Evolution smuggled in under the rubric of popular misunderstandings of natural phenomena

Scienceblind: Why our intuitive theories about the world are often so wrong

Andrew Shtulman

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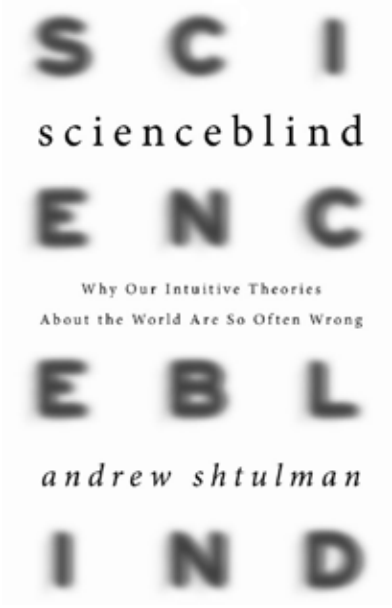

John Woodmorappe

The author is identified as Associate Professor of Psychology and Cognitive Science at Occidental College. There he directs the Thinking Lab. His degrees are in psychology, not biology, and yet he portrays himself, to the reader, as an authority on organic evolution. As discussed below, his descriptions of organic evolution are simplistic and apologetic, and reminiscent of those of an old high school biology textbook.

Shtulman discusses many popular children's misconceptions, including about physics. That is a strength of this book. However, his discussion of some of these is deficient, and I supplement his statements with those of my own experiences as a science teacher.

The author exhibits a condescending, almost snobbish attitude towards those who disagree with him on certain things—such as a man-caused global warming crisis (pp. 121–124). He also displays strong rationalistic prejudices against such things as life after death and the efficacy of prayer.

Piaget's theory is largely discredited

For a long time, psychology textbooks had taught us that young children do not realize the fact of conservation of volume, when the water in a tall container is poured into a wide container, because they are pre-operational. On the other hand, Shtulman suggests that, contrary to the Swiss psychologist Piaget, there is no 'pre-operational' and then 'concrete-operational' stage in children. Instead, children learn conservation of weight, volume, etc., at different times. It is simply a matter of children coming to realize which transformations change the substance in one way but not another.

It all has to do with overcoming errors of conservation. Not only young children get fooled by volume of liquids. When adults look at a slanted pint glass, they are liable to underestimate the amount of volume lost when the level of liquid drops a small amount.

Adults, too, are fooled; so are scientists

Density is not an easy concept to grasp by children—or even adults. This is why the question, "What weighs more, a pound of gold or a pound of feathers?" is not altogether ridiculous. This is because it is common for even adults to conflate heft and bulk with density. For instance, it is apparent that a block of metal will sink, and that a styrofoam peanut will float, but it is not so easy to see that a speck of metal will sink and a giant block of styrofoam will float. Again, heft and bulk get in the way of thinking accurately. In addition, the fact that the high surface tension of water may prevent the speck of metal from sinking as a block of metal would, makes it difficult to see the fact that density is completely independent from size and mass.

Lest the layperson feel unintelligent, this need not be. Shtulman warns the reader that even long-experienced scientists drift into intuitive-but-incorrect ways of thinking. He quips: "Heat, sound, light, and electricity are all preferentially viewed as substances, and no amount of training can scrub these substance-based views from our brains" (p. 56).

Conceptual hindrances to the effectiveness of 'discovery' science-teaching methods

The author describes a series of experiments in which middle school students could, using balls and ramps, empirically determine for themselves the counter-intuitive fact that more-massive balls do not roll down ramps any faster than do less-massive balls.

Another group just simply read in a textbook, written by an authority figure (science educator), that objects roll down ramps at the same speed, regardless of their mass. Both groups were tested, and, unexpectedly, textbook-instructed students were more likely to acquire a correct understanding of the independence of mass and gravitational acceleration than those who studied this experimentally.

Why was this so? Shtulman reminds us that it took centuries of experiments by scientists to arrive at the truth, and in particular to overcome their ingrained intuitive belief that more-massive objects roll (and fall) faster than less-massive ones. Surely it is unreasonable for a group of children to accomplish the same in just one experiment!

The best way to use hands-on methods of science instruction, in Shtulman's opinion, is through instructor-guided experiments. Consider, for example, teaching the counter-intuitive fact that the table exerts an upward-acting force on the book sitting on it just as surely as gravity exerts a downward acting force on the book. The instructor puts the book on a spring, and students see that the spring pushes back up against the book. However, there is too large a conceptual gap between the spring exerting an upward force and the table doing the same. So the instructor introduces bridging observations: A fairly stiff foam pushing back up against the book, then a thin board pushing back up against the book, and finally the apparently unchanged table pushing back up against the book.

Learning from authority figures versus learning by empirical observation

The foregoing has unmentioned implications which I now discuss. Rationalists have long snickered at religion, telling us that, in religion, you accept something merely because some authority figure (preacher, Bible, etc.) tells you so, whereas in science and reason, you accept something because you have empirically verified it for yourself.

We see from this book that the foregoing caricature is a gross oversimplification. Even in science, there is considerable overlap between an-authority-said-so and see-for-yourself enlightenment. Finally, not only science, but also religion, has to struggle against ingrained misconceptions. In both science and religion, things are not always what they seem. In science, it is our ignorance and our limited and misperceived understanding of the natural world. In religion, it is our sinfulness and our limited and misperceived understanding of God and His ways.

More needed in explaining misconceptions about motion

Author Shtulman does a fairly good job in explaining to the reader why both scientists and non-scientists had taken so long to grasp the reality of Newton's three laws of motion (figure 1). However, he could have done better. I provide the following illustrations.

For an object to continue moving forever, it would have to be in a frictionless environment. There are no frictionless environments on Earth. Thus, every rolling or moving object must eventually come to a stop. No wonder that it was hard to conceive that a moving object would—by default—continue moving forever. It is hardly surprising that it was thought that every moving object has impetus (or, later, momentum), which it runs out of, causing it to stop.

If humans could have travelled to space centuries ago, they would have experienced first-hand a virtually frictionless environment. Pioneer 10 and 11, having reached escape velocity from the Sun, and now beyond the solar system, are moving in essentially a straight line, and will continue doing so 'forever', until they run into an object or are deflected by its gravitational pull. This is a graphic illustration of Newton's First Law of Motion. In space it is easy to see that an object continues moving by default, that there is no such thing as impetus, and that 'something else' (friction) is what causes moving objects to stop on Earth whenever there is no apparent cause for their cessation of motion.

The space environment would also have helped in an earlier discovery and appreciation of Newton's Third Law of Motion. Normally on Earth it is usually not easy to see that one action of our body creates an equal and opposite reaction. In space weightlessness, it is quite evident. For instance, when the first attempts, in the 1960s, were made by the Gemini astronauts to perform effective work while on spacewalks, they soon became exhausted while trying to control the motions of their bodies. An astronaut would thrust his arm forward, and that would cause his whole body to drift backward, and also to start rotating backwards about the centre of mass of his body. That is a classic demonstration of Newton's Third Law of Motion. It was solved by astronauts clamping their bodies to the spacecraft during spacewalks. The spacewalker's challenges are not experienced on Earth owing to the restraining effects of gravity, with the exception of extreme circumstances, such as the boxer who must position his feet in order to prevent getting thrown backwards whenever he delivers a hard punch, or the gunman who feels the recoil of a firearm while it is discharging.

Finally, author Shtulman missed a chance to discuss a classic example of intuitively held misconceptions about Newton's third law—that of rocket propulsion. It is commonly

but erroneously believed that rocket propulsion works because the exhaust gas pushes against air. It is not difficult to figure out why: The human experience with rockets is normally limited to their operation in Earth's atmosphere. If humans could have observed rockets firing in space centuries ago, they would quickly have realized that rocket propulsion works fine in a vacuum, despite the fact that there is no air for the exhaust gases to push against. Ironically, rockets actually function better in a vacuum because there is no air resistance acting against either the expulsion of the gases in one direction and against the motion of the rocket in the other.

Mass and weight: supplementary information provided

The author touches on how people misconceive weight as being a constant. They do so because they lack experience with the fact that the weight of a given object varies a little from place to place on Earth, and that would likely differ entirely from that on Earth were the object to be moved to another planet. In addition, Shtulman fails to address a major common misconception—that which confuses mass with weight.

The erroneous conflation of mass and weight stems from the fact that, not only does weight seem to be a constant, but also the weight of an object 'follows' that of its mass. Yet they are not synonymous. An analogy I have found useful, as a science teacher with my students, is that of

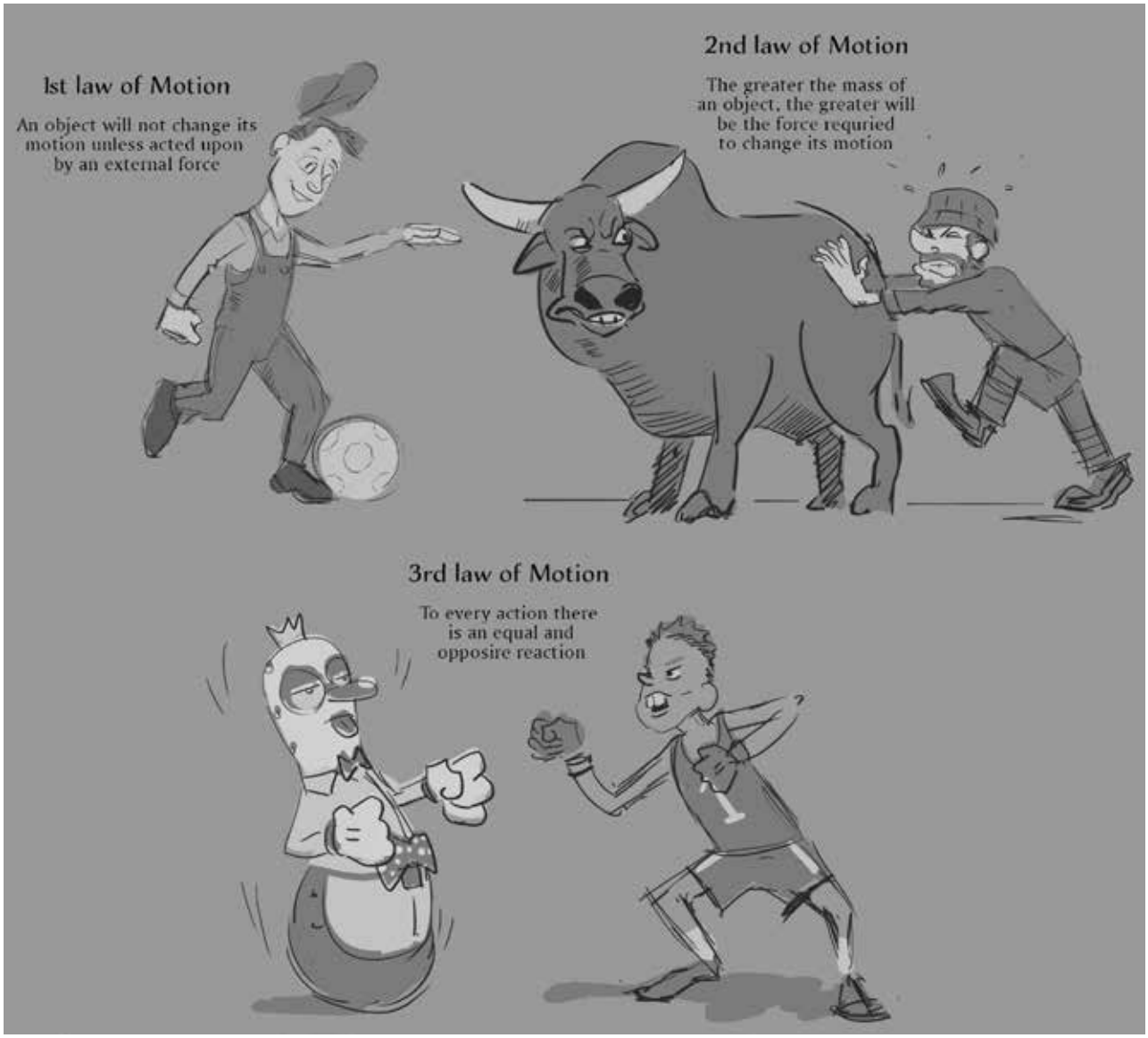

Figure 1. Newton's three laws of motion seem simple and intuitively obvious, but they took centuries of overcoming misconceptions to realize.

two unequal-height objects and their respective shadows. The length of the shadows change according to the position of the sun in the sky, but the length of the taller object is always greater than the length of the smaller object. After sunset, and on cloudy days, the objects cast no shadows at all, but one object still remains taller than the other. Clearly, the objects can exist without their shadows, but the shadows cannot exist without the objects.

In this analogy, the heights of the objects are their 'masses', and the shadows are their 'weights'. In real life, the weights of objects can vary greatly from planet to planet, but the weight of the more-massive object is always greater than the weight of the less-massive object. While orbiting Earth, neither object has any weight, but they still retain different masses. So mass can exist without weight, but weight cannot exist without mass.

Let us further illustrate the independence of mass from weight. Imagine a mouse and an elephant in a spacecraft while orbiting Earth. Both weigh nothing. Yet the fact that mass still exists is proved by the fact that it takes a much smaller force to accelerate the floating mouse across the cabin than it is to accelerate the floating elephant, does the same degree as the floating mouse, across the cabin. This also illustrates Newton's Second Law of Motion, which acts regardless of the presence of weight.

The author's misconceptions about evolution

Ironically for an author writing a book about science misconceptions, he entertains some of his own. Shtulman credits Darwin with coming up with the concept of selective survival and reproduction of well-adapted organisms, over many generations, at the expense of less-adapted organisms (p. 203). This is incorrect. The concept was developed by creationist Edward Blythe, if not earlier. In fact, none other than Stephen Jay Gould, a famous evolutionist and rather strong anti-creationist, nevertheless acknowledged that "Natural selection ranked as a standard item in biological discourse among the pre-Darwinian creationists."[1]

Shtulman also brings up the peppered moths. He correctly notes that natural selection does not imply that individual moths themselves become darker over successive generations. Instead, it means that dark moths become more common, and light-coloured ones less common, over many generations, and that this owes to differential reproduction and natural selection. However, although the peppered moths have long been textbook orthodoxy, Shtulman appears to be unaware of the fact that serious questions have been raised about the validity of Kettelwell's original experiment on the peppered moths, e.g. the 'camouflaged moth' photos were staged.

As a psychologist, not biologist, Shtulman shows a naïve lack of understanding of the now-known functions of such 'vestigial' structures as the whale hipbone. His knowledge is definitely not up to date.

Evolution is inherently atheistic

Unlike far too many Christians, author Shtulman has no illusions in this regard:

> "Widespread endorsement of theistic evolution is thus good from a sociological perspective, but it may not be good from a cognitive perspective, as theistic evolution is logically problematic. The evolutionary machinery of mutation plus natural selection (see Chapter 12) leaves no role for divine intervention—at least no role beyond what scientists can learn about evolution without making such an assumption" (p. 238).

I long ago described this in a somewhat graphic manner.[2]

The author, in a roundabout way, identifies some of the reasons that students are prone to believe that God and evolution are compatible—besides of course their desire to embrace evolution while hanging on to God. Students labour under misconceptions of evolution in terms of essentialism (what is the animal's core nature?), intentionality (what does the organism *want*?), or teleology (what does the organism *need,* or more accurately, what is the organism *for*?). In actuality, evolution is a blind process of differential survival that is oblivious to the wants and needs of *any* entity (including God).

The author laments the fact that children seem to be 'intuitive theists' and that they tend to have ingrained creationist beliefs from an early age. Worse yet, not a few adults hold the same views. Shtulman does not grasp the fact that no evidence has been found that demonstrates that specified complexity can spontaneously arise from disorder. Maybe *that* is the real reason that so many adults conclude that the evolutionary explanation does not 'add up'. He also fails to realize that no evidence has shown that one organism can be transformed into a radically different organism. Perhaps *that* is the real reason that people tend to persist in essentialist views of living things.

So-called theistic evolution is inconsistent with God's character

Shtulman has a better grasp of the situation than do far too many Christians. He quips:

> "Theistic evolution also flies in the face of what most people believe to be true of God, namely, that God is omnipotent (all-powerful), omniscient (all-knowing), and omnibenevolent (all-good). Why

would an omnipotent being choose random mutation as a starting point for evolutionary change rather than directed mutation or, for that matter, plain old creation? Why would an omniscient being produce superfluous or imperfectly designed forms, like the human tailbone, the whale hipbone, the snake leg bone, the ostrich wing, or the rabbit stomach (which is so inefficient at extracting nutrients that rabbits must eat their feces so as to digest their food twice)? ... And, most troubling, why would an omnibenevolent being use natural selection as a tool for creation? Natural selection is a cruel process, as noted in Chapter 12. Most organisms die of starvation, predation, or disease before reaching reproductive maturity" (p. 238).

The author (like theistic evolutionists!) has no understanding of the Fall and its consequences, as he continues:

"Does God delight in watching orcas drown baby seals by the dozens? Watching wasp larvae devour caterpillars from the inside out? Watching viruses annihilate entire populations of humans, including infants and children? Billions of 'God's creatures' have died violent, painful deaths, and 99.9 percent of earth's species have gone extinct. Why would an omnipotent, omniscient, and omnibenevolent being have created all those life-forms just to destroy them?" (p. 238).

(The 99.9% figure is based on evolutionary deep-time beliefs, not facts).

The author's rather primal anti-supernaturalism

The author expresses puzzlement at the 'misconception' that supernatural forces have an outcome on diseases. He sees this as yet another holdover of intuitive theories that continue to persist in spite of the 'correct' scientific explanation of diseases being caused by pathogenic bacteria and viruses. He laments that:

"For Christians and Jews, reprieve from illness is one of the most common forms of petitionary prayer. Christians and Jews seek God's help even in coping with infectious diseases, like hepatitis or pneumonia. They do so not because they are unaware that infectious diseases are caused by germs but because they view God and germs as complementary. God is the distal agent of human health and germs are the proximal agent" (p. 200).

He ridicules such beliefs by comparing them with the Hmong belief that epilepsy is caused by demon possession, and the Creole belief that tuberculosis is caused by sorcery. According to Shtulman's reductionistic mentality, diseases are caused by germs and viruses, and nothing more.

The author's intellectual arrogance and rationalistic hubris are as astounding as they are foolish. What makes him think that he has exhaustive knowledge of *every* cause of events (including human illness) that take place in the universe? Ironic to his criticizing others for being science-blind, Shtulman is the epitome of science-blindness himself—by failing to even have a clue about the limitations of science.

More fundamentally, what makes him think that there is only one valid layer of explanation for whatever takes place? As an example, consider the person who walks to the post office to mail a belated letter to a government query, and is hit and injured by a car. What caused it? Newton's Third Law of Motion, which implies that two objects in rapid collision will do damage to both? The choice of the driver to be careless? The choice of a nearby shopkeeper to put up gaudy signs that attracted attention and facilitated distracted passerby drivers? The choice of the builder in constructing a building that prevented the pedestrian from seeing the oncoming car sooner? The choice of the pedestrian to be less than fully inattentive? The decision of the government to send a query, to a citizen, which requires a personal response via paper mail? The failure of the government to put a stop sign at the nearby corner, which would have stopped the car and refocused the driver? God's decision as to who gets spared, who gets injured, and who dies in an accident? All of the above?

No immortal soul: we are nothing more than a combination of atoms

The author focuses on children's misconceptions about death. This includes their lack of comprehension of the fact that death is irreversible. (I can relate. When I was five years old, my grandmother died of cancer. When no one was watching, I lifted up one or both eyelids on her body, thinking that opening her eyes would bring her back to life.)

Shtulman partly blames religious teachings, on the afterlife, for children's misunderstandings about death. He shows his thoroughgoing materialistic bias as he makes this revealing statement: "Religion dictates that humans are blessed with an immortal soul, whereas evolution dictates that humans are material creatures through and through" (pp. 238–239). Really? How can he know *that*? And he is lecturing *us* not to jump to conclusions or rely on hunches! Physician, heal thyself.

If anything, modern science should make more credible the belief that the Self can survive death, even if the Self is nothing more than the neuronal firings in our brain. By analogy, the printed text in a WORD program is the manifestation of electrical impulses in the computer. Yet, if the text is saved, the text can be sent across cyberspace, and end up open in another computer,

even if the original computer that made it is destroyed, and its electrical impulses have long died out. Likewise the Self, even if merely the product of neurobiological processes in the brain, can exist outside the brain upon its destruction at death, and can be implanted in another body.

Ironic to the author's primal (even vulgar) materialism, some secular scientists have begun to toy with the idea that consciousness is more than just the firing of neurons in the human brain. Some have gone as far as suggesting that 'inanimate' matter, and even the entire universe, may be conscious in its own way.

Conclusions

This book is strong in its analysis of common misconceptions in physics, but quite weak, and rather doctrinaire, in its understanding of organic evolution. The author emphasizes misconceptions in science, but, in some ways, is the worst offender. That is, he has a weak to non-existent understanding of the absence of hard evidence for organic evolution. In addition, his thinly veiled anti-supernatural biases show through in such things as his disparaging of belief in life after death, and of the role of God in allowing or healing illnesses.

References

1. Gould, S.J., *The Structure of Evolutionary Theory*, Harvard University Press, Cambridge, MA, pp. 137–141, 2002.
2. Woodmorappe, J., The horse and the tractor, *Creation* **22**(4):53, 2000.