The *Sunday Times* top ten bestseller

Bad Science

Ben Goldacre

'A fine lesson in how to skewer the enemies of reason and the peddlers of cant and half-truths' *The Economist*

'You'll laugh your head off, then throw all those expensive health foods in the bin' *Observer*, Book of the Year

INCLUDES A BRILLIANT, SHOCKING AND PREVIOUSLY UNPUBLISHABLE NEW CHAPTER

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2008

Guardian columnist Dr Ben Goldacre takes us on a hilarious, invigorating and informative journey through the bad science we're fed by the worst of the hacks and the quacks! When Dr Ben Goldacre saw someone on daytime TV dipping her feet in an 'Aqua Detox' footbath, releasing her toxins into the water and turning it brown, he thought he'd try the same at home. 'Like some kind of Johnny Ball cum Witchfinder General', using his girlfriend's Barbie doll, he gently passed an electrical current through the warm salt water. It turned brown. In his words: 'before my very eyes, the world's first Detox Barbie was sat, with her feet in a pool of brown sludge, purged of a weekend's immorality.' Dr Ben Goldacre is the author of the 'Bad Science' column in the Guardian and his book is about all the 'bad science' we are constantly bombarded with in the media and in advertising. At a time when science is used to prove everything and nothing, everyone has their own 'bad science' moments—from the useless pie-chart on the back of cereal packets to the use of the word 'visibly' in cosmetics ads.This book will help people to quantify their instincts—that a lot of the so-called 'science' which appears in the media and in advertising is just wrong or misleading. Satirical and amusing—and unafraid to expose the ridiculous—it provides the reader with the facts they need to differentiate the good from the bad. Full of spleen, this is a hilarious, invigorating and informative journey through the world of 'bad science'.

INTRODUCTION

Let me tell you how bad things have become. Children are routinely being taught—by their own teachers, in thousands of British state schools—that if they wiggle their head up and down it will increase blood flow to the frontal lobes, thus improving concentration; that rubbing their fingers together in a special sciencey way will improve ‘energy flow’ through the body; that there is no water in processed food; and that holding water on their tongue will hydrate the brain directly through the roof of the mouth, all as part of a special exercise programme called ‘Brain Gym’. We will devote some time to these beliefs and, more importantly, the buffoons in our education system who endorse them.

But this book is not a collection of trivial absurdities. It follows a natural crescendo, from the foolishness of quacks, via the credence they are given in the mainstream media, through the tricks of the £30 billion food supplements industry, the evils of the £300 billion pharmaceuticals industry, the tragedy of science reporting, and on to cases where people have wound up in prison, derided, or dead, simply through the poor understanding of statistics and evidence that pervades our society.

At the time of C.P. Snow’s famous lecture on the ‘Two Cultures’ of science and the humanities half a century ago, arts graduates simply ignored us. Today, scientists and doctors find themselves outnumbered and outgunned by vast armies of individuals who feel entitled to pass judgement on matters of evidence—an admirable aspiration—without troubling themselves to obtain a basic understanding of the issues.

At school you were taught about chemicals in test tubes, equations to describe motion, and maybe something on photosynthesis—about which more later—but in all likelihood you were taught nothing about death, risk, statistics, and the science of what will kill or cure you. The hole in our culture is gaping: evidence-based medicine, the ultimate applied science, contains some of the cleverest ideas from die past two centuries, it has saved millions of lives, but there has never once been a single exhibit on the subject in London’s Science Museum.

This is not for a lack of interest. We are obsessed with health—half of all science stories in the media are medical—and are repeatedly bombarded with sciencey-sounding claims and stories. But as you will see, we get our information from the very people who have repeatedly demonstrated themselves to be incapable of reading, interpreting and bearing reliable witness to the scientific evidence.

Before we get started, let me map out the territory.

Firsdy, we will look at what it means to do an experiment, to see the results with your own eyes, and judge whether they fit with a given theory, or whether an alternative is more compelling. You may find these early steps childish and patronising—the examples are certainly refreshingly absurd—but they have all been promoted credulously and with great authority in the mainstream media. We will look at the attraction of sciencey-sounding stories about our bodies, and the confusion they can cause.

Then we will move on to homeopathy, not because it's important or dangerous—it's not—but because it is the perfect model for teaching evidence-based medicine: homeopathy pills are, after all, empty little sugar pills which seem to work, and so they embody everything you need to know about 'fair tests' of a treatment, and how we can be misled into thinking that any intervention is more effective than it really is. You will learn all there is to know about how to do a trial properly, and how to spot a bad one. Hiding in the background is the placebo effect, probably the most fascinating and misunderstood aspect of human healing, which goes far beyond a mere sugar pill: it is counterintuitive, it is strange, it is the true story of mind-body healing, and it is far more interesting than any made-up nonsense about therapeutic quantum energy patterns. We will review the evidence on its power, and you will draw your own conclusions.

Then we move on to the bigger fish. Nutritionists are alternative therapists, but have somehow managed to brand themselves as men and women of science. Their errors are much more interesting than those of the homeopaths, because they have a grain of real science to them, and that makes them not only more interesting, but also more dangerous, because the real threat from cranks is not that their customers might die—there is the odd case, although it seems crass to harp on about them—but that they systematically undermine the public's understanding of the very nature of evidence.

We will see the rhetorical sleights of hand and amateurish errors that have led to you being repeatedly misled about food and nutrition, and how this

new industry acts as a distraction from the genuine lifestyle risk factors for ill health, as well as its more subtle but equally alarming impact on the way we see ourselves and our bodies, specifically in the widespread move to medicalise social and political problems, to conceive of them in a reductionist, biomedical framework, and peddle commodifiable solutions, particularly in the form of pills and faddish diets. I will show you evidence that a vanguard of startling wrongness is entering British universities, alongside genuine academic research into nutrition. This is also the section where you will find the nation's favourite doctor, Gillian McKeith, PhD. Then we apply these same tools to proper medicine, and see the tricks used by the pharmaceutical industry to pull the wool over the eyes of doctors and patients.

Next we will examine how the media promote the public misunderstanding of science, their single-minded passion for pointless non-stories, and their basic misunderstandings of statistics and evidence, which illustrate the very core of why we do science: to prevent ourselves from being misled by our own atomised experiences and prejudices. Finally, in the part of the book I find most worrying, we will see how people in positions of great power, who should know better, still commit basic errors, with grave consequences; and we will see how the media's cynical distortion of evidence in two specific health scares reached dangerous and frankly grotesque extremes. It's your job to notice, as we go, how incredibly prevalent this stuff is, but also to think what you might do about it.

You cannot reason people out of positions they didn't reason themselves into. But by the end of this book you'll have the tools to win—or at least understand—any argument you choose to initiate, whether it's on miracle cures, MMR, the evils of big pharma, the likelihood of a given vegetable preventing cancer, the dumbing down of science reporting, dubious health scares, the merits of anecdotal evidence, the relationship between body and mind, the science of irrationality, the medicalisation of everyday life, and more. You'll have seen the evidence behind some very popular deceptions, but along the way you'll also have picked up everything useful there is to know about research, levels of evidence, bias, statistics (relax), the history of science, anti-science movements and quackery, as well as falling over just some of the amazing stories that the natural sciences can tell us about the world along the way.

It won't be even slightly difficult, because this is the only science lesson

where I can guarantee that the people making the stupid mistakes won't be you. And if, by the end, you reckon you might still disagree with me, then I offer you this: you'll still be wrong, but you'll be wrong with a lot more panache and flair than you could possibly manage right now.

Ben Goldacre
July 2008

1 Matter

I spend a lot of time talking to people who disagree with me—I would go so far as to say that it's my favourite leisure activity—and repeatedly I meet individuals who are eager to share their views on science despite the fact that they have *never done an experiment*. They have never tested an idea for themselves, using their own hands; or seen the results of that test, using their own eyes; and they have never thought carefully about what those results mean for the idea they are testing, using their own brain. To these people 'science' is a monolith, a mystery, and an authority, rather than a method.

Dismantling our early, more outrageous pseudoscientific claims is an excellent way to learn the basics of science, partly because science is largely about disproving theories, but also because the lack of scientific knowledge among mirade-cure artistes, marketers and journalists gives us some very simple ideas to test Their knowledge of sdence is rudimentary, so as well as making basic errors of reasoning, they also rely on notions like magnetism, oxygen, water, 'energy' and toxins: ideas from GCSE-level science, and all very much within the realm of kitchen chemistry.

Detox and the theatre of goo

Since you'll want your first experiment to be authentically messy, we'll start with detox. Aqua Detox is a detox footbath, one of many similar products. It has been promoted uncritically in some very embarrassing articles in the *Telegraph*, the *Mirror*, the *Sunday Times*, *GQ* magazine and various TV shows. Here is a taster from the *Mirror*.

> We sent Alex for a new treatment called Aqua Detox which releases toxins before your eyes. Alex says: 'I place my feet in a bowl of water, while therapist Mirka pours salt drops in an ionising unit, which will

> adjust the bio-energetic field of the water and encourage my body to discharge toxins. The water changes colour as the toxins are released. After half an hour, the water's turned red…she gets our photographer Karen to give it a go. She gets a bowl of brown bubbles. Mirka diagnoses an overloaded liver and lymph—Karen needs to drink less alcohol and more water. Wow, I feel virtuous!'

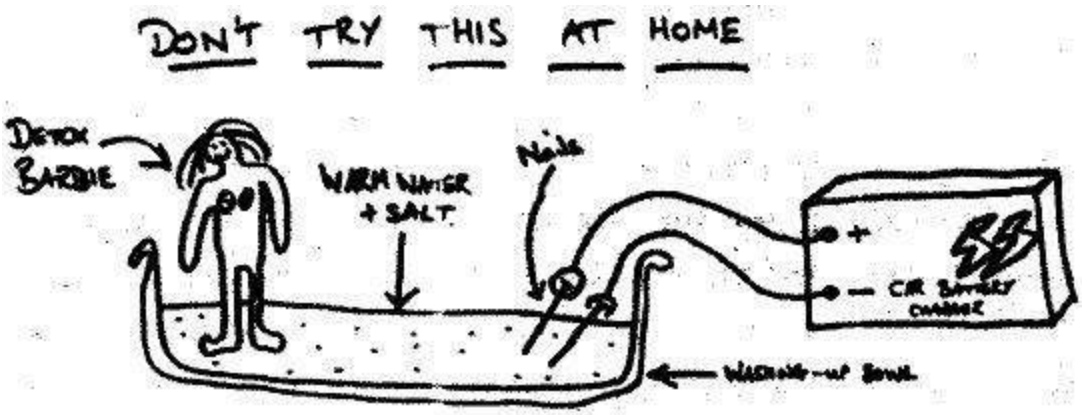
The hypothesis from these companies is very clear: your body is full of 'toxins', whatever those may be; your feet are filled with special 'pores' (discovered by ancient Chinese scientists, no less); you put your feet in the bath, the toxins are extracted, and the water goes brown. Is the brown in the water because of the toxins? Or is that merely theatre?

One way to test this is to go along and have an Aqua Detox treatment yourself at a health spa, beauty salon, or any of me thousands of places they are available online, and take your feet out of the bath when the therapist leaves the room. If the water goes brown without your feet in it, then it wasn't your feet or your toxins that did it. That is a controlled experiment: everything is the same in both conditions, except for the presence or absence of your feet.

There are disadvantages with this experimental method (and there is an important lesson here, that we must often weigh up the benefits and practicalities of different forms of research, which will become important in later chapters). From a practical perspective, the 'feet out' experiment involves subterfuge, which may make you uncomfortable. But it is also expensive: one session of Aqua Detox will cost more man the components to build your own detox device, a perfect model of the real one.

You will need:

- One car battery charger
- Two large nails
- Kitchen salt
- Warm water
- One Barbie doll
- A full analytic laboratory (optional)



This experiment involves electricity and water. In a world of hurricane hunters and volcanologists, we must accept that everyone sets their own level of risk tolerance. You might well give yourself a nasty electric shock if you perform this experiment at home, and it could easily blow the wiring in your house. It is not safe, but it is in some sense relevant to your understanding of MMR, homeopathy, post-modernist critiques of science and the evils of big pharma. Do not build it.

When you switch your Barbie Detox machine on, you will see that the water goes brown, due to a very simple process called electrolysis: the iron electrodes rust, essentially, and the brown rust goes into the water. But there is something more happening in there, something you might half-remember from chemistry at school. There is salt in the water. The proper scientific term for household salt is ‘sodium chloride’: in solution, this means that there are chloride ions floating around, which have a negative charge (and sodium ions, which have a positive charge). The red connector on your car battery charger is a ‘positive electrode’, and here, negatively charged electrons are stolen away from the negatively charged chloride ions, resulting in the production of free chlorine gas.

So chlorine gas is given off by the Barbie Detox bath, and indeed by the Aqua Detox footbath; and the people who use this product have elegantly woven that distinctive chlorine aroma into their story: it’s the chemicals, they explain; it’s the chlorine coming out of your body, from all the plastic packaging on your food, and all those years bathing in chemical swimming pools. ‘It has been interesting to see the colour of the water change and smell the chlorine leaving my body,’ says one testimonial for the similar product Emerald Detox. At another sales site: ‘The first time she tried the Q2 [Energy Spa], her business partner said his eyes were burning from all the chlorine, that was coming out of her, leftover from her childhood and early adulthood.’

All that chemically chlorine gas that has accumulated in your body over the years. It's a frightening thought.

But there is something else we need to check. Are there toxins in the water? Here we encounter a new problem: what do they mean by toxin? I've asked the manufacturers of many detox products this question time and again, but they demur. They wave their hands, they talk about stressful modern lifestyles, they talk about pollution, they talk about junk food, but they will not tell me the name of a single chemical which I can measure. 'What toxins are being extracted from the body with your treatment?' I ask. 'Tell me what is in the water, and I will look for it in a laboratory.' I have never been given an answer.

After much of their hedging and fudging, I chose two chemicals pretty much at random: creatinine and urea. These are common breakdown products from your body's metabolism, and your kidneys get rid of them in urine. Through a friend, I went for a genuine Aqua Detox treatment, took a sample of brown water, and used the disproportionately state-of-the-art analytic facilities of St Mary's Hospital in London to hunt for these two chemical 'toxins'. There were no toxins in the water. Just lots of brown, rusty iron.

Now, with findings like these, scientists might take a step back, and revise their ideas about what is going on with the footbaths. We don't really expect the manufacturers to do that, but what they say in response to these findings is very interesting, at least to me, because it sets up a pattern that we will see repeated throughout the world of pseudoscience: instead of addressing the criticisms, or embracing the new findings in a new model, they seem to shift the goalposts and retreat, crucially, into *untestable positions*.

Some of them now deny that toxins come out in the footbath (which would stop me measuring them): your body is somehow informed that it is time to release toxins in the normal way—whatever that is, and whatever the toxins are—only more so. Some of them now admit that the water goes a bit brown without your feet in it, but 'not as much'. Many of them tell lengthy stories about the 'bioenergetic field', which they say cannot be measured, except by how well you are feeling. All of them talk about how stressful modern life is.

That may well be true. But it has nothing to do with their foot bath, which is all about theatre: and theatre is the common theme for all detox products, as we will see. On with the brown goo.

Ear candles

You might think that Hopi Ear Candles are an easy target. But their efficacy has still been cheerfully promoted by the *Independent*, the *Observer* and the BBC, to name just a few respected news outlets. Since these people are the authoritative purveyors of scientific information, I'll let the BBC explain how these hollow wax tubes will detox your body:

> The candles work by vaporising their ingredients once lit, causing convectional air flow towards the first chamber of the ear. The candle creates a mild suction which lets the vapours gently massage the eardrum and auditory canal. Once the candle is placed in the ear it forms a seal which enables wax and other impurities to be drawn out of the ear.

The proof comes when you open a candle up, and discover that it is filled with a familiar waxy orange substance, which must surely be earwax. If you'd like to test this yourself, you will need: an ear, a clothes peg, some Blu Tack, a dusty floor, some scissors, and two ear candles. I recommend OTOSAN because of their strapline ('The ear is the gateway to the soul').

If you light one ear candle, and hold it over some dust, you will find little evidence of any suction. Before you rush to publish your finding in a peer-reviewed academic journal, someone has beaten you to it: a paper published in the medical journal *Laryngoscope* used expensive tympanometry equipment and found—as you have—that ear candles exert no suction. There is no truth to the claim that doctors dismiss alternative therapies out of hand.

But what if the wax and toxins are being drawn into the candle by some other, more esoteric route, as is often claimed?

For this you will need 10 do something called a controlled experiment, comparing the results of two different situations, where one is the experimental condition, the other is the 'control' condition, and the only difference is the thing you're interested in testing. This is why you have two candles.

Put one ear candle in someone's ear, as per the manufacturer's instructions, and leave it there until it burns down.*

≡ Be careful. One paper surveyed 122 ENT doctors, and collected twenty-one cases of serious injury from burning wax falling onto the eardrum during ear-candle treatment.

Put the other candle in the clothes peg, and stand it upright using the Blu

Tack: this is the ‘control arm’ in your experiment. The point of a control is simple: we need to minimise the differences between the two setups, so that the only real difference between them is the single factor you’re studying, which in this case must be: ‘Is it my ear that produces the orange goo?’

Take your two candles back inside and cut them open. In the ‘ear’ candle, you will find a waxy orange substance. In the ‘picnic table control’, you will find a waxy orange substance. There is only one internationally recognised method for identifying something as earwax: pick some up on the end of your finger, and touch it with your tongue. If your experiment had the same results as mine, both of them taste a lot like candle wax.

Does the ear candle remove earwax from your ears? You can’t tell, but a published study followed patients during a full programme of ear candling, and found no reduction. For all that you might have learnt something useful here about the experimental method, there is something more significant you should have picked up: it is expensive, tedious and time-consuming to test every whim concocted out of thin air by therapists selling unlikely miracle cures. But it can be done, and it is done.

Detox patches and the ‘hassle barrier’

Last in our brown-sludge detox triptych comes the detox foot patch. These are available in most high-street health-food stores, or from your local Avon lady (this is true). They look like teabags, with a foil backing which you stick onto your foot using an adhesive edging before you get into bed. When you wake up the next morning there is a strange-smelling, sticky brown sludge attached to the bottom of your foot, and inside the teabag. This sludge—you may spot a pattern here—is said to be ‘toxins’. Except it’s not. By now you can probably come up with a quick experiment to show that. I’ll give you one option in a footnote.*

≡ If you take one of these bags and squirt some water onto it, then pop a nice hot cup of tea on top of it and wait for ten minutes, you’ll see brown sludge forming. There are no toxins in porcelain.

An experiment is one way of determining whether an observable effect—sludge—is related to a given process. But you can also pull things apart on a more theoretical level. If you examine the list of ingredients in these patches, you will see that they have been very carefully designed.

The first thing on the list is ‘pyroligneous acid’, or wood vinegar. This is a brown powder which is highly ‘hygroscopic’, a word which simply means

that it attracts and absorbs water, like those little silica bags that come in electronic equipment packaging. If there is any moisture around, wood vinegar will absorb it, and make a brown mush which feels warm against your skin.

What is the other major ingredient, impressively listed as ‘hydrolysed carbohydrate’? A carbohydrate is a long string of sugar molecules all stuck together. Starch is a carbohydrate, for example, and in your body this is broken down gradually into the individual sugar molecules by your digestive enzymes, so that you can absorb it. The process of breaking down a carbohydrate molecule into its individual sugars is called ‘hydrolysis’. So ‘hydrolysed carbohydrate’, as you might have worked out by now, for all that it sounds sciencey, basically means ‘sugar’. Obviously sugar goes sticky in sweat.

Is there anything more to these patches than that? Yes. There is a new device which we should call ‘the hassle barrier’, another recurring theme in the more advanced forms of foolishness which we shall be reviewing later. There are huge numbers of different brands, and many of them offer excellent and lengthy documents full of science to prove that they work: they have diagrams and graphs, and the appearance of scienciness; but the key elements are missing. There are experiments, they say, which prove that detox patches do something…but they don’t tell you what these experiments consisted of, or what their ‘methods’ were, they only offer decorous graphs of ‘results’.

To focus on the methods is to miss the point of these apparent ‘experiments’: they aren’t about the methods, they’re about the positive result, the graph, and the appearance of science. These are superficially plausible totems to frighten off a questioning journalist, a *hassle barrier*, and this is another recurring theme which we will see—in more complex forms—around many of the more advanced areas of bad science. You will come to love the details.

If it’s not science, what is it?

Find out if drinking urine, balancing on mountain ledges and genital weightlifting really did change their lives forever.

—Channel 4’s *Extreme Celebrity Detox*

These are the absurd extremes of detox, but they speak of the larger market, the antioxidant pills, the potions, the books, the juices, the five-day ‘programmes’, the pipes up the bum and the dreary TV shows, all of which we will torpedo, mostly in a later chapter on nutritionism. But there is something important happening here, with detox, and I don’t think it’s enough just to say, ‘All this is nonsense.’

The detox phenomenon is interesting because it represents one of the most grandiose innovations of marketers, lifestyle gurus, and alternative therapists: the invention of a whole new physiological process. In terms of basic human biochemistry, detox is a meaningless concept. It doesn’t cleave nature at the joints. There is nothing on the ‘detox system’ in a medical textbook. That burgers and beer can have negative effects on your body is certainly true, for a number of reasons; but the notion that they leave a specific residue, which can be extruded by a specific process, a physiological system called detox, is a marketing invention.

If you look at a metabolic flow chart, the gigantic wall-sized maps of all the molecules in your body, detailing the way that food is broken down into its constituent parts, and then those components are converted between each other, and then those new building blocks are assembled into muscle, and bone, and tongue, and bile, and sweat, and bogey, and hair, and skin, and sperm, and brain, and everything that makes you you, it’s hard to pick out one thing that is the ‘detox system’.

Because it has no scientific meaning, detox is much better understood as a cultural product. Like the best pseudoscientific inventions, it deliberately blends useful common sense with outlandish, medicalised fantasy. In some respects, how much you buy into this reflects how self-dramatising you want to be; or in less damning terms, how much you enjoy ritual in your daily life. When I go through busy periods of partying, drinking, sleep deprivation and convenience eating, I usually decide—eventually—that I need a bit of a rest. So I have a few nights in, reading at home, and eating more salad than usual. Models and celebrities, meanwhile, ‘detox’.

On one thing we must be absolutely clear, because this is a recurring theme throughout the world of bad science. There is nothing wrong with the notion of eating healthily and abstaining from various risk factors for ill health like

excessive alcohol use. But that is not what detox is about: these are quick-fix health drives, constructed from the outset as short-term, while lifestyle risk factors for ill health have their impact over a lifetime. But I am even willing to agree that some people might try a five-day detox and remember (or even learn) what it's like to eat vegetables, and that gets no criticism from me.

What's wrong is to pretend that these rituals are based in science, or even that they are new. Almost every religion and culture has some form of purification or abstinence ritual, with fasting, a change in diet, bathing, or any number of other interventions, most of which are dressed up in mumbo jumbo. They're not presented as science, because they come from an era before scientific terms entered the lexicon: but still, Yom Kippur in Judaism, Ramadan in Islam, and all manner of other similar rituals in Christianity, Hinduism, the Baha'i faith, Buddhism, Jainism, are each about abstinence and purification (among other things). Such rituals, like detox regimes, are conspicuously and—to some believers too, I'm sure—spuriously precise. Hindu fasts, for example, if strictly observed, run from the previous day's sunset until *forty-eight minutes* after the next day's sunrise.

Purification and redemption are such recurrent themes in ritual because there is a clear and ubiquitous need for them: we all do regrettable things as a result of our own circumstances, and new rituals are frequently invented in response to new circumstances. In Angola and Mozambique, purification and cleansing rituals have arisen for children affected by war, particularly former child soldiers. These are healing rituals, where the child is purged and purified of sin and guilt, of the 'contamination' of war and death (contamination is a recurring metaphor in all cultures, for obvious reasons); the child is also protected from the consequences of his previous actions, which is to say, he is protected from retaliation by the avenging spirits of those he has killed. As a World Bank report put it in 1999:

> These cleansing and purification rituals for child soldiers have the appearance of what anthropologists call rites of transition. That is, the child undergoes a symbolic change of status from someone who has existed in a realm of sanctioned norm-violation or norm-suspension (i.e. killing, war) to someone who must now live in a realm of peaceful behavioural and social norms, and conform to these.

I don’t think I’m stretching this too far. In what we call the developed Western world, we seek redemption and purification from the more extreme forms of our material indulgence: we fill our faces with drugs, drink, bad food and other indulgences, we know it’s wrong, and we crave ritualistic protection from the consequences, a public ‘transitional ritual’ commemorating our return to healthier behavioural norms.

The presentation of these purification diets and rituals has always been a product of their time and place, and now that science is our dominant explanatory framework for the natural and moral world, for right or wrong, it’s natural that we should bolt a bastardised pseudoscientific justification onto our redemption. Like so much of the nonsense in bad science, ‘detox’ pseudoscience isn’t something done *to* us, by venal and exploitative outsiders: it is a cultural product, a recurring theme, and we do it to ourselves.

2 Brain Gym

Under normal circumstances this should be the part of the book where I fall into a rage over creationism, to gales of applause, even though it's a marginal issue in British schools. But if you want an example from closer to home, there is a vast empire of pseudoscience being peddled, for hard cash, in state schools up and down the country. It's called Brain Gym, it is pervasive throughout the state education system, it's swallowed whole by teachers, it's presented directly to the children they teach, and it's riddled with transparent, shameful and embarrassing nonsense.

At the heart of Brain Gym is a string of complicated and proprietary exercises for kids which 'enhance the experience of whole brain learning'. They're very keen on water, for example. 'Drink a glass of water before Brain Gym activities', they say. 'As it is a major component of blood, water is vital for transporting oxygen to the brain.' Heaven forbid that your blood should dry out. This water should be held in your mouth, they say, because then it can be absorbed *directly* from there into your brain.

Is there anything else you can do to get blood and oxygen to your brain more efficiently? Yes, an exercise called 'Brain Buttons': 'Make a 'C' shape with your thumb and forefinger and place on either side of the breastbone just below the collarbone.

Gently rub for twenty or thirty seconds whilst placing your other hand over your navel. Change hands and repeat. This exercise stimulates the flow of oxygen carrying blood through the carotid arteries to the brain to awaken it and increase concentration and relaxation.' Why? 'Brain buttons lie directly over and stimulate the carotid arteries.'

Children can be disgusting, and often they can develop extraordinary talents, but I'm yet to meet any child who can stimulate his carotid arteries inside his ribcage. That's probably going to need the sharp scissors that only mummy can use.

You might imagine that this nonsense is a marginal, peripheral trend which I have contrived to find in a small number of isolated,-misguided schools. But no. Brain Gym is practised in hundreds if not thousands of mainstream

state schools throughout the country. As of today I have a list of over four hundred schools which mention it specifically by name on their websites, and many, many others will also be using it. Ask if they do it at your school. I'd be genuinely interested to know their reaction.

Brain Gym is promoted by local education authorities, funded by the government, and the training counts as continuing professional development for teachers. But it doesn't end locally. You will find Brain Gym being promoted on the Department for Education and Skills website, in all kinds of different places, and it pops up repeatedly as a tool for promoting 'inclusivity', as if pushing pseudoscience at children is somehow going to ameliorate social inequality, rather than worsen it. This is a vast empire of nonsense infecting the entirety of the British education system, from the smallest primary school to central government, and nobody seems to notice or care.

Perhaps if they could just do the 'hook-up' exercises on page 31 of the *Brain Gym Teacher's Manual* (where you press your fingers against each other in odd contorted patterns) this would 'connect the electrical circuits in the body, containing and thus focusing both attention and disorganised energy', and they would finally see sense. Perhaps if they wiggled their ears with their fingers as per the Brain Gym textbook it would 'stimulate the reticular formation of the brain to tune out distracting, irrelevant sounds and tune into language'.

The same teacher who explains to your children how blood is pumped around the lungs and then the body by the heart is also telling them that when they do the 'Energizer' exercise (which is far too complicated to describe), 'this back and forward movement of the head increases the circulation to the frontal lobe for greater comprehension and rational thinking'. Most frighteningly, this teacher sat through a class, being taught this nonsense by a Brain Gym instructor, without challenging or questioning it.

In some respects the issues here are similar to those in the chapter on detox: if you just want to do a breathing exercise, then that's great. But the creators of Brain Gym go much further. Their special, proprietary, theatrical yawn will lead to 'increased oxidation for efficient relaxed functioning'. Oxidation is what causes rusting. It is not the same as oxygenation, which I suppose is what they mean. (And even if they are talking about oxygenation, you don't need to do a funny yawn to get oxygen into your blood: like most other wild animals, children have a perfectly adequate and fascinating

physiological system in place to regulate their blood oxygen and carbon dioxide levels, and I'm sure many of them would rather be taught about that, and indeed about the role of electricity in the body, or any of the other things Brain Gym confusedly jumbles up, than this transparent pseudoscientific nonsense.)

How can this nonsense be so widespread in schools? One obvious explanation is that the teachers have been blinded by all these clever long phrases like 'reticular formation' and 'increased oxidation'. As it happens, this very phenomenon has been studied in a fascinating set of experiments from the March 2008 edition of the *Journal of Cognitive Neuroscience*, which elegantly demonstrated that people will buy into bogus explanations much more readily when they are dressed up with a few technical words from the world of neuroscience.

Subjects were given descriptions of various phenomena from the world of psychology, and then raiadomly offered one of four explanations for them. The explanations either contained neuroscience or didn't, and were either 'good' explanations or 'bad' ones (bad ones being, for example, simply circular restatements of the phenomenon itself, or empty words).

Here is one of the scenarios. Experiments have shown that people are quite bad at estimating the knowledge of others: if *we* know the answer to a question about a piece of trivia, we overestimate the extent to which other people will know that answer too. In the experiment a 'without neuroscience' explanation for this phenomenon was: 'The researchers claim that this [overestimation] happens because subjects have trouble switching their point of view to consider what someone else might know, mistakenly projecting their own knowledge onto others.' (This was a 'good' explanation.)

A 'with neuroscience' explanation—and a cruddy one too—was this: 'Brain scans indicate that this [overestimation] happens because of the frontal lobe brain circuitry known to be involved in self-knowledge. Subjects make more mistakes when they have to judge the knowledge of others. People are much better at judging what they themselves know.' Very little is added by this explanation, as you can see. Furthermore, the neuroscience information is merely decorative, and irrelevant to the explanation's logic.

The subjects in the experiment were from three groups: everyday people, neuroscience students, and neuroscience academics, and they performed very differently. All three groups judged good explanations as more satisfying than bad ones, but the subjects in the two non-expert groups judged that the