THE TIMES

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Planning revolt fuels fears over economy

Countryside lobby opposes easier development

Sam Fleming, Roland Watson

Ministers must defy opposition to plans that would ease restrictions on building in the countryside, one of the country's foremost business leaders has warned.

The Government must "hold its course" as the row intensifies over proposed changes that would create a "presumption in favour of sustainable development", David Frost, the departing chief of the British Chambers of Commerce, told *The Times*.

Reforms making it harder for councils to block development have provoked another dispute between the coalition and rural campaigners.

Vince Cable, the Business Secretary, accused lobby groups of "semi-hysterical" criticism of the changes, but Conservative and Liberal Democrat MPs fear a backlash in their constituencies.

Mr Frost, whose organisation represents 100,000 businesses employing more than 5 million people, warned the coalition that it would damage growth if it buckled in the face of resistance. "The Government is absolutely right to move on planning but my worry is that it is going to stall. It has to hold its course. There is a stand-off and you have serious forces lined up against the proposed change," he said.

Business groups argue that the reforms are vital to streamline building and revitalise growth. The Home Builders Federation yesterday accused a coalition of groups opposed to the reforms, including the National Trust, of scaremongering.

But the Greenest Planning Ever Coalition, which also includes the RSPB and the WWF, says that new laws would damage the countryside.

Jack Neill-Hall, of the Campaign to Protect Rural England, said: "The proposals are overwhelmingly geared to delivering the needs of business and short-term growth rather than long-term needs of communities and the environment."

An alliance of leading town planners

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'Reform will cut banks' earnings by a quarter'

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George Clooney's political thriller The Ides of March, about backstabbing on the campaign trail, opened the Venice Film Festival last night. News, page 4

Clooney cruises in for 'overdose of handsome'

How UK waged 'oil war' in Libya

Sam Coates, Tim Webb

When the history of the overthrow of Colonel Muammar Gaddafi is finally written, two shabby disused rooms on the top floor of the Foreign and Commonwealth Office will deserve a special mention.

Next to redundant photocopiers and surrounded by maps of the Maghreb, half a dozen Foreign Office and Ministry of Defence officials worked for four months alongside Alan Duncan, the oil trader turned minister, and MI6 on a second critical front.

When David Cameron meets the victorious Mustafa Abdul Jalil, the chairman of the National Transitional Council (NTC), in Paris today he may quietly credit a covert team that he commissioned, the Libyan Oil Cell.

Its mission was to defy recent history and make the sanctions on Colonel Gaddafi operate effectively, against the backdrop of an increasingly bitter Whitehall turf war to control the unit.

The six-strong team, led first by an admiral and then a senior diplomat, was created in early April after the first flush of bombing failed to oust Colonel Gaddafi.

Mr Duncan confronted the National Security Council with intelligence from the oil world that hastily arranged sanctions were hurting the rebels while leaving the Libyan dictator's war machine untouched.

With the dictator ready to pay $150 to $200 more than the going rate for a tonne of petrol, the behaviour of a few oil traders was brazen. Some dodged sanctions by delivering to the Tunisian port of La Skhirra and trucking supplies across the border, while some

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Breast screening risk
Women are "still being kept in the dark" about the risks associated with NHS breast cancer screening. News, page 3

Child rioter convicted
A boy, 11, became the youngest person to be convicted in connection with last month's riots in London. News, page 5

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Nicolas Sarkozy accepted illegal campaign donations from France's richest woman, a judge claims. World, page 29

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THE TIMES

Eureka

Issue 24 · September 2011 · Science. Life. The Planet

What's real?

By Richard Dawkins

Science master with a lesson for us all

As one of Britain's pre-eminent academics and authors, Richard Dawkins could command the attention of the world's opinion formers. Yet three years ago he gave up his day job to concentrate on writing a book for children. *The Magic of Reality*, extracts of which appear in this issue of Eureka, is destined to become a classic; to do for science what Ernst Gombrich's *A Little History of the World* has done for its subject.

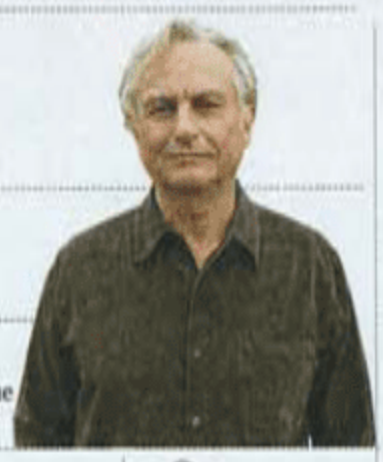
But it is his motivation that is important. In directing his energy at children, Professor Dawkins is addressing the greatest educational challenge this country faces. Britain is running short of scientists and engineers; unless we start growing more, and quickly, we will have to import scientists and outsource the industry that should be powering our future growth.

In 2000 Britain was ranked fourth by the Organisation of Economic Cooperation and Development in science attainment by pupils aged 15. By 2009 it was 16th. The trend is clearly one we need to reverse, and imaginatively.

Educators and politicians should heed the findings of science. The more we learn about how our brains work, the more likely we will be able to inspire children to become scientists. If that means going out of the margins, starting school later in the day or offering Ritalin on the lunchtime jelly, then that should be considered.

There are already signs of rekindling interest. This year the numbers of A level maths and science students have soared, inspired perhaps by Brian Cox et al. Prof Dawkins may not have quite the same pop star appeal, but the science magic he weaves is as awe-inspiring. It might be the impetus we need to set Britain back on track to the top bench of scientific excellence. ●

This month
The school run



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PHOTOGRAPHY: DAVID STEWART

...why are there so many animals?

In his new book Richard Dawkins teaches young and old alike the fundamentals of science. So take your seat in the classroom...

Adam's task of naming all the animals was a tough one. It's been estimated that about 2 million species have so far been given scientific names, and even these are just a small fraction of the number of species yet to be named. How do we even decide whether two animals belong in the same species or in two different species? Where animals reproduce sexually, we can come up with a sort of definition.

Animals belong to different species if they don't breed together. There are borderline cases, such as horses and donkeys, which can breed together but produce offspring (called mules or hinnies) that are infertile. We therefore place a horse and a donkey in different species. More obviously, horses and dogs belong to different species because they don't even try to interbreed, and couldn't produce offspring if they did, even infertile ones. But spaniels and poodles belong to the same species because they happily interbreed, and the puppies that they produce are fertile.

Can you see the shape of a tree developing in your mind? It is a family tree: a tree with many branches, each branch having sub-branches, and each sub-branch having sub-sub-branches. The tips of the twigs are species. The other groupings — class, order, family, genus — are the branches and sub-branches. The whole tree is all of life on Earth.

The following isn't exactly how the tree of animals branched, but it gives you an idea. Imagine an ancestral species splitting into two species. If each of those then splits into two, that makes four. If each of them splits into two, that makes eight, and so on through 16, 32, 64, 128, 256, 512 . . . You can see that it doesn't take long to get up into the millions of species.

For species, the equivalent of words is DNA — the genetic information every living thing carries inside it that determines how it is made. When individuals reproduce sexually, they mix their DNA. And when members of one local population migrate into another local population and introduce their genes into it by mating with individuals, we call this "gene flow".

The DNA of two separated populations of a species becomes less and less alike over time. Their DNA becomes less and less able to work together to make babies. Horse DNA has drifted so far from donkey DNA that the two can no longer understand each other. Or rather, they can mix well enough — the two "DNA dialects" can understand each other well enough — to make a living creature, a mule, but not well enough to make one that can reproduce.Animal species almost never exchange DNA again once they have drifted far enough apart to have stopped breeding together.

...who was the first person really?

This may surprise you, but there never was a first person because every person had to have parents, and those parents had to be people, too.

It's the same with rabbits. There never was a first rabbit, never a first crocodile, never a first dragonfly. Every creature ever born belonged to the same species as its parents. So that must mean that every creature ever born belonged to the same species as its grandparents. And its great-grandparents.

And so on for ever.

For ever? Well, no, it's not as simple as that. This is going to need a bit of explaining.

In your imagination, find a picture of yourself. Now take a picture of your father and place it on top. Then find a picture of his father, your grandfather, and place that on top. Then place on top of that a picture of your great-grandfather. Carry on piling up the pictures, going back through more and more great-great-greats.

How many greats do we need for our thought experiment? Oh, a mere 185 million or so will do nicely.

It isn't easy to imagine a pile of 185 million pictures. If each picture were printed as a picture postcard, then a stack of 185 million tipped on its side would need a bookshelf three miles long.

The near end of the bookshelf has the picture of you. The far end has a picture of yourdistant ancestor. What did he look like? We don't know exactly what he looked like, but fossils give us a pretty good idea.

Your 185-million-greats-grandfather was a fish. So was your 185-million-greats-grandmother, which is just as well or they couldn't have mated with each other and you wouldn't be here.

Let's now walk along our three-mile bookshelf, pulling pictures off it one by one to have a look at them. Every picture shows a creature belonging to the same species as the picture on either side of it.

Yet if you walk steadily from one end of the bookshelf to the other, you'll see a human at one end and a fish at the other, and lots of interesting relatives in between, which include some that look like apes, others that look like shrews, and so on. Each one is like its neighbours in the line yet, if you pick any two pictures far apart in the line they are very different.

So it was all very gradual — so gradual that you wouldn't notice any change as you walked back ten thousand years, which would bring you to somewhere around your 400-greats-grandfather.

Now, let's push a bit further back in time. If you walked the first million years along the shelf, the picture of your 50,000-greats-grandfather would be different enough to count as a different species, the one we call *Homo erectus*. We, today, are *Homo sapiens*.

So, the question of who was the first person, and when they lived, doesn't have a precise answer. It's kind of fuzzy, like the answer to the question: when did you stop being a baby and become a toddler? At some point, probably less than a million years ago but more than a hundred thousand years ago, our ancestors were sufficiently different from us that a modern person wouldn't have been able to breed with them if they had met.

> “At some point, probably less than a million years ago, our ancestors were sufficiently different from us that a modern person wouldn't have been able to breed with them if they had met

Hear Richard Dawkins explain "Who was the first person really" in an exclusive audio extract on *The Times* iPad edition on Thursday September 1

Read a full interview with Richard Dawkins in *The Times* on Saturday September 3

...what is the inside of an atom like?

An atom of lead is the smallest object that still deserves to be called lead. But can you really not cut an atom any further? And would an atom of lead actually look like a tiny little chip of lead? No, it wouldn't look like anything, because an atom is too small to be seen, even with a powerful microscope. And, yes, you can cut an atom into even smaller pieces — but what you then get is no longer the same element. What is more, this is very difficult to do, and it releases an alarming quantity of energy. That is why, for some people, the phrase "splitting the atom" has such an ominous ring to it. It was first done by the great New Zealand scientist Ernest Rutherford in 1919.

Although we can't see an atom, and although we can't split it without turning it into something else, that doesn't mean we can't work out what it is like inside.

The Rutherford model, later refined by Rutherford's pupil, the celebrated Danish physicist Niels Bohr, treats the atom as a tiny, miniaturised solar system. There is a nucleus in the middle of the atom, which contains the bulk of its material. And there are tiny particles called electrons whizzing around the nucleus in "orbit".

One surprising thing about the Rutherford/Bohr model is that the distance between each nucleus and the next is very large compared with the size of the nuclei, even in hard, solid matter, such as a diamond.

A diamond is made up of carbon atoms. Suppose we represent the nucleus of each carbon atom in the crystal by a football, with electrons in orbit around it. On this scale, the neighbouring footballs in the diamond would be more than 15km away.

The 15km between the footballs would contain the electrons in orbit around the nuclei. But each electron, on our football scale, is much smaller than a gnat, and these miniature gnats are themselves several kilometres away from the footballs they are flying around. So you can see that – amazingly – even the legendarily hard diamond is almost all empty space.

The same is true of rocks, no matter how hard and solid. It is true of iron and lead. And it is true of you and me. Solid matter is made of atoms "packed" together, but "packed" means something rather odd here because the atoms are mostly empty space.

Why do rocks and walls feel hard, and why can't we merge our spaces with theirs? We have to realise that what we feel and see as solid matter is more than just nuclei and electrons – the footballs and the gnats.

Scientists talk about "forces" and "bonds" and "fields", which act in their different ways both to keep the "footballs" apart and to keep the components of each "football" together. And it is those forces and fields than make things feel solid.

When you get down to really small things, such as atoms and nuclei, the distinction between "matter" and "empty space" starts to lose its meaning. It isn't really right to say that nucleus is "matter" like a soccer ball, and that there is "empty space" until the next nucleus. We define solid matter as "what you can't walk through". You can't walk through a wall because of these mysterious forces that link the nuclei to their neighbours in a fixed position. That's what solid means.

...what would ET and other aliens look like?

If there are living creatures on other planets, what might they look like?

There's a widespread feeling that it's a bit lazy for science fiction authors to make them look like humans, with just a few things changed — bigger heads or extra eyes, or maybe wings.

But perhaps it is not just lazy, not just a lack of imagination. Perhaps there really is good reason to suppose that aliens, if there are any (and I think there probably are), might not look too unfamiliar to us. Fictional aliens are proverbially described as bug-eyed monsters, so I'll take eyes as my example.

Eyes are pretty good things to have, and that is going to be true on most planets. Light travels, for practical purposes, in straight lines. Wherever light is available, such as in the vicinity of a star, it is technically easy to use light rays to find your way around, to navigate, to locate objects. Any planet that has life is pretty much bound to be in the vicinity of a star, because a star is the obvious source of the energy that all life needs.

So the chances are good that light will be available wherever life is present; and where light is present it is very likely that eyes will evolve.

Let's exercise our imaginations a bit more. On the planet of our hypothetical aliens, the radiant energy from their star will probably range from radio waves at the long end to X-rays at the short. Why should the aliens limit themselves to the narrow band of frequencies that we call "light"? Maybe they have radio eyes? Or X-ray eyes?

A good image relies on high resolution. The higher the resolution, the closer two points can be to each other while still being distinguished from each other. Not surprisingly, long wavelengths don't make for good resolution. Light wavelengths are measured in minute fractions of a millimetre and give excellent resolution, but radio wavelengths are measured in metres.

So radio waves would be lousy for forming images, although they are very good for communication purposes because they can be modulated. Modulated means changed, extremely rapidly, in a controlled way. As far as is known, no living creature on our planet has evolved a natural system for transmitting, modulating or receiving radio waves: that had to wait for human technology. But perhaps there are aliens on other planets that have evolved radio communication?

What about waves shorter than light waves — X-rays, for example? X-rays are difficult to focus, which is why our X-ray machines form shadows rather than true images, but it is not impossible that some life forms on other planets have X-ray vision.

Or, if the aliens have evolved organs that can handle radio waves for communication, they might also evolve true radar to find their way around.

Duckbilled platypuses have electric sensors in their bills which pick up the electrical disturbances in water caused by the muscular activity of their prey. It is easy to imagine an alien life form that has evolved electrical sensitivity along the same lines as fish and the platypus, but to a more advanced level.

...how is a rainbow made in the sky?

First, we need to understand about something called the spectrum. It was discovered about 350 years ago by Isaac Newton, who may well have been the greatest scientist ever. He discovered that white light is really a mixture of all the different colours. To a scientist, that's what white means.

How did Newton find this out? He set up an experiment. First he blacked out his room so that no light could get in, and then he opened a narrow chink in the curtain, so that a pencil-thin beam of white sunlight came streaming in. He then let the beam of light pass through a prism, which is a sort of triangular chunk of glass. What a prism does is splay the narrow white beam out; but the splayed-out beam that emerges from the prism is no longer white. It is multicoloured, like a rainbow, and Newton gave a name to the rainbow that he made that day: the spectrum.

Here's how it works. When a beam of light travels through air and hits glass, it gets bent. The bending is called "refraction". Refraction doesn't have to be caused by glass: water does the trick, too.

So, light is bent when it hits glass or water. But now here's the point. The angle of the bend is slightly different depending on what colour the light is. Red light bends at a shallower angle than blue light. So, if white light really is a mixture of coloured lights, as Newton guessed, what's going to happen when you bend white light through a prism?

The blue light is going to bend farther than the red light, so they will be separated from each other when they emerge from the other side of the prism. And the yellow and green lights will come out in between.

The result is Newton's spectrum: all the colours of the rainbow, arranged in the correct rainbow order — red, orange, yellow, green, blue, violet.

Prisms are all very well, but when you see a rainbow in the sky, there isn't a great big prism hanging up there doing the refracting. No, but there are millions of raindrops.

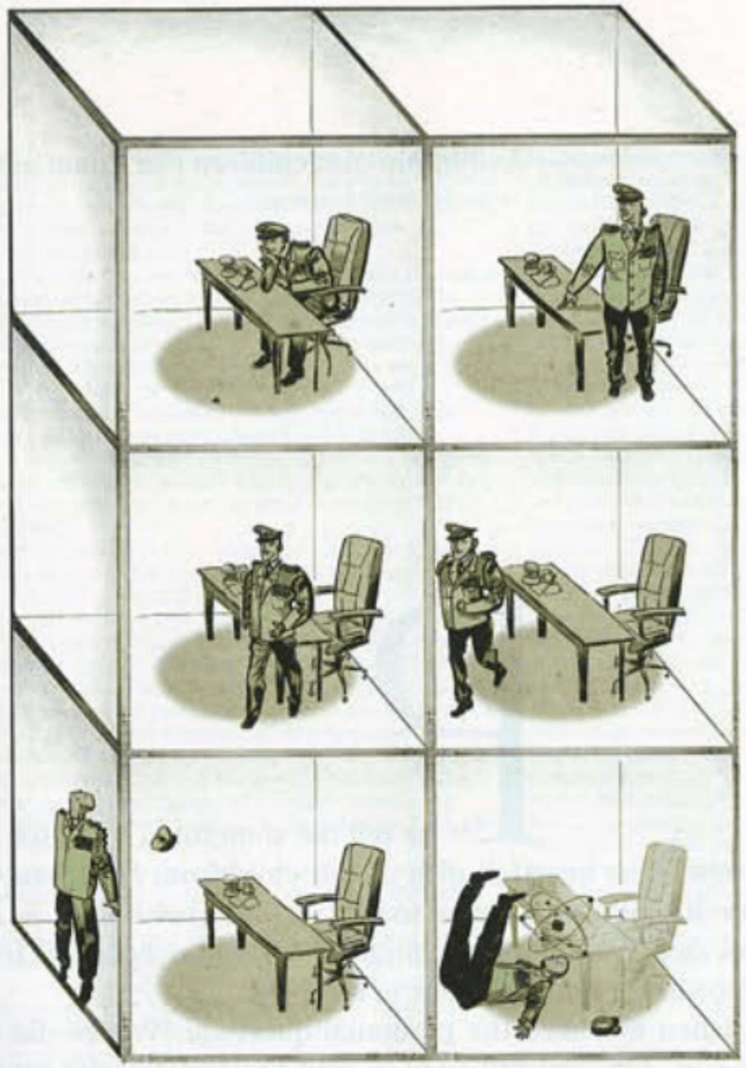
If you want to see a rainbow you have to have the sun behind you when you look at a rainstorm. Each raindrop is more like a little ball than a prism, and light behaves differently when it hits a ball from how it behaves when it hits a prism.

The difference is that the far side of a raindrop acts as a tiny mirror. The light from the sun turns a somersault inside every raindrop and is reflected backwards and downwards, where it hits your eyes.

Nobody sees the full spectrum from any one raindrop. There are millions of other raindrops, and they are all behaving in the same kind of way. While you are looking at A's red beam, there is another raindrop called B, which is lower than A. You don't see B's red beam because it hits you in the stomach. But B's blue beam is in exactly the right place to hit you in the eye.

And there are other raindrops lower than A but higher than B, whose red and blue beams miss your eye but whose yellow or green beams hit your eye. So lots of raindrops together add up to a complete spectrum.

“Let's exercise our imaginations a bit more. Why should the aliens limit themselves to the narrow band of frequencies that we call “light”? Maybe they have radio eyes? Or X-ray eyes?

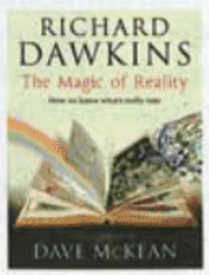


LEFT
The story of Major General Albert Stubblebine III, the US Army's former chief of intelligence. Convinced he could walk through walls (he reasoned that both were made of near-empty atoms), he ran at one in his office in Arlington, Virginia in 1983. He couldn't.

BELOW
A spindly legged rhinoceros. In *The Magic of Reality*, Richard Dawkins explains that if Earth was made from coal, it would have a gravitational pull about a fifth as strong as we are used to. So animals the size of a rhino could skitter about on thin, spindly legs like a spider.

Harry Potter, Coraline, The Magic of Reality — the illustrator Dave McKean is well versed in the art of science communication

Picture this



How do you set about illustrating unexplainable, or at least complex, theories in science?
I think everything is explainable. Most areas of science, and definitely the subjects covered in the book, are explainable by a clear-sighted writer, which Richard certainly is, and imagery can help to make things solid and clear in a different way. In the same way that it is sometimes useful to use sound to talk about a painting, or colours to talk about music, imagery can throw a different perspective on a subject.
Is art the key to science communication, or will words always be more powerful?
I think some people can think more clearly about a subject if they can see it laid out on the table in some form. Sometimes images can create an atmosphere or feeling, they can evoke emotions, show colours and textures and, of course, they can clearly show data in the form of charts, diagrams and relative distances. I certainly think images are a powerful tool in storytelling, that's the power of graphic novels. They give you half the story, and the engaged reader evokes the other half — the sound and motion — in the mind.
What lengths do you need to go to to research and understand science briefs?
I'm not a scientist, so I have to understand the subject from scratch. It was fun to go back to school and learn (or re-learn) about the periodic table and light refraction. I appreciate the knowledge much more as an adult than I did as a child.
What's the key to successful and beautiful science illustrations?
They must be accurate (and in this book's case, that's accurate according to Richard, and several friends and colleagues who offered critiques) and beautiful (I still value beauty in art). Our goal for this book was to try to show how "awesome" — in the proper sense of the word — the real world is, and the mechanisms and processes that govern it. The stories embedded in the history and development of our Universe are even more astounding than fiction, not least because they are true.

Evolution? Yes, children can Adam and Eve it

WORDS: RICHARD DAWKINS

"Please tell me something I can tell Daddy, which he doesn't already know." The heartfelt plea of this child from Northern Ireland is the more poignant because his father happened to be a devout Christian — as is common in that unfortunate province. What nonsense might the boy have been fed, from the cradle on? And what true knowledge could we offer in response?

Perhaps this little boy, when he asked the perennial question: "Where did I come from?" was told: "God made you." Or "You came out of your mother, and she came from her mother and so on back to your great-great-great-great-grandmother who came from Eve. And Eve, along with her husband Adam, was made by God."

No educated person believes the Adam and Eve myth nowadays, but it is surprising how many parents think that it is somehow fun to pass on this falsehood (and others in the same vein) to their children. Or they expect their child's school to do so. Perhaps they think it harmless, like Father Christmas. Or maybe they think the truth is less poetic, less "fun" or harder to understand than the myth.

But I would want to argue that the truth of evolution is more interesting and more poetic — even more fun — than this myth, or any of the hundreds of creation myths from around the world. And — perhaps surprisingly — evolution could be taught in such a way as to make it easier to understand than a myth. This is because myths leave the child's questions unanswered, or they raise more questions than they appear to answer. Evolution is a truly satisfying and complete explanation of existence, and I suspect that this is something a child can appreciate from an early age.

Nevertheless, many adults find evolution hard. It is a striking fact that nobody understood it until Charles Darwin and Alfred Russel Wallace in the 19th century, two centuries later than Issac Newton's (on the face of it more difficult) comprehension of the laws of motion, force, acceleration and universal gravity.

Could there be aspects of science that children find easier than adults because adults are weighed down by misleading familiarity? Maybe weight itself is literally misleading? I was fortunate this year to attend a conference of scientists with astronauts — American, Russian and European — and I talked to some of them about what it is like to be weightless, but not massless. I quoted Douglas Adams to them:

"The fact that we live at the bottom of a deep gravity well, on the surface of a gas-covered planet going around a nuclear fireball 90 million miles away and think this to be normal is obviously some indication of how skewed our perspective tends to be, but we have done various things over intellectual history to slowly correct some of our misapprehensions."

I suggested to the astronauts that, if children were ever to be born and brought up in a space station where they never experience weight, they will find Newton easy to understand. They will intuitively grasp the idea — so foreign to us troglodytes at the bottom of the gravity well — that the default condition for a moving body is to continue forever in the same direction. They will effortlessly comprehend the difference between weight and mass, and will understand that, although a cannon ball and a ping pong ball can have equal weight, they very much do not have equal mass. Try to throw a cannon ball across the space station and you are likely to shoot off in the opposite direction. Jump towards what you think of as the "ceiling", and you will be shocked to find that the "ceiling" turns into the "floor" as you "fall" "heavily" "down" on it. Weightless children might even be primed to understand the Einsteinian equivalence between gravity and acceleration.

Computer games typically are programmed with a virtual physics which mimics, on the screen, the familiar physics of the outside world. Simulated objects don't pass through each other, simulated balls bounce off walls and off each other, they follow ballistically calculated parabolic trajectories, and so on. What if a computer game were programmed with an alternative physics, perhaps even a virtual rendering of counter-intuitive quantum physics? Or of something resembling Einsteinian physics at close to a maximum permitted velocity? Might children brought up on such games have a head start when they come to study physics at school or university?

Newton and Galileo had to wrest themselves free of false intuitions born of their upbringing in the gravity well. Is there a similar barrier to understanding evolution? Is there a parallel respect in which naïve children might actually find evolution easier to understand than adults?

According to the great German-American zoologist Ernst Mayr, the chief historical barrier to understanding evolution has been the philosophy of essentialism, for which he blames Plato and Aristotle. Steeped in geometry, the Greeks thought of triangles in the real world as imperfect approximations to an abstract ideal of triangliness. In the same way that individual rabbits, rhinos and cormorants — variable, flesh-and-bone individuals — were flawed approximations to the ideal rabbit, the perfect rhino, the essence of cormorant. Mayr argued that such essentialist thinking delayed, by centuries, humanity's understanding of evolution. The idea that one species could turn into another — the idea that, given a sufficient number of generations, species of fish could gradually change so far that their descendants could be aardvarks or philosophers — is, according to Mayr, deeply antithetical to all our intuitions, and this is because we are dyed-in-the-wool essentialists. But maybe children are not.

Children's fairytales are replete with anti-essentialist propaganda. Mice turn into white horses, and pumpkins into gleaming coaches at the touch of a fairy's wand. It takes only a kiss for a frog to morph into a handsome prince. Such radical changes undermine Mayr's essentialist bogeyman. Indeed, they go too far in the other direction. Magical transformations are not just anti-essentialist, they are anti-evolution, too. And anti-science. Complex things, such as horses, coaches and princes, cannot spring spontaneously into existence from nothing; nor can they be spawned in a puff of smoke from other complex things, such as mice, pumpkins and frogs.

To be sure, a tadpole can turn into a frog, and a caterpillar into a butterfly, but those are revealing special cases. A caterpillar's DNA is dual purpose: full instructions for how to build a caterpillar from an egg, and then a second tier of instructions for how to build a butterfly from deconstructed caterpillar flesh. You can't make a caterpillar or a butterfly or a frog or a prince by magic, from nothing. The DNA has to be already in place, and the only way we know for that to happen — at least until human technology catches up — is the slow, gradual, generation-by-generation filtering process of natural selection.

But at least fairytales give the lie to — or perhaps positively undermine — essentialism. Humans can't turn into werewolves by moonlight. No species can turn into a radically different species. But any species can turn into a slightly different species. And given enough millions of years, slight difference adds to slight difference and then accumulates slight difference again . . . until eventually the descendant of a fish turns out to be a fishmonger.

"I'll believe in evolution the day a monkey gives birth to a human." So speaks the ignorant creationist, flat-footedly misunderstanding the gradualness of evolution. No animal ever born was a member of a different species from its parents. The trick is to understand how that truth is fully compatible with another truth: every one of us is descended from an animal which, were we to meet it today, we would classify (and very probably eat) as a fish. Before that, every one of us was descended from an ancestor that we would need a microscope to see, and that we would probably classify as a bacterium. All that is literally true, at the same time as it is true that every intermediate link in the chain would have been classified as the same species as its parents and its children.

It isn't really all that paradoxical. Every child is familiar with gradual change, too slow to notice. The hour hand of your watch seems motionless. But look away for an hour and it has moved. You were once a baby, then you became a toddler, then you became a child. Yet there never was a day when you woke up and said, "Yesterday I was a toddler; today I seem to have become a child."

In the same way, there never was a first *Homo sapiens* baby born to *Homo erectus* parents. When anthropologists heatedly argue whether a particular jawbone belongs to *Homo* or *Australopithecus*, they may turn out to be engaging in essentialist foolery. There never was a moment when *Australopithecus* parents gazed fondly down at the firstborn *Homo* baby. Every baby ever born belonged to the same species as its parents. Yet, if you sample an ancestor's descendants at a sufficiently long interval (like sampling the position of the hour hand on a watch), you'll find descendants that belong not just in different species but different orders, classes and phyla. It is a certain fact that there once was an animal that is the common ancestor of you and a snail.

I have sometimes worried about the educational effects of fairytales. Could they be pernicious, leading children down pathways of gullibility towards anti-scientific superstition and religion? Maybe. But could they also be beneficial, in leading children away from static essentialism? and towards a state of mind that is receptive to the dynamics of evolution?

I don't know. And, as so often when I don't know the answer to a question, I'd like to find out.

The Magic of Reality — An Evening with Richard Dawkins
Royal Albert Hall, October 19, 8.30pm
James Harding, Editor of *The Times*, hosts an evening with Richard Dawkins. Times+ members can book premium seats (normally £65) for £50 each. Ticket prices include a voucher for one free copy of *The Magic of Reality* to be exchanged on the night and a glass of Moët champagne.
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