THE POCKET GUIDE TO PSEUDO SCIENCE

FAULTY FINDINGS, REAL APPEAL -- THE PSYCHOLOGY OF PSEUDOSCIENCE

The Earth is not flat. Vaccines don't cause autism. Astrology doesn't work. Neither does 'detox'. Bringing a snowball into Congress doesn't disprove climate change.

None of those ideas hold any truth, but a growing number of people are buying into pseudoscientific beliefs. It's not easy to say exactly why and how this is taking place, but at the core of the problem, we feel, lies a lack of trust. In experts, in science, a lack of trust in what we don't understand.

Pseudoscience propagates this lack of trust. It is, by its very nature, so completely opposed to what science is and stands for that it's corrosive to it. These theories are presented as authentic research, but fail to meet the standards of the scientific method -- i.e. there's no evidence to back them up.

Just like matter and anti-matter, science and pseudoscience seem to cancel each other out with a bang -- and the long-term effects are dramatic, often deadly, and insidious.

We've talked to Karen Douglas, a Professor of Social Psychology at the University of Kent who specializes in social psychology and the belief in conspiracy theories. For her, pseudoscience is a refuge; the safe place in our minds where we retreat to feel right, keep our beliefs safe from any outside interference, hardships, from being challenged.

One paper[1] Douglas and her colleagues published explains that pseudoscience offers us a way to make sense of the world when information is unavailable or conflicting. It reduces uncertainty and bewilderment, both states that we severly dislike. It finds patterns even in random events and defends our beliefs from being disproved.

For Douglas Allchin, a historian and philosopher of science, it's not just about a lack of trust -- it's also about who to trust. Pseudoscience is a lot about power and profit, he argues. People who promote pseudoscience are essentially con artists, practicing a deliberate deception. The trick is to make it *seem* real.

"Hucksters want their claims to look like science for a reason," Allchin explains. "Science works hard to ascertain facts. But just looking like science is not the same as having all the evidence. Pseudoscience is like a magician's trick. It seems believable, but it is all crafty illusion."

WHICH BRINGS US TO THE QUESTION: HOW CAN WE KNOW WHAT'S REAL AND WHAT'S SNAKE OIL?

The line between science and pseudoscience can sometimes be tricky to delineate clearly. Science isn't a sum total of information wholly beyond critique nor does it claim to have all the answers.

Science is a process -- namely, the process through which we obtain information and gain knowledge. It's a set of long-proven methods, a systematic approach that helps us make sense of the universe around us. It's what brought us planes, nice houses, and the smart device you're reading this on.

Pseudoscience, on the other hand, is a body of claims built on shaky reasoning (and quite a bit of cherry-picking) that masquerades as science. It uses seemingly correct but flawed ideas, unscientific methods, and manipulation.

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It's what brought us diet fads, "fake news", and the recent measles epidemic. The effects of this trend cannot be overstated.

We're facing real, significant, nigh-irreversible climate change. We're seeing the reemergence of diseases that our vaccines had almost wiped out. We're trying to go to Mars while some people still insist the Earth is flat. Public opinion is increasingly polarized around key issues such as energy, climate change, politics, and health. Pseudoscience has a big role to play in that. Many situations can be spun and manipulated, taken advantage of.

But we can't afford to waste time and energy being divided on topics that are clear-cut. We can't afford to doubt the experts and listen to those who make us feel good instead. We can launch world-ending nukes with a button -- we can't risk having people not listen to basic scientific facts, or judging life through a twisted, distorted lens. The growth of pseudoscience in all its forms is one of the most worrying developments of our modern times, we believe.It's more important than ever to be well-advised, to stay informed and -- why not -- to learn more about the very world we live in.

The time has never been more ripe for good science. So, here, we will be presenting some of the most widespread and insidious pseudoscientific ideas going around. Every chapter is a new idea, arranged in a way that's short and easy to read.

HOW SURE ARE WE?

Very sure. We've only selected topics where there's absolutely overwhelming evidence.

WHY ARE WE WRITING THIS?

It's not just about fighting the dangers of pseudoscience. We do it because the world is an incredibly beautiful place, and science is how we explore it. This passion to know and understand is what drives us forward. In a world where you have the sum of the world's knowledge at the push of a button, everyone deserves the truth.

We hope you will enjoy this foray into some of the most popular (and dangerous) pseudoscientific beliefs. Since it's dangerous to go alone, here is a short guide with some healthy habits:

- Listen to facts over opinion. Everyone has their own biases, we all think of the world in our own unique way. But it's important to mold your opinions from facts, rather than the other way around.
- Keep a critical mindset. Double-check. We scour libraries or the Internet for data, but we also pay mind to the sources of that data. Be critical of others, even yourself, but stay within reason. Don't doubt anything just for the sake of doubting.
- Trust in the (provable) competence of others. If you want someone to fly a plane, you need a pilot. If you want someone to build a house, you need an engineer. If you want to learn about science, well, trust the scientists.
- Stay humble. There's no quick and easy solution that substitutes for years spent in academic study and research, and there's always something new to learn if you keep your eyes open.
- Lastly, understand that unrestrained skepticism can be as toxic as no skepticism. After a certain point, you simply have to defer judgment to those whose entire job is to know what they're talking about.

THE EARTH IS FLAT-OUT SPHERICAL.

HERE'S WHY, AND WHY WE'RE SURE

FLAT EARTH

They say that fashion goes round in circles. It seems that sometimes, pseudoscience also does that -- an idea that was widespread 2,000 years ago is gaining steam on social media.

Yes, I'm talking about Flat Earth.

The Earth is most definitely spherical (technically, it's an oblate spheroid, but for the sake of this discussion, suffice to say that it is some kind of sphere). The Earth isn't unique in that -- all planets are round, and for a very good reason: gravity.

Planets start off as clouds of dust and gas. Under the effect of gravity, all of this matter is compressed near its center. Gravity pulls equally from all directions towards the core, giving planets their spherical shape.

Of course, planets aren't perfect spheres -- they have features like mountains or valleys, and tend to form bulges around their equator -- but they're definitely, without a doubt, not flat.

WHY AREN'T PLANETS FLAT?

Let's assume for a second that you could make a flat Earth. We'll still need a hypothetical, dense 'core' which would also be flat, or slab-like.

This model is already unstable. Gravity as a force acts between the center of mass of two or more objects -- and by mathematical definition, centers of mass are points, not volumes or lines. Under the sway of gravity, particles will try to move as close as they possibly can to that center of mass. A slab or a disk simply has too many particles too far away from the center to be stable.

Even if such a slab formed , it would later collapse into a sphere-like object.

For debate's sake, let's consider the slab to be indestructible. Even so, any new material drawn by the slab's gravitational pull will tend to gather as close to the center of gravity as possible, and in time, will also end up forming a sphere.

If that doesn't convince you (because, let's face it, it's a bit too abstract), here's more tangible evidence against Flat Earth:

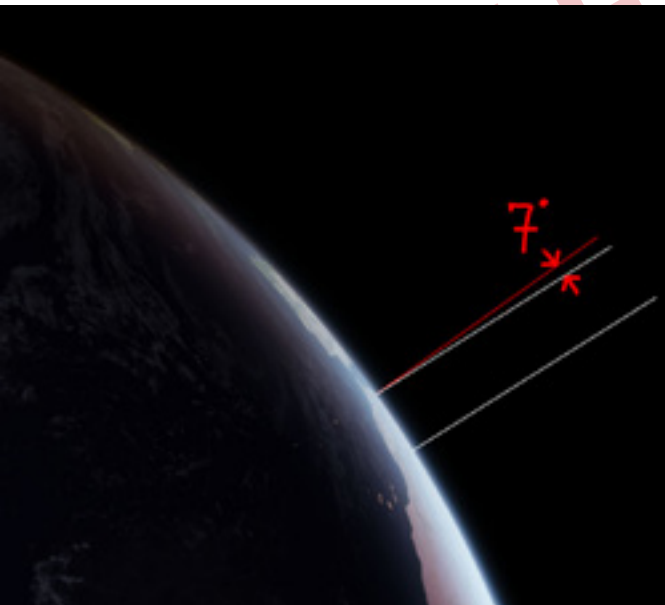
2,000 YEAR-OLD PROOF

It's a common misconception that the Earth was only recently shown to be round.

The ancient Greeks already suspected that the Earth was spherical.

The idea popped up in the 5th century BC, in the works of Herodotus and later Pythagoras, to whom the spherical model is widely attributed.

Before 200 BC, the Greek mathematician named Eratosthenes used shadows to not only show that the Earth is round, but to calculate its circumference as well -- and he was able to do this without leaving Egypt, where he was living. He did it by noting the angles of shadows in two cities on the Summer Solstice, when the Sun reaches its highest position in the sky (there are two solstices every year, one for each hemisphere). By knowing the distance between the two cities and the shade angle, you can calculate the size of the Earth's sphere.



His result was 40,074 km, a mere 66 km off (0.16%) from the currently accepted polar circumference of the Earth.

We don't know if Eratosthenes was the first to devise this, but his experiment remained in history.

The idea was replicated several times, and can be still tested today -- all you need is a friend from a nearby city, a protractor, and two sticks.

MAGELLAN

His is perhaps the most famous example.

Loaded with money from the Spanish Crown, renowned explorer Ferdinand Magellan embarked on August 10, 1519, from Seville (Spain), leading five ships.

Maggelan sailed across the Atlantic, passed what would be known as Strait of Magellan, finally taking a little break in the province of Cebu in the Philippines -- where a bunch of natives killed him in battle.

Realizing that things were very problematic, second-in-command Juan Sebastián Elcano took charge and led the expedition back home -- to the other side of the planet. They arrived back in Seville on September 6, 1522, after fully circumnavigating the globe. Charles I of Spain rewarded Elcano with a coat of arms and the motto 'Primus circumdedisti me' ("You went around me first").

More recently, the Transglobe Expedition (1979–1982) was the first expedition to make a circumpolar circumnavigation, traversing both poles of rotation (north and south) using only surface transport. Together with Magellan's east-west circumnavigation, this clearly proves that the Earth is a sphere.

Another simple experiment, particularly popular with kids, is the "ships on the horizon" example: if you're next to a port or a large body of water, you might see that approaching ships seem to emerge from the horizon. They don't move up and down; it happems because the Earth is round. Think of an ant walking around on an orange -- that's the type of effect you see with the ships, even though the scales are much larger.

Something else you can try to do by yourself is keeping an eye on the sky. For thousands of years, people have noted that constellations shift depending on your position on the planet. This can only be realistically explained if the Earth is round. You can try this yourself, whenever you have a long-distance trip coming up.

If you look at the sky, you might also see that the Moon and other planets are round -- although interestingly, the Flat Earth Society tweeted that "Unlike the Earth, Mars has been observed to be round."

Lastly, in the past decades, people have done something pretty neat: they've gone to space and taken photos of the Earth.

Lo and behold, it's pretty round.

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We sometimes ridicule people for buying into these fairy tales.
Which isn't particularly nice of us.
For many people who give in to pseudoscience, these ideas offer an escape from a world that's often cruel, unfair, or just doesn't make sense -- but end up making them feel even more powerless.
That's what makes this whole affair tragic.

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THE STARS

DON'T CARE ABOUT YOU.

ASTROLOGY

To most people, the idea of a flat Earth seems absolutely ridiculous. So let's continue with something just as ridiculous: a 2,000-year-old divination practice which claims that the life and personality of some primates is defined by the movement of the moon, planets, and a few randomly defined constellations.

Or, as most people call it, astrology.

Astrology is the belief that the alignment of stars and planets affects every individual's mood, personality, and environment -- it all depends on when the individual was born.

Except, it doesn't. There is no mechanism to justify this, no force that can back it up, and no rational reason to split up the entire human population into 12 groups represented by randomly assigned constellations. It's been thoroughly disproven as a pseudoscience.

Renowned astrologer Elizabeth Teissier famously tried to explain astrology by saying that "the sun ends up in the same place in the sky on the same date each year," but that couldn't be further from the truth-- on any specific date, there's a difference in Earth's location of about twenty-two thousand miles between two successive years.

The constellations used in the western zodiac were first described in Babylon, some 3,000 years ago. They hardly even look like what they're supposed to represent, and there's no reason to assign 1/12th of the world's population to one constellation. Does my life depend on Babylonian pattern-matching and ancient magic?

Certainly not.

TESTING ASTROLOGY

It's not easy to test astrology because astrologers themselves can't agree on what it's supposed to do.

Throughout its history, astrology has been regarded as a science, an art, and a form of divination magic. Some claim that astrology is a real branch of science, and that there is a verifiable mechanism behind it which underpins its workings -- but we just haven't found it yet.

Despite several trials and experiments, astrology has never demonstrated its effectiveness scientifically and was refuted through various methods (more on that a bit later).

Others astrologers propose conventional causal agents such as electromagnetism and gravity. But the gravitational effect of constellations is completely negligible compared to even that of the moon, let alone the Earth -- and the perceived magnetic field of other planets and constellations is far weaker than even those produced by modern household appliances.

Finally, some practitioners don't try to explain a causal agent, simply saying that the field cannot be researched -- essentially, they classify astrology as a form of divination, a supernatural force at work. Well, there's not much we can do to disprove magic.

OR CAN WE? (OF COURSE WE CAN)

ASTROLOGY STUDIES

It's not easy to find new studies about astrology. It's been disproven through and through, and there's very little incentive to carry out additional studies. But the few existing ones are quite convincing.

THE CARLSON STUDY

In 1985, a young physicist called Shawn Carlson carried out what is widely regarded to be the most comprehensive test of astrologers' abilities. He involved renowned astrologers from Europe and the US, and designed the study to meet both scientific rigor and astrology demands. During the study, neither the participants nor the researchers knew which participants belonged to which group, thus eliminating bias from all sides -- a so-called double-blind trial. The results were clear: the astrologers' guesses were no better than chance -- and even when the astrologers were very confident that they had made a match correctly, results were still no better than chance. Or, as Carson himself put it, astrologers "are wrong."

ASTROLOGY WORKS, BUT ONLY IN RIGGED STUDIES

Not all studies are made equal. Look hard enough through the literature, you'll come across studies that seem to suggest astrology might work.

In 1979, Ivan Kelly from the University of Saskatchewan showed that the vast majority of studies conducted do not confirm astrological claims and the few studies that do need additional clarification.

Kelly also carried out a separate study over several decades, where he tracked more than 2,000 people under the same zodiac sign -- most of them born within minutes of each other. According to astrology, the subject should have had very similar traits, but this was not the case.

The study participants had no notable similarities, outside what you'd expect from a random distribution. Peter Hartman from the University of Aarhus designed a similar study with an even larger sample size which produced similar results.

No matter how you look at it, astrology simply doesn't work. But sometimes, it seems like it does.

Our brains are hardwired to look for patterns. Sometimes, when two unrelated or random events happen, our mind tries to see a connection -- even when there's no connection to be seen. In the case of astrology, a very similar effect pops up.

This effect is called "subjective validation," and it occurs when two unrelated or random events are perceived to be related because of a previous belief or expectancy, which "demands" a relationship. So you read a horoscope, it says that something will happen to you, and whenever something somewhat relevant happens, you attribute it to the horoscope you read previously.

THE FORER EXPERIMENT

Forer gave a "unique" personality analysis to his students and asked them to rate how well it suits them, on a scale from 0 to 5.

By now, you've probably guessed what happened -- all the students received the same personality analysis, and all of them thought it suited them. Even better, Forer created the personality analysis from various horoscopes.

HERE'S WHAT SUCH A HOROSCOPE SOUNDED LIKE:

- "You have a great need for other people to like and admire you."
- "You have a tendency to be critical of yourself."
- "You have a great deal of unused capacity which you have not turned to your advantage."
- "While you have some personality weaknesses, you are generally able to compensate for them."
- "Disciplined and self-controlled outside, you tend to be worrisome and insecure inside."
- "At times you have serious doubts as to whether you have made the right decision or done the right thing."
- "You prefer a certain amount of change and variety and become dissatisfied when hemmed in by restrictions and limitations."
- "You pride yourself as an independent thinker and do not accept others' statements without satisfactory proof."
- "You have found it unwise to be too frank in revealing yourself to others."
- "At times you are extroverted, affable, sociable, while at other times you are introverted, wary, reserved."
- "Some of your aspirations tend to be pretty unrealistic."

Does this sound like you? Well, the average rating that students gave this assessment was 4.26/5 -- in other words, they found the assessment to be 85% accurate, even though they were all blanket statements.

These type of blanket statements became known as Barnum statements, after P.T. Barnum, who used them in his performances, allegedly stating:

"There's a sucker born every minute."

MORE EVIDENCE OF PARANORMAL INACTIVITY

A similar experiment was carried out, ironically, by astrologer Michael Gauquelin. Gauquelin offered free horoscopes to any reader of a Parisian newspaper, provided that they would give feedback on the accuracy of his supposedly "individual" analysis. As with Forer's experiment, he sent out thousands of copies of the same horoscope to people of all astrological signs -- 94% of readers replied that the reading was accurate and insightful. To top it off, the horoscope he gave out was that of a local mass murderer, Dr. Petiot, who had admitted during his trial that he had killed 63 people.

Gauquelin set out to scientifically analyze astrology, and his results came out strongly against his profession.

In a sense, astrology is a benign pseudoscience -- it doesn't really do anything bad directly. It's glorifying, gives a sense of communion with the cosmos, and it promises to bring a bit of magic into your day-to-day life.

But, at the end of the day, it's just not real. There's a sucker born every minute -- and most of them are looking for magic.

HOMEOPATHY IS STILL BS.

HOMEOPATHY

While astrology may be largely bening, here's a pseudoscience that isn't: homeopathy.
Despite a mountain of science disproving homeopathy, many people are using it as a treatment -- sometimes, at the expense of getting proper medical treatment.
Let's have a look at it.

When Samuel Hahnemann proposed homeopathy 1796, he based it on the idea that "Like cures like," and that dilution increases potency of a treatment. Diseases are caused by miasms, he further alleged, -- predispositions to a particular disease. You're likely not familiar with the term, as miasms long have been disproven.

Not all homeopaths today believe in the so-called miasm theory, but all homeopathy is based on like-cures-like (also long disproven). At the core of the homeopathic beliefs is a fairly simple process:

DILUTION

You take the active substance (whatever that may be) and usually dilute it by putting one drop of it in 1 liter of alcohol or distilled water.

Then, you mix it well (according to some, keeping it aligned with the center of the Earth), take 1 drop of this newly obtained substance and put it in another fresh liter of alcohol or distilled water.

And then you do it again.

And again.

And again.

Many, many times.

This obviously takes the 'medicine' to point where none of the original molecules remain in a bottle of the finished product. That's a-ok, however, if you ask a homeopath, because the more diluted the substance is, the more effective it becomes.

The idea is that the alcohol or distilled water will somehow "remember" the molecule and have an impact on your body. Right off the bat, this goes directly against all we know about 'science' science -- not something one pharma company or another might be saying, but against well-established, basic science. So the theory is fundamentally flawed.

WHAT ABOUT THE PRACTICE? ABSOLUTELY IMPLAUSIBLE

Study after study has tried to find evidence or even just a workable mechanism for homeopathy, but they've found the exact opposite. There's nothing behind homeopathy, and there's no healing effect past a placebo.

If water did have a "memory," we would have to rewrite all of science as we know it. Even ignoring the centuries of scientific research disproving homeopathy, a simple thought experiment can help us understand why it's absurd.

Just imagine: in its history, water will have contacted literally millions of other substances, and by this thought process, it has a memory of all of them -- so just drinking a glass of regular water should make you immune to a swarm of diseases, right? So then, why even have homeopathy? Water is naturally diluting all sorts of things, so we should kind of be immune to everything, right?

Lastly, even if there were any active substance, and even if water did have a memory, something that causes symptoms similar to the X disease doesn't cure said disease. That's just wishful thinking, and there is nothing to suggest that this works. The scientific consensus is pretty strong in this case. Here are just a few studies.

HOMEOPATHY STUDIES

If water did have a "memory," we would have to rewrite all of science as we know it. Even ignoring the centuries of scientific research disproving homeopathy, a simple thought experiment can go a long way when it comes to the process.

Unlike astrology, homeopathy studies abound. In just the past 5 years, several thorough studies have disproved homeopathy. A 2014 paper by Australia's National Health and Medical Research Council found that there are "no health conditions for which there was reliable evidence that homeopathy was effective." Furthermore, they write, "no good-quality studies" report that homeopathy works better than a placebo.

A year later, the same group combed through the results of 1,800 studies, again with the same findings.

Just one year later, Paul Glasziou, a leading academic in evidence based medicine at Bond University, verified 176 trials of homeopathy, finding "no discernible convincing effects beyond placebo." He concluded that "there was no reliable evidence from research" that homeopathy was effective for treating health conditions.

These aren't new findings -- for decades, researchers have been proving that homeopathy doesn't work, and it's dangerous to use it instead of reliable treatments.

In 2005, Kevin Smith from the University of Abertay Dundee published a paper concluding that since homeopathy is completely implausible, it's not only unscientific, it's also unethical. In 2010, a British Medical Journal study found that homeopathy can be particularly dangerous for children, and is never recommended.

But why then do so many people stick by it? You often hear things like "This worked for me" or "It's the only thing that helped me."

WHY HOMEOPAHY SEEMS TO WORK

a) unassisted natural healing - Your body is awesome at self-healing. Some people are more resilient than others, but generally speaking, your body heals itself all the time. It can handle even strong diseases on its own.

b) the placebo effect - Simulated treatments are surprisingly effective in many cases. Combine this with your self-healing, and you get quite a powerful tool.

c) the consultation effect - Modern research has shown that if you just go to the doctor and receive a consultation, the care, concern, and reassurance a patient experiences when opening up to a compassionate caregiver (read: homeopath) can have a positive effect.

d) cessation of unpleasant treatment. Many times, homeopaths recommend ceasing of conventional treatments -- this is extremely dangerous and should never be done without consulting an actual medical doctor. Oftentimes, the conventional treatment causes some unpleasant side effects, perhaps even more so than the disease's symptoms. When you stop taking the treatment, the side effects may go away, but the disease stays and can get worse.

e) regression towards the mean - Many diseases and conditions are cyclical -- the symptoms naturally get stronger then weaker over time. Since patients tend to seek care when discomfort is greatest, it's pretty likely that the symptoms will naturally impove after the consultation (but not because of it).

f) unrecognized treatments - An unrelated food, exercise, environmental agent, or treatment for a different ailment may have occurred. Maybe you drank a lot of green tea, or that trip to the ocean did wonders for your lungs.

WHAT HARM CAN HOMEOPATHY DO, THOUGH?
I MEAN... IT'S PLAIN WATER, RIGHT? (YES)

CAUTIONARY TALES

In 2002, one-year-old Isabella Denley from Calgary was prescribed medications for her epilepsy. Instead of taking the meds, her parents consulted an iridologist, an applied kinesiologist, a psychic, and an osteopath. They settled on a homeopathic treatment. She was still only taking this homeopathic treatment when she died.

In 2009, another infant girl, Gloria Thomas, died of complications due to eczema which was treated only with homeopathy. Eczema -- let that sink in for a while. An easily manageable disease. By the time she died, she was the weight of an average three-month-old, her body was covered with angry blotches, and her once-black hair had turned completely white. Her parents were declared guilty of manslaughter, but they still stood by their support for homeopathy.

These are not isolated cases. This is a serious issue. It may seem fun and hip to choose homeopathy instead of the "nasty" drugs from a pharmacy, but if you're using homeopathy at the expense of medical treatments, you're putting yourself and others at risk. Please, don't do this to yourself or the ones you love. Consult a real doctor.

A NOTE ON NATURAL REMEDIES

There is a lot of confusion with people mistaking homeopathy with naturopathic treatments. That's a separate discussion in itself, but for now, let's just say that the two things are very different. Natural remedies (herbs, teas, plants, etc.) are not homeopathy. You should always consult with your doctor or pharmacist before taking anything, and only follow treatments prescribed by an authorized physician.

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VACCINES DON'T CAUSE AUTISM

Never have, never will.

ANTI-VAXXING

While homeopathy has been discussed in one form or another for a long time, a more recent movement is sending ripples -- and causing a lot of damage -- through the world: anti-vaxxers.

Talking about vaccines is almost always hyperbolic. They've single-handedly ushered in a new age of medicine and are widely regarded as one of the greatest medical breakthroughs of the modern era. While they may not be perfect, they have historically been the most effective means to fight and eradicate infectious diseases, saving hundreds of millions of lives since they were first introduced.

Smallpox, a disease caused by the variola virus, had existed for at least 3,000 years and was one of the world's most feared diseases until it was eradicated by a collaborative global vaccination program led by the World Health Organization. The last known natural case was recorded in Somalia in 1977.

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"[All] evidence favors rejection of a causal relationship between MMR vaccine and autism" -- The United States Institute of Medicine.

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CONSEQUENCES OF THE VACCINE SCARE

All states in the U.S. require vaccinations for children to be enroll in school. However, 18 states allow parents to opt out of vaccinations for their children based on personal beliefs.

According to a 2016 report[2] issued by the American Academy of Pediatrics (AAP), vaccination prevented about 322 million illnesses among children born between 1994 and 2013. In the US, vaccine immunization campaigns against diseases like smallpox, diphteria, measles, and mumps have reduced disease incidence by at least 90% -- even up to 99%. If you look elsewhere in the developed world, figures are similar. Diseases that were once widespread and life-threatening are now all but extinct.

In addition to saving the lives of our children, vaccination has resulted in net economic benefits to society -- amounting to almost $69 billion in the United States alone. A study published by health economist Sachiko Ozawa[3] reported that the $34 billion spent on immunization programs in the developing world resulted in savings of $586 billion by reducing costs of illness and $1.53 trillion when broader economic benefits were included.

Opposition to vaccines has been around for as long as vaccines themselves, but this is something different. The anti-vaxxer movement is a recent one, sparked by one particular fraudulent, long-disproven paper which claimed that some vaccines can cause autism.

Wait, do you mean the whole vaccines / autism thing is based on one paper?

Yes, and it gets even better.

ANTI-VAXXERS AND THE INFAMOUS WAKEFIELD PAPER

This association first sprouted in 1998 when Andrew Wakefield, then a British surgeon, published a study in the prestigious medical journal, The Lancet, suggesting that the measles, mumps, rubella (MMR) vaccine was increasing autism in British children. Although the paper itself did not demonstrate a causal relationship between MMR vaccination and autism, Wakefield released a video coinciding with the paper's publication claiming that a causal relationship did, in fact, exist.

The media loved Wakefield's article because it rang an emotional chord with the public, sparking fear and outrage. But for scientists, it raised all sorts of red flags. For starters, no one could replicate his results -- essential for any scientific claim. Everything blew up after an investigation by journalist Brian Deer in 2004.

Deer's investigation showed that Wakefield purposely manipulated medical histories to support his claims. Deer also showed that Wakefield wanted to use the MMR scare for his own financial profit.

According to Fiona Godlee, the editor in chief of the BMJ[4], the article by Wakefield "was based not on bad science but on a deliberate fraud," and Wakefield grossly and intentionally manipulated the data as he willed. Pseudoscience is often about power and profit.

The paper was officially retracted by the Lancet, and Wakefield was stripped of his clinical and academic credentials. Several times, he was given the opportunity to try and replicate his research, which he refused. To this day, however, Wakefield makes a living perpetuating the false views that vaccines cause autism.

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"The British Medical Journal concluded that Wakefield's study linking vaccines to autism was a "deliberate fraud".

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MORE ANTI-VAXXERS, MORE DISEASES

The media loved Wakefield's article because it rang an emotional chord with the public, sparking fear and outrage.

Many major (and honest) studies[5] have been carried out since, demonstrating without any doubt that MMR vaccines do not engender a higher risk of autism or colitis. Not a single study found a connection between the two, but the damage has already been done.

The number of parents who refuse to vaccinate their children has grown, surpassing 3%. Many parents feel like vaccines are no longer necessary because they haven't heard of the diseases they're vaccinating against. That's right: vaccines have been so effective that people forget why we need them -- and the diseases are bouncing back. Talk about irony!

A 2013 paper[6] linked falling immunization rates to the recent resurgence of vaccine-preventable diseases. California, for instance -- a hub for the anti-vaxxing movement -- saw 9,120 cases of whooping cough (pertussis) in 2010, which more than any year since the whooping cough vaccine was introduced in the 1940s. During this particular outbreak, ten infants died of the disease.

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American Association of Pediatricians reports[2] that up to 87% of pediatricians have encountered a parent who refused to vaccinate their child, a figure which has been steadily increasing.

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In Europe, anti-vaxxing has led to a dramatic increase of measles cases, with over 40,000 cases in 2018 (so far), and 37 fatalities.

Although vaccines have proven themselves as one of the greatest public-health achievements of the 20th century, people throughout history have found various reasons to distrust them. Some found it too counter-intuitive that exposure to a disease could provide protection, others believed vaccination violated God's will, and others simply felt that mandatory vaccination violated personal liberty.

In a sense, today's vaccine-related "urban myths" are the manifestation of a longstanding distrust of inoculation:

A child's immunity needs to develop naturally

Vaccines actually strengthen the immune system. Because they introduce a weakened form of a virus into the body, vaccines help the immune system by teaching it to identify and defend against infections in the future. Children need to be vaccinated at a young age because that's when their immune system is the most susceptible. However, young and old people alike need an immune system boost with a vaccine.

Vaccines contain toxic chemicals such as mercury, aluminum or formaldehyde

While some vaccines contain potentially toxic substances, these chemicals become toxic to the human body only when present at certain levels. All vaccine ingredients are present in very low quantities, and they don't cause any harm in these small amounts. Mercury used to be present in negligible amounts, but due to public outrage, it was removed entirely from vaccines in 2001. A vaccine contains only 0.1 mg of formaldehyde, which is far less than the 500 mg the human body makes every day for DNA synthesis.

A baby's immune system can't handle that many vaccines

On any given day, a child will fight between 2,000 and 6,000 immune challenges, which is far more than the number of antigens or reactive particles in all of the 14 scheduled vaccines combined. Even if a baby were to take them all at once, the vaccines would only slightly tax their immune system -- less than 0.1% of its total capacity. Immunizations are negligible in comparison to the countless bacteria and viruses that a baby fights off every day.

The side effects aren't worth it

Children have been vaccinated for decades and, despite what you may have read, there is no one reputable source or credible study linking immunization to long-term health problems. Significant side effects are extremely rare (around one in a million cases), and are far outweighed by the advantages.

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Some vaccines can lead to mild symptoms resembling the infections they are designed to prevent.
In the very rare cases where these symptoms occur, the person's immune response is to the vaccine's content, not the disease itself.

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5 Hygiene and better sanitation are responsible for the drop in infections, not vaccines

While these socioeconomic elements are important and significantly lowered the population's death rate, their effect on infectious diseases isn't nearly as great as that of vaccines. It was a vaccine, not running water and soap, that eradicated polio. The immune response is to the vaccine's content, not the disease itself.

6 Vaccines infect children with the diseases they're supposedly trying to prevent

There is only one instance in which a vaccine was shown to cause disease -- the Oral Polio Vaccine (OPV), which in some cases caused patients to develop poliomyelitis due to the live virus being used. OPV is no longer used and was replaced by an injection that doesn't contain live viruses.

7 Vaccines are a conspiracy designed by big pharma for profit

Pharmaceutical companies make money from vaccines, like all companies do from their products. Compared with drugs that require daily doses, vaccines are only administered once a year or once in a lifetime, which offers far less economic incentive than other drugs. Besides, if more people don't use vaccines and get sick, that would make pharma companies even richer.

8 People have the right not to vaccine themselves (or their children) because it's their body

Vaccines are designed to protect you but are just as important for protecting those around you -- especially vulnerable groups like the elderly or those who can't be vaccinated due to medical considerations. By choosing not to vaccinate, you put others at risk, which interferes with their right to a healthy life. Even if it's just for yourself, vaccines aren't nearly unique in this -- laws also mandate wearing seatbelts, for instance, or local smoking bans.

9 Vaccines are no longer required -- there aren't any more diseases left to fight!

The Polio virus (like many others) is still around and could easily start re-infecting unprotected individuals when re-introduced to the country. A better example is measles, which was very rare in the United States until outbreaks occurred as a result of Americans traveling to countries where the disease remained widespread.

When there are adequate vaccination rates, most types of outbreaks can be prevented.

10 Vaccines cause autism

We've already gone through this, but it deserves another mention. Hopefully, this long-disproven idea will eventually go away. As the APP mentioned in the previous chapter highlights, a growing number of people refuse to vaccinate their children because they think it's unnecessary.

Why bother?

DETOX

VERY GOOD

AT SELLING YOU STUFF THAT DOES NOT WORK.

SO, WHAT'S DETOX*?

*These fads will do nothing to remove toxins and some are very risky and may seriously harm you.

Many people use so-called detox diets to cleanse their bodies of toxins -- or so they think.

There's only one real type of detox: the kind performed in hospitals in order to treat a person suffering from dangerous levels of drugs, alcohol, or poison. In any other context, 'detox' refers to unproven alternative medicine hacks like diets, supplements, or colon irrigations meant to flush toxins out of your system.

Essentially, detoxing is supposed to remove 'toxic' things that have accumulated in the body. Needless to say, there's no scientific evidence behind these practices. The supposed toxins are never specifically named, and instead are generally referred to as "poisons", "pollutants", and "toxins". Like true snake oil salesmen, detox practitioners like to use vague statements to trick people.

Detox programs may involve a variety of approaches, such as:

- Fasting;
- Exclusively consuming juice or some other liquid for days at a time;
- Eating a very restricted selection of foods;
- Using various dietary supplements or other commercial products;
- Cleansing the colon (lower intestinal tract) with enemas, laxatives, or colon hydrotherapy (also called "colonic irrigation" or "colonics");
- Combining several of these together, or utilizng other approaches.

If you go online, you'll find thousands of articles on all sorts of detoxes. Some are relatively benign, such as the "carrot juice cleanse", but others are downright dangerous. Many programs permit no food, just tea and lemonade, and sometimes including more exotic ingredients like maple syrup and cayenne pepper.

DETOXING AND SCIENCE

There is no scientific evidence that these diets remove any toxins.

The only thing that they achieve is weight loss but that's, of course, to be expected when a person stops eating food. Even the weight loss bit is a smokescreen, as detox helps you lose fluids, not fat.

In fact, using this diet can harm you in the long run because it robs the body of important nutrients like protein, vitamins, and minerals. According to the Harvard Medical School, the laxative component of the diet can lead to dehydration and electrolyte loss as well as an impaired bowel function. Other side effects may include fatigue, nausea, and dizziness over the short-term, and loss of muscle mass and a heightened risk of heart attack in the long-run.

Most other popular body cleanses make similar promises and follow more or less the same low-calorie, nutrient-poor diets. It's important to understand why this is happening, and that just because you're losing weight doesn't mean it's good for your body.

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A lot of people who fall for detoxing are drawn in by the mirage of healthy live. They see detoxing as a quick fix, a miracle cure, or a much-needed reset that will let them feel refreshed and anew.

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WANT A DETOX? JUST ASK YOUR LIVER

Good news! You already have the perfect ally against toxins: your body! Your body is an expert at getting rid of waste, and it's doing fine whether you're doing a detox or not. The key is your liver.

Out of the hundreds of functions your liver performs, ensuring toxins are safely removed from your blood is one of its most critical jobs. Your body is exposed to potentially toxic chemicals (only toxic if their concentration in the blood passes a certain threshold) when coming into contact with certain environmental pollutants such as pesticides, but also as a result of normal digestion. For instance, when we digest protein, ammonia is released as a byproduct, which is eliminated through urine. Any wastes your liver cannot use are converted and either carried out by bile into your small intestine or by the blood to your kidneys.

But the truth is that these toxins don't build up in your liver, kidneys, or any other part of your body, and if they did, you'd be in major trouble -- and no detox program would be able to help. It's basic biology.

In 2009, a group of young British scientists -- part of the pro-science charity Sense About Science -- compiled the "Detox Dossier". This was an investigation into "some of the many products, special diets, tonics and supplements which are widely promoted as being able to 'detox' you after the festive season."

The authors of the report felt the public was being duped by dodgy science claims such as detox so they contacted the manufacturers of 15 detox products. What did these producers mean by detox?

None had any clue!

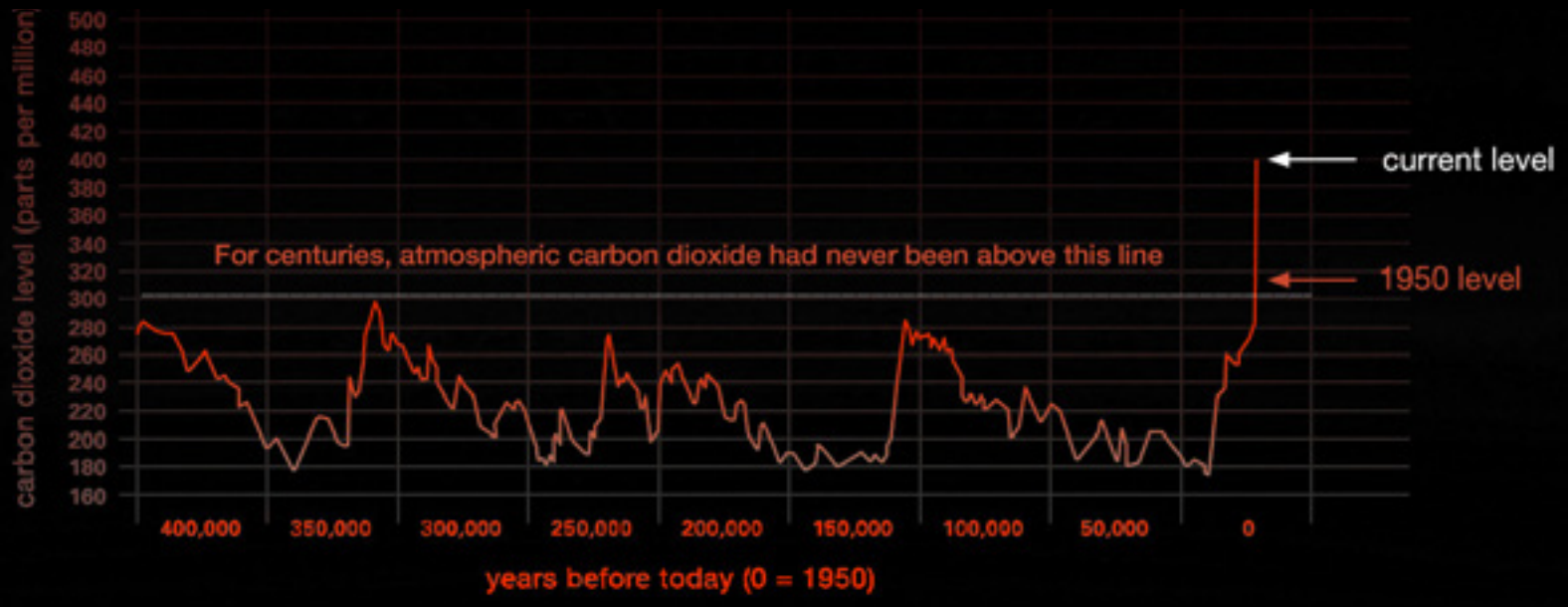
A FAD

There is not one credible scientific paper that endorses a detox product, diet, or remedy. A review recently published in the Journal of Human Nutrition and Dietetics sums it up nicely:

"To the best of our knowledge, no rigorous clinical investigations of detox diets have been conducted. The handful of studies that have been published suffer from significant methodological limitations including small sample sizes, sampling bias, lack of control groups, reliance on self-report and qualitative rather than quantitative measurements."

That being said, of course a healty diet will help your body function better -- but this is no detox. Ultimately, the best 'detox' is not smoking, exercising regularly, and enjoying a healthy balanced diet that is rich in fruits and vegetables.

THE CLIMATE ISN'T CHANGING



WE ARE CHANGING IT.

CLIMATE CHANGE DENIAL

The Earth's climate is changing, this change is unnatural, and we humans are causing it. That is the extent of what we know so far.

Lastly, it's time to address a problem much more complex than what we've dealt with so far: climate change. Surely enough, a counter movement has also emerged: climate change denial. Groups of people (often with vested interests) are spreading unwarranted doubts, opposing the overwhelming scientific evidence, denying that this change is happening and/or that humans are responsible. The evidence linking climate change to human activity is so clear it resembles the relationship between smoking and cancer risk -- in fact, there is more statistical relevance linking human activity to climate change than smoking to cancer. Therefore, climate change denial can only be regarded as a pseudoscience [1].

SURELY EARTH'S CLIMATE HAS CHANGED BEFORE?!

The Earth is no stranger to climate change. From the narrowly-avoided "snowball Earth" 650 million years ago [2] to the ice-less Cretaceous period, our blue dot has had its fair share of changes. But our era is unlike any others -- there was no dramatic event or natural phenomenon like a volcano eruption that can explain this change -- it's simply happening too fast.

Natural changes on this scale tend to happen in geological time, on a scale of tens of thousands of years to millions of years -- whereas most of the changes we've seen have happened in the past 30 years.

We've also observed far more than a correlation -- the causation mechanism is also pretty clear: the large amount of greenhouse gases we're outputting, particularly CO2, is what's causing climate change. There have been tens of thousands of studies on this, with only a handful (often dubious works) casting any doubt on the conclusion that climate change is, indeed, happening [3].

HOW DO WE KNOW THAT CLIMATE CHANGE IS HAPPENING?

There is, almost literally, a mountain of science supporting this.

If you were to pile up all these studies, which tend to have around 20 pages, you'd end up with a pretty impressive mountain of paperwork supporting climate change.

Jokes aside, there are very clear indicators that climate change is happening, and that it is linked to human activities:

a) **temperatures are rising**: this is the most direct piece of evidence. The planet's average temperature has risen by about 1.62 degrees Fahrenheit (0.9 degrees Celsius) since the late 19th century, when the Industrial Revolution kicked in. This doesn't mean that every single place is warmer than it used to be, or that every single day is warmer than usual -- it's important to make the distinction between weather (atmospheric conditions over a short period of time) and climate (an "average" of the weather over a longer period of time).

Just because we occasionally have cold days doesn't mean climate change isn't happening. On a large scale, the Earth is definitely heating up [5].

b) **oceans are heating up**: it's not just the atmosphere or the land that's heating up -- global waters are absorbing much of this heat as well. Overall, 90% of the planet's excess heat is trapped by oceans. The top 700 meters (2,300 feet) have increased in temperature by 0.4 degrees Fahrenheit since 1969 -- which is particularly concerning because it takes much more heat to warm 1 liter of water than it does to warm the same volume of air. This is already affecting water circulation, global currents, and salinity.

c) **ice sheets are shrinking**: as you'd expect, rising temperatures are causing ice sheets to melt. Again, think of this as a long-term problem: if you were to look at things at a particular moment in time (say, summer vs. winter), you might be misled, but if you look at the big picture, the ice loss becomes clear. Data from NASA's Gravity Recovery and Climate Experiment show Greenland lost an average of 286 billion tons of ice per year between 2012 and 2017. Antarctica lost about 127 billion tons per year during the same time period. The rate of Antarctic ice mass loss has tripled in the last decade.

d) **glaciers are shrinking**: it's not just ice sheets -- glaciers all around the world are receding, from the Himalaya to the Rockies and from Africa to the Alps. This phenomenon also been linked to climate change.

e) **CO2 & basic science**: several greenhouse gases are significant, but CO2 is by far the most prevalent. Basic science tells us that we're burning a lot of CO2, which is warming the planet.

We have a fairly good idea of how much CO2 we're emitting (we can also measure this from satellites): we're adding a whopping 2.57 million pounds of carbon dioxide into the air every second, and that figure is growing. Atmospheric and oceanic measurements reveal that CO2 content has increased by about 40% since the start of the Industrial Revolution in the 19th century. Furthermore, chemical analyses have confirmed that the extra CO2 is, indeed, coming from industrial activities.

Moving on, basic physics tells us that this extra CO2 traps heat through a process called the greenhouse effect. This has been projected, observed, and confirmed through various scientific models.

e) **advanced science**: a single climate change study takes months or even years, and is carried out by experts who have dedicated much of their lives to studying these processes -- and since there are tens of thousands of such studies, you can imagine how much qualified effort was put into understanding this complex issue.

In fact, there's so much science on climate change that it used to be quite challenging to keep track of it all. That's why the Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to review all the published literature and assess the planetary context. Their latest assessment found that "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia."

Furthermore, they found that human influence on the climate system is clear, with an overwhelming probability (95%) that it is the dominating force around climate change. Outside of the IPCC, separate studies have found a consensus between studies on climate change hovering at around 97%.

CLIMATE CHANGE DENIERS (BOO!)

With so much science to back it up, you'd expect global warming to be a settled debate, and people to focus on taking action against it -- but that's far from how things stand. For decades, a campaign to undermine public trust in climate scientists has been carried out by groups with industrial and political interests -- a campaign that also has been documented by scientists [8], [9], [10]. Manufactured controversies, misleading media appearances, and outright lies have eroded public trust in real climate science, and as a result, much of the public is still being misled about climate change.

NOWHERE IS THIS CAMPAIGN AS PREVALENT AS IN THE US.

From the oil lobbyist and Senator James Inhofe (who called climate change "the greatest hoax ever perpetrated against the American people" and brought a snowball to Senate to "disprove" climate change), to the infamous Koch Brothers and other industry representatives who pour millions of dollars into funding conservative think tanks that promote climate change denial, much of the US administration and fossil fuel industry is riddled with climate change deniers.

ExxonMobil, the world's largest oil company, was shown to be aware about climate change since the 70s [11], yet they continue to fund climate change denial[12].

It's fitting that the US is the only country to back out of the Paris Agreement to combat climate change.

Although things like homeopathy and antivaxxing can be just as dangerous and harmful to people, no other pseudoscience has been as aggressive, as pervasive, and as successful as climate change denial -- up until now, at least. Things have slowly started to change, but there's good reason to believe that they're not changing fast enough.

From the rising temperatures threatening countless ecosystems and human settlements to the ocean acidification and exacerbation of extreme weather events, climate change affects all of us -- every single creature on the planet.

We can stick our heads in the pseudoscientific sand as much as we want, but that's not going to help the situation.

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At the end of the day, it's up to each and every one of us to drive the change we want to see in the world -- and there's no better foundation for change than science.

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ENDING

So, it seems we've reached the end of the book. If you've made it this far, we can only thank you for your patience and your interest.

We don't claim to have all the answers, and we've only scratched the surface here. We hope it will spur your curiosity and critical spirit, however-- the world sure needs more of that.

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