# THE WORKINGS OF SCIENCE

# TRANSCRIPT

**Dr. Melinda Baldwin:** The modern scientist is a strange thing for a society to have because if you think about it, it's really remarkable how much we trust scientists about what they say. So, a physicist can walk into a room and she can tell us that she knows something about the inner workings of particles that are so small that not only can you not see them with your eye - you can see them with a microscope. And she'll be believed. And I think that's remarkable and slightly strange because that's a tremendous amount of social and cultural authority to give to someone.

## THE MODERN SCIENTIST

**Dr. Melinda Baldwin:** The scientist as we know him or her today is a figure that really arose during the Cold War. Riding high on the success of the Manhattan Project after World War II, all of a sudden you had the public consulting scientists for opinions on everything from the best way to combat poverty to the best way to treat the common cold. Scientists became invested with a tremendous amount of trust, with a tremendous amount of cultural authority.

## BEYOND THE SCIENTIFIC METHOD

**Dr. Melinda Baldwin:** In grade school, in middle school, or in high school, in most tellings of the scientific method, there's a hypothesis and then there's an experiment. Well, right off the bat there, you have a lot of scientific fields that aren't able to do experiments. For example, if you want to know something about plate tectonics, you can't really do an experiment that's going to change the way that the plates of the Earth move against each so that you can gather new data. In fields like astronomy or geosciences or ecology, a lot of what scientists do is more about collecting observations, about the way the natural world works. The scientific method can be a useful introduction, but if you push it too far and expect all of science to adhere to exactly that same five or six step method, you're missing a lot of what science does and you're missing a lot of more observational or a lot of more instrument-based science that is still producing really valuable and exciting results.

**Dr. Sylvester J. Gates:** I do not understand how science can discover truth. There are other realms of human activity, philosophy, religion that are about absolute truths.

**Dr. Michael Ruse:** Take something like poetry, which I think can be tremendously evocative. I think at some level you can capture an insight that perhaps you can't capture in quite the same way in the psychology lab.

**Dr. Sylvester J. Gates:** As I have experienced science, what it discovers is accuracy, and maybe for most people, truth and accuracy are the same thing but they're not to me.

**Dr. Melinda Baldwin:** Oftentimes, when you read about a study, either from a university press release or from a journalistic outlet, the results will get reported as, for example, “Scientists prove that coffee is healthy for you.” But then, if you actually go to the scientists who did the study, they’ll usually have a much more nuanced answer. They’ll usually say something like, “Coffee consumption at *x* number of cups a day is correlated with these positive health outcomes at this numerical confidence level,” controlling for all of these other factors like age, weight, income…and I think that for a lot of people, that can be kind of frustrating. It sounds a little wishy-washy when scientists want to throw in all of these caveats, but I think that that’s an outcome of the way that scientists are taught to communicate. They really care about accuracy, and in some ways, I wonder if this is sort of an artifact of the peer-review process. So, before a scientist can publish an article in a scientific journal, they have to answer referee reports. Oftentimes, they’ll have to go back and do more experiments in order to bolster their conclusions, and so, a lot of training goes into teaching a scientist to be really specific about what their data shows.

**Dr. Sylvester J. Gates**: Because science ultimately is about what we humans can measure and stating the relationships of those measured quantities. If you have a concept that you have no way of measuring and I have no way of measuring, I cannot ascribe the doing of science to for example refute that concept. I have no framework for doing that.

## SCIENCE AS METAPHOR

**Dr. Michael Ruse:** I'd want to argue that the very nature of science gives itself limits. You start to see the heart doing something like this. Immediately you're saying, "Well, what kind of machine do I know where I get this sort of thing going on?" Bingo! Obviously, pumps, because that's what pumps do. As soon as you start to think of the heart in these sorts of terms, then you start to say, "Well, what's it pumping? Oh, it's pumping the blood. Why is it pumping the blood? Obviously if something's going out, it's coming in. Is there ..." And you’re off and running, you know, veins, arteries, and the lot, but at the same time, the whole point about metaphors is that they take you away from other questions, which aren't necessarily bad questions. Using a metaphor, you're immediately putting on those blinkers so that you think in certain ways, and you're not wasting time asking other sorts of questions.

## SCIENTIFIC WORK AND THE UNKNOWN

**Dr. Sylvester J. Gates:** There are things in science that we cannot prove. There are things in mathematics that we cannot prove. In the other part of the 1900s, a mathematician by the name of Gödel derived an astounding result. They're called Gödel incompleteness theorems. What these theorems basically say is that in any mathematical system that one can build, there are elements in the system that cannot be proven that in fact have to be taken as postulates and that's another way of saying there are things that must be taken on faith even in the doing of mathematics. Not only does one have to have faith in one's self. One also has to have a kind of faith that the universe is understandable. This is again an important element of science.

## QUESTIONS & ANSWERS, PROBLEMS & SOLUTIONS

**Dr. Michael Ruse:** I think there's an awful lot of misconception about the nature of science. That somehow, we can finish science, we can get it all done, and it's just a question of going out at it like that. I see good science as coming into the lab in the morning, or going into the field, and having a problem which they've solved by lunchtime but leaving the lab at the end of the day with two problems.

**Dr. Melinda Baldwin:** I think, in fact, that if you actually talk to scientists about why they got involved in science in the first place, they really care about the implications of their research for the big questions, you know, what does it mean to be human? What is our place in the universe? How did the universe begin? Is there life on other planets? But they're not necessarily the kind of questions science answers.

**Dr. Sylvester J. Gates**: Science in and of itself cannot be thought of as the be all and end all for human activities. In my opinion, it should not be thought of. It should contribute to how we as a society move forward. For me, it's about my species' ability to understand and to adapt and ultimately to utilize the structures of the universe and hopefully for our long-term benefit as a species.