

BOOK MEDIA KIT

Beyond Comprehension

A Scientific Look at the Challenge of Knowing Everything

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BOOK INFORMATION

Title:	Beyond Comprehension: A Scientific Look at the Challenge of Knowing Everything
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Publisher:	Hamilton-Haverbrook
Date:	August 22, 2017
ISBN:	978-0999208700
Pages:	150

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The universe is infinite.

The human brain isn't.

The human mind is extraordinary, with capabilities far beyond that of other living creatures. But is it capable of comprehending all that is? And what does this mean for science and its impact on the human spirit?

In *Beyond Comprehension*, Dr. E. Andrew Boyd examines human cognitive limitations by exploring enigmatic results spanning the disciplines of math, physics, philosophy, neuroscience, and computer science.

Containers filled with paint that can't be painted. Equally valid science experiments yielding contradictory results. Numbers that don't add up. Each chapter is designed to leave readers asking "What on earth?" as they discover new and wonderful things about our world and, in the process, develop a new appreciation of the human experience.

BIOGRAPHICAL INFORMATION

Dr. E. Andrew Boyd has immersed himself in math, science, and philosophy for as long as he can remember. With a doctorate in applied mathematics from MIT, he's been graced with a career that's spanned fields ranging from polyhedral combinatorics to airline ticket pricing.

For the last ten years Dr. Boyd has worked as a scheduled contributor to *The Engines of Our Ingenuity*, a nationally syndicated radio program and podcast produced by Houston's National Public Radio affiliate KUHF, part of Houston Public Media. Evan Hadingham, Senior Science Editor at NOVA, has called Engines "the best-written short-form science podcast on the internet," adding, "Every episode is a gem." Dr. Boyd has written and commented on a wide array of science and engineering topics, with a special focus on science and its impact on the human spirit.

PROMOTION INFO

Whenever promoting the book, please link to
<http://www.beyondcomprehension.info>.

When you post a review or promotion, please let us know so that we can link to your promotion.

POTENTIAL INTERVIEW QUESTIONS

1. What impact is science having on the human spirit?

Let me say that the scientific method is one of the greatest achievements in all of human history. But I believe we've reached a point where we're making some rather bold proclamations in the name of science that aren't only unwarranted, but erode the human spirit.

2. Can you give me an example of a scientific claim that erodes the human spirit?

A survey of philosophers was conducted in 2013 asking if they believed in human free will. Nearly three-quarters of the respondents said they did not, at least not as you and I think of free will.

The typical argument goes something like this. If I have table of billiard balls and I set them in motion, I know exactly how those balls will move at every instant in the future. That's because the universe operates according to physical laws.

It's then argued that the atoms that make up our bodies are like the billiard balls. Once set in motion, they just bounce around according to the laws of motion. We feel like we have free will, but we don't.

3. You believe that science is making some unwarranted claims. Why do you believe this?

Unwarranted claims come from extrapolating simple principles to their extreme. Let me give you an example. We learn from early on that the order in which we add numbers together doesn't matter. $1 + 2 + 3$ is the same as $3 + 2 + 1$. It doesn't matter how the pennies get into the pot, we always get the same number of pennies.

However, when we start adding together an infinite collection of numbers all bets are off. Order matters. For example, I can show how the summation $1 + 2 + 3 + 4 \dots$ without stop doesn't add up to infinity, but adds up to $-1/12$.

4. How do you know when a scientific claim is unwarranted?

In most cases it's clear -- that's what the scientific method is all about. You make a hypothesis and experimentally prove or disprove that hypothesis. A claim is unwarranted if it doesn't fit experimental fact. But the claims I'm thinking of fall somewhere in the cracks.

If, for example, someone claims that free will doesn't exist because our bodies consist of billiard ball-like atoms moving according to deterministic physical laws, how do you prove or refute that claim? According to our understanding of natural physical laws, the claim seems warranted on the surface. But it takes a very simple precept, "atoms bump around like billiard balls on a table," and extrapolates this precept an awfully long way. We don't even understand how a handful of lifeless elements can give rise to conscious life, so are we free to proclaim that same conscious life doesn't have free will?

And how do we refute the billiard ball claim? It certainly feels as though we have free will. Philosophers typically write off these feelings as epiphenomenological -- a byproduct of atoms colliding, not the source of our actions. How do you respond to such a claim?

In the end I don't think you can be fully certain whether scientific claims that fall in the cracks are warranted or not. But what I do know is that we need to remain aware of our cognitive limitations and what that implies.

5. You say that we need to remain aware of our cognitive limitations. Can you elaborate?

Let's look at an example. Take dogs. They're very smart, but they haven't a clue about, say, the number 10. The concept of "10" just doesn't register since their minds aren't wired for it. We humans are absolutely remarkable animals, but the fully developed human brain weighs about three pounds. Like dogs and other animals, I suspect we, too, aren't up to the challenge of knowing everything; that some things remain beyond our comprehension.

6. You point out that some things are beyond comprehension for dogs and other animals then use this to argue the same is true of humans. Can you offer any evidence to support this claim?

Actually, yes. I certainly can't prove it -- after all, things that are beyond comprehension are beyond comprehension! But I do believe we can find shadows of things beyond comprehension in the form of inexplicable realities.

It turns out there are a lot of conundrums in math and science that are utterly inexplicable. As with any good puzzle they're fun to learn about. But these puzzles can't be solved. We're just left to scratch our heads and ask "how can that possibly be?"

7. Can you give me an example of a conundrum?

One of my very favorites is Torricelli's Trumpet, named after a mathematician who lived in the early seventeenth century. It's a shape that looks like one of those long trumpets you see at Renaissance festivals, only it doesn't end in a mouthpiece. It gets smaller and smaller but never manages to come to a point. And here's the interesting thing. It has finite volume but infinite surface area. Or less precisely, you can fill it with paint, but you can't paint it.

Follow up. Does that make any sense?

You have to be the judge of that for yourself. It doesn't make any sense to me. And I should add that there's not a mathematician in the world who'd argue the facts of the case -- finite volume, infinite surface area.

8. Can you give me an example of another conundrum?

Physics is filled with observations that don't make any sense. The most well known relate to wave/particle duality, that photons, electrons, and really pretty much everything sometimes behaves like a particle and sometimes like a wave. This is impossible in our day-to-day world. Particles and waves are entirely

different beasts. Yet if you set up one experiment, you scientifically validate the particle nature of matter. If you set up another, you scientifically validate the wave nature. And things get much, much stranger. Bohr and Einstein argued for decades about Bohr's belief that the act of observing a particle/wave caused it to collapse from a wave into a particle. If that's not metaphysical I don't know what is. Richard Feynman famously quipped that it was safe to assume no one understood quantum mechanics.

9. Can you give me an example of another conundrum?

This isn't a true conundrum, but it comes with a good story. We know that "full" and "no space available" mean the same when it comes to hotels. But the mathematician David Hilbert changed our perspective when he asked us to think about a truly grand hotel, a hotel so big it had an infinite number of rooms labeled 1, 2, 3 ... and so on.

One day a visiting dignitary came looking for a room, but learned the hotel was full. He turned to leave, but was called back by the proprietor. "We may be full, but we still have room," said the proprietor, at which point he sent a note to all the guests asking them to move to the room that was numbered one higher than the room they were in. This in turn freed up room number 1 for the dignitary.

When dealing with infinity, "full" and "no room available" don't mean the same thing. Hilbert pointed out that he could have handled even an infinite number of new guests by asking guests to move to the room with a number two times larger than their room number, thus freeing up all the odd numbered rooms.

10. Can you give me an example of another conundrum?

Think about the following recipe. Take 15 gallons of water. Add to that a gallon and a half of graphite, a gallon of frozen nitrogen, and smaller amounts of about six other ingredients. Mix them together properly, and you get a 150 pound human being. How do all those lifeless ingredients give rise to life, and in particular, to consciousness? For all the research activity surrounding the human brain, this question in particular remains a conundrum, and it's not clear if we'll ever resolve it.

11. What are your plans for the future?

I'm hoping to spend a fair amount of time on the road sharing some of the things we've talked about. I've got some interactive presentations that audiences seem to find a lot of fun. The various conundrums really lend themselves to that. And

obvious as it seems, most people have never thought about the fact that our brains may not be up to the challenge of knowing everything, so it's a joy to talk with people as this idea starts to settle in.

Of course the bigger message is important and is ultimately what drives me. Science does so much good, but it has the potential to dim the human spirit. As our perspective on what it means to be human becomes ever more mechanistic, we risk viewing ourselves as nothing but machines. Many have already drawn this conclusion. I don't believe it's warranted. I believe that by recognizing our cognitive limitations we can rationally consider the likelihood that there's more than meets the eye -- that some things are simply beyond comprehension.