorer was just fine for structuring that identity.

So a little bit about where I came from. I did later in life acquire objections to the tradition of Judaism from which I came and which shaped my people. And they most certainly were and are my people over 2000 years and of course were very important to the development of Christianity.

Let me tell you a little bit about what my objections were to my own tradition which I didn't share already. But they were later and they were reason. And some of them are fairly obvious.

One is for instance the description in the Bible of taking literally. And here I mean the Torah, the five books of Moses and the subsequent writings, especially in subsequent writings. There were acts which violated my contemporary 20th century morality, the extermination of cities down to the last inhabitant.

We know those passages in kings where for instance where that is described. And that is obviously abhorrent to a modern sensibility. The second thing is there were rules and taboos that did not seem realistic.

You know what I'm talking about whether some food is kosher. They were even much more esoteric ideas about not mixing linen and wool in your clothing which you probably haven't heard about. But these things which make anthropological sense which I could tell you about did not make sense to an aspiring scientist.

Why should it matter to God that we mix linen and wool together in our clothing. The third thing was that there was an obvious inability to adjust the modern times. Now this was weird because there was some ability.

So slavery which is talked about positively in some ways within the Old Testament went out of Judaism of course it had to. And so did polygamy or rather polygyny. That was no longer even though that was also among the patriarchs allowed.

So there was some adjustment but there were these religious people who were still telling me that I couldn't listen to a woman singing in public. And that is one of the kind

of esoteric rules of so Barbara Streisand could not sing for me. So that obviously set me off in a wrong direction.

Much more interesting, not interesting but there were also psychological things. But the things that I've mentioned so far incidentally part of what Christianity reacted to as it split off from Judaism was some of the same things that bothered me. And to the rekindle population that was at the heart of some of the initial recipients of Catholicism, the Hellenistic culture that was strange.

What bothered me also was the weird psychology as I grew more I would say, adult or sensitive to psychology things. The weird psychology of a God needing continuous affirmation of his existence. I mean that we would have to say over and over that blessed be the God king of the universe who has given us this.

Why does he need that? That just didn't make sense. It seemed to me from my knowledge of people. So I was building it to God and what I knew of people.

It seemed to me a weakness which I associate with people who are insecure on sure of themselves that they needed constant affirmation and constant praise and I didn't see that. So those are some of the things that initially honestly were in my turning against Judaism. I will tell you later about why it's not just Judaism but in general, the idea of a God also gave gives me trouble but maybe that's enough to begin with.

Great, thank you so much for all the prevence. Yes, thank you. I do want to thank the very toss forum for inviting me here today and for Cornell for hosting me and Dr Avery for moderating the event.

I do also want to say a few words about the distinguished gentleman with whom I share the stage today. It's an honor and a privilege to share the stage with you. You are a true treasure of Cornell and your reputation precedes you.

But in our brief interactions what I what has impressed me most about Rold is his humility, his thoughtfulness and his heart. If you haven't gotten to know Rold, I would. Thank you Rold for participating in today's event and for contributing your voice and your experience to today's discussion.

And I do look forward to many more years of friendship with you. Both Rold and I have been asked as you heard to keep our opening remarks fairly brief under 10 minutes. If you know anything about academics, it's that we like to talk.

We rarely do anything under 10 minutes, but I promised Rosemary and I'm going to do my very best to keep this brief so that we can get to some of the more interesting Q&A sections of today's event. So what makes us human? That's the topic for today's discussion. And at the heart of this question, I believe is a search for identity, which is something that I think resonates with most, if not all of us.

So who am I? Well, I am a Christian, a scientist with a Hindu background, Indian ancestry, Canadian birth, and American citizenship. So it's a lot to unpack and I'm certainly not going to accomplish that in five minutes. But in my opening remarks this evening, I think what I'll do is just highlight three major aspects of my identity.

So the first is my name, Praveen Saitubati, which is of Sanskrit origin, and it means skillful. The Praveen does anyway. My family also calls me Raghu, which is after a great emperor in Hindu mythology, whose line gave rise to Rama, an incarnation of the Hindu god Vishnu.

Saitubati means Lord of the Bridge, and the bridge refers to a former chain of limestone shoals that connected the southern tip of India to the northern coast of Sri Lanka. And according to ancient Hindu epic Ramayana, the bridge was constructed by Lord Rama and his army. So needless to say, my name is steeped in ancient Indian tradition and Hindu lore.

And my name is one of the precious few elements of my day to day life that serves as a welcome reminder to me of where I come from. It strengthens my bonds with my Indian heritage, my family, my father who gave me my name grew up in a small village in South India, where he was raised with age-old traditions and cultural ideals, many of which he passed on to me and that I'm now passing on to my children today. India is an inextricable part of who I am, an inextricable part of my identity.

I feel blessed to be an Indian American. And as an English speaking Christian, born and raised in North America, my name is one of the few things that highlight my Indian heritage. The second aspect of my identity that I'd like to highlight is my genetic makeup.

Rosemary referenced this in the opening remarks. Our DNA holds traces of not only our recent human ancestry, but of a much longer evolutionary history. My genome contributes substantially to all sorts of traits, some rather prosaic like my skin color or my height, other interesting ones like my competitive drive and my need for the Buffalo Bills to win.

My genome even holds clues about predispositions that I might have to various diseases. But as much as my genetics shapes my identity, advances in science have demonstrated that by no means does it seal the fate of my identity. For example, our environment heavily influences how our DNA works.

So individuals with very similar or even identical DNA sequences will develop different traits and behaviors and identities as a result of how their unique life conditions have shaped how their DNA functions. And we can get into a little bit more of the science of theirs interest as the evening progresses, but the key point is that our identities are influenced but not fully determined by any means by our genetics. The third and final

aspect of my identity that I'll share is something that is wrapped up within the person of Christ.

In my own spiritual journey during my years at Cornell, I studied many different faith traditions, including Christianity. And the hero of that story is a naked and disfigured and seemingly pathetic man on a cross. It seemed to me the antithesis of a hero at first.

But what I would learn is that in the cross, Jesus was turning upside down my notions of power. You see, you and I, if you're anything like me anyway, would think about exercising power by exerting our perceived superiority or authority often by force on the world. But it seemed as though he was laying his life down before the world.

In other words, it wasn't that he was powerless to stop what was happening to him. But it was that he, this is how far he would go to exercise his power to make things new. So, as a Christian, and one who claims to follow in the way of Christ, I'm also called to live a life of self sacrifice for the benefit of others.

Now let's be clear, I don't always live up to that calling, but it really does shade the way that I think about who I am. So that's a brief look at culture and genetics and faith and their contributions to my identity. Thank you again for the privilege to be a part of this event.

I look forward to the discussion. Great, thank you both for keeping it nice and short and to the point. Very interesting.

So the rest of the discussion now we're going to have sort of two parts. The first parts are going to be pre-prepared questions that I've actually shared with the speakers. And either can answer them, they might be more pertain to one or the other.

And the first part of that's going to address the issue of biology and genetics. And then the second part is going to be more of the faith and the genetics and how those two interact. So the first question that I have pre-prepared is the following, is there empirical evidence within science that tells us that we are more than our genes and sort of carry on question to that is some of the research that I've done has suggested that if I answer this is went through traumatic experiences, such as a war or a famine or the Holocaust, that our genes carry some memory trace of that energy through our genes.

And so what my question is, is that a possibility? And then second, what part do all these memory traces and these genetic traits play in giving us freedom to determine who we are? So other if you can take that question. Well, I think Ravi should answer it because the immediate answer is a branch of science that in which he has pioneered. So tell us a little bit.

Sure. So the answer. We also have answers for meaning of life and things like that tonight if you're interested.

So the answer Rosemary in brief is yes, that is indeed very possible and there are a lot of advancements in science in the last few decades that have brought us to the point where we actually can have a fairly robust conversation, not only about whether it can happen but how it can happen, the mechanics of it. Let me give you a few examples. You've probably heard it said very many very often that we have billions to trillions of cells in our body.

And that's true. But did you know, and maybe some of you do, that there are more bacterial cells in our body than human cells 10 times as many. Right.

So right off the bat, there's a confusion when we're talking about what it makes what it will, you know, how we define our humanity. And we're referencing our biology. We have 10 times more cells that are microbes of various sorts than human cells in our body, whether it's on our skin or in the deep recesses of our gut.

And so right off the bat, it tells you that, you know, we are indeed more than just the genetics in the human cells, just the DNA in the human cells. And these microbial organisms influence us in very complex ways, and we are just at the tip scratching the surface of understanding. They are doing this and how effective and potent they can be.

But it certainly has these microbes have been connected to the development of a wide range of diseases such as diabetes, obesity, and a number of others. And so the first example is the field of epigenetics. And so the prefix there means above or beyond.

And so this was meant to indicate that it was the study of something beyond DNA itself. In our cells, DNA is not naked. It is wrapped up in this packaging material.

And the packaging material can be modified chemically in diverse kinds of ways. And it's a mechanism of different kinds of chemical modifications that can be deposited on the packaging material of DNA. That the different combinations of chemical modifications dictate whether or not certain portions of the DNA are actually going to be on or off.

And if they're going to be on, to what extent are they going to be on? Are we going to turn on a particular nearby gene to 40 units or 80 units or 100 units? So you can think about them almost as dials or re-estats. And so you could have the same exact DNA sequence, but have it packaged differently. And what that is going to do is make the genome function differently.

And so why is that critical to this discussion where any number of lifestyle choices that we make can influence what chemical modifications are made to the packaging material. And thereby influence how our DNA is going to function, which genes are going to get turned on and turned off, and to what extent. And so smoking, our diet, any number of the kinds of obvious lifestyle choices can influence the modifications of the packaging material of our DNA.

And there are also much more subtle things, conditions of life, abuse in early age, any number of other things like that that have also been shown to be able to modify the epigenome, if you will. So these are all things that are happening to us externally, and yet controlling how our cells are interpreting the DNA information. And so when Rosemary refers to there being memory traces, this can indeed be the case because it turns out that some chemical modifications are heritable.

They can be passed on from some one generation to the next in the same way that our DNA material can. The mechanisms of this are still being worked out, but that it can happen with some kinds of chemical modifications on the packaging material is now well appreciated. It's an interesting, it's a return of Lamarckian ideas in a way, but I sometimes wonder if things have gone another way and somehow Darwin and Wallace were not there.

If Lamarckianism had been there for a longer time, would Darwinism have come in another way? It had to come in. Right. So the reason I let him talk about it is because that's what he works on, is epigenetics, and it's wonderful to read about it.

I think we are genetically prompted, perhaps limited somewhat, but prompted is mainly. And we are culturally conditioned. It sets in early on any of us who have children or you can reflect on your childhood, the extent to which your peers had a greater influence on you than your parents.

And ultimately we are individually formed, and the choices are ours. As was said, if we share 99% of the genetic material, I want to expand that a little bit. We share with great apes, 98% or some figure like that.

And even with E. coli, we share a very substantial amount. And I don't think there is any doubt about this. These are facts which come out of DNA analysis.

Does that make us like E. coli? Does it make you like me? Does it free us of choices for good and for evil? No more than the original sin. It prevents you from making a choice about being good and evil. Your genes are set some of the stage, but the diversity is quite remarkable.

And especially when you add on top of biological evolution, cultural evolution, which moves so much more quickly and allows more diversity. What I mean is that, yes, you get tired if you hear that song for the ninth time, but you have the freedom to look for another song. And there is an incredible variety of songs out there.

You can form your life given chance and thoughtfulness about the choices that you make. You can form your life in an essential infinity of infinity's way and to make the choices that you need to make. So, Rob, let me pick up on that and pick up definitely on this memory trace issue.



And that is, you've spoken in the past about the experiences that your appearance went through and you went through in the Holocaust. And you're now picking up on the social influences, advertising, TV, movies that we see that tell us not only who we are, but who we're supposed to be, right, within that culture. So, what degree do you determine that we have actually got that freedom to choose? And maybe you could also talk a little bit about what impact the experiences of your appearance in you and the Holocaust has determined your worldview and your way of making those choices in your life? There are two different questions, but I think I do worry like many people about the choices that we make when those little cookies that you leave on your computer influence.

Yes, they influence what ads you get from Google on the sidebar, but we are headed toward a future which looks ominous where a lot of the visual and textual prompts in our life around us will be provided based on some computer's evaluation of your likes and dislikes. And I do worry about that. I still think we have choices, you know.

So, in our time, we were formed by what? By articles we read in the magazines, by movie, by pictures of American life generated in the movies, a convenient fiction serving somebody and ideal ones. But then they were modified by the realities of life. I think we were shaped by the cultural influences among us and foremost among them was that great instrument of moral instruction, which is the novel, novel books, which I think shaped how we behave.

And I worry a little about what that shaping will take place. Now, in my case, you mentioned the Holocaust, and that is one of the reasons why I lost the faith that I didn't have for it, so I didn't have it to begin with. But we are getting here immediately into one of the fundamental problems which every religion faces, and that is the existence of evil and how we deal with it, and how we reconcile it with an idea of a good God or a good presence, a good idea in us.

The Holocaust with its great destruction of innocent lives on a measure which was just impossible to conceive, but only one of the great destructions of our times, be it the Armenian genocide or the number of people killed in the under Stalin's rule, for instance, in the Ukraine where I come from by the Gholodomor, by the starvation or in Mao's China. The number of innocent lives of life was enough certainly to make some people unreligious, but one person in my family became religious, so it's unpredictable even what that suffering, what that suffering will cause. But it certainly played an important influence in my life and then many people in my family.

Can you remind me Rosemary of the usual? The same question. We would have another one. Yes, I do.

Maybe we'll move on. So I'd like to sort of move a little bit more into the sort of science and faith area here, and sort of nexus of science and faith that were. All of us as we grow from infancy through to maturity, we sort of adopt or choose, I'm hoping we can choose,

and it's not all just genetic.

We choose a set of principles by which we organize our lives and we make sense of our lives and we interact with the world. And this sort of presents what is this a worldview, right, a worldview that we hold. And you two hold very different worldviews in terms of, you know, is there a God? What role does that God play? And I've heard roles say many times before, both in various forums and in person, that there's a certain amount of knowledge that we generate about our world that isn't scientifically provable in any way.

So the question I want to ask now, maybe role of Perveen can take this. How does the reason and logic and intellect, you apply in your research and your professional life as scientists, can inform your understanding of who you are and sort of shape your life. And maybe you could also comment on any tensions that you feel in maintaining your intellectual integrity, as well as your spiritual integrity.

So, I can speak for the life sciences. There's a common misconception that the scientific pursuit is pure objectivity. Particularly when it comes to doing science to investigate things you cannot see.

I do that every day. And we even joke around about how when we isolate RNA or protein, we expect to see something at the bottom of the tube and often we don't. We walk by faith and not by sight.

But more seriously, there's a diverse kinds of scientists that are more familiar. That are investigating things that you cannot directly observe. How deep is the ocean floor? What are the mechanisms of speciation, you know, x billion years ago.

These are clearly not things that we can directly observe. And so what is it that we're doing as scientists? We are making observations and generating hypotheses, doing tests, making observations, all of the classical things. But fundamentally what we're doing is accumulating evidence in favor of one model or the other.

And so when we sit down to try to uncover a particular biological phenomenon or answer a biological question, there are any number of models that might explain that. And our job is to, in a rigorous manner, with a careful project, evidence that either supports or refutes one model over another. And so the reason why, for example, that the vast majority of biologists subscribe to the evolutionary theory is not because in the purest sense of the word, anybody has gone back in history and proven it and shown the tape of history to everybody and said, well, here it is.

Actually just the inferences that have been made over many years. In fact, when Darwin came out with his origin of species, there was a tremendous amount of skepticism in the scientific community. And in fact, it was actually a segue that theologian at Princeton University who encouraged our ideas in America and how much times have changed.

But over the years is the development of evidence that eventually suggested that that model was far more plausible, enormously more plausible than really any other model that we might invoke. And that's a lot of the times what we're doing in our scientific research. And so I think it is important that we are careful in thinking that science is pure objectivity and everything else is just subjective.

We're not necessarily proving anything the way that you might in theoretical mathematics. It often feels like a proof because it's extremely convincing, but it's not technically a proof. So I think it is important to make that point.

The second thing I would mention is that Enroll has written elegantly about this. There are other ways of knowing. That is something that I believe.

For example, consider the love that my wife has for me. If any one of you challenged me to prove it. I'm not sure what I would do because I don't really think I could.

I would sit there and say, "Well, look, consider our life and look at what she has done for me here and there. And here's our story. But I would essentially be telling you a story.

And I would be relaying a set of experiences to you. That would either be convincing or not. But I wouldn't be able to prove it.

And yet I don't know that any one of you would challenge me that I don't really know that my wife loves me. So there are different kinds of ways of knowing. And so even as a scientist as I pursue reason and logic, I'm well aware the entire time that there are other ways of knowing and other ways of shaping my identity.

Even in two hard sciences like chemistry and physics, the ways of knowing are different. And the ways of knowing in chemistry or the most interesting part of what chemistry is is not reducible to physics. That's not necessarily a popular view among the physicists.

But even among some chemists who are willing to accept reductionism, which is when it comes vis-a-vis biology, but then they maybe draw a line of physics. I think what Praveen has said is right, very little of science operates in a strictly scientific process of gathering evidence, forming hypotheses and disproving them. A lot is a stepwise accumulation of knowledge, just like he said, a kind of knowing without seeing.

In a particular context of chemistry, the structures of all these molecules, we did not wait for any microscopes. There is scanning tunneling microscopy, which can show us these images. We did not wait for any microscopes to show us this, but with the hard and soft knowledge of our minds and hands combined, there have to be experiments.

With our fallible senses, with the extension of our senses that instruments are that have to be calibrated. Somehow we got little pieces of indirect knowledge that there was a double bond between the carbons in this molecule, and then that we could build from

that and knowledge so that we could tell whether this molecule of chlorophyll or morphine was the way that it is. And that indirect knowledge needs to be admired, and it is very important.

Nevertheless, there is a scientific frame of mind, a way of looking at phenomena, which even the disparate fields of chemistry and physics and others that we share. We somehow have a feeling it has to do with a marshaling of the evidence, the kind of questions that you ask, and nothing is proven definitely, but somehow a structure builds. Can one apply that way of thinking to questions that are questions of faith? So part of it you can, and when Praveen talks for instance, as I've heard him talk about the historical evidence for the existence of Christ.

He will, or the resurrection, he will, part of it, he will marshal a quasi scientific way of approaching that historical evidence. And the historicity question, yes, but then on other questions, I think you would, you take a leap of faith. Yes, there's only so far in certain kinds of knowing.

I mean, again, going back to the love that my wife has for me, she didn't know she was going to feature so prominently in today's discussions. But, you know, we're honest with ourselves, there is a little bit of this isn't a perfect analogy, but there's a little bit of accumulation of evidence, you know, when you're dating, according, you're looking for the signs or whether there is the evidence that this person is interested in you, that kind of thing. A leap of faith that this is going to work.

As I said, this is not a perfect analogy, but this isn't a lot of ways how my own journey and my spiritual journey was. You know, I had an impulse even at an early age to want to be as rigorous in my investigation of things as I could. And you know, Paul himself says that if the resurrection is not real, then Christians are to be pitied among all people, because it's a royal waste of time.

Everything hinges on that. Right. And so if that is indeed the case, which I believe, then I darn well better do some due diligence to see whether this there's feasibility here.

Right. And so there is, as Roald said, a quasi scientific approach. And again, really for me that just meant there are a lot of different models to explain what I'm sitting here reading in the Bible anywhere from this was real.

And that's why I'm reading it to this is legend fabrication, you know, the greatest story ever told and that's it. Right. And then all sorts of, you know, the possibilities in between.

And so I have to look at those models and begin to look at the evidences that I can in as much as is available to me from biblical and extra biblical documentation and begin to build a case for one or the other models. But at some point, one has to take a leap of faith. And the reason alone is not going to bring you to the place where you say, "Aha,

I've proven it to myself." It is, it's, it's, it's, you know, the scientific process is necessarily agnostic with respect to God in the sense that it can neither definitively prove or disprove his existence or any particular faith tradition.

So I do want to tell you how my undertaking a similar quasi experimental quasi scientific approach led me to a lack of faith. And so when I was 18, I spent the summer in Washington, DC. I was working in National Bureau of Standards then in Delta Washington living in a dingy boarding house.

And I decided I was going to do something rational about religion. So I went each week and to a different religious surface. And one time to a Catholic church, which I knew because we had been Catholics for a year and a half.

But, but then I went to, to a Evangelico church where I was the only white person in town in, in the, in Tabernacle. And I went to a Baha'i and Islamic service and I looked at those and what I saw around me, so I'm telling you of my experimental investigation, what I saw around me was people of good faith. I was welcomed in that black community.

I was, I was not made to feel any different, though I was different. And everyone was saying good things about their neighbors, about themselves. They were holding hands at the end of the service.

But what I saw was these good, honest people had clearly reached rather different ideas about what religion and God met. And I took that, not as any direct evidence. I took that as part of a forming a worldview.

I also had read, I had studied comparative religion in some way and a course of Columbia shortly thereafter. I took it as a worldview that there must be, so this is very different from Dawkins and Hitchens. I think religion is deeply human.

It is an as, emergent aspect of human evolution. But it was also clear to me from this examination that whatever, whoever God or God's were, they clearly were different to different people. And so that there was no one God to me was my empirical conclusion to seeing the good faith diversity of religious feelings that was out there.

So we're getting to the end of the structured question portion. We're going to be taking audience questions, but I have one last question I want to ask, Rold. So Rold previously, you've spoken on, in fact, you've actually written on a topic that just fascinates me and it's called the Romance of Discovery.

And the sense that there's something very thrilling and exciting and exhilarating about scientific discovery, something that is beyond the discovery itself. A well-known atheist, Richard Dawkins, concurs with you that there could be something incredibly grand and incomprehensible and sort of beyond our understanding about science. And in fact, Cornell scientist Carl Sagan said the following, science is not only combatable with

spirituality, it's a profound source of spirituality.

Some take this as to be a signal that maybe there is a belief in a transcendence in your life and their lives, and I'd like you to comment on that you agree or disagree with Carl Sagan. In general, I agree with Carl Sagan. He also said a number of other things about science being a beacon in a world full of darkness in other ways.

I just put a different spin or angle on what you say. I think there is something emerging out of the human condition as many other, let us not speak of the evil things, but as many of the other good things, music, language. Ethics.

These are human creations, I would say. I think religion is one of them. There is something, there is a natural emergent quality, and I could talk some more on what emergent emergence means in science or other outside of science.

But it is an emergent quality that when you put diverse human beings together that they will seek aside from the self-satisfaction that they have in gaining specific knowledge that I do in the science, I publish it. Part of it is that part of the professionalism of science that I publish it, but part of it is I do want to share it. There is something that I do share with other people.

And when I go outside at night, we are near a full moon and I look at that moon and if I am lucky enough to see stars, yes, I have personal pleasure in doing so, but part of that pleasure is that I am sharing it with other people who are looking at the same objects. And I think we are sharing a spiritual feeling. I think the closest probably that we come to a shared transcendence or religious experience in our world is probably in listening to music.

The most abstract of art forms, and yet capable of making you cry. And is there anything better in the world than dancing with friends? I think Anita let Praveen answer that. Well, that was a wonderful way to enroll because I feel there are a lot more similarities in the way that we think that there are dissimilarities actually.

And I too am quite fond of music and perhaps even more so because in fact I think it's what makes me tick. I have, I meet with God in moments when I am listening to music and believe it or not, it can be human nature Michael Jackson as much as it could be, you know, air, air, you know, air clue and some sort of smooth jazz. You know, music is a very transcendent experience for us.

With regard to Carl Sagan's quote, I sort of, whether I agree or disagree, I think to some extent depends on what spiritual means. I think we all use it in very different ways. Based on the context of that quote, I think what Carl was going after and my best estimation is the awe and the wonder that we feel as scientists in the scientific enterprise, but really as any of us as we're interacting with the world around it, I think

that there is a remarkable beauty that most of us are extremely inspired by and impressed by.

And if that's what Carl means by spirituality, then you know I completely agree with that sentiment. In some ways though, I think that the scientific enterprise has been spiritual for me, not only in what it has shown me, but what I have come to understand it can't show me. And, you know, Darwinian evolution has done a beautiful job of helping us to understand any number of traits that humans or a number of other organisms may have.

And it has even done so far a good job in explaining our various behaviors that may be hard to quantify and nail down. But why it is that we have emotional correlates for those things and that we have subjective experiences. And importantly, why is it that we are even here having this discussion striving to determine whether there is any meaning in life.

And these are things that do make us uniquely human. And these are things that as of yet anyway are not well addressed. And even the most strident of atheists or people that are non-believers generally concede that while that doesn't of course necessarily point to the existence of God, it is something that science is not addressing.

It is something that we are uniquely human in. There are a lot of emotional traits that we share with animals and the organisms, but that we have these consciousness and subjective experiences that help shape our identity and lead us to question why there is anything at all and why there is meaning. That is something that I think makes us uniquely human and is a spiritual experience.

Find more content like this on [baritas.org](http://baritas.org). Be sure to follow the baritas forum on Facebook, Twitter, and Instagram.

[Music]