Science under siege: the hijacking of scientific technology and terminology for profit

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ABSTRACT

Corporations often use scientific language and imagery to make the products and services they are promoting appear more state-of-the-art or innovative than their competition's offerings. Such techniques are particularly prevalent amongst purveyors of alternative medicine, but also extend to consumer goods especially cosmetics. Words like "quantum", "scientifically tested", or "DNA", and images of microscopes and white-coated lab workers not only blind consumers with science, but lend a false air of scientific legitimacy to products that may have little or no proof of efficacy.

This strategy can impart consumers with a sense of confidence, resulting in them handing over money for products and services which at worst are a scam or, at best, overpriced. In a time when there appears to be an under-current of mistrust in science, including but not exclusive to climate change and vaccination, this activity is particularly mischievous since it effectively co-opts science for nefarious purposes. The result is an undermining of the trust of scientists and science in general.

Key words: bad science, pseudoscience, scams, cosmetics, alternative medicine, hijacking

Introduction

Products and services purporting to be better, faster, more advanced and simpler to use are becoming easier to market and publicise, particularly with the growth of the largely unregulated internet. As a result, consumers are falling victim to all kinds of scams, not all of which are complicated or clever. The old saying, "a fool and his money are soon parted" is well illustrated by continuing reports of people falling victim to the computer virus phone call scam (1) or the Nigerian money transfer scams (2) and this is in spite of considerable publicity. Juxtaposed with these simple, yet very effective schemes are those more complex in nature, which make it easier to understand why people get fooled.

Sometimes this even includes the person spruiking the product, demonstrating that honest people can promote dud products. An example of this is The Energy Polariser which was a fuel saving device purported to produce "orgone" energy "unknown to physics" and famously spruiked by racing driver Peter Brock (3). Whilst such a device might seem obviously suspicious to many, it didn't stop honest people handing over good money for a product with little evidence for efficacy.

Yet, the perception that one must be stupid or unintelligent to be fooled by such scams couldn't be further from the truth. Anyone can be deceived, regardless of the number of degrees or IQ points you have.

You don't have to be a fool to be fooled.

An elegant example of such was orchestrated by James "The Amazing" Randi, a magician, when he introduced two conjurors posing as psychics into The McDonnell Laboratory for Psychical Research at Washington University, St. Louis in 1979. The newly created laboratory was designed to test psychic powers under scientific conditions but Randi was interested in two different hypotheses. He suspected that some parapsychologists (psychologists who study the paranormal) might struggle to conduct unbiased objective research precisely because of their inherent beliefs and sympathy towards the paranormal. Further, he agreed with some researchers within the field who insisted that objective tests required consultation with qualified, experienced conjurors and/or or magicians whose input would be essential for design, implementation, and evaluation of experiments in parapsychology, especially where deception – involuntary or deliberate – by subjects or experimenters might be possible. So Randi recruited two subjects – a magician and a part-time mentalist – who were accepted into the study and subsequently succeeded in convincing many academics they were psychic or possessed paranormal abilities when in fact they were using simple magic tricks. When the deception was revealed (and after the initial embarrassment and criticisms of Randi's methods), Project Alpha, as it came to be known, was hailed as, "an important sanitary service", "commendable", "long-needed", and "worthwhile." Said one scientist, "If I were you, I would have tried something like this long ago."

In hindsight, researchers also described their own work as "entirely too lax" and their controls as "not the tightest" (4). Randi's point was well and truly made – why should scientists or parapsychologists be expected to spot magic tricks when they're trained in science not in magic? As Randi observed, "Generous funding doesn't make scientists smart . . . Nor are they able to detect trickery without help". Importantly, neither does it make them unintelligent, it simply makes them not trained in the tricks of magicians or mentalists.

This phenomenon also explains why we are impressed by magic tricks, since they are designed to deceive for entertainment purposes. The major difference being when

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you pay to see a magician you know you are being tricked, however with a product or service that is peppered with scientific terminology for the purposes of appearing cutting-edge, the deceit may be deliberately obscured.

And so it is with science. To those of us in the field who understand the terminology, a couple of "beta-hydroxys" or "CoQ10s" claims on a tub of face cream might give us a giggle, but it is reasonable for the average consumer to presume this is legitimate. Indeed, adding "sciencey" sounding words might make the product sound state-of-the-art and progressive but that's usually all it does. Quantum dishwashing liquid does not harness quantum mechanics to wash your dishes nor does DNA face cream possess DNA repairing age-reversing abilities. Often the only guarantee you'll get is a substantial hike in the price.

This paper will address some examples of science being hijacked for nefarious purposes such as those described above. It will cover some of the tricks used by people attempting to swindle money from consumers and provide examples of bad science including hair analysis and ear candles.

Six signs of pseudoscience

Adding "sciencey" sounding words to lend legitimacy to products is a common marketing trick. I call this practice "name-out-of-a-hat-science" since the results make about as much sense as randomly pulling scientific terms out of a hat and sprinkling them on a page. Once you familiarize yourself with some of the common techniques, it makes it easy to spot suspicious products almost immediately on account of their "red flags" or pseudoscientific claims.

1) The product claims to cure many different types of illnesses.

If you come across a miracle product that claims to cure or diagnose a wide range of illnesses of differing etiology, put your cash away. The old adage if it sounds too good to be true it probably is, usually applies in these cases. Some products that fall under this category include magic hologram energy bracelets, alkaline or other miracle water, magic cancer curing bleach, homeopathy, live blood analysis, miracle pain patches that give you extra energy or help you lose weight, stickers to shield you from electromagnetic radiation, and many more. There are too many products to address individually but once you know the tricks you will find that many of them apply across the board. Since biology is extremely complex, and medicine follows, the idea of a "cure-all" or "diagnose-all" remains relegated to the realms of science fiction. Snake oils, potions and elixirs of the days of old often made similar claims (Figure 1).

In Australia, laws exist to protect consumers from scam products and services, particularly those that claim to cure incurable diseases such as cancer and HIV (5), but they are rarely enforced – just take a stroll down the aisles of your local wellbeing festival for plenty of examples of the law being flaunted. The more savvy snake oil salesman won't be caught telling you they can cure cancer to your face but take a look at their literature and it becomes clear what they infer. Taking advantage of vulnerable people who are desperate to find anything to assist with an incurable disease is about as low as scammers/opportunists can go.

Figure 1. St Jacobs Oil. Advertising found printed on the end papers of an edition of "Ivanhoe" published by "International Book Company" of New York, published 1892. Photo credit: Tim and Selena Middleton on Flickr Creative Commons.

2) Evidence that the product works is provided with testimonials, not published science.

If product information is splashed with "it worked for me!" or "I tried everything before this..." *in lieu* of scientific evidence, be suspicious. Along these lines, a campaign was recently launched by the UK charity Sense About Science called "Ask for Evidence". The campaign says; "If you are concerned about the risks or benefits that are being claimed on a website, product, advert, advice, publication or policy announcement, ask the people responsible to show you their evidence" (6). But, as is often the case for science, it's usually a bit more complicated than that. Some sellers will happily present you with "research" in the form of "sciencey" looking essays peppered with graphs and charts but how do you know if the research is good quality or even legitimate? For example, Lifewave (7), which are homeopathic, non-transdermal patches sold via network marketing offer products for Improved Energy, Pain Relief, Better Sleep, Anti Aging and Weight Loss, have a page dedicated to their research (8), both published and unpublished. But in order to ascertain if the research is legitimate and even if it supports the companies' claims you would need to read it all – not something the average consumer has the time or expertise to do. In fact, there is a name for the technique of overwhelming someone with information they will unlikely be able to decipher – it's called Gish Gallop, named after a creationist who used it when debating the topic of evolution (9).

Depending on the type of evidence you are presented with, whether peer reviewed and published or not, you may be satisfied at this stage that the product works. Ultimately it is up to you to decide when you have collected enough evidence – a good rule of thumb is to weigh up the amount of research against the financial outlay. If you're

only parting with a few bucks then you might not mind, but if it's a few thousand or your life savings then thorough and meticulous research would be advised.

Keep in mind however that just because there are testimonials associated with a product doesn't automatically mean it is a scam. If it is *the only* evidence provided, be suspicious and ask for further evidence. There are several academic databases that store scientific peer reviewed studies that can be accessed by consumers to varying degrees should you wish to do you own research – try PubMed (10), Google Scholar (11) or simply type the name of the product into Google with the term "skeptic" or "scam".

3) The product has been unearthed from an ancient tribe and only now been revealed to the western world.

Guru figures spruiking Amazonian berries with miracle anti-oxidant properties or miracle juice for weight loss are commonly marketed in this manner. The pitch often involves an individual who has been searching the world for decades to find the miracle cure and has now decided to share his/her knowledge with others. This technique has also been called "The Institute of Bob", which refers to a lone maverick entrepreneur who has single-handedly researched and developed the product. When you come across claims such as these, be suspicious. Particularly with weight loss products, as sadly there is no quick fix when it comes to trimming down – reduced caloric intake and/or increased output remain the most effective way to drop the kilos.

4) The practice has been in use for thousands of years therefore it must work.

Associating products with antiquity – it's been used for thousands of years therefore it must work – is another popular way of lending legitimacy to quackery. Some brands of ear candles, which are hollow tubes of wax that you insert into your ear and set alight (12), are marketed as originating from an ancient American Indian tribe. The Biosun company (13) claims (14) that their Hopi Ear Candles are based on "the formula that is traditional to the Hopi Indians of the USA...The Hopi who are renowned for their great medicinal knowledge collaborated with Biosun to pass their formula on to the rest of the world". But not according to Vanessa Charles, the public relations officer for The Hopi Tribal Council, who has stated there is no such treatment within traditional Hopi healing practices. According to a statement, ear candling "is not and has never been a practice conducted by the Hopi tribe or the Hopi people" (15). And despite The Hopi Tribal Council issuing Biosun with cease and desist requests, Biosun continue to claim that ear candles have a long and colourful history with The Hopi.

Even if it were true that The Hopi tribe have been using ear candles for hundreds of years, this doesn't necessarily mean they work. Many medical and scientific ideas from antiquity are no longer in use, superseded by more effective or safer techniques, as our understanding of science and medicine has progressed. Bloodletting was once considered to be beneficial to health with fevers, apoplexy and headache considered to be a result of too much blood. But as medicine and science has evolved, so practices have changed and today the only form of bloodletting used is that of extracting small quantities for diagnostic tests and microsurgery or donation. This is largely what sets science-based medicine apart from pseudoscience – practices (usually) change when new evidence comes to light, unlike the dogmas clung to by those who embrace quackery.

To make it even more confusing for consumers, Australian authorities will accept evidence from antiquity when sponsors apply for listing of complementary and supplementary preparations on the Australian Register of Therapeutic goods (ARTG; 16). According to the "Levels and kinds of evidence to support claims" (17), evidence based on traditional use of a substance or product is acceptable when applying for an official listing by the government. "Traditional medicines are based on an extensive history of use, often measured over thousands of years. This history provides an accumulated repository of systematic observation that underpins the use of these medicines." This may be true in some cases but as demonstrated by the ear candles example, this policy is open to abuse by mischievous sponsors. There are currently 17 different types of ear candles listed on the ARTG meaning they are rubber stamped with an official looking AUSTL number – which in itself lends legitimacy.

Regardless, attributing an ancient tribe or thousands of years of use to your quackery can be a lucrative exercise. In the case of ear candles, it enables you to charge 16 dollars for hollow tubes of candle wax which you can buy at a cost price of around 20 cents a piece. It's also important to note that there is evidence that ear candles can cause harm, such as temporary deafness, burst ear drums from hot wax dripping inside people's ears, and burns (18).

4) "Extraordinary claims require extraordinary evidence" or new laws of nature must be proposed to explain the product.

This famous quote comes from the science communicator and astrophysicist Carl Sagan and he makes a good point. If you claim you can cure cancer with water that has an alkaline pH then I'm going to need to see some pretty extraordinary evidence to be convinced. Likewise, if you claim that homeopathy (19) can cure breast cancer (20) then you'd better have some pretty water tight clinical trials and maybe also some paradigm shifting theories of biology to demonstrate these new found cancer killing powers of water.

5) "Things your doctor won't tell you!" or Big Pharma doesn't want you to know.

Any product that is sold with the tag that "your doctor doesn't want you to know" or the cure that "pharmaceutical companies have suppressed" is likely to be pseudoscience. There are many books on alternative medicine, in particular quack cancer treatments, which cover this theme. Just search Google for "10 cures/secrets/things you doctor doesn't want you to know".

6) The product uses weasel words and has a "quack Miranda".

If a product is littered with words like "energy", "wellness" and "balance" you have good reason to be suspicious. In all my time of asking purveyors of "energy products" to explain precisely what they mean, I've never got a satisfactory answer. Another thing to be aware of is the disclaimer you will find on many alternative medicine products and websites. Known in the US as a "quack Miranda" (21), it avoids making any direct medical claims, instead resorting to "may help..", and "might assist with..". Unless a product has been proven to work in clinical trials you cannot make specific claims about it, only vague statements such as the latter. The disclaimer you will come across on websites will be along the lines of "not intended as medical advice, this product is not intended to diagnose, treat, cure or prevent disease".

A case study of bad science: the hijacking of a legitimate scientific technique: hair analysis

The principle of hair analysis is that blood supply around the hair follicle provides nutrients and extraneous materials such as drugs, medications and heavy metals to the growing hair. These are absorbed into the hair shaft, carried along with growth, and can be accurately measured. Hair analysis is a legitimate scientific technique used for drug testing in sport (22) and in heavy metal poisoning such as lead and mercury (23). Advantages of analysing hair include easy and non-invasive collection, the small sample size required for analysis, and easy storage at room temperature (24).

Several high profile cases of hair analysis have featured in the media in recent times. Champion cyclist Lance Armstrong, seven times winner of Le Tour de France, has been the subject of rigorous doping testing throughout his career including hair analysis. In 2009 a report from Paris detailed how "a French anti-doping inspector armed with a pair of scissors took six clumps of the …champion's hair that will now be tested for signs of drug use". Armstrong reported his hair was so "butchered" by the test that he had to get a buzz-cut to hide the mess (25). More recently in Australia, AFL footballer Ben Cousins, who was sacked for excessive use of recreational drugs and alcohol, was hired by a new team on the condition that he "submit to three urine sample tests a week and a hair-follicle test every three months" (26).

Whilst these are examples of legitimate uses for hair analysis there are plenty of opportunists making fantastic claims about the technique as a diagnostic for a wide variety of ailments. One example is diagnosis of allergies utilising hair analysis and "quantum technology". I came across such a service offered by naturopaths at a well-being festival, where for only around 200 Australian dollars they were spuiking the "affordable way to find out what is making you sick". The process involved a piece of your hair being placed in an empty beaker (no chemicals were used) inside a "quantum machine" that flashed, flickered and a list of foodstuffs you were allergic to appeared on a printer. The "standard 300 item list" contained items under headings including fruits, seafood, drinks, vegetables, chemicals and dairy. The machine must have been using a lot of quantum that day because apparently it was sensitive enough to differentiate between allergies to Coke, Diet Coke or Pepsi, different brands of chocolate such as Darrel Lea, Nestle or Lindt and even different brands of washing powder.

Interestingly, the company also jumped on the bandwagon of the Ben Cousins hair testing regime, printing the following statement in their literature (complete with spelling mistakes); "..Hair analysis testing is becoming widely spread as an exceptable (sic) form of testing and measuring. Ben Cousins (the footballer) has to submit a hair sample each week as his testing proticol (sic) for drug consumption."

But there's nothing scientific about this process, except for the "sciencey" sounding words peppered throughout their literature, where phrases such as "inflammatory mediators, eczema and psoriasis" are fired off at random.

Unsurprisingly (unlike in the movies and on the television) science is a little more complicated than that. Indeed the process of scientific hair analysis is long and complex, requiring multiple steps and high-end analysis techniques such as gas or liquid chromatography, conducted by specialist technicians. Unlike the $200 dollar quantum machine, which apparently identifies your allergies in no time at all (see Table 1).

Table 1. Comparison of the methods of analysis for science-based versus pseudoscientific hair analysis.

Science	Pseudoscience
Designed to detect drugs and toxins absorbed via the blood stream including medications	Medications do not effect the test
Hair samples must be washed with either (a) acetone; methanol; or ethanol (b) sodium dodecyl sulphate (c) dichloromethane (d) combined organic solvents (min 15 min) and phosphate buffers (3 x 30 min)	Extent of washing not indicated*
Method of hair digestion: Alkaline (sodium hydroxide overnight 37°C); acid (hydrochloric or sulphuric overnight 37°C); enzymatic (e.g., proteinase K)	Extent of digestion unknown*
Methods of analysis; immunological, gas chromatography (GC); liquid chromatography; capilliary electrophoresis. Most common method is GC and mass spectrometry (MS) or GC-MS/MS	"Quantum technology"
Compounds capable of being detected: drugs of abuse; benzodiazepines (e.g., sleeping tablets) prescribed drugs, pesticides, organic pollutants, doping agents.	Allergy testing for over 300 food/ chemical types

However, there is always the chance that the quantum machine does possess something currently unknown to science, thus it is only fair to test it. This was done in 2003 (27) in a pilot study where two pieces of hair were taken from the same person but identified as from the different people and sent via mail order to a hair analysis company for allergy diagnosis. If the accuracy and precision of the protocol was sufficient, we would expect results to be very similar, consistent with the fact that the samples came from the same person. This was not the case. In fact, from the list of over 300 different substances identified, only two – carrots and soy milk – were the same for both samples (Table 2). This was by no means a scientifically controlled study, and the sample size was too small for statistical analysis but it suggests there may be some problems with the protocols if the results are so disparate.

The worst offenders: the Cosmeceutical industry

One of the worst offenders in the category of hijacking science for nefarious purposes is cosmetics companies or "cosmeceuticals". In 2009, L'Oreal was awarded a Shonky Award from Choice Magazine for "blinding us with dodgy science" with an honourable mention going to the industry in general (28). Choice cited terms such as "clinically proven", "dermo-clinical trials" and "in vitro testing", and tantalisingly obscure substances with names such as "Tetrahydroxypropyl Ethylenediamine", "Elemi PFA", "Oli-vityl", "Bioxilift" and "Nutrileum" as designed to blind consumers with science. They also made a parody video where they suggested that these companies "make stuff up" (29).

This is not the first time L'Oreal have been called out either. They were taken to task as recently as December 2010 when a Swedish court ordered them to provide evidence for anti-wrinkle claims made about two of its products. One of their ads claimed a cream reduced wrinkles at "laser speed", making them between 43 to 70 per cent less visible, and the other cream reduced wrinkles by rebuilding the skin.

In the UK in 2009, a television advertisement for Olay Regenerist Face Cream was banned for claims that "pentapeptides" could reduce the appearance of visible lines and could be used as a substitute for cosmetic surgery (30). The Advertising Standards Authority upheld a complaint challenging the evidence for the effectiveness of pentapeptides in skin care products and deemed the ad to be misleading and containing bogus science.

Table 2. Results of comparison of two identical hair samples but identified as from different people. From reference 27.

	Person a	Person b
Fruit	Kiwifruit Lychee	Pineapple Dates
Condiments	Chicken stock (Magi) (sic) Mixed herbs	Msg (621) Tomato sauce (Fountain) Tomato paste (Leggos) Bbq sauce (Eta) Worchestershire sauce Soy sauce Horseradish sauce Gravox Vegemite Promite Beef stock (Magi) (sic)
Vegetables	Carrots	Carrots
Nuts	Pistachio	Hazel
Meats/fats	Canola oil	Olive oil
Grains cereals	Kidney beans Baked beans (Heinz)	White rice Wheat bran
Dairy foods	Margarine (Flora) **Vitasoy** Ice cream (Paul's vanilla)	Nuttalex margarine **Aussie soy**
Sugars	Honey Carob Chocolate (Lindt)	
Drinks	Beer Tea Fanta (orange)	Port Coffee Green tea
Chemicals	Softly fabric softener	Cold power blue
Hair/fibres	Silk	
Food colours		Yellow
Other		Cigarette smoke

The mischief of the cosmeceutical industry was also highlighted in 2007 when the UK equivalent of Choice Magazine known as Which? Magazine found skin care companies were "blinding consumers with science" (31) using terms like nanoparticles, pentapeptides, lipopeptides and hyaluronic acid. A biologist from Sense About Science said that the claims for commercially available creams were insulting to people's intelligence. *"There may be evidence to justify using some of these chemicals — but not in products claiming to improve the signs of ageing or having an active effect on the skin. The companies are taking the real science out of context so it becomes bad science."*

Adding scientific jargon to a tiny bottle of cream is just another way manufacturers can get away with charging you an arm and a leg for a tub of sorbolene and water with some nice perfume added.

Conclusion

The hijacking of scientific terminology and technology has become a common marketing technique used to lend legitimacy to products that may have a paucity of evidence for efficacy. Consumers would do well to familiarise themselves with some of the more common methods used in order to avoid being scammed.

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