Unweaving The Rainbow

Category: Skepticism

By: Richard Dawkins (RD)

This Bookthought is by Thoughtpiece.com, editor RM, done in 2009 based on the paperback published 1998

General Bookthoughts:

It is by definition a silly idea to try to paraphrase someone who writes in such lean sentences. But, nonetheless, I will try.

This book explores the wonder of science, unpacking many wonderful conundrums. It shows how much more wonder we get by understanding more about the world - we can admire the reasons behind why a flower is so beautiful, whilst also enjoying its visual appeal. The beauty is enhanced by more knowledge - knowledge only adds to the experience. There is so much to learn, read the book and then read it again a few years later.
Specific Bookthoughts:

- He talks about how lucky we to be alive and that this should make us appreciative of our existence. If we consider the chances of us being born at all – the number of sperm and eggs of our parents, let alone that they have to first meet (imagine all the factors that could have altered this outcome – for the English, he points out the importance of someone like Napoleon). Then we can be even luckier to be alive at this time, rather than beforehand where quality and quantity of life was far less. We are also lucky to be human beings who have significant benefits, like language and thought (and control over natural resources). RD shows that if you represent the history of evolved life by opening your arms (fingertip to fingertip), bacteria cover the entire one side, over your neck and across the shoulder of the other side. Multi celled life then starts somewhere along the next arm, dinosaurs in the right palm and the whole history of Homo Sapiens and Homo Erectus is in one “finger nail clipping”. We can add to this good fortune, a further unlikely outcome – a planet that is just right (distance from the sun, angle from the sun, its natural resources, its life supporting chemistry etc.)

- We are reminded that there is a wonderful paradox at the heart of science. It advances by “disproof of its hypotheses.”

- There is a typically insightful quote from Feynman that reminded me of a comment by Dawkins (I forget when and where). Dawkins was asked what he would tell his daughter if she asked him why flowers were so colourful (I think she was 6 or so). His answer, he said, would be that the flowers are colourful because it helps their reproduction. So, how does it tie to Feynman? Someone was asking Feynman if his scientific understanding of something like a flower did not reduce his appreciation - supposedly because science removes the qualitative aspects of appreciation and only brings quantitative (boring) appreciation. Feynman’s answer was that his scientific knowledge only added to the experience – he had both levels of appreciation. The built in one, we all have and the learnt one that sciences gives that adds to the experience (is the flower red because it attracts insects, are insects useful for the flower, has the plants colour evolved to attract insects etc.). Importantly, Feynman also said it was sometimes not worth thinking too hard about things – just let them be. Like someone slipping on a banana peel – just laugh, don’t think about how silly the person was etc.

- The title of this book in many ways talks to this point above. If we unweave white light into its rainbow of component colours, do we diminish the experience? Definitely not. Indeed, as RD reminds us, if Newton had not done this, it would probably not have led to Maxwell’s equations and to Einstein’s. Newton, by the way, proved that white light was made up of the “rainbow” by using a prism to create the rainbow and then a second prism to create white light again.

- This refraction of light is because the individual colours have different wave lengths - in many ways showing that light behaves like a wave. Remember with a wave, nothing actually “travels” from start to finish, although this is the appearance that is created.

- Reflection of light is interesting. White objects reflect all wave lengths (a big mixture), but scatter it “into incoherence.” Mirrors also reflect all wavelengths, but nearly perfectly. Black objects reflect no light. Colours, reflect some wavelengths and absorb others.

- RD, as usual, anticipates the inquisitive reader. How can a prism slow light down (which is what is happening) if light travels at one speed – the speed of light? The answer is that light only travels at the speed of light in a vacuum. It does slow down when it goes through certain mediums (called the refraction index).
RD discusses actual rainbows and how they work. The front of the rain drop refracts light onto the back of the rain drop, which acts as a concave mirror that reflects light back as a rainbow. We therefore see the rainbow in the part of the sky opposite the sun. The rainbow is also steady to us, although raindrops clearly aren’t. This is because there are many drops that pass through the point where the angle is perfect to you, as viewer of the rainbow at that angle. This is why the rainbow is curved – the rainbow is actually a circle and you are at the centre (equidistant from the all the drops). The horizon takes away the half of the circle you cannot see.

RD discusses a further use of the rainbow – Fraunhofer lines (as in spectroscopy). Chemical elements absorb different wave lengths of light. Elements that are “in the path of light” create an individual finger print on that lights spectrum by absorbing some of its light. The spectrum has certain black lines in it and each chemical has a unique set of black lines. This is how we know the composition of stars.

Fraunhofer lines also tell us about temperature, pressure and size of the star (as part of the science of spectroscopy).

We always need reminding that our visual sense is significantly impaired. We only see colours in our visible spectrum. Of course, there is far more – longer than red are infra red (snakes use infrared, for example), micro waves (for cooking and radar) and radio waves (radio signals) and shorter than violet are ultra violet (sun burn and insects see ultra violet, although they are blind to red) and X rays. Gamma rays are even smaller.

Uses of the rainbows – X Rays, television, radio, microwaves etc.

Uses of the rainbows – big bang theory and an expanding universe. Light that arrives at Earth from an object that is moving away from us is “red shifted”. We can see that the cosmos is filled with stars and planets that are steadily accelerating away from eachother – we see them as all red shifted when analysing their light. This is a form of Doppler Effect of light, where the wave lengths of light are stretched as objects emitting light move away from us. The opposite is also true – objects moving towards us are “blue shifted”. Again Doppler effect.

Uses of the rainbows – spotting planets near distant stars. The stars shine too brightly for us to spot the nearby planets, so we have to use another method (other than direct observation). Planets cause minor changes to the expected orbits of stars as witnessed in small red or blue shifts in their light. This is how we know a star has planets.

Soundwaves, too, can be “unwoven like a rainbow”. Sound, RD reminds us, only travels through a medium like water or air. It cannot travel in a vacuum (unlike light which does so optimally). Sounds do form a “spectrum of wave lengths” as witnessed by different pitches.

When sound travels in air, the sounds we hear are effectively variations on the airs compression. Our ears, as RD shows, are little “barometres” that decode changes in pressure. The direction from which the sound comes is not built into our ear (although in insects it is – like a weather vane) – our brains have to calculate it based in the timing difference between the loudness of same sound hitting our different ears (triangulates).

RD discusses the way the brain unwraps the sound rainbow. He imagines listening to an orchestra, all with different instruments at different pitches. And then he adds, for good measure, a person whispering to you off and on and a dodgy neighbour with some sweet wrappers. All of these sounds arrive simultaneously as one combined wave and your ear needs to unravel them which it does effortlessly.

We are reminded that all our cells contain a copy of our DNA in their nucleus, except two cell types. Red blood cells no longer have a nucleus and reproduction cells have half our DNA.
DNA fingerprinting is interesting and often misunderstood. Most people probably expect that the entire genome is compared. But it is a sample of “equivalent parts of the genome” – comparing actual to the suspect. I understand this is done within the “junk DNA” rather than the active DNA (because active DNA, as you would expect, should seldom change – although some genes have variation - whereas junk DNA has more changes because it has not really mattered over time).

I must apologise for adding some interesting facts, albeit slightly off the thread of the book. The sun is 8 light minutes away, it therefore sets 8 minutes before we actually see it set. Another one – it has been argued that dictators like Hitler, Stalin, Hussein and others have moustaches because it makes them easy to have body doubles.

He makes the point that astrology outsells astronomy on a major scale (books, TV etc.). I wonder why this is? What is it about being human that makes it more interesting to follow something ethereal over something factual and real?

RD suggests an answer for our apparent hard-wired gullibility (i.e. reading more into a coincidence than chance). Fossil evidence shows that our ancestors lived in small communities and therefore sample sizes were small. Coincidences would be far rarer in such small communities and our wiring would cause us to “gasp with astonishment” when we saw one. Sample sizes/communities now are huge, which multiplies the coincidences we encounter – yet, we process them in the same way because our wiring is largely unchanged.

Astrology relies on stereotyping a broad group of people (on their birthdates) – like racism or sexism does. It seldom has bad news, perhaps that is why it is not put into the same camp as bigotry. Clearly, as RD further points out, there is also fraud involved in astrology – deliberate misleading of people for money.

I enjoyed the quote by David Hume which I have seen before. It reminds us that, when confronted by a testimony of a miracle, the test of whether we should believe it should come down to what is more likely – it actually happened or it never actually happened. Testimony is not enough, alternative explanations are far more likely (that the apparent miracle was a conjuring trick, or was a coincidence, or was the placebo effect).

RD, as we know and appreciate, discusses the potential for children to be misled by the biased teachings of their parents. Children are gullible/credulous – natural selection will favour children who listen to their parents (as opposed to children who are sceptics). But, with this comes the risk and cost of believing falsehoods blindly.

I have often considered a thoughtpiece on what is counterintuitive to us. For example – the very small, like atoms and molecules (their quantum and behaviour), relativity, Newtons law that states objects remain in motion unless acted against, that feathers and bricks fall at the same speed in a vacuum, that solids are mostly empty space etc.

Interestingly, the Aryans of ancient India practiced the doctrine of transubstantiation long before Christians (consecrating bread could turn the bread into the body of their God and then, by eating it, you became closer to God).

RD argues against macro mutations (which Gould seems to argue for) – sometimes referred to as punctuated evolution. He reminds us that there are significantly more ways of being dead than alive. His point is that most mutations are bad for us. The smaller a mutation, the greater likelihood there is of it not killing us – whilst at the same time may be good for us – is far more likely than a step change.
- RD quotes John Maynard Smith. Smith made the point that Gould seemed to be considered a leading (if not the leading) evolutionary theorist in the US. This is because he wrote and spoke so eloquently. The reality was that he was not considered to be highly regarded as an evolutionary theorist by his peers.

- It is important to be reminded that there is no connection between a selfish gene and a selfish human (cooperation seems to be the best general strategy for gene propagation). Genes themselves, rather than humans, also need to cooperate with other genes.

- RD also believes mitochondria are descended from bacteria. They have their own DNA, which is only "distantly related" to ours and is far more closely related to other bacteria. Mitochondria is involved in regulating cell death (programmed cell death), among many other functions.

- He calls them parasites, because they hitch a ride with the host. He makes the point parasites, such as mitochondria, require ongoing relationships with the host and they become cooperative – they pass their DNA on longitudinally (rather than horizontally like a flu virus, which becomes a more virulent over time).

- He makes the further point that our genes are parasitic with respect to each other. Each body (plant or animal) is a "community"

- Like mitochondria, chloroplasts ("small bodies in plant cells") also hitch a ride, but in plants. They perform the very important role of photosynthesis and are the reasons plants are green. They are generally considered to be descended from "photosynthetic bacteria."

- To explain the selfish gene paradox (i.e. that his famous book is mostly about cooperation). He makes the important point that genes have selfish motives as their primary drivers. But this manifests itself in cooperation which is often the best strategy for survival and reproduction (selfish co-operators).

- The sex chromosomes are interesting. Y, for example, only has experience of male bodies. X, has the experience in females, 2/3 of the time. This is the opposite in birds, by the way.

- We are all products of successful ancestors – those that lived to reproductive age and reproduced. And, in many instances, the male gene pool is smaller – generally few successful males are responsible for much of the mating.

- He calls species averaging computers. I like this idea. We, and other species, are refined by our past experience in a statistical sense. We are not perfect – rather we are equipped to manage the issues that we confront (or our ancestors confronted). These traits, skills, physical abilities, decision making faculties have all been built by constant refinement – trade offs where the best outcome was the one that was statistically most likely to favour survival and reproduction.

- We are wired to respond to what is "unexpected", showing far less response to anything expected. We can surmise from this that our brains have a continuous picture or representation of the norm – what is expected, "statistical representations".

- It is extremely complicated for our brains to construct accurate 3D imagery from the 2D image that lands on our retina. Added to this complexity is that the 2D image on the retina moves, like a shaky video recording (because we are not perfectly still). Yet, the image in 3D is perfectly still (imagine being a bird, blown by wind).

- He makes the good point that this virtual reality that our brains reconstructs for us, can also lead to delusions (arguably much of what we experience is an illusion or reconstruction of actual events anyway).