

The Grand Illusion

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Magic fascinates us. Good magicians take us on journeys of wonder and mystery, convincing us that the impossible *can* happen. We find it easy to go along for the ride, temporarily suspending our skepticism and allowing the magician to create worlds of fantasy right before our eyes. Some people leave the show convinced that the magic is real, and that somehow the magician has access to mystical powers that are off-limits to the rest of us mere mortals. Carefully crafted magic is designed to make people feel this way. It's part of the illusion. Of course, most people leave the show knowing that the magician has created and performed these illusions with the intention of making us believe that magic is real. And in a way, this knowledge is part of the fun. Simply accepting that magic is real has a limited entertainment value. It is far more interesting to contemplate the fact that these illusions look *as if* magic exists when we *know* that it doesn't. And many of us even go a step further. It is not enough to know that these are tricks—we want to know *how* the tricks work. What mechanisms are hidden behind the scenes? How are the illusions perpetrated? Could I perform the same tricks? Of course, the magician is sworn to secrecy and will never divulge the intricacies of his illusions. This is fair enough. After all, there would be no magic if every magician revealed their secrets. Some people are happy to put the question to rest right there. For these people, not knowing how the magic works helps maintain a little mystery in their otherwise mundane, mechanical lives. But for others, this is unsatisfactory. We have a drive; an urge; an insatiable desire to find out how

the illusions work, and when we figure one out we feel a sense of relieved satisfaction. Our human curiosity compels us to figure things out. Ultimately we are not content living in a world of magic. We need to know how it all works.

Until relatively recently, the question of life on Earth was stuck firmly in the realm of magic and mystery. Before the time of Charles Darwin, people believed that God had created the world, and that we humans were somehow special—separate from the natural world. People believed that humans, having been created in God's image, were more closely related to God than to the animal kingdom. We are, after-all, intelligent, and we can reason in Godlike ways, which is something that animals cannot do. No-one had ever seriously considered the proposition that we are related to animals, and most people believed that the world had only existed for around 7000 years—a comfortable time-scale that fits in with biblical references. Now, this explanation relies on the existence of God, the grand magician who, through the use of his supernatural powers, created the world and all the wonderful diversity of life we see today. This belief persists in some circles and has been labeled *Intelligent Design*, though more traditionally the belief is known as *Creationism*. Unfortunately, there is a problem with the creationist picture of the world. The problem is that it attempts to explain the sophistication and complexity we see in the world by referring to something more sophisticated and complex. Ultimately this is unsatisfactory because it simply shifts the problem to another level and leaves unanswered questions about the nature of God. Take God out of the picture and the magic falls to pieces.

What we need is another way to look at the question of life on Earth—a way to explain the sophistication and complexity of life without appealing to more complex entities. Fortunately, Charles Darwin was able to provide just such an alternative. He developed an explanation for how complexity can arise through a basic, unintelligent process. This was a revolution. Darwin's remarkable insight the realization that the complexity and variation of life on Earth can be

explained by a gradual process of modification and descent. Essentially, Evolution by natural selection explains the existence of complex forms of life by breaking the problem into an easy to understand step-by-step mechanism.

The illusion of Intelligent Design worked in the past partly because we only had access to a very small snapshot of time. We had no way to look back into Earth's deep history, so we assumed that everything that currently exists was created at the beginning of time. Furthermore, the illusion convinced us that the beginning of time was around 7000 years ago. Now, one way to reveal the secret of magic is to peak behind the curtain and take a sneaky look back stage, and thanks to the geological discovery of deep-time, we got glimpse behind the scenes. We found evidence of massive geological change, along with an immense fossil record demonstrating the existence of a plethora of species that had long ago become extinct. The astronomical discovery of cosmic background radiation, and Charles Darwin's discovery of Evolution revealed more of the magic, allowing us to look beneath the stage and directly into the magician's hidden box of tricks, truly exposing the truth behind the magic of life. We now have a vastly different world-view to that of our ancestors. We know that the universe is around 13 billion years old and that Earth first formed around 4.5 billion years ago. We have reason to believe that life originated on Earth approximately 3.5 billion years ago, and that Homo-sapiens (modern humans) first appeared around 100,000 years ago. We understand that humans are biologically very similar to other animals, and that the only real difference between us and the rest of life on Earth is our complex mind.

It is difficult to fully appreciate the time-scale involved in the evolution of life. Our lives revolve around timeframes of days and months—perhaps a few years—and we have knowledge of recorded history which dates back a couple of thousand years. A million years is very difficult to conceptualize. One way to form an impression of the timeframe involved in evolution is to represent the history of life visually. Think of a city that is 350 kilometers away from where

you live. The drive to that city represents the history of life on Earth, each kilometer representing around 10 million years. Where you stand right now is the present day, and the center of the other city is where life began.

Now, stretch your arm about half a meter towards the other city. All of recorded human history is contained in that space. Every person and civilization that you've ever heard of lived in that half meter distance. Farming was invented about half a meter further away, around 10,000 years ago. Modern humans first appeared about 10 meters away from you, and the hominid line from which we are descended split from the great apes around 500 meters away—a few city blocks. The dinosaurs became extinct around 6.5 kilometers away, after becoming the dominant form of life 23 kilometers away—that's about 230 million years ago. Now, when you look at these distances you can appreciate the timeframe involved in the history of life. Life goes all the way back to the center of that city 350 kilometers away from where you live, and that's 3.5 billion years ago. Life has been around for a very long time. Of course, for a huge part of its history, life was no more complex than single-celled organisms. It took eons for life to evolve passed the cellular level, but when it did an explosion of variety occurred.

So, what is the theory of Evolution? Well, the basic idea is that all living things are related by descent, and that Natural Selection explains adaptive change. Consider the following rundown of evolution, which is based on thoughts contained in Thomas Malthus's 1798 Essay on the Principle of Population.

1. In ideal circumstances (unlimited resources) populations will grow exponentially
2. Resources are limited
3. Because resources are limited, populations tend to remain stable
4. Individuals within a population have unique characteristics

5. An individual's characteristics are passed on to its offspring (inheritance)
6. Change can occur. This sometimes results in offspring having slightly different characteristics to their parents
7. Given the fact that individuals have varied characteristics, it is reasonable to suppose that some individuals will have characteristics that give them a better success at surviving and reproducing
8. Given premise 5, it is reasonable to assume that characteristics that enhance an individual's survival and reproductive success will be passed on to its offspring. This is natural selection.
9. Evolution is the result of this process
10. Populations that possess the above characteristics will evolve.

Given the evidence, and the process stated in the above form, it is reasonable to accept Evolution as true. Many people object to Evolution by stating that it is not "proven" and that it is "just a theory". But this is a misguided objection. Of course it's a theory—it's science, after all. Gravitation is a theory too, and it explains real world phenomena with wonderful precision. Science isn't in the business of "proving" things, but it *is* in the business of providing the best possible explanation for the evidence we see around us, and Evolution currently *is* the best explanation for evidence found in the world.

Another common objection to the Theory of Evolution suggests that since the probability of humans evolving is so extremely low, it is more likely that we were *created* by an intelligent designer. This objection, along with some other assumptions, is part of the *Intelligent Design* illusion. The first and most obvious response to this objection is to remind the creationist that improbability *does not entail* impossibility. Lots of improbable things obviously happen; just ask the winner of the latest lottery draw. Furthermore, the

objection does not take the immense timeframe into account. Often when creationists are formulating their objection, they apply weak analogies to the situation such as the often used example that runs something like:

A gust of wind rushing through a junk yard will not cause random pieces of junk to spontaneously assemble into a functional airplane, therefore evolution can't produce humans—the odds are too low.

But this analogy is misleading, because it implies that creatures such as humans were randomly assembled out of dust rather than being built through the gradual process of adaptation and descent over millions of years.

A further response to the anti-evolutionists would be to suggest that they are misguided in their portrayal of the probabilities. Consider the following magic trick:

6 people are each given a randomly chosen card from a normal deck of 52 cards. Suppose the values of their cards are:

1. King of Diamonds;
2. Queen of Spades;
3. Five of Clubs;
4. Two of Hearts;
5. Jack of Hearts;
6. Eight of Spades

Now what is the probability that this exact series of cards would be dealt? You can work it out like this:

$$\frac{52 \times 51 \times 50 \times 49 \times 48 \times 47}{6 \times 5 \times 4 \times 3 \times 2 \times 1}$$

It turns out that the probability of this particular hand being dealt is 1 in 20,358,520. That's 1 in over 20 million—such an extremely low probability *and yet it happened!* How did this happen? Is this real magic, or is it just an illusion? Well, there is no mystery here. It is simply a mistake to look at the end result and then attempt to calculate the likelihood of that result occurring. A better approach is to look at the likelihood of each step along the way. For example:

Card 1:	1 in 52;
Card 2:	1 in 51;
Card 3:	1 in 50;
Card 4:	1 in 49;
Card 5:	1 in 48;
Card 6:	1 in 47

When calculated this way the probability mystery disappears, and the illusion is revealed. We need to think about evolution in exactly the same way. It is a mistake to look at our existence and then attempt a backwards calculation of the probabilities involved in our evolution. Instead, we need to think about evolution as a 3.5 billion year long list of small changes, each with a plausible probability. These changes compounded over time and resulted in the diversity of life that we now find in our world.

It is important, here, to note the meaning of the word *evolution*. In everyday language, *evolution* means progressive change. For example, when we speak about the evolution of clocks we are generally referring to *purposeful change* over time. This is to say that designers have modified clock design to enable the device to better serve specific purposes. *The same is not true for biological evolution.* In biology, evolution is not progressive, nor does it serve a purpose. Evolution is a blind mechanical process and has no end goal. This means that the term “more evolved” has no meaning in the world of biology. People are not “more evolved” than chimps, or dogs, or worms—rather, all animals are

perfectly evolved to suit their environmental niche. A chimpanzee cannot survive underwater, and a dolphin cannot survive up a tree, but both these creatures can survive in their own environments. All species have been built by evolution to survive in their own environments.

But what exactly does *species* mean? Although many people take the definition of *species* for granted, interesting questions can be raised around the term *species*. For example, how exactly are species differentiated? In some respects, the concept of *species* is quite artificial. It's a human invention, which serves the purpose of identifying different types of animals and conveniently grouping them according to their specific features. Generally, we differentiate species on the basis of reproduction. If two creatures can produce viable offspring, they are considered to be of the same species. Two creatures that cannot naturally reproduce together are labeled as different species. Of course, this is an arbitrary system of categorization, and from an alien perspective we are actually all very similar. In fact, a visitor from another world may not see the logic in the way we categorize life forms as different *species*.

One of the common objections to Evolutionary Theory refers to the appearance of new species. Many people accept that natural selection builds adaptations within species, but they deny that this process will ever bring about a change from one species to another.

There are lots of different types of dog, but a dog is always a dog. It cannot turn into a cat.

Interestingly, it turns out that this objection is misguided because it overlooks a body of research and evidence. Biologists have, in fact, observed species divergence in both natural and artificial environments. The process by which species diverge is known as *speciation*, and an example of this process can be found in the world of the *Three-Spined Stickleback* fish. Over ten thousand generations, a population of Stickleback have lost their pelvic hind fins, gained

tougher armor, and lightened in color (Carroll 2005, see also Doughton 2009). Importantly, these new Stickleback fish can no longer reproduce with their cousins who have not undergone this change (Carroll 2005). This is an example of *parapatric speciation*, which means that the two species who occupy the same geographic area, and come into frequent contact, have selected mechanisms that prevent breeding (for more on this, see the research being carried out by David Kingsley, <http://kingsley.stanford.edu>).

Examples of speciation can also be found in the world of artificial selection. Domesticated sheep, cattle, and dogs were created by a long process of artificial selection. Some modern species of sheep no longer produce viable offspring with *Ovis Orientalis*—the species from which they are descended. Interestingly, many modern breeds of dog cannot interbreed naturally. For example, a Great Dane cannot breed with a Chihuahua without human intervention. Perhaps this is the first step towards speciation. Perhaps descendants of the modern Great Dane will be a different species to the descendants of the modern Chihuahua.

Humans have, for thousands of years, been selectively breeding plants and animals. The process is essentially the same as natural selection, except that with human intervention change occurs over much shorter timeframes. In artificial selection, people choose certain traits in animals and plants, and ensure that those traits are bred into subsequent generations. Creatures containing undesired characteristics are not chosen for reproduction. It is interesting to compare the modern banana with the banana as it existed before people started selecting certain characteristics. Bananas were originally rounded and quite ugly, but through centuries of artificial selection, bananas slowly evolved to their current shape. Creationists often use the banana as evidence of creative design in the universe. They point to its convenient shape (perfect to fit in the hand), its color (indicates ripeness), and its useful pull tab (perfect for a human hand to open). In a way they are right; the banana was

designed. But it was not designed by God. It was designed by the selective activity of people over hundreds of years.

Artificial selection builds systems that solve *human* problems. Natural selection builds systems that solve *adaptive* problems. As mentioned earlier, natural selection has no foresight and therefore adaptations are not planned. This means that nature's solutions to problems are not elegant. Rather, they are rough and ready solutions that solve problems faced in the organism's natural environment. There are some deliciously entertaining examples that expose nature's cheap solutions to adaptive problems. One example can be found in the behavior of frogs. We can trick a frog by throwing a small ball-bearing across its visual field. The frog will leap and swallow the ball-bearing. Why? Well, frogs eat insects, and in the frog's natural environment, virtually every small moving object was an insect. There was no need for nature to provide the frog brain with an *insect detection system* when a *small moving object detection system* would do the same job.

We humans also exhibit behavior that emerged as solutions to adaptive problems in our evolutionary environment. This behavior continues to exert itself in our daily lives, and in some cases the behavior, which served our ancestors well, has now become maladaptive. For example; we have an innate sweet tooth, which compels us to seek out and eat sweet food. In our hunter-gatherer environment this would have been very useful, since pretty much anything sweet contained vitamin C and energy giving sugars. We need to eat vitamin C, and sugar is a good source of energy, so natural selection gradually built a solution—the sweet tooth—which compelled our ancestors to eat fruit. The problem is that our modern environment is overflowing with sweet things that are *not* sources of vitamin C. Our inbuilt desire for sweet things drives us to consume these tempting sweet treats, ultimately leading our overindulgence in candy, cake, and sugar drinks. A similar adaptation compels us to eat meat. In our hunter-gatherer environment meat was rather difficult to come by. But it is a very good source of energy, so nature—through gradual modification—

built into our ancestors an insatiable desire to consume meat. This was useful 100,000 years ago because in those days people would probably only get a taste of meat every few days. However, in our current environment meat is readily available. People eat meat for breakfast, lunch, and dinner. And some people then continue to eat meat into the night, even getting up for the traditional “midnight snack”, which usually involves meat. Meat based foods are at the center of the fast food industry, for an obvious reason—we can’t resist it, which means it sells well. The problem is that our desire to eat meat no longer provides us with a survival (and essentially a reproductive) advantage. Instead, it leads us to become overweight, obese, and prone to diseases that may drastically shorten our lives. Our compulsion to eat meat is now a disadvantage.

Ancient behavioral adaptations can be triggered by placing yourself in situations that tickle your senses in the right way. These tickles can cause the brain’s subsystems to swing into action, launching pre-programmed behavioral patterns—patterns that gave our ancestors a survival and reproductive advantage. Imagine, for example, the following situation: You are walking down a dark suburban street. It’s late at night, and there is no-one around. The street is dimly lit and there is an eerie glow emanating from the cloud obscured moon. All is quiet; in fact, you can hear nothing but your own footsteps. An uncanny—almost sinister—atmosphere prevails, and you find yourself unusually attentive to the sound of your own footsteps. Occasionally you think you hear another sound—perhaps another footstep! Is there someone else there, watching, maybe following you? You quicken your pace and feel a nervous shiver as your sense of awareness heightens. Maybe someone *is* following! You look behind but see no-one. You stop for a moment to listen. You hear nothing. Did he stop as well? Quickly you resume your walk—there’s not far to go, home is just 20 meters away. You feel your heart rapidly beating in your chest as you reach your front door. You stumble inside, quickly reaching for the light switch—the safety of light. Relieved and safely

wrapped in the warm glow of light, you close the door and lock it securely. Safe again!

This is a scenario that many people have experienced. It is an interesting situation, because it highlights an internal battle between our rationality and our innate behavioral systems. Rationally we know that we are alone and there is nothing to fear, and yet we experience a sense of urgency and somehow fool ourselves into believing that there is someone watching. Why does this happen? Well, one way to explain this forceful illusion is to consider the environment of our ancestors, and the types of behavior that nature would have selected to aid survival. In our hunter-gatherer environment it was very dangerous to be separated from the group. It was a pretty safe bet that something out in the dark would be watching you, and if you strayed too far, for too long, you would probably be eaten. This was a serious problem, which nature solved by providing humans with a default sense of *being watched*. This sense ensured that people would stay close to the protection of the group. Ancient humans who had this sense of *being watched* didn't stray too far from the protection of the group, while the humans who did not have this sense would have been more likely to roam and get eaten. The people that had this *being watched* mechanism survived to pass on the adaptation, while the others were eaten and left fewer offspring. You can see how the sense of *being watched* would quickly filter through the gene-pool and become a standard human trait. Next time a child tells you that she really thinks there is a monster under her bed, think carefully before you dismiss her claims. She is feeling a strong, inbuilt compulsion to avoid isolation and seek the safety of adults. We are all slaves to our inbuilt behaviors—behaviors that gave our ancestors a selective advantage, but have now become something of a disadvantage.

Although we live in a modern technological society, we are ancient creatures, adapted for an environment that we no longer inhabit. Remnants of our ancient behaviors exhibit themselves in our day-to-day lives, and betray our

hunter-gatherer origins. We have the ability to understand the origin of our behavior, and we can recognize that our behavioral systems were built to suit the environment of a species that lived in a vastly different world. In looking at our innate behavior, we uncover more of nature's illusion. Evolution by Natural Selection is a mechanical process that we can understand. We have discovered the true age of Earth and have pieced together a history of life on Earth. Our intellect has provided us with curiosity and the ability to reason about the world. When we encounter mysteries, we want to know the truth. When we see a magic trick, we want to know how it was accomplished. Nature has provided us with a drive to understand the world and our place in it. In uncovering the mechanism of Evolution, we have removed the smoke and mirrors of creationism. We have looked through the magician's bag of tricks and revealed the secret of the Grand Illusion.

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