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PART SEVEN
THE SCIENTIFIC EXPLANATION

The problem of false balance when reporting on science

Peter Ellerton

How do you know the people billed as science experts that you see, hear and read about in the media are really all that credible? Or have they been included just to create a perception of balance in the coverage of an issue?

It's a problem for any media and something the BBC's Trust is trying to address in its latest report on science impartiality in programming.

As part of ongoing training, staff, particularly in non-news programs, were told that impartiality is not just about including a wide range of views on an issue, as this can lead to a "false balance". This is the process of providing a platform for people whose views do not accord with established or dominant positions simply for the sake of seeming "balanced".

The BBC has been criticised before for "false balance" and there are reports now that certain climate change sceptics are banned from BBC News, although this is denied by the BBC.

It's understandable that such false balance could grow from a desire to seem impartial, and particularly so since public broadcasters such as the BBC and the ABC in Australia are sensitive to claims of imbalance or bias.

Couple this with the need to negotiate the difficult ground of expert opinion, authentic balance and audience expectation, not to mention the always delicate tension between the imperatives of news and entertainment, and it hardly seems surprising that mistakes are made. An investigation this year found the ABC breached its own impartiality standards in its *Catalyst* program last year on statins and heart disease.

Finding the right balance

How then can journalists decide the best way to present a scientific issue to ensure accurate representation of the views of the community of experts? Indeed, how can any of us determine if what we are seeing in the media is balanced or a misrepresentation of expert opinion?

As I have written elsewhere, it is important to not confuse the right to be heard with an imagined right to be taken seriously. If an idea fails to survive in the community of experts, its public profile should diminish in proportion to its failure to generate consensus within that community.

A common reply to this is that science isn't about consensus, it's about the truth. This is so, but to use a consensus as evidence of error is fallacious reasoning.

While it's true that some presently accepted notions have in the past been peripheral, the idea that simply being against the majority view equates to holding your intellectual ground in the best tradition of the enlightenment is ludicrous.

If all views are equal, then all views are worthless.

Were I to propose an idea free of testing or argument, I could not reasonably expect my idea to be as credible as those subject to rigorous experimentation and collaborative review. If such equality did exist then progress would be impossible, since progress is marked by the testing and rejection of ideas.

Defining an expert

In the case of science, this testing is the process of experimentation, data analysis and peer review. So, if someone — scientist or otherwise — has not worked and published in an area, then they are not an expert in that area.

The first imperative for a journalist covering any story is to determine exactly in what field the issue best sits and then to seek advice from people who work and publish in that field.

Knowing how the issue fits into the broader picture of scientific investigation is very useful in determining this. It is one of the reasons that good science journalism follows from having journalists with some training in science.

Such a selection process, performed transparently, is an excellent defence against charges of bias.

Avoiding false balance

False balance can also be created by assuming that a person from outside the field (a non-expert) will somehow have a perspective that will shed light on an issue, that the real expert is too "caught up in the details" to be objective.

But suggesting that an expert is naive usually indicates an attempt at discrediting rather than truth seeking. Credibility is more about process than authority, and to be a recognised expert is to work within the process of science.

Also, if a piece of science is being criticised, we should ask if the criticism itself has been published. It's not enough that someone with apparent authority casts doubt as this is simply an appeal to authority — an appeal that critics of mainstream science themselves use as a warrant to reject consensus.

A second journalistic imperative would be to recognise that not all issues are binary. The metaphor that a coin has two sides is a powerful one, and the temptation to look at both sides of an issue is naturally strong. But the metaphor also assumes an equal weighting, and that both sides present the same space for discussion.

Proof and evidence

When an issue is genuinely controversial, the burden of proof is shared between opposing views. When a view is not mainstream, say that scientists are engaged in a conspiracy to defraud the public, the burden of proof sits with those promoting that view. In such cases, as Christopher Hitchens succinctly put it:

> What can be asserted without evidence can also be dismissed without evidence.

Attempting to dishonestly shift the burden of proof is a common device in the push to have young earth creationism taught in science classrooms.

The idea of "teaching both sides" or that students should be allowed to make up their own minds seems again like a recourse to the most basic ideas of a liberal education, but is in reality an attempt to bypass expert consensus, to offload the burden of proof rather than own it.

The fact is, that for issues such as creationism, vaccination and that climate change is occurring and is a function of human activity, it's not about journalists suppressing views, it's about quality control of information.

Stay with the issue

A classic means of muddying the waters is to employ straw man arguments, in which the point at issue is changed to one more easily defended or better suited to a particular interest. Politicians are adept at doing this, dodging hard questions with statements such as "the real issue is" or "what's important to people is".

Deniers of climate science often change the issue from global warming to whether or not consensus is grounds for acceptance (it alone is not, of course), or focus on whether a particular person is credible rather than discuss the literature at large.

The anti-vaccine lobby talks about "choice" rather than efficacy of health care. Young earth creationists talk about the right to express all views rather than engage with the science. Politicians talk about anything except the question they were asked.

The third imperative, therefore, is to be very clear as to what the article or interview is about and stick to that topic. Moving off topic negates the presence of the experts (the desired effect) and gives unsubstantiated claims prominence.

The impartiality checklist

The best method of dealing with cranks, conspiracy theorists, ideologues and those with a vested interest in a particular outcome is the best method for science reporting in general:

- insist on expertise
- recognise where the burden of proof sits
- stay focused on the point at issue.

If the media sticks to these three simple rules when covering science issues, impartiality and balance can be justifiably asserted.

Explainer: how does our sun shine?

Brad Carter

What makes our sun shine has been a mystery for most of human history. Given our sun is a star and stars are suns, explaining the source of the sun's energy would help us understand why stars shine.

An early explanation offered as to why the sun shines came from the Greek philosopher Anaxagoras. In around 450 BCE he taught that the sun shines because it is a "red-hot" stone.

During the mid-19th century, German physician Julius Mayer estimated that if the sun were a giant lump of burning coal it could only shine for some thousands of years. Thus it became

generally appreciated that any form of chemical combustion was insufficient.

Both Mayer and Scottish hydrographer John Waterston speculated that the sun was powered by the release of gravitational energy from impacting meteorites.

Waterston also suggested that the gravitational energy could instead come from a slow contraction of the sun. This idea is now discounted for the sun today, but is the means by which all stars can shine when they are forming.

Later in the 19th century the renowned physicists Lord Kelvin and Hermann von Helmholtz pursued the idea of gravitational contraction. But the problem remained that the sun could only shine this way for some tens of millions of years.

This is a small fraction of the age of the Earth as then estimated from geological studies, and increasingly discrepant as Earth's estimated age was revised upwards.

The atomic age

The situation changed in the early 20th century with the advent of so-called "modern physics", which began to understand the structure and behaviour of atoms. This included Albert Einstein's work equating mass with energy.

So, while some suggested radioactive decay as the source of the sun's energy, the relative absence of the atoms needed was against this explanation.

Instead, we turn to the work of the British physicist and chemist Francis Aston, who showed that four hydrogen atoms have more mass than a helium atom. This led the British astrophysicist Arthur Eddington to propose the conversion of the sun's hydrogen atoms into helium. The resulting conversion of matter to energy could keeping the sun shining for many billions of years.

Following Eddington's insight, it took years for a theory to be developed as to how the collision of hydrogen atoms inside the sun and other stars makes helium atoms and release energy.

Due to the work of scientists such as George Gamow, Robert Atkinson, Fritz Houtermans, Edward Teller, and then Carl von Weizsacker and Hans Bethe, by the eve of World War II the theory eventually became clear.

Hydrogen fusion inside the sun and other stars is a multi-step process, and involves a series of collisions of two atoms together, rather than the improbable collision of three or even four atoms together as a single event.

In addition, stars generate energy by the fusion of hydrogen atoms into helium into two ways. Inside stars more massive than the sun, the dominant process is a "CNO cycle" that also involves atoms of carbon, nitrogen and oxygen. But for stars such as our sun, the dominant process is the "proton-proton" chain reaction.

Where's the evidence?

In science, theories produce predictions that are subject to testing via experiment and observation, and the proton-proton chain predicts that subatomic particles called neutrinos will flood outwards from the sun and be detectable here on Earth.

But solar neutrinos are particles that are difficult to observe as they only weakly interact with matter. Most pass unhindered through our bodies and the entire bulk of the Earth.

Nevertheless, it is possible to construct a neutrino observatory, using a large underground fluid-filled chamber in which neutrinos are detected as occasional flashes of light from a collision of a neutrino with the atoms in the fluid.

When various teams started observing solar neutrinos from the 1960s onwards they were greatly surprised to detect fewer solar neutrinos than predicted, by a factor of two or three. What was going wrong? Was a new theory needed?

The solution to the solar neutrino mystery was to be found through the suggestion of Vladimir Gribov and Bruno Pontecorvo. They found that solar neutrinos oscillate between between different states that were not all being detected by the existing neutrino observatories.

Work done at the so-called Super-Kamiokande neutrino observatory in Japan resulted in the detection of these oscillations in the 1990s. This supported our basic picture of the sun as a hydrogen fusion reactor with the proton-proton chain reaction ultimately powering the sunlight we all take for granted.

Despite the scientific advances made over the years, the key initial step in the process of hydrogen fusion inside the sun has lacked direct observational evidence. Until now.

A new discovery

A team from the Borexino neutrino observatory in Italy have announced, in a research paper published in *Nature* today, the detection of low-energy neutrinos produced in the nuclear reaction that initiates solar energy generation.

This finding is significant as these so-called "pp neutrinos" constitute the overwhelming majority of neutrinos produced inside the sun. It demonstrates that 99% of the sun's power indeed results from the proton-proton chain reaction.

Science has thus made clearer the nature of solar energy generation, and supporting the general picture of stars as factories that transmute one element to another.

The physics of what makes our sun and stars shine informs our understanding of the origins of our solar system, our planet and ourselves. As the astronomer Carl Sagan would say, we are all "star-stuff".

While the Big Bang made the hydrogen and helium that is abundant in the universe, stars have essentially produced the remainder of the periodic table. They made the atoms that are today part of our planet and ourselves.

So the latest insight provided by the Borexino Collaboration about our sun is another step in the long but now detailed path that science has illuminated between the beginning of our universe and our present moment in time here on Earth.

Jupiter's Great Red Spot could disappear in a generation

Alan Duffy

NASA revealed today that the iconic Great Red Spot on Jupiter has shrunk to its smallest size ever — and astronomers have no idea why.

The Great Red Spot is a giant anticyclone storm that has been raging for at least 400 years, when astronomers were first able to build a telescope large enough to notice it. How it formed and has even lasted this long is still a mystery.

The first observations in the 1800s measured the storm to be about 41,000 km across — wide enough to comfortably fit three Earths (the Earth's diameter is about 12,700 km). But by 1979–80 when the Voyager spacecraft flew by for a closer look it had already shrunk to 23,335 km.

Now with the incredible precision of the Hubble Space Telescope, astronomers were able to accurately measure the extent of the Great Red Spot over the past 20 years and found that it's been shrinking by about 1,000 km per year.

The Great Red Spot's width is about 16,000 km — still big enough for the Earth to fit within the eye of the storm — but at current rates of shrinking it could be gone by 2030, depriving the next generation of astronomers of one of the solar system's most enigmatic objects.

While the shrinking has been hinted at before, the quality of the Hubble Space Telescope images have made it clearer than ever, as well as revealing a possible reason behind this amazing disappearing act.

Thanks to the superb resolution of the Hubble Space Telescope astronomers have seen the Great Red Spot swallow

smaller "eddies" or whirlwinds which might be somehow cancelling out the giant storm.

To confirm this we need to measure the speed and direction of the winds in these eddies. This is a topic of intense research as there may only be a few years left to study the storm before it's gone.

Earth storms made large

On Earth we get anticyclones (regions of highest pressure on a weather map) but they don't last long as eventually they pass over land which drains the energy from the storm.

But Jupiter — the fifth planet from the sun — is a gas giant. It doesn't have a land surface to slow down its storms so they can continue to build.

The problem for astronomers though is that current theories show the planet isn't spinning fast enough to power up a storm this large. So how did the Great Red Spot get so big?

One way to form such a large storm was seen by astronomers in 2000 as they noticed the formation of a new storm on Jupiter, known as the Oval (or Little Red Spot), through the merger of three smaller systems.

This suggests that Great Red Spot might just be a particularly successful storm in capturing neighbours to power itself to this size.

The Great Red Spot isn't the only large storm in the solar system. In particular there's the Great Dark Spot on Neptune. This is nearly as big as the (shrunken) Great Red Spot but only seems to last a few years at a time before vanishing.

Mysteries of the Spot

One of the most striking features of the Great Red Spot is its colour. It can change hue from blood red to salmon pink to nearly indistinguishable from neighbouring clouds, all in the space of months.

Even though astronomers have studied this feature for hundreds of years, this is still a mystery. The colour is believed to result from complex organic molecules or sulphur-based compounds, which can also change colour when exposed to sunlight at the top of the storm, but we don't know for sure.

The Great Red Spot may be a fraction of its former size but the storm clouds still tower 8 km above their neighbours, with winds at the edge of the storm racing around the eye at hundreds of kilometres per hour. The entire storm itself takes six days to make a lap of the gas giant (although thanks to the rapid spin of Jupiter we see it come in and out of view every 10 hours).

There is always the chance that it might yet rebuild itself by engulfing a neighbouring storm, surprising astronomers yet again.

Regardless of the fate of the storm, it's captivated astronomers and the public imagination alike for hundreds of years and will live on in the gorgeous images that the Hubble Space Telescope have managed to capture.

In many of the school talks I give, the Great Red Spot is one of the favourite topics of the class. There's something about a world-devouring storm that captures kids' imaginations!

Thanks to this latest finding though the tempest is just a little less grand and for the next generation may have all but disappeared.

Strut your stuff: how rockstars and peacocks attract the ladies

Malcolm P. Forbes
and Ryan Anderson

Malcolm Forbes

Ryan Anderson

What is it that makes rockstars so attractive to the opposite sex? Turns out Charles Darwin had it pegged hundreds of years ago — and it has a lot to do with peacocks.

In *The Descent of Man, and Selection in Relation to Sex* (1871), Darwin suggested natural selection can occur by individuals out-producing others in a population, through enhanced ability to secure a mate.

Darwin used the ornate peacock plumage and bird songs to exemplify this concept.

Peacocks are best known for flaunting their brightly coloured and sizable tails. Yet the tail is cumbersome and expends energy. In addition, its extravagance makes the peacock conspicuous to predators and less able to escape them, reducing its survival prospects. Why then has the tail not been bred out of existence?

The existence of the tail reflects the fact that it plays a major role in attracting the peahen, allowing greater numbers of offspring that inherit the genes for a long colourful tail from their father.

Not only does the peacock enjoy greater reproductive success, his sons are likely to inherit a similar capacity for increased reproductive success.

Shake your tail feathers

Sexual selection in humans, as in peacocks, is predominantly at the discretion of females.

The prevailing explanation behind this is the Bateman Principle — male reproductive success increases with the number of mates, whereas female reproductive success does not.

Thus males compete with each other for female mates and females mate only with the males they prefer. This mechanism of sexual selection is termed intersexual selection.

The tail of a peacock is an example of intersexual selection. Conflict and physical violence between male members of a species is called intrasexual selection.

Voulez-vous coucher avec moi?

Studies conducted in the US and France, where male and female confederates approached members of the opposite sex and requested "Will you come over to my apartment?" and "Would you go to bed with me?", found that the majority of male respondents were willing to comply with a sexual proposition from an averagely attractive female.

But zero of the female respondents in the American study and only one of the female respondents in the French study were willing to go to bed with a male they had just met.

The authors interpret the findings as evidence of men's eagerness for sexual relationships, and women's association of higher risk with having a sexual liaison.

But it seems men can increase their chances by holding a guitar. A recently published study had male confederates approach women in the street holding a guitar, a sports bag or nothing, and ask for their phone number.

Significantly greater compliance was elicited by men merely holding a guitar. Additionally, when asked to rate men as potential partners for a short-term relationship, women at peak fertility preferred creativity (including musical creativity) over wealth in prospective partners.

A 2014 British study of 1,500 women with an average age of 28 replicated this finding, showing that women have sexual preferences for composers of complex music during peak conception times, but not outside this time.

Finally, of interest, studies suggest that higher levels of narcissism in men correlated with improved prospects in courting a woman.

Swapping the tail for a guitar

Harvard cognitive psychologist Steven Pinker has referred to music as: "auditory cheesecake, an exquisite confection crafted to tickle […] our mental faculties".

Evidence suggests that this is the case, with music arousing feelings of euphoria and craving through dopamine release in the brain's striatal system.

Researchers suggest that men who can play music display specific adaptive qualities, demonstrating excellent physical coordination and learning capacity.

Akin to a peacock ostentatiously fanning its brilliant plumage or a songbird vocalising a pleasant harmony, a strutting male rockstar generates an aesthetically and aurally pleasing performance.

Rather than demonstrating his capacity for survival, he is producing something that is mentally gratifying to others, and appealing to the opposite sex.

Mick Jagger and Jimi Hendrix were known for their musical ability, narcissism and sexual escapades.

Before the advent of birth control, these men would have fathered many offspring. Their genes would have multiplied in frequency through the power of attracting members of the opposite sex.

Charles Darwin's words from 1871 appear to ring true for male rockstars:

> musical notes and rhythm were first acquired by the male or female progenitors of mankind for the sake of charming the opposite sex.

Why using Myers-Briggs at work Might Be a Terrible Idea (MBTI)

Jesse E. Olsen
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Jesse Olsen

Peter Gahan

The Myers-Briggs Type Indicator (MBTI) is the most popular personality test, boasting millions of test-takers each year. Developed in the 1940s by Isabel Briggs Myers and Katharine Briggs, the MBTI is based on the ideas of Carl Jung. Upon completion, test-takers are presented with one of sixteen personality types based on four dichotomies: extraversion-introversion (E-I), sensing-intuition (S-N, because "I" was already taken), thinking-feeling (T-F), and judging-perceiving (J-P).

Despite its general popularity, however, the Myers Briggs test is met with seemingly unanimous revulsion among academics (who are probably just sceptical INTPs). We (the authors) like to see ourselves as open-minded ENFPs, but alas, we must own up to our I and T tendencies. While we don't necessarily meet the MBTI with revulsion, we're far from impressed. Further, as management scholars, we have reservations about promoting the use of the MBTI in the workplace.

1. The MBTI to make any employment decision Is Definitely a Terrible Idea (IDTI).

Here, we are in full agreement with the test developers' original intent. According to the Myers-Briggs Foundation:

> It is unethical and in many cases illegal to require job applicants to take the Indicator if the results will be

> used to screen out applicants. The administrator should not counsel a person to, or away from, a particular career, personal relationship or activity based solely upon type information.

The MBTI is meant for developmental purposes, and the 16 types are meant only to emphasise uniqueness, rather than goodness or badness — a lot like a horoscope.

But importantly, research suggests that scores or personality types as measured by the MBTI do not relate to job performance. Employee selection tools should be chosen based on the degree to which they find good employees; the MBTI does not do this — a lot like palm reading or handwriting analysis.

Further, in using personality tests more generally, we have to understand that there are limitations to measuring self-reported personality even with the more reliable instruments, and that situational factors also play a very important role in determining our behaviour.

2. Using the MBTI as a reliable measure of personality Is Probably a Terrible Idea (IPTI)

MBTI results are based on self-reported preferences, which are forced into categories or types. The more reliable tests of self-reported personality — like the Big Five — measure aspects of the personality on more of a continuum, rather than as types.

When we measure many human characteristics — like height, weight, intelligence, and many personality traits — we tend to find that most people fall fairly close to the average and very few people fall at the extremes, forming what is known as a bell curve or normal distribution. What would happen if we chose to represent intelligence as an arbitrary dichotomy — "sophisticated-simple" ("S-I", because they clearly can't both be represented by "S") — rather than as a continuous IQ score? If the average person (who sits around the middle of the distribution, near the arbitrary dividing line) took an intelligence test twice, they'd have a good chance of falling into a different category each time.

Here lies one of the big problems with the MBTI and the reason many people find their type changes when they take it multiple times. Most of us are about average on at least one of the four dimensions, which means that we probably teeter on the edge between two (or more) types. Answer one of the questions differently, and you might fall into a different personality type. This happens about 50% of the time, according to some reports, which should further emphasise the importance of not using the MBTI to make any important decisions.

3. Using the MBTI as a development tool Might Be a Terrible Idea (MBTI)

Using the MBTI in training and development can provide for some fun times at work. People like typologies, and going through the MBTI assessment and feedback process can provide an opportunity for self and/or mutual understanding.

You may have reasons for spending around $35 per person on an unreliable and invalid test to further self-understanding or think about your career. (We won't judge; we're Ps, not Js.) However, we submit that there are plenty of equally unreliable and invalid tests available online for free, or that you might make your own, and that they might even be more fun than the MBTI. Your $35 could instead be directed to satisfying the world's growing demand for creative ice bucket challenge videos.

So, in sum, the MBTI unreliably, invalidly, and perhaps even inappropriately assigns four-letter labels to test-takers. Of course, if this sounds like your idea of fun, go for it, but we'll take our $35 to the local pub, for measurably more fun as we assign our own four-letter label to the MBTI.

Metadata and the law: what your smartphone really says about you

Philip Branch

Metadata related to lawful interception has been in the news a bit lately. You may have seen last week the Australian Federal Police (AFP) called for more access to electronic metadata as a Senate committee evaluates Australian mass surveillance laws.

Probably most people understand that lawful interception (wiretapping or phonetapping) has moved beyond connecting alligator clips to a phone line, but "metadata" might be a bit of a mystery.

If you have ever wondered why you need to provide identifying information such as a driver's licence when you purchase a new phone, "metadata" is a big part of the answer.

So what is metadata?

Metadata is information about communication, rather than the content of the communication itself.

We are all familiar with metadata. It consists of such things as telephone numbers, email addresses, webpage addresses and the like. It is what we see when we look at our telephone bill.

The reason it is in the news now is that modern telecommunications has caused an explosion in new forms of metadata.

When telecommunications mainly consisted of voice and perhaps short message service (SMS), the actual content of the communications was rarely collected. Capturing, recording, storing and listening to voice conversations was expensive and, at least during the early stages of an investigation, probably of limited value.

What was useful though was information about the call — information as to who was talking to whom and how often, enabled investigators to construct a model of the relationships between those of interest.

Maybe at a later stage conversations would be recorded, but usually intercepts requested by the authorities delivered information about the call, rather than the call itself — in other words, the "metadata".

Mobile metadata

Even before smartphones and the internet, metadata from the mobile phone system was surprisingly rich. Metadata could provide information as to whether the call was forwarded and where it was forwarded to, whether or not it was answered, and so on.

Such information is invaluable in building up a model of relationships. But not only did the phone network provide information about the participants to a call, it could also provide approximate information about where the call was made.

Since mobile phones are connected to the network via nearby base stations usually located only a few kilometres away, metadata reporting which basestation the handset is attached to gives location information accurate to a few kilometres.

Also, since the phone is connected to a basestation whenever it is switched on, the phone can provide continuous location information regardless as to whether or not calls are made.

This was the situation with the widely used 2G mobile phone networks which were deployed in Australia during the early 1990s and which are still in use. However, telecommunications has moved on a great deal in the past few decades with many more possibilities for investigators.

All the metadata available in the 2G network is available along with much more, but of particular importance is that the way mobile devices are used has changed. Most obviously, mobile devices are used to access internet services.

Enter mobile internet

Mobile internet has been both a blessing and a curse for investigators. Smartphones are used for many more purposes than voice-only telephones.

Generally, people use a smartphone much more than they used older types of telephones. Consequently, many new forms of metadata have become available. Email addresses, websites visited, and files downloaded all present many new opportunities for investigators to gather metadata.

Not only is material downloaded, but a considerable amount of material is also uploaded.

Pictures, videos, social media updates all provide metadata that could be of use in an investigation. For example, images captured on a smartphone will, unless steps are taken to remove it, contain GPS location information accurate to within a few metres.

Other metadata that might be of interest includes when the image was created, who created it and the device it was created on. Metadata might even be added, perhaps unwittingly, when people tag images with comments.

The proliferation of metadata options has caused problems for investigators too. Any online service that enables communication can be used to thwart interception. For example, most online games contain some messaging feature, and there is no reason why this cannot be used as a way of exchanging messages.

Webmail drafts are another example. In this approach, people who wish to communicate do so by sharing an email address from a webmail provider and write drafts of emails that are saved and read by participants, but are never sent. The metadata of interest here is not just the email address, but the identities of those who accessed it.

Integrating metadata from potentially multiple sources is also a challenge. A draft webmail communication as described might involve metadata from the telephone company, an internet service provider (ISP) and the webmail provider.

Because there are so many new possibilities and difficulties regarding metadata, the whole area of lawful interception and surveillance has come under frequent review the past decade. There was a proposal last year by the Australian government — since shelved — that all ISPs should store for two years all communications that contained potentially useful metadata.

There are many issues to consider, from both law enforcement and privacy perspectives. No doubt we will hear a lot more about metadata in the next few years.

Windows XP is still popular — so why is Microsoft pulling the plug?

Srikumar Venugopal

As operating systems go, Windows XP has had a fantastic run since debuting 13 years ago. It can be still found on nearly 28% of the desktops in the world.

It is the second-most installed desktop operating system, behind Windows 7, and it can be found in banks, government departments, in desktops across China and India, and in automated teller machines (ATMs).

So why, as of tomorrow, is Microsoft ceasing support for its iconic operating system?

Insecurity updates

When it was released in 2001, Windows XP introduced many features such as built-in support for Wi-Fi and burning CDs, Internet Explorer (IE) 6 web browser, improvements to the user interface and an integrated system management console, setting it apart from its predecessors Windows 2000 and Windows ME.

Windows XP's release also coincided with the boom in worldwide desktop shipments in the early 2000s, especially in emerging markets such as India, China and the Middle East. This ensured that it quickly became the most widely installed desktop operating system in the world.

Companies with Windows XP installations depend on internal services that themselves depend on features only found in this version of the operating system, such as IE 6. Upgrading their desktop installations would also require costly investment in upgrading these services. This has led to tremendous inertia in migrating from Windows XP to more recent operating systems.

Microsoft released three "Service Packs" to upgrade Windows XP and to fix the many security vulnerabilities that were discovered in the course of its usage. Since 2009, Microsoft has provided only security updates for Windows XP. This facility comes to an end on April 8, 2014. This deadline has caused some panic among the current users of the operating system.

Recently, the UK Government was forced to enter into a £5.5 million deal with Microsoft to extend security support for Windows XP installations in the Crown offices for another year. Chinese web giant Tencent has taken on the responsibility of ensuring security updates for XP users in that country.

The Windows family tree

The years have also not been kind to Windows XP. The numerous vulnerabilities in the OS have forced Microsoft to spend significant effort in issuing regular security patches, and wish for its users to move on to relatively secure Windows 7 or 8.

At launch in 2001, XP featured a striking default theme called "Luna", which has been sometimes unkindly compared to the look of a Fischer-Price toy. But today, XP's Luna looks dated compared to the sleek, modern interfaces found on all the newer, major computing platforms.

Internet Explorer 6 is widely considered as the single biggest obstacle in the progress of web-based applications conforming to World Wide Web (W3C) standards.

A 1998 agreement with the US Department of Justice forced Microsoft to decouple its web browser from the rest of the OS and allowed alternative browsers such as Opera, Google Chrome and Mozilla Firefox to become successful.

Three years ago, Microsoft itself advised that consumers upgrade to later versions of Internet Explorer such as IE 9 and above.

Microsoft itself has faced the curse of *Star Trek* movies (even-numbered instalments are better than the odd-numbered) in upgrading its users to newest version of Windows. Vista, the successor to XP, was widely panned for its heavy system requirements and pervasive prompts for user authorisation of activities.

On the other hand, Windows 7, released in 2009, is the most popular desktop operating system today. Its successor, Windows 8, was designed to address both touch interaction in tablets, and mouse and keyboard interaction in desktops in Windows 8. However, this resulted in a few omissions, notably the lack of a "Start" button, that confused and infuriated many users.

And while Windows is still dominant on the desktop, the world is moving faster towards other computing platforms. The Apple iPhone, introduced in 2007, provided users with a mobile, always-connected device to browse the web and communicate instantly.

The advent of low-cost, low-powered laptops, called netbooks, forced Microsoft to continue offering XP as an alternative to open source software Linux. The introduction of the Apple iPad and its competitors not only put paid to this category, but also provided users with an alternative to desktops for tasks such as document creation, messaging and web browsing.

What now for operating systems?

Desktop shipments have been stagnant for a few years and there is little chance of a revival in near future. Resource-heavy computing tasks are being migrated to data centres in a trend known as cloud computing.

Microsoft has acknowledged this by not only offering a cloud-hosted version of its Office suite, called Office 365, but a version for the Apple iPad as well.

Thus, the end of support for Windows XP also coincides with the end of the age of the desktop. There will be less fanfare around operating system updates, and less mourning when an OS rides off into the sunset.

Take your marks … the science behind the perfect swimming dive

Elaine Tor

The swimming events of the Glasgow Commonwealth Games are among the first on the schedule. Australia and the UK tend to do quite well in the swimming events — as does Canada — so it's an excellent opportunity to learn a little about the all-important swimming dive start while watching our swimmers compete.

The swimming dive start is highly linked to overall performance during competition. In fact, the start can contribute anywhere between 0.8-26.1% of total race time, depending on race distance.

Obviously, it's important that elite swimmers get their dive down pat.

The swimming dive start is defined as the time from the starting signal (the gun or beep) to when the centre of the swimmer's

head reaches 15 m down the pool. Elite swimmers can typically perform a start between 5.5 and 8 s.

The swimming start is broken into three phases:

1. on-block
2. flight
3. underwater.

The average percentage contribution for each phase of the start for elite swimmers is 11% (0.74 s) spent in the on-block phase, 5% (0.30 s) in the flight phase, 56% (3.69 s) in the underwater phase and 28% (1.81 s) free swimming.

- On-block phase: The time from the start signal to when the swimmer's toe leaves the block.
- Flight phase: The time from when the swimmer's toe leaves the block to when the swimmer enters the water.
- Underwater phase: The time from when the swimmer enters the water to when the swimmer's head breaks the surface of the water.

The underwater phase is the longest of a swimming start — it can account for 95% of variance in start time — and is the most decisive in determining efficient overall start performance, because it is when the swimmer is travelling at their fastest through the water.

So, what makes the perfect dive?

It is important to remember the fastest starter is not always the one that enters the water first. The fastest starts are the ones that can maintain the highest velocity for the longest after they enter the water.

Prior to hitting the water, a swimmer must learn to maximise their take-off horizontal velocity while also reducing their reaction time, but if a swimmer does not optimise the underwater phase, increasing their take-off horizontal velocity won't be advantageous to start performance.

There are a number of factors that affect the swimmer after they enter the water which determine how much velocity is maintained during the underwater phase and, in turn, the overall outcome of the start. These include:

- being as streamlined as possible
- starting underwater undulatory swimming (dolphin kick) after about 6 metres
- generating propulsive kick using only the feet and legs during the underwater water kick phase.

The swimmer can also vary the depth at which they swim, although this will affect the amount of drag acting on the swimmer and can affect the trajectory of the underwater phase. Specifically, the timing of a swimmer's first kick, their maximum depth and the underwater trajectory used will have the greatest influence on overall start performance.

If a swimmer's maximum depth is too deep they will spend longer travelling up toward the surface, and if the swimmer's maximum depth is too shallow they will experience higher drag forces acting on them.

Similarly, beginning the first kick too early will increase the amount of drag acting on the swimmer.

The ideal underwater trajectory

Through a number of research studies a number of theoretical guidelines for the ideal underwater trajectory have been detailed as:

- travel at least 0.5 m below the surface
- hold glide for 2 s
- maximum depth between 0.9 m to 1.0 m
- start the first kick after 6.5 m
- breakout at 10.5 m.

But the optimal underwater trajectory will also depend on each individual swimmer's anthropometric characteristics and underwater kicking ability.

By using these recommendations swimmers are able to adopt the ideal underwater trajectory that will reduce the amount of resistance acting in the opposite direction to slow the swimmer down.

As a result they will be able to maintain a higher velocity for longer and set themselves up for better start performances.

Explainer: why chilli burns, and milk helps soothe the pain

Alex Russell

Whether it's a few flakes on a pizza or the spiciest vindaloo known to humankind, most people can tolerate or even enjoy the tingling, burning sensation chilli can bring.

So, how does chilli deliver its sting? And why is it that milk can take the edge off a spicy meal, while water doesn't work as well?

Our senses of taste and smell are collectively known as the chemosenses; they detect certain chemicals in the environment.

Smell (olfaction) refers to the detection of volatile chemicals in the nasal cavity, whether they enter via the nostrils or via the throat. We don't know why certain chemicals smell the way they do, so we can't predict what a new chemical will smell like based on chemical structure. Whoever works that out is almost certainly in the running for a Nobel Prize.

"Taste" refers to the five primary tastes:

- sweet
- sour
- salty
- bitter
- umami.

But people often misuse the word "taste". Wines are often described as tasting along the lines of "complex varietal flavours of cherries and blackberries, with a promise of herbs".

Actually, the only taste you're getting from the wine is some sweetness (sugars) and some sourness (acids). The cherries, blackcurrants and promised herbs are part of the flavour of the wine, which is the combination of the tastes and smells that enter the nasal cavity via the throat.

Our nose and mouth also pick up other sensations, such as pain or irritation, through chemical reactions. That tickle that you get with wasabi or hot English mustard is actually a pain reaction. The same is the case with chilli.

Chilli, capsaicin and hallucinations

The active ingredient in chilli is capsaicin (pronounced kap-say-sin). Capsaicin irritates eyes, lungs and skin, so you need goggles, respirators and HAZMAT suits when dealing with the pure stuff.

It is also potentially lethal. Concentrations of 118.8 mg/kg are lethal to 50% of mice (also known as the LD50 dose). And yet, the ability to eat very hot chillis is often seen as a badge of honour.

Chilli heat is measured using Scoville heat units (SHU), which is an inexact measure of capsaicinoid concentration.

Bell peppers have a Scoville rating of 0. Tabasco sauce is around 2,500 Scovilles, while Jalapeños are somewhere around 3,500–10,000 depending on the Jalapeño. There is a sauce called Dave's Insanity Sauce, which is (allegedly) the only sauce ever to be banned from the American National Fiery Foods Show (imagine the portaloos at that place). It has a Scoville rating of 180,000.

In January last year, British doctor Ian Rothwell became the first person to eat a curry with a Scoville rating of 6,000,000 (called "The Widower"). The chefs used goggles and facemasks during preparation.

After signing a disclaimer, Rothwell took an hour to eat the curry, including a trip outside for fresh air, during which he was said to be hallucinating, although he denies this. Unfortunately,

chilli-induced hallucinations are not well understood. (I'd love to run some experiments on this, but think that ethics committees might have something to say about it.)

Why milk helps

When a friend of mine turned 21, we went out for Indian. We ordered him a vindaloo, only to have him say "Pfft, that's not hot enough" and send it back to the kitchen. We heard the cook yell "What? I'll show him!" and ten minutes later, a waiter brought out the new and improved vindaloo.

My friend took a bite, started to sweat profusely and reached for any water he could find. Fortunately, the waiter was ready for this and brought over a glass of milk, which immediately took the edge off. He collected a decent tip from my mate that night.

So, why is milk, and not water, your go-to pain relief after a spicy curry?

Without getting too into the chemistry, capsaicin has a long hydrocarbon tail, meaning it binds strongly with lipoprotein receptors on the tongue.

Capsaicin doesn't dissolve in water, so water won't help much, but it does dissolve in alcohol and vegetable oils. Beer is not very alcoholic, so it won't do much. Stronger drinks may help more, but there's a limit to how much alcohol you can have.

The traditional cure is mammal's milk. Milk contains casein, a fat-loving substance that essentially has a detergent effect on the capsaicin, just like soap has on grease. But it has to be mammal's milk — coconut milk does not contain casein.

But some chillies are still ridiculously hot and milk can only help so much. If you do try The Widower, you'll essentially need a fully-functional milking shed next to the table to get you through it. And you'll still most likely want to prepare by putting your toilet paper in the freeze.

Explainer: how much sleep do we need?

Gemma Paech

The amount of sleep adults need has once again come under the spotlight, with a recent *Wall Street Journal* article suggesting seven hours sleep is better than eight hours and the American Academy of Sleep Medicine drawing up guidelines surrounding sleep need.

So, what should the guidelines say? Unfortunately, when it comes to the amount of sleep adults require there is not really a "one size fits all". Sleep need can vary substantially between individuals.

Sleep is regulated by circadian and homeostatic processes, which interact to determine the timing and duration of sleep. The circadian process represents the change in sleep propensity over 24 hours, or our internal "body clock". The homeostatic process represents the accumulation of sleep pressure during wakefulness and the dissipation of sleep pressure during sleep.

Both the circadian and homeostatic processes are influenced by internal factors, such as genes, and external factors, such as prior sleep history, exercise and illness. Individual variations in sleep timing and duration can largely be explained by these internal and external factors.

Individual sleep need

Genes are important in determining diurnal preference: whether we are "night owls" who prefer to stay up late at night, or "early birds" who prefer to get up early in the morning. Genes may also contribute to whether we are "short" or "long" sleepers.

But although genes form the foundation for sleep timing and duration, many external factors also affect sleep need.

Perhaps one of the more common causes affecting sleep duration relates to sleep history. Many adults, whether they know

it or not, experience sleep restriction, often on a daily or weekly basis. Restricting sleep or going without sleep (pulling an "all-nighter") increases sleep pressure.

This sleep pressure dissipates within sleep, so higher sleep pressure requires longer sleep duration. As such, following sleep loss, sleep need increases.

Health, exercise, heavy labour, and even mental workload can affect sleep duration. During times of illness, following exercise, or even following periods of mental stress (such as exams), the amount of sleep needed to recover or restore back to normal can increase. Likewise, individuals who suffer from disease or who have poor health may need more sleep than their healthier counterparts.

Sleep need also varies with age, with elderly people generally sleeping less than younger individuals. Age-related changes associated with sleep duration are thought to be due to changes in the interaction between the circadian and homeostatic processes.

The individual variations in sleep need make it difficult to provide a specific recommendation as to how much sleep adults need. However, most sleep researchers generally agree that seven to nine hours sleep is what the majority of adults require to function at their best.

Why eight hours sleep?

Sleep restricted to seven hours or less results in impairments to reaction time, decision making, concentration, memory and mood, as well increased sleepiness and fatigue and some physiological functions.

On the other hand, eight hours or nine hours sleep has little impact, either negatively or positively, on performance.

Based on these findings, it would seem that for most of the adult population, somewhere between seven and nine hours of sleep is the "right amount".

This is not to say that more than nine hours sleep is not good. Rather, extending sleep duration may help to "protect" waking function during subsequent periods of sleep loss. While we may

not need ten hours sleep all the time, there are some clear benefits from getting more sleep.

But I am fine with six hours sleep …

The first question you need to ask yourself is, are you really?

You may be one of the lucky few with the "right" genetics. However, it's more likely that you are simply unaware of how sleep loss is impairing your waking functions.

How we feel does not always reflect how badly we may be functioning, which may result in delusions about how much sleep we really need. Needing an alarm clock to wake up, and the desire to sleep in on weekends and holidays, suggests that sleep need is not being met.

Critically though, if you have difficulty sleeping for a continuous eight hours, try not to worry too much, as this may make things worse.

Finding your optimal sleep duration

The amount of sleep need can vary significantly and can depend on multiple different factors, making it difficult to work out optimal sleep need. Below is a guide that might help to determine sleep need.

1. Keep a diary of your sleep. Include the times you went to bed and woke up, how you slept and how you felt during the daytime.
2. Go to bed when you feel sleepy/tired.
3. If you can, don't use an alarm clock, rather, let your body naturally wake up.
4. Try to get natural sunlight exposure during the day.
5. Keep to a regular sleep schedule all days of the week.

After a while, you should be able to work out the best timing and duration for your sleep. If you are still unsure or concerned, see your general practitioner. Remember, though — sleep need can change with circumstances, so always listen to your body.