Journal and Proceedings of the Royal Society of New South Wales

2018

Volume 151 Part 1

Numbers 467 & 468

"... for the encouragement of studies and investigations in Science Art Literature and Philosophy ..."

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 1–4. ISSN 0035-9173/18/010001-04

Editorial

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On May 31, 2018, I was privileged to be a guest at the N.S.W. Judicial Commission Ngara Yura Program's[1] visit to the Sydney Observatory when a star was named in honour of Bonita Mabo AO, Eddie Mabo's widow. Bonita could not be present but was represented by their daughter, Gail, who thanked the Observatory and the Museum of Applied Arts & Sciences on her mother's behalf. On the 23rd anniversary of the Mabo decision[2] in 2015, a star had been named Koiki, in memory of Eddie Koiki Mabo.[3] We peered at both stars through the Observatory's 40cm North Dome reflecting telescope[4], and discussed the vexed issue of longitude[5] at the date of the Observatory's founding, in 1858.[6] The Observatory has been a running theme in the *Journal & Proceedings*, with early Sydney astronomers, such as W. Scott, J. Tebbutt, H.C. Russell, and G.D. Hirst, regular contributors. The Sydney Southern Star Catalogue (SSSC) was compiled by Sydney Observatory during its time as a research facility and published in 1983 (King and Lomb, 1983).[7]

This convergence between astronomy and Indigenous affairs[8] is timely, since the first paper in this issue is an address given at the annual dinner of the Royal Society (the first at the State Library of N.S.W.) on 18 May 2018 by recently elected Dist-FRSN Tom Keneally. He is writing a historical novel about Mungo Man, who lived and died in western N.S.W. about 42,000 years ago, and who was ceremonially laid to rest, decorated with ochre from a distant deposit. The printed version of the address includes references Tom used in his research, but I have also found some, including the recently published work by Billy Griffiths, *Deep Time Dreaming* (2018), which is an account of the people and discoveries and disputes that have arisen in the past half century of Australian archaeology, written by a historian who has also worked on some digs. This book, for instance, discusses the issues around ownership of ancient remains, the protocols established since Mungo Lady and

[1] https://www.judcom.nsw.gov.au/education/ngara-yura-program/

[2] Recently elected Fellow, Sir Anthony Mason FRSN, was the Chief Justice of the High Court when the decision was handed down.

[3] The stars' SSSC numbers are: Koiki 803504, Bonita 803544. And see Indigi Lab (2016).

[4] See photos of the stars on page 5 below.

[5] See Tebbutt (1878) and Russell (1878) and Sobel (1995).

[6] See Ashcroft et al. (2018).

[7] In a recent email, Nick Lomb tells me: "The catalogue is online. In 1983 I sent off the catalogue on a reel of computer tape to an astronomical data centre in the US. It has been preserved all these years and is now available through a data centre in Strasbourg at http://vizier.u-strasbg.fr/viz-bin/VizieR-3?-source=I/86A/primary. Through that link you can interrogate the catalogue by putting in the star's SSSC number, eg 803504 (Koiki), in the box marked num and pressing Submit."

[8] See also Bhathal (2009).

Mungo Man appeared to Dr. Jim Bowler in 1969 and 1974.[9]

The second paper is an address given on Australia Day, 2017, by this year's Australian of the Year, DistFRSN Michelle Simmons, on, inter alia, her team's progress at making a quantum computer, using single phosphorus atoms on a silicon lattice. As teams here and abroad compete to design and construct quantum computers, theoretical computer scientists are discussing how such machines will behave. Aaronson (2018) stresses that "Quantum computers would (sic) not solve hard search Problems instantaneously by simply trying all the possible solutions at once." Rather, he and de Wolf (2017), argue that they could provide dramatic speed-ups of a few specific problems, three of which they emphasise: first, simulation of quantum physics and chemistry, to design new drugs, materials, solar cells, high-temperature superconductors, etc. Second, breaking existing public-key cryptography, although probably not future standards, and not private-key cryptography. Third, optimization and machine learning, they believe. But there will no doubt be benefits for other applications. At a more mundane level, Professor Simmons, who has recently been elected as an FRS (London), also focused on high-school education, and deplored the watering down of HSC physics, for instance, given the need for pupils to be challenged in order to learn and to develop confidence in the STEM subjects.

After some delays in receiving their papers (and never hearing from one participant — his paper is an edited version of the transcript of his talk), the proceedings of the Royal Society of N.S.W. and Four Academies Forum, "The Future of Reason in a Post-Truth World," on November 29, 2017, at Government House, Sydney, are presented in this issue. A wide variety of issues is raised in the presentations, and news (of Russian influence in various votes and elections outside Russia, for instance) and research into the phenomena discussed continues to appear. In particular, to understand how false news spreads, Vosoughi et al. (2018) used a data set of rumour cascades on Twitter from 2006 to 2017. About 126,000 rumours were spread by about 3 million people. False news reached more people than the truth; the top 1% of false news cascades diffused to between 1000 and 100,000 people, whereas the truth rarely diffused to more than 1000 people. Falsehood also diffused faster than the truth. The degree of novelty and the emotional reactions of recipients might be responsible for the differences observed. This is depressing, if not entirely unexpected.

Finally, I wish to thank the team of people who have helped me with this issue: new father Ed Hibbert, and new Members Jason Antony and Rory McGuire. A note: following a chat between us, Rory found that his grandfather's grandfather, Henry Grattan Douglass (1790-1865),[10] a physician from Dublin, was the first secretary of the Australian Philosophical Society and later helped re-form it into the Royal Society of N.S.W. He was also a vice president of the Mechan-

[9] See Bowler (2014) and Bowler et al. (1970), (1972). For a longer discussion of the issues between Indigenous peoples and archaeologists and science over the past 40 years, see Colley (2002). As members of the Royal Society, we should not always assume that science must trump the interests, ownership, and responsibilities of Aborigines.

[10] http://adb.anu.edu.au/biography/douglass-henry-grattan-1987

ics' School of Arts in 1850. And much more besides.[11]

While using the Trove database to confirm Dr. Douglass' role, I found the transcripts of seven papers presented to the Australian Philosophical Society in 1850 and 1851 and subsequently published in the popular press. I have added links to them in the *Journal* Archive[12]. Fortuitously, one is the earliest paper known on the utility of the bomareng (sic) (Mitchell 1851).

Stop press: On the fiftieth anniversary of Jim Bowler's first seeing the remains of Mungo Lady (July 15, 1968), he has written a piece in *The Conversation* (2018), arguing that inaction by state and federal authorities has deprived us "of that fundamental right to honour the dead to whom our history owes so much."

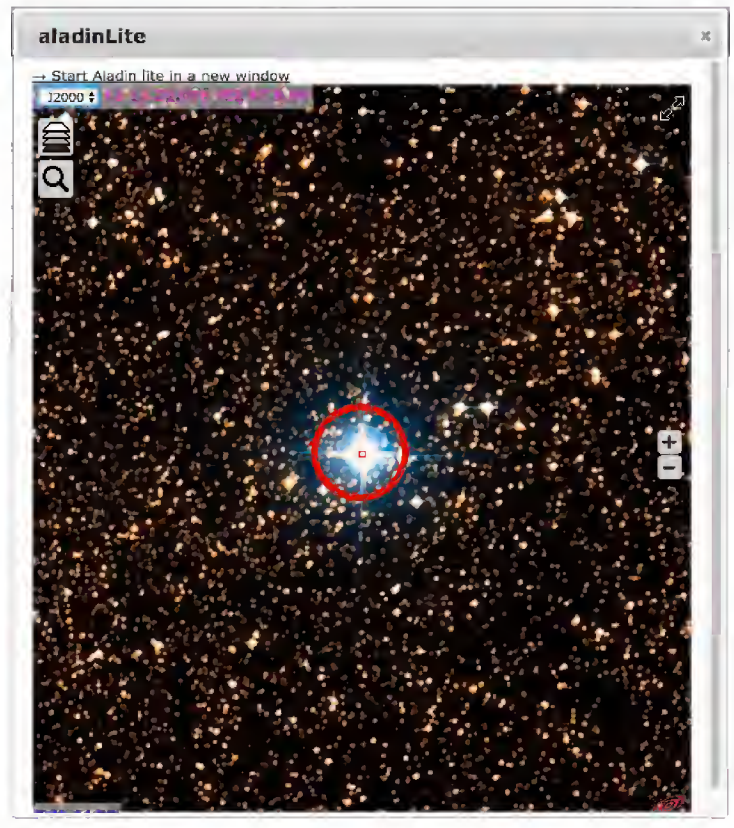
Ackowledgements

The photo of the stars made use of the "Aladin sky atlas" developed at CDS, Strasbourg Observatory, France (http://aladin.u-strasbg.fr). The photo was forwarded by Joanne Selfe of the Ngara Yura Program (images courtesy of VizieR).

Bonita

SSSC 803544
SAO 251838
GSC 897900623
1630 light years

Hot blue "B" star
Vis mag 9.26
Constellation Crux
RA 12h 18m 09.42s
Dec –63° 01' 14.1"



Koiki

SSSC 803504
SAO 251790
GSC 897805899
4800 light years

Hot blue "B" star
Vis mag 5.97
Constellation Crux
RA 12h 12m 12.9s
Dec -62° 57' 03.0"

[11] On page 16 of his inaugural address to the Royal Society, on 9 July, 1867, the Rev. W.B. Clarke (1867) reports that H.G. Douglass was the first Honorary Secretary of the Australian Philosophical Society, formed in 1850.

[12] https://royalsoc.org.au/links-to-papers-since-1856

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 5–13. ISSN 0035-9173/18/010005-09

Mungo Man imagined: writing the ultimate historical novel

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Abstract

On writing a historical novel about a man who died 42,000 years ago. This is an address given at the annual dinner of the Royal Society of New South Wales on May 18, 2018, by the recently elected Distinguished Fellow, noted novelist and historian, Tom Keneally.

Your Excellency, Governor General Hurley, and Mrs Hurley, Fellows, Members, and Guests, I have a mutual friend who works for the Hurleys, and while working for someone you generally see all their flaws. This woman, however, is unstoppable on their virtues and the way they have continued the heritage of Dame Marie Bashir and engagement with the Australian public. And if we have people like them serving the community, all an old republican like myself can say is "God save the Queen."

And I see with awe a list of Distinguished Fellows, including some that I know by sight, like Professor Peter Baume, and some I've read of, such as Dr. Michelle Simmons, quantum lady, Australian of the Year. These are names which would adorn any learned society anywhere on Earth. So, I'm very sensible of the honour of being given this from a high hand, and being amongst the Fellowship. I think I can genuinely claim to be the most poorly educated of all the Distinguished Fellows.

I would like to dedicate this little speech appropriately to the late Tommy Lewis, the Aboriginal actor whom Fred Schepisi, the Australian director, saw in an airport and asked to audition for the 1978 film. Traditional people in Australia, I've noticed, can all dance, can all sing, can all act, and as Tommy Lewis said to me once, "The Elders don't care whether you're in a picture or not, they think any idiot can do that, they only care about whether you've done your ceremony." Well, Tommy is now gone to join his ceremony: he died about ten days ago, and it's appropriate to dedicate this to him, as a fully initiated Roper River man.

My favourite place of pilgrimage in Australia is not Uluru or the Great Barrier Reef, but the dry lake bed named Mungo, awash with semi-desert plants like saltbush and cottonbush, where in 1974, Professor James Bowler discovered the largely intact and ritually buried skeleton of Mungo Man, who we now know to have lived at least 42,000 years in the past. It bears repeating. Mungo Man's DNA was laid down at least 42,000 years ago in the womb of a far-dispersed daughter of Mitochondrial Eve. His flesh expired at least 42,000 years ago. Some early estimates put his height at 5 foot 7 — which I think is a perfectly acceptable height — or 170 centimetres, but later modelling has suggested a height of over six feet and as high as 196 centimetres. He had in any case a robust frame except for osteoarthritis of the shoulder, possibly from hunting, but I think also possibly from knapping stone. They needed to knap a lot of stone out there and that had to have affected his shoulder. Significantly, he was missing two lower canines, which some propose indicated a ceremonial extrac-

tion early in his life. And he was buried by cooperative effort, involving a sacramental fire and encrustation with red ochre acquired by trade with a society of humans from two hundred kilometres away, beyond the present Darling River. His eloquently disposed bones speak to us of the reverent intervention of fellow members of our species, *Homo sapiens*, over a bridge of 42,000 (and some say many more) years.

I am often accused of being a "historical novelist". It is not an insult to be so called. But when I had an impulse to write imaginatively about the man found at Lake Mungo, our fellow Australian removed from us by those millennia, I did think, "I'll give 'em historical novelist. Is 42,000 years ago historical enough for you?"

I call Lake Mungo "Lake Learned" in the novel I'm writing, due to appear in Australia later this year. I call Jim Bowler Peter Jorgensen in the novel, and give him a Scandinavian blonde rather than Celtic ginger complexion. I write about fictional Learned Man, who is really Mungo Man, and fictional Peter Jorgensen, who is really a version of the very scholarly and very amiable Jim Bowler. This is an edited, penultimate version of the discovery, which is very like the real discovery by Professor Bowler. So, this is what I wrote in the novel, which is based very much on what Jim Bowler himself told me of the discovery:

> At the time of the discovery of astonishingly ancient Learned Man, some decades back, my friend Peter Jorgensen, whom I nicknamed the Viking, was testing dried lake basins and their sediments for records of ancient climatic oscillations. Ironically, modern heavy rain had kept him bound to the homestead of the old Lake Learned Station, where he had a bed in the shearers' quarters. This area had been in modern times marginal country in terms of rainfall. The Willandra Lakes are lakes in a different sense than European lakes. The European eye would facilely expect them to contain water from season to season — that is part of the northern hemisphere definition of a lake: lakes that assert their lake-ness by brimming and thus accommodating the eye. The Lake did hold water in the Old Man's day, and accommodated his eye. But now the average of ten inches a year did not fall predictably in all years, and did not come at all in some, although the saltbush of the basin made grazing sheep for wool viable …

In any case, on that historic day in 1974, as I describe in the novel, Jim Bowler, and his fictional counterpart, Peter Jorgensen, set out, as the ground dried, to the lunette at the eastern end of Mungo Lake, about 100 kilometres north of Balranald, N.S.W. He rode his motorbike off to the south of the lunette and to that big semicircle of sand dunes and hills of ancient lake sediments, which you will never forget should you see it and which will become part of the landscape of your imagination if you have been there. He abandoned the motorcycle, trudged up the hill, trudged up the layers of sediment, 70,000-year-old sediment, 60, 50, and so on, and saw a glint in the sand deposits.

In 1969 Bowler had already discovered a palaeolithic skeleton in those sand dunes: a cremated young woman who had been ritually buried with reverence but whose bones had been shattered in reverence as well, or, some would say, in fear. This was Mungo Lady, nearly two thousand years younger than Mungo Man, the man he was about to discover. But, although Jorgensen knew there must be other ancient remains, he was

not looking for them. Then he saw a glimpse of white, and it was the glint of the temple of Mungo Man's skull, exposed by rain, and this was the Old Man, Mungo Man, Learned Man of the novel, presenting his forehead. Late afternoon, and one of the Ancients had chosen to resurrect himself!

"It had the flavour of a willed meeting," I wrote. "Peter Jorgensen thought that he had found the Old Man, but he would always be mindful of what a Riverina woman elder of the Paakintji people would later tell him, 'You didn't find the Old Lady and the Old Man. They found you!'"

In his vastly popular book, *Sapiens,* the Israeli historian Yuval Noah Harari declares the journey of the first humans to Australia was one of the most important events in history. It was the first time, he says, that any human managed to leave the Afro-Asian ecological system, and was the first time that any large terrestrial had managed to cross that barrier, and it was the moment, when, upon entering Australia, humans became the dominant species. They were not yet dominant anywhere else on Earth.

The moment the first hunter-gatherer arrived on an Australian beach, says Harari, was the moment that *Homo sapiens* climbed to the top rung in the food chain on a particular landmass, thereby setting a pattern for all that was to happen on other continents, where our species did eventually become the dominant intelligence, and the dominant decider of what would happen to other species. Until then, humans had displayed some innovative adaptations and behaviours, but their effect upon the environment had been negligible.

The settlers of Australia did not merely adapt to the continent but, Harari argues, transformed the Australian ecosystem beyond recognition. The attraction of Mungo Man and his society and his ancestors, who preceded him onto the shore probably at least 15,000 years before then, was that they lived amongst megafauna: 200-kilo, two-metre-high kangaroos, an enormous diprotodon of two-and-a-half tonnes, like a giant, slow wombat, and a terrifying relative of the larger koalas, the marsupial lion, the largest carnivore on the continent, *Thylacoleo carnifex*, with its terrible prehensile claw, and its terrible teeth. *Carnifex*, in Latin, means executioner, as any member of the Society learnt in kindergarten, I think, and computer modelling on intact skeletons of this extinct beast has shown that it was immensely more efficient, by slashing jugulars and severing the spine, than any present living predator. But *Carnifex* ran up against *Homo sapiens*, a cleverer beast still, with cognitive skills beyond its magnificent capacities. So, Mungo Man and his society, according to Harari, were the people who put paid to long-gestation, small-litter megafauna. The other theory is that it was climate change, but Harari argues that climate change in Australia was not significant enough to have caused the extinctions. You can read his book, *Sapiens*, and encounter his claims.

There were also enormous perenties in Mungo Man's world: *Varanus giganteus*, two metres in length, and like the other animals, protein on claws, coming to the lake to drink. In the lake itself, of course, were predecessors of the Murray cod, and visiting migrating birds, and huge supplies of thirsty meat coming to the shore. And that was the world that Mungo Man lived in, and that was the world that triggered his imagination. There were intimidating snakes, tall koalas, and huge flightless birds. The balance between species in the Australian ecosystem was dis-

rupted, Harari and others controversially argue, by Mungo Man and his people.

In pointing the finger at the forebears of modern day Aboriginals in the matter of the death of the megafauna, Harari and others argue that the Ice Age that ended perhaps forty-five thousand or fewer years ago didn't produce results catastrophic enough to render the megafauna extinct all at once. If the diprotodon alone became extinct, that would have been a fluke, but more than 90 per cent of Australia's megafauna disappeared at the same time as the diprotodon. The small-litter, long-term gestation of many of the megafauna meant that they could not recover as quickly as did smaller, more prolific animals.

Guilty or not of the death of the megafauna, these fellow children of Mitochondrial Eve lived probably a far more bountiful and comfortable life than our ancestors did, beside a fifteen-foot-deep lake which contained such plenty, and to which were drawn waterbirds and the hinterland population of fauna. In such a merry situation, Mungo Man needed to travel for only the same reasons as we do now: for pilgrimage, education, romance and trade. What a wonderful quartet of human motivations!

The Mungo People were the inheritors too of the cognitive revolution, the powers of abstraction which characterised humans from about 70,000 years ago and which endowed them with potent but intangible concepts governing religion, art, identity and a universe of laws. (Fred Hollows was always waiting for another burst of DNA which would give us the further cognitive revolution in our brains, which would make us slightly less illogical; but it never came.)

I set about to write a story of two old men and their parallel deaths, separated by 42,000 millennia. One is a contemporary Australian movie director named, in the manner of smart-alec novelists, Shelby Apples, to honour Australian optimism — once, in a Green Room of a TV show Alan Alda said to me, "Who is this guy you Australians talk about, Shelby Apples?" and I thought that one day there must be a Shelby Apples. The second man is a fictional version of Mungo. I won't speak much of Shelby's story. Indeed, the two stories have seemed to some editors ill-matched, and I am still trying to prove by re-writes that they definitely and obviously belong together, even if Learned Man is a man of law and Shelby a man of cinematography, which itself, after all, has a place in law, as evidence and witness.

The issue of cultural appropriation arises. Mungo Man and Mungo Lady are seen as relatives and forebears by the three tribes whose country meets at Lake Mungo. One is the Paakintji ("People of the River"), the Darling River people, the others the Mutthi Mutthi of the Northern Riverina, and the Ngiyaampaa of the Menindee region. Quite appropriately, the three tribes feel a primary claim on Mungo Man.

Both Professor Bowler and the palaeontologist, the late Professor Alan Thorne, founder of the controversial Parallel Continuity theory of human development, became aware that they had committed a trespass and an abduction by taking remains away without reference to the traditional owners, and both went to some trouble to appease the justly aggrieved tribal owners and thenceforth to collaborate with them in creating protocols involving the discovery of ancient remains.

The Elders' abiding concept was that Mungo Man had come again to tell Australia something of great significance, a view that

the eighty-nine-year-old Jim Bowler shares to this day. He does not believe, either, that Mungo has finished speaking yet, and he certainly does not believe that white society, often through no fault of its own, has heard Mungo resonate.

Given the claim the three tribes have on him, by what right do I presume to write of Mungo, or, as he is in the novel, Learned? I merely claim secondary ownership in him as a (shorter, it seems) member of the same species, whose own forebears once lived a more materially impoverished life than Mungo did. Primary ownership and primary decision as to what befalls Mungo Man remain with the Elders. But I felt justified in purely imaginative terms to attempt to create in narrative a sort of Ur culture, the culture in which we know our forebears too were then participating. In justifying myself, in any case, I flashed the *Homo sapiens* badge, and — I believe — validly so. But it is true that there has been an emergence of great Aboriginal writers, including Jonathan Birch of Melbourne, Ellen van Neerven of Queensland, Alexis Wright and Michael Fogarty, and Aboriginal stories should be left to them. They own Aboriginal stories., and any cultural justice would say so, and any system of fraternal, creative etiquette would say so.

I had earlier said that I could not have written *The Chant of Jimmy Blacksmith* now, as I did in my white-man ignorance of the late 'sixties and early 'seventies. But, I felt I could claim Mungo Man, again in a secondary sense and at a prodigious distance of time, as my uncle, and my brother. And uncle and brother and fellow Australian of everyone in this room.

I decided that, as a token reparation for all the fractured English attributed to indigenous people in white writers' books, I would give my fictional Mungo an august voice, and set out to do so. But not only a kind of sticky white sentimentality reigned here, but something that has struck all observers of pre-literate societies. Culture does not cease for lack of literacy. In fact, as the Cambridge anthropologist Jack Goody says, instead of individual glories such as attach to Dickens and Dostoyevsky, Shakespeare and Shaw, rather, "one of the features of oral communication in pre-literate societies lies in its capacity to swallow up and to incorporate in a body of custom" the stories and images of any individual, and to compose them into a body of culture. The pre-literate man and woman speak richly — commentators would have us believe — from the implanted oral anthologies of their culture. The playwright of the Irish revival, J. M. Synge, in *The Playboy of the Western World*, presents us with a world where pre-literate Aran Islanders create the vividness of poetry in their daily speech. If all this is true, Mungo Man spoke in vivid tropes, not in grunts.

It is easy enough to begin in a voice for Learned Man, as I do:

> *O my Hero, I devote this account of my latter days to you* — he's addressing his hero in the sky, his ancestor — *so that you understand how well I love you and love the Earth, and know my duty to them, to all the Heroes, to all the beasts and to all the people. I am thinking pleasantly of the wrestling that comes at the start of the cold season, when we occupy equal days of moon and sun, the days when the half of everything yearns for the half of everything else, when ice sings to light, and when there should be efforts made at wholeness. So we come to the equal day-night wrestling, and to its banquet.*

We know about the antiquity of wrestling, and it is fair game as a novelist if not as a scholar to recruit it for a narrative of the palaeolithic world. We know about feasts, for there are areas out on the Lake Mungo lunette part glazed over by 31,000 years, till the end of the last ice age, of great traditional fireplaces. Here, at ceremonial times, haunches of megafauna were baked on radiant mulga coals in coatings of aromatic bark.

But we come to guesswork very quickly. If palaeolithic humans had the equivalent of cardinal points, what did they call them? How did they convey what we mean by, say, northwest? How did they count? There are some anthropological and paleontological hints in that area, but also contradictions of opinion. What did they make of seasons and how did they name them? Did they, like traditional Aboriginals, believe in journeys to the sky during sleep, and encounters there with the revelations and wishes of hero-ancestors? How did they manage society? Did they possess a system of moiety, clan, skin laws of the kind Aboriginal culture still lived by in the age of anthropology?

I was helped by my own inherent animism, my own unscientific sense that antediluvian presences, precedent and challenging, but not hostile, to my soul, inhabit the Australian landscape. I would assert, on the basis of personal mytho-poetic (forgive the pretension) experience, that animism and ancestor-worship are the two natural religions of humanity, or at least of myself and many other humans. And the connection between geology and zoology — the outcrop that transmutes to the marsupial lion — there are places in Australia where that happens on some level of our imaginations, and the world puts us in our place. As well as that I believe, utterly unscientifically, that the terrors and exultations and imageries and awes of all our forebears have left their traces in our imaginations.

And what was vegetation like in Ice Age Australia? There is a handy consensus for the idea that during ice ages savannah grasslands were more extensive in the interior, and forest not as common as since the last ice age.

As I wrote, Mungo Man induced in me an urgency, as he had in others, to make his presence amongst us more widely known. He is far more important than any novel, and so in 2016 I wrote to Malcolm Turnbull, putting to him that this was a chance to undertake a work of nation-building, requiring both Federal and State ministers:

October 13, 2016
The Hon. Malcolm Turnbull
Prime Minister
AUSTRALIA
Re: The Willandra Lakes World Heritage Site: The Chance for a Great World Heritage Site.

Dear Prime Minister,

I recently had a chance to speak on a Heritage issue with the amiable Minister of Environment and Heritage, Mr Mark Speakman. I have also spoken on this matter to my local member, Premier the Hon. Mike Baird. I feel though that the unique project I outlined to him and am now outlining to you will require national vision on the part of a Prime Minister, a Premier, and the commitment of both governments.

Mungo Man, a set of bones waiting on a bench at an Australia Museum depository for disposal and return to his native Willandra Lakes area north of Balranald, is 42,000 years old. Mungo Lady is a set of remains nearly as old. They represent the two oldest

human ritual burials we possess evidence of on Earth. These enormously ancient members of the species *Homo sapiens*, our species, were also members of a community which inhabited the lunette of Lake Mungo between 60,000 years Before the Present Era and the end of the last Ice Age. The remains of that community and of the environment it lived in are pervasive throughout the Willandra Lakes area in New South Wales. That community and its remains are nothing less than a world treasure. Most of Australia is, through no fault of its own, ignorant of it. May I suggest that this represents an oblivion which a visionary leader could put paid to, and all to massive Australian heritage, economic and social benefit.

There are have been plans for a Keeping Place of some kind for Mungo Man and Lady, plans involving input from interested parties and especially, and above all, from traditional owners, the three tribes, Mutthi Mutthi, Ngiyaampaa, and Paakintji, whose traditional territory all converges on Lake Mungo. But these plans have lacked direction and intent from the highest level of government.

You will see that in raising with you this huge national opportunity, I am influenced by the urgency of two noble men even older than me; firstly, Dr James Bowler, discoverer of Mungo Man and Mungo Lady and, secondly, the father of Australian palaeontology, the great scholar and author Dr John Mulvaney, who died last week. I attach to this letter their rather despairing letter to UNESCO about Australian inaction.

Like many Australians, I feel that if the appropriate disposal of Mungo Man's remains is made, the result will be a shrine not only for Australians, black and white, but for anyone interested in the history of *Homo sapiens*. Mungo Man is, in an extended sense, the heritage of all members of our species. He sheds light on what it is to be human, Aboriginal, and Australian in equal measure and in such a graphic way. For one thing, he represents a society that had language, religion and technology all that time ago. It is one of the oldest human communities we have ever had a glimmering into — and we have more than a glimmering into it, out there in Mungo — a community so old that it reflects on scientific issues such as when we left Africa, and when we began to speak.

It would be sad if Mungo Man were allowed to remain indefinitely in storage, or if, for lack of interest by government, the traditional owners are left with no option but to dispose privately of this incalculable treasure.

Apart from potential world interest in Mungo Man and the other remains, and the community and landscape they lived in, there is the consideration that a Keeping Place, organised according to the wishes of the traditional owners, could also provide great infrastructure and employment benefits for the region. It could also be a centre for learning for all young Australians, and of scholarship and education for the rest of us in general. It could also stand as our ultimate site of national reconciliation.

I have taken the liberty of including some notes on three World Heritage sites of the kind that benefit other modern nations at the same time as celebrating the ancient communities that occupied the sites. I see the Willandra Lakes people of 40,000 to 60,000 BPE as being potentially as engaging and intriguing to the world as are the remains of the Anasazi Pueblo dwelling areas at Mesa Verde National Park in Colorado; as

the ruins of Petra in Jordan; and as the great Heritage Centre at Ceide Fields in County Mayo. All these are national treasures in their countries and attract world attention and international visitors. And yet, just as Mungo Man himself is at least fifteen times older than Tutankhamen and the society of the New Empire of Egypt, so the Willandra Lakes story is over twenty times older than that of Petra, nearly ten times older than Ceide Fields, and forty times older than the cliff houses of Mesa Verde.

I hope it is not too crass of me to suggest that it would be a wonderful thing if your government, at a time when we are considering a respectful constitutional recognition of indigenous stewardship and occupation of Australia, were responsible for combining with traditional owners to move this treasure from the shadows to a place where it could occupy its proper place in the geography and imaginations of our people.

As ever, my warmest wishes,
Thomas Keneally

Malcolm Turnbull's reply was amiable, urbane and non-conclusive, but he hadn't caught the bug, sadly.

As you may know, last year, after his sojourn at the A. N. U. and on a shelf in a Museum of Australia repository, Mungo Man was returned to his country by important men and women of the three tribes and a number of others, including the Yorta Yorta. Jim Bowler was there, following the Elders, to see Mungo's casket laid in an underground safe. But not a single cabinet minister, state or federal, not a single member of parliament, state or federal, appeared to witness the passage of this exceptional, ancient Australian, the Australian not of one year, but of millennia upon millennia. His movement could have shaken the earth not only for indigenes but also for us, who in these matters so badly need enlightenment. One wonders if there are forces that do not want to join Mungo's story to the story told in two recent revolutionary books about who Aborigines were, and how they lived: Canberra historian Bill Gammage's *The Biggest Estate on Earth* and Victorian Aboriginal Bruce Pascoe's *Dark Emu*.

All I can say to my uncle and Elder, Mungo Man, is: "Keep talking!" But the idea that Mungo has finished speaking to us is not yet true, because we do not know of him generally, because he is a minority sport who deserves to be a major one. He will, along with Bill Gammage's *The Biggest Estate on Earth* and Bruce Pascoe's *Dark Emu,* bring us a new version of Australian history. One which will legitimise both races, and one which will unify us in the future.

So all I can say to my uncle and Elder, Mungo Man, is "Keep talking!," for though my book will probably go straight through to the keeper, Mungo Man is the one who without ball tampering will in the end take the most difficult cosmic wicket — and that is the wicket of our popularly accepted, nonsense version of pre-history.

Thank you.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 14–21. ISSN 0035-9173/18/010014-08

We must set the bar high and tell students we expect them to jump over it

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Abstract

The 2018 Australian of the Year is quantum physicist, Michelle Simmons. Below is reprinted the address she gave on Australia Day, 24 January, 2017; she was elected FRS in May 2018.

His Excellency, the Governor of New South Wales and Mrs Hurley; the Honourable Gladys Berejiklian, Premier of New South Wales; chairman and board members of the Australia Day Council of New South Wales, distinguished guests, ladies and gentlemen. It feels very odd for me to be here today.

I went to a pretty rough school, a south-east London comprehensive. Out of the 200-300 students in my year, only 16 of them did A Levels (that's the equivalent of the HSC); and, of those, only two passed.

I have always been an introvert. As a child, I hated the limelight; I still do. In my English literature lessons at secondary school, our teacher used to go systematically around the class to encourage each of us [to learn] to read out aloud. Such was my fear of public speaking, however, that instead I quickly learnt to shift desks every day so I made it through the whole four years without having to speak up once.

What's more, growing up in that part of England, I was not raised within a culture that said: "It would be essential to go to university, let alone leave Britain and set up a life at the other end of the earth."

So, if someone had told me 30 or 40 years ago that I would one day be asked to deliver an Australia Day address, you can imagine I would never have believed them.

Yet life is full of ironies. In my south-east London home, when I was a little girl, I had an older brother Gary who, whenever I got a little too annoying, used to joke with me: "One day I am going to buy you a one-way ticket to Australia."

As things turned out, he didn't need to because, in 1999, I came here of my own volition; and in 2007, I became an Australian citizen. When I say that, all the little hairs on the back of my neck stand up and I feel really proud to be Australian.

For some reason, though, I always kept that plane ticket that brought me over here, and just a year ago I had it framed and sent to my brother for his 50th birthday. Ironically, and a little sad for my father, my brother now lives in the US and I live here and I joke with Gary that I got the much better deal. Only, for me, it's not a joke. I really believe it. I genuinely do believe it is better here than over there. And the 26th of January, Australia Day, is one day when I can say this wholeheartedly without feeling as though I am bragging.

Today is a day for celebrating Australia: the wonderful country it is, and all the opportunities it offers. And to this end I want to share with you why I came here — and why I choose to stay. Along the way, I hope to describe to you why I think Australia is a great place to be for anyone interested in scientific discovery and innovation.

I also want to leave you with a sense of why Australia is well placed to realise the next revolution in computing — the quantum revolution.

But let me begin by telling you how unexpected it was for me to become an Australian. A physics PhD is, in a sense, a passport to the world, and I was lucky in my early career because I gained some terrific experience in excellent research groups in the UK. I went to Durham University in the north of England where I was able to design and build electronic devices — solar cells for capturing the sun's energy. I then went to Cambridge University in the south of England where I learnt the complexity and fragility of discovering new quantum effects. This is the weird physics that emerges when dealing with [the] world as it gets very small — in particular when we get down to the size of individual atoms (the fundamental building blocks of nature from which we are all made), which are approximately a million times smaller than the width of a human hair.

Working at Cambridge, in the semiconductor physics group, I learnt to design, fabricate and measure my own samples — three completely different skill sets, a unique combination that really makes you the master of your own destiny. But there also came a point when I wanted to find a more ambitious project to work on than the very fundamental physics they were doing there. Specifically, I was drawn to the technological challenge of trying to create new devices that had never been made before, where each atom had to be put in place to engineer a particular effect — in essence to create electronic devices at the atomic scale.

It was this that brought me to Australia.

Back in the 1980s, IBM invented a new kind of microscope, which, for the first time, enabled humans to "see" on the atomic scale. These are fabulous tools — giant stainless steel contraptions that fill a room with a vacuum inside akin to that in outer space. As with so much in science, the machine itself looks incredibly complicated from the outside, but the principle of its operation is simple. They are built around a very fine metal tip, which we bring down, under electrical control, towards a sample surface. When it is in close contact with the surface, electrons tunnel from the tip to the sample and create a current. We measure this current and keep it constant as we scan the tip across the surface, hence the term "scanning tunnelling microscope" (STM). We scan the atoms across the surface rather like a TV screen to build a topographic image of the surface.

The invention of this microscope enabled scientists to see individual atoms for the first time and to observe how the arrangement of the atoms on a surface was completely different to those in the bulk crystal. When we cut the surface, we remove the atoms above, causing the atoms at the surface to rearrange, moving closer together to lower their energy. Since most of life's processes occur at surfaces or interfaces, being able to actually see atoms and understand how they behave differently at surfaces was a huge breakthrough. This was, then, an incredibly important discovery. The STM, as a consequence, was one of the fastest inventions to

win the Nobel Prize, just four years after its discovery in 1984.

But seeing atoms was just the beginning. In the 1990s, IBM found a way to exploit this technology to go one step further and to actually move atoms around on a surface. Using an early scanning tunnelling microscope, they formed the world's smallest logo — the letters I, B, and M — out of atoms of xenon on a copper surface. That was a great demonstration of technological prowess — to be able not just to image atoms but to manipulate them. But it is one thing to push a few atoms around and make a logo, and quite another thing to take that technology and create an electronic device where the active, functional component is a single atom.

It was in the hope of realising this dream that, in 1998, I applied for fellowships in Australia and in Cambridge, and for a faculty position at Stanford in the US. As a young academic we are taught that the prestige of the institutions that we work at is very important. However, when I was offered the Australian fellowship, I accepted immediately and pulled out of the other two processes. It was a decision, I'll be honest with you, that perplexed not only my colleagues overseas, but also many Australians. When I arrived here, people would ask me, "Why on earth did you come?" But the choice was easy.

In practical terms, I did not want to stay in Cambridge. The structure was too hierarchical and the research was esoteric. Who cares if you can answer a fundamental physics question? I wanted to build something — something that could prove to be useful. The British research system also offered that wonderful possibility of working with pessimistic academics who will tell you a thousand reasons why your ideas will not work.

American culture was more appealing than this, but it too had its limitations. The US offered a highly competitive environment where you would fight both externally and internally for funds and be beholden to a senior mentor. Their system also restricted responsibility for the early-career researcher, whereas Australia offered the freedom of independent fellowships and the ability to work on large-scale projects with other academics from across the country.

Seriously, there was absolutely no competition. To this day, I am delighted with my choice and firmly believe that there is no better place to undertake research. Australia offers a culture of academic freedom, openness to ideas, and an amazing willingness to pursue goals that are ambitious. And the results speak for themselves — we have achieved tremendous success in our endeavour, largely because we gave things a go that the rest of the world didn't dare to try, as I hope I will explain.

When I moved to Australia, back in 1990, silicon device research was focused on Moore's Law. Have you ever noticed that every year your computing devices are getting smaller and faster? Many years ago, Gordon Moore, the co-founder of Intel, noted that the number of transistors on a silicon chip was doubling every 18 months to two years. In practice, this meant that each individual transistor had to be decreasing in size at the same rate. The amazing thing about this law is that in the late 1990s you could plot the size of future transistors as a function of time, allowing us to predict that by 2020, we would reach the level of individual atoms.

With the industrial world focused on the iterative process of making devices smaller and smaller each year to maintain their

margins, back in 1999, with a few others I hatched a plan. The plan was to focus on adapting the technology that existed to image atoms to see if we could make a functional electronic device where the active component was a single atom — in other words to leapfrog the global IT industry and make devices on the atomic scale.

This ambition was fuelled by a separate theoretical proposal coming out from Australia back in 1998 which suggested, if we could control things at the atomic scale, then we could make a completely new type of computer that worked entirely on quantum physics.

Such a computer is called a "quantum computer" and is predicted to bring with it an exponential speed-up in computational power. This is because, instead of performing calculations one after the other like a conventional computer, a quantum computer works in parallel, looking at all the possible outcomes at the same time. The result is massively parallel computing, allowing us to solve problems in minutes that otherwise would take thousands of years.

One thinks here of problems where computers work on large data bases or consider lots of variables, problems such as predicting the weather, stock markets, optimising speech, facial and object recognition (such as self-driving cars), looking at optimising aircraft design, targeting drug development to the patient's DNA, optimising traffic flow and working out the shortest possible delivery routes. UPS in the US have determined that if they could shorten the distance that every one of their drivers travels each day by one mile, they would save their company $50 million per year. That's an ideal problem for a quantum computer. But this is a capability with widespread application. Indeed, a US defence firm has predicted that 40 per cent of all Australian industry will be impacted if we can realise this technology.

The potential rewards are certainly significant. I firmly believed when I arrived here that we had a viable yet ambitious pathway to get there. Yet, when we first proposed our concept, there were many critics all over the world, including senior scientists at IBM, who said that, whilst it was a nice idea, there were many technical challenges that had to be overcome. We identified eight different steps, none of which had been demonstrated. The consensus view within the global scientific community was that the chances of our getting through all eight stages were near impossible.

On top of this, to make things work, we had to combine two technologies: linking the STM (which provides the ability to measure and manipulate individual atoms) with another technology called molecular beam epitaxy (MBE) which allows us to grow, layer by layer, material to protect the atoms we have put down.

Both these instruments must operate under ultra-high vacuum, but no one had successfully combined the two, and they seemed incompatible: the STM system needed low vibrational noise to have the sensitivity to image individual atoms, while the MBE system had very large pumps to ensure high purity crystal growth — pumps that caused a great deal of vibration. It was high risk. When I told the two independent system manufacturers in Germany about the idea, they said they would make a system to my design, but that there would be no guarantee that it would work. And, for a combined system that cost $3.5 million, that was a pretty big risk!

It took two years from the design of the system to its delivery and set-up and was a nail-biting time for my career. It explains where a lot of my grey hairs started to come in. It was hosted in two specially designed adjacent laboratories but connected through the wall.

Did it work? I think I wouldn't be here if it hadn't! But to my delight it worked a factor of six better than I had hoped. And over the past decade we have systematically solved all those eight challenges that were predicted to block our way. In fact, the video[1] shows the step-by-step process we have developed by which we place and build electronic devices using a single phosphorus atom in silicon — the phosphorus being the atom on which we encode information for the atomic-scale computer.

In recent years, we have used this unique technology right here in Sydney to create a stack of world-first atomic-scale devices. We have built the world's smallest transistor where the active functional part is just a single atom beating those industry predictions from Moore's Law by nearly a decade. Following this, we fabricated the world's narrowest conducting wires in silicon, just four atoms wide with the same current-carrying capability of copper. We are systematically working towards demonstrating all the individual components of a 10-qubit system, which we hope to achieve within the next five years. Using this technique, we have shown that, in addition to placing the atoms and wires, we have built unique transistors that we can align next to the atoms with sub-nanometre precision to initialise and read out information on these atoms. We have demonstrated a concept like entanglement between the atoms where the state of one atom depends on the other — rather like a marriage. It does, however, have the added "quantum" benefit that both parties can read each other's minds. It's a beautiful world to be in.

Finally, we have moved to two-, three- and four-qubit architectures and shown our long-term ability using our STM to pattern a 1024 atomic precision array. These achievements have been published not only in the usual scientific places. My team were in the orders today and I'm very proud of them. They have also made it into *Guinness World Records* — as my son discovered one day to his great surprise while sitting in his school library.

On the back of this success, we have attracted to Australia some incredible young scientists from all parts of the world — from Europe, the UK, the US, and Asia — some of whom, I'm delighted to say, have decided to make Australia their permanent home too. We have also patented this technology extensively at each stage and remain the only group in the world that can make electronic devices at the atomic scale. Most exciting of all, though, is that we are now on a mission to build a complete prototype quantum computer for which all the functional elements are manufactured and controlled at the atomic scale.

The significance of this for Australia should not be underestimated. Today, there is an international race to build a quantum computer and the field is highly competitive — nicknamed the space race of the computing era. There are currently four fast-moving potential implementations for making this work: one based upon superconducting circuits; one based on ion traps; one

[1] https://newsroom.unsw.edu.au/news/science-tech/seeing-believing-precision-atom-qubits-achieve-milestone

based upon a theoretical proposal involving rare sub-atomic particles called the Majorana fermions; and one based in the industrial-compatible silicon material. We are the world leaders in the last area, where Australia has established a unique approach with a globally competitive edge that has been described by our US funding agencies as having a two- to three-year lead over the rest of the world.

It is nail biting, it's exciting and it's happening here right now in Sydney. But what really inspires me now is that we are at the threshold of making this into something practical and real, with a demonstrable benefit.

Over the past three years, we have established a unique government/industry/university consortium with the focused aim of building a 10-qubit prototype quantum computer right here in Australia. It's not going to be easy. Technologically and scientifically, we face a new set of challenges as we scale up. I am acutely conscious too that getting these types of inter-sectoral undertakings off the ground is very difficult — more difficult, in fact, than some of the scientific challenges in quantum physics that I've faced in my career! To take things to the next level, we need to work across different cultures, where goals and expectations may sometimes be at odds.

Yet strangely, in this country, as in other parts of the world, we tend to institutionalise our researchers and to blinker them to the advantages and skills of their colleagues in other sectors. Thus, in the academic world, it is surprisingly common for people to disparage the profit motive and the private sector; while, in the commercial world, one often hears people denigrating the ivory-tower mentality of academics. And between both groups, I think governments sometimes struggle to understand either side of this equation. Yet parties fulfil important but different roles in our society, and play complementary parts in making new discoveries and in developing them into products or services of value to society. Sometimes we need to work together.

Given the importance of quantum information for the finance, health, transportation and logistics industries, and for the computing and communications industries, it is natural for Australian industry to begin to invest in this area. And in this regard, I have had the great fortune to work with outstanding trailblazers in some of Australia's leading high-technology companies, including the Commonwealth Bank and Telstra — an experience that has transformed my view of Australia's technological prowess in the commercial sphere. I am serious — if anyone can help us to make it happen, it is these guys. The technology leaders at these organisations are sharp, on the ball, an absolute delight to work with and at the very top of their game.

To do what we are planning we will all need to be. Quantum physics is hard. Technology at the forefront of human endeavour is hard. But that is what makes it worth it. I strongly believe that the things that are most worth doing in life are nearly always hard to do.

Which brings me back to the beginning, and to the fundamental lessons I learnt as a child. When I was growing up in England, before I became an Australian, I always knew that I liked doing things that were difficult — things that you had to try really hard to succeed at but that, when you did, the euphoria was immense. It is interesting, therefore, to admit now that I actually gave up physics

at O Level as I also really enjoyed biology, chemistry, history and English literature. (Career advice at the time encouraged people to follow the subjects they enjoyed the most.) Shortly into my O Level year, however, I knew I had made an awful mistake. While I enjoyed these subjects, they didn't challenge me. I realised then that my greatest joy was solving problems that were complex and not so instantly rewarding to do.

The consequence for me was I ended up doing physics outside of school, and it took me a while to catch up. The lesson I learnt was you can always do the things you enjoy and find easy outside of work. But problem solving and technical skills require consistent effort and are not so easy to pick up at any time in life. For me, it was better to do the things that have the greatest reward. Things that are hard, not easy. And things that will continue to challenge you throughout your life.

Now, there's a message here for our educators, our scientists and for all Australians. First, science education.

Great teachers with high expectations challenge their students to be the best they can be. But equally important are the curricula that they teach. One of the few things that horrified me when I arrived in Australia was to discover that, several years ago, the high school physics curriculum was "feminised." In other words, to make it more appealing to girls, our curricula designers in the bureaucracy substituted formulæ with essays! What a disaster. From the students coming to university, I see little evidence that this has made any difference and indeed I see many students complaining that the physics curriculum has left them ill equipped for university.

In my experience, there is a big cost in this type of thinking. When we reduce the quality of education that anyone receives, we reduce the expectations we have of them. If we want young people to be the best they can be (at anything) we must set the bar high and tell them we expect them to jump over it. My strong belief is that we need to be teaching all students — girls and boys — to have high expectations of themselves.

What about our scientists?

Our country has established centres of excellence that are the envy of scientists across the globe, in areas like robotic vision, astronomy, big data, gravitational wave discovery, brain function, ageing and ecology. Collectively, these initiatives continue to attract brilliant people from all over the world — most of whom come, no doubt, with a shared sense of hope and excitement, just like the one I held, and still hold, for this place.

Remarkably, three of these centres of excellence are focused on quantum physics and related technologies — each with a particular presence here in NSW. Australia, for some reason, is disproportionately strong in quantum information science. And, with billions of dollars of investment going into this field across the world, our next challenge is to see whether we can benefit from our international lead, to try to translate that research into high-technology industries here in Australia.

Finally, there's a broader message for all Australians. In Australia, when praising ourselves, even on occasions like this one, we tend to emphasise the beauty of our natural environment, our great lifestyle, and the easy-going nature of our people. The lucky country. I think this is a mistake, because it doesn't acknowledge the hard work that

people have done to be successful and it encourages us to shy away from difficult challenges. In short, I believe it will eventually stop us from being as ambitious as we might be.

Of course, ours is a country of great spirit and enormous promise — something that outsiders don't always appreciate. With our inherent scepticism towards dogma and our openness and collaborative spirit, Australians are natural discoverers. We are also problem-solvers who like to get things done. But is this enough?

As we take things to the next phase of trying to build a prototype quantum computer, I feel proud to be a part of the team that is going to make this happen. I am grateful for that Australian spirit to give things a go, and our enduring sense of possibility. In this, we have so much to be thankful for — and, more importantly, so much to look forward to. But there is room for improvement as well. In our innovation policies, in our education system, and in the ambitions of our scientists and discoverers, I want Australians above all to be known as people who do the hard things.

Thank you, and happy Australia Day.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 22–24. ISSN 0035-9173/18/010022-03

The Future of Rationality in a Post-Truth World

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Abstract

This is the opening address given by His Excellency General The Honourable David Hurley AC DSC (Ret'd), Governor of New South Wales, to the *Royal Society of New South Wales and Four Academies Forum* on *The Future of Rationality in a Post-Truth World* on Wednesday, 29th November 2017.

Ladies and Gentlemen, I am delighted to welcome you for this third annual Royal Society and Four Academies Forum, "The Future of Rationality in a Post-Truth World."

Before we commence, let me acknowledge the ancestral knowledge systems of our traditional custodians, who have sustained this land for tens of thousands of years. I pay my respects to Gadigal Elders, past, present and future, and to all Aboriginal and Torres Strait Islander Peoples.

I would like to acknowledge Professor Brynn Hibbert, Professor Mary O'Kane, distinguished Law Society and Academy Fellows and their representatives, and presenters and members.

I began this series of forums three years ago when I first became Governor of New South Wales.

Upon my appointment as Governor, I found that there were three "Cs" to the role of Governor—which relate to the Constitutional, Ceremonial and Community engagement roles of the appointment. Constitutional and ceremonial duties took about 10 per cent of my time.

Ninety per cent of my time was involved in engaging with the people of New South Wales. It was clear to me that I needed a strategic direction and a business plan for both my role and Government House. In the area of community engagement, I wanted to value-add to the role.

When looking at my predecessors, I considered the role of Governor Brisbane in the establishment of the Philosophical Society of Australasia. Why was that link in place? Obviously, the roles and functions, the authorities of Governors have changed since Brisbane's days. The role of the Governor—then—was to try to help the development of the early community, including its intellectual life, and see the great potential that existed in Australia. Why should that not be the role of the Governor now? I thought I should follow in those footsteps.

I considered that one of the things I could do as Patron of the Royal Society would be to provide an opportunity to have a "think-tank" here at Government House where we could look at some of the bigger and more difficult issues that are facing us today in a political sense, in a neutral academic environment. That's the course we have undertaken.

It's often hard to have discourse and discussion in public life these days without divisiveness being drawn to people's attention. If you have two views, then there must be

division, and division creates conflict; conflict creates news. That seems to be the way of our media and news channels. This Forum is not about that: it's about examining issues of importance to our society.

The topic we'll look at today is not new, but there are aspects of it that have changed. For example, if we take the American journalist, critic and theorist H.L. Mencken, we may have different views about him as a person, but he's very rich in comments about democracy.

"Democracy is a pathetic belief in the collective wisdom of individual ignorance" was a comment written in 1926, or thereabouts. He had a view that our right to individual speech—and our right to have an opinion—does not necessarily make that opinion, in itself, "right." Therefore, how do we engage with the community, with people, with institutions, with policy makers?

We now have transient "fake news," "alternative facts," and "post-truth" discourse—these are not new ideas but, perhaps, different titles. Of course, "post-truth" was the word of the year for 2016 in the *Oxford Dictionary*. It has now created an industry and many books are written on "post-truth."

So, is the topic we are about to discuss something *new*—or something *old* with a new title? Is it an old or a new phenomenon? Is it the result of today's staggering growth in information data and social media which has brought it to the surface?

Or is something more concerning in play?

If we look at the history and development of our civilisation, primarily western civilisation, rationality has been one of its foundation stones.

A number of years ago I did a post-graduate course at Deakin University. I had to write a paper on rational decision-making and a proposed plan to have a second airport in Sydney. This was in 1993. I came to the conclusion that we were far removed from the point of being able to make that decision, because if you looked at the process we were going through at that time, we were not making a rational decision about a second airport. I claim no position on any decision that's been made recently.

But what are the alternatives to rationality? Of course, subjective belief, faith, selective opinions, stand on this ground. What do they mean for science, for society, for democracies as we know it—and, therefore, for our future? Are these really threats or are they impacts that new technology, new ways of doing business have introduced to the society that we have? Is democracy on the decline? Is there a threat to democracy that will increase that decline or are we going through a growth spurt in democracy, where it is just a different type of democracy that is emerging that has challenged us as never before?

If we believe this, why do we wring our hands instead of girding our loins? If we believe in it, we defend it, we promote it; we take it forward. I reference George Orwell through a quotation from a letter he wrote in 1944: [1]

> (I fear) the horrors of emotional nationalism and a tendency to disbelieve in the existence of objective truth because all the facts have to fit in with the words and the prophecies of some infallible fuhrer.
>
> Already history has, in a sense, ceased to exist. That is, there is no such thing as a history of our own times which can be

[1] https://www.thedailybeast.com/george-orwells-letter-on-why-he-wrote-1984

> universally accepted, and the exact sciences are endangered as soon as military necessity ceases to keep people up to the mark.
>
> But if the sort of world that I'm afraid of arrives, the world of two or three great superstates which are unable to conquer one another, two and two could become five, if the fuhrer wished it.

I would like to remind you of when these words were written: 1944.

I could quote from Orwell's novel — *Nineteen Eighty-Four* — about the falsification of history:

> I know, of course, that the past is falsified but it would never be possible for me to prove it even when I did the falsification myself. After the thing is done, no evidence ever remains. The only evidence is inside my own mind.

Is this "falsification" another aspect of the issue that we will discuss today? What is "truth"? What is "post-truth"? How do we deal with it as a democracy and a society? More importantly, how do we assist decision-makers in performing their duties? And that's what we should be aiming towards — to assist, to enable, to take our society forward.

The "big plus" from today is bringing together four Academies, which may not, on a daily basis, come together. That's one of the purposes of this forum: collaboration.

Today is a day for some very intriguing presentations. At the end of it, I hope we will come out of this Forum more engaged and enlightened on these issues.

It is my honour to now introduce the third Royal Society of New South Wales and Four Academies Forum: *The Future of Rationality in a Post-Truth World*.

Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 25–27. ISSN 0035-9173/18/010025-03

The Chief Scientist & Engineer's view

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Rationality in a post-truth world

This is a timely topic. According to Wikipedia[1], while the term "post-truth" is 25 years old, the term largely came into heavy use during elections in several countries in 2016. These elections were characterised by strong populist trends. As this Wikipedia entry notes: "The term 'post-truth politics' was coined by the blogger David Roberts in a blog post for *Grist* on 1 April 2010, where it was defined as 'a political culture in which politics (public opinion and media narratives[2]) have become almost entirely disconnected from policy (the substance of legislation).'"

CSE sees a version of this involving science issues

The Chief Scientist & Engineer (CSE) has been asked by Government to review or provide comment on many matters where the issue is ostensibly a science one but it is often one where the science issues are accompanied by very strong emotions. I suggest these are examples of the science version of post-truth problems.

We often note that these issues are typically wicked problems. According to Wikipedia,[3] "a *wicked problem* is a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize. The use of the term 'wicked' here has come to denote resistance to resolution, rather than evil. Moreover, because of complex interdependencies, the effort to solve one aspect of a wicked problem may reveal or create other problems."

Examples of wicked problems the Chief Scientist & Engineer has been asked to deal with include the following:

- Review of Coal Seam Gas activities in NSW
- Review into the Decline of Koala Populations in NSW
- Energy Security Taskforce — The energy crisis in Australia
- Independent Review of Rail Coal Dust Emissions
- Advisory Committee on Tunnel Air Quality
- PFAS/PFOA Contamination, often from military bases
- Sea-level-rise advice
- The rat population of Lord Howe Island
- Medicinal Cannabis.

In all of these, we found that people can be enormously distressed about many aspects of the issue. Moreover, unlikely coalitions can emerge, e.g. in the case of Coal Seam Gas we had a strong coalition between Lock the Gate and the National Farmers Federation.

[1] https://en.wikipedia.org/wiki/Post-truth_politics

[2] https://en.wikipedia.org/wiki/Narrative

[3] https://en.wikipedia.org/wiki/Wicked_problem

What characterised the CSG issue in NSW?

As an example, let's consider the CSG Review. Extracting coal seam gas in NSW is relatively straightforward technologically, but it needs to operate within a strong regulatory framework to deal with the community concerns. The main community concerns about proceeding with it were:

- land access issues
- land value issues
- could the industry be regulated effectively given its distributed nature?
- fear of fracking chemicals and resultant health concerns (particularly in the light of the movie *Gasland*)
- would fracking induce seismicity?
- would fracking chemicals cause contamination?
- subsidence
- surface, groundwater, and aquifer contamination
- aquifer wrecking by drawing down water
- gas coming into drinking water —lighting the Condamine
- produced water including radioactive salts; would it wreck the soil?
- air-quality impacts
- bad behaviour on the part of CSG companies, e.g. unauthorised access to land (hence *Lock the Gate*), trucks tearing up narrow country roads, etc.
- trustworthiness (or lack of) of CSG companies and governments.

A lot of the objections were rational … but based on odd premises

The Office of the Chief Scientist & Engineer (OCSE) carried out extensive community consultation as part of the Review. Many of the arguments proffered to the Review were rational but a large number were based on odd, mistaken or only partially correct premises. When we discussed the matter with those consulted, it became clear that their starting "facts" often came from poor media stories. People are often too time-poor to spend time sifting fact from fiction or partial fact. They are often sceptical about government sources, citing bad past experiences with chemical spills, PFAS, dangerous side-effects of drugs they were not warned about, Three Mile Island, etc. They are more inclined to think "there is something to" press stories emphasizing dangers.

It would seem we are in a "post-factual" world (see Barber 2017). And the largely positive (at least with positive outweighing negative) contributions of science (e.g. sanitation, antibiotics, refrigeration, telecommunication, motorised transport, the internet, etc.) are taken for granted or forgotten Maybe just as we take democracy for granted!

So what did we do in the Review?

In carrying out the Review we tried to get a handle on these matters. Some of the things we did included the following. We:

- listened to as many different groups as we could, striving always to be respectful
- commissioned a study of the community psychological issues
- considered the literature worldwide including the grey literature
- held extensive community consultations —— everywhere affected and with all key stakeholder groups
- established processes for managing potential conflicts of interest.
- recruited staff: engineers, scientists, writers, media expert
- commissioned parallel reports from multiple experts on a range of topics relevant to the issue

- held workshops of top experts from different fields and cognate fields to identify and tackle the issues — with robust discussions to really stress test matters
- developed a detailed sampling approach to understanding whether regulatory compliance was adequate (it wasn't)
- published all reports we commissioned, including parallel reports we commissioned from different experts which often were partially conflicting
- always answered press queries
- responded to all invitations for the CSE to give speeches on the matter
- pointed out everyone's rights under the Government Information Public Access Act (GIPA), noting everyone has open access rights with respect to government documents and data in NSW
- encouraged open data mechanisms so that compliance with all environmental conditions imposed on CSG and mining companies can be monitored by everyone. Specifically we recommended the creation of the Whole-of-Environment Data Repository for this (see Recommendation 10 in the Report of the Review, CSE 2014)
- were careful with our use of language, for example:
  - ◊ no "chemical" — bad. As in 'nasty chemicals'
  - ◊ no "renewable energy" — good. (Though that is getting more mixed with wind farm objections.)
  - ◊ no "clean, green".

So where does this leave us? What should we do?

In my time as Chief Scientist & Engineer it has been very important to me that the work coming out of the Office is "just the facts, ma'am", not advocacy, not spin.

Some things I've learned along the way:

- Science doesn't stand still and it's about finding an intelligent way through the problem given the state of knowledge at present, acknowledging and emphasising there is always more to find out.
- It is important to pose the problem well in an effort to try to understand the *real* problem.
- It is important to get multiple views from the experts; don't rely on one expert only on any given topic.
- Empower people to ask questions — promote openness and always recommend open data and better communication.
- Encourage governments to be preemptive in anticipating community concerns. They need to encourage well-founded and robust discussion before policies are finalised.

In other words, science, at least to some extent, can be a vital part of governments regaining trust when dealing with wicked problems. Science can help governments reconnect politics with policy in a post-truth and post-factual world.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 28–38. ISSN 0035-9173/18/010028-11

Rationality and post-truth — the threat to democratic society

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Abstract

Two-thirds of Americans get at least some of their news from Facebook and over half get some of their news from Twitter. What has happened to reason? The post-modernists and relativists are in the ascendancy. The great Enlightenment philosopher David Hume said that errors in religion are dangerous but that errors in philosophy are only ridiculous. That is not the case. Rejecting established sources of reason and accepting that belief should have equal sway with fact puts an open, free society in great danger.

This paper examines two issues: what is meant by the words "is true"? And the criteria for truth — how can we establish whether something is true or false? The situation is further complicated by the cognitive processes humans used to consider these issues. To determine whether a judgement, a choice, or a decision is likely to be successful, there are two to things consider. First: is the judgement rational — that is, is it coherent with the prevailing paradigm? and second: is the judgement accurate – does it correspond to established, accepted facts? Both are necessary for a sound judgement to be reached but neither is sufficient. But human cognition is flawed – our rationality is bounded and this can lead to serious errors.

Bringing these two subjects together – philosophy and cognitive psychology – can give some insight into the nature of post-truth and the implicit threat to our open, democratic society.

Introduction

What a mess! Why can't people be sensible! Wherever we turn, there are astrologers, homeopaths, conspiracy theorists, miracle workers and anti-vaxers. Politicians prefer to follow their "gut instinct" rather than evidence-based rationale. The internet has made everyone an expert! Two-thirds of Americans get at least some of their news from Facebook and over half get some from Twitter. How much substance can there be in 140 characters? Is it the case that only twits tweet? Are the post-modernists and relativists in the ascendancy? What has happened to reason?

The great Enlightenment philosopher David Hume said that errors in religion are dangerous but errors in philosophy are only ridiculous. That is not so. Rejecting established sources of reason and accepting that belief should have equal sway with fact puts an open, free society in great danger.

The advances made in human civilisation in the last 600 years have been greater than in the previous 60,000. In 1840, there was no country in the world where the life expectancy at birth was greater than 40 years. Today, just 180 years later, there is no country in the world where life expectancy is less than 40 years — there are several countries where now it is more than double this. The rediscovery of Greek philosophy during the Renaissance, the emergence of the scientific method, mathematics, flourishing art, music

and literature together brought about the agricultural revolution, the scientific revolution, the Industrial Revolution and an extraordinary period of human creativity. Of these the scientific revolution was the most important because it changed the fundamental paradigm of Middle Ages Christianity and the ancient world: belief gradually gave way to evidence and reason.

The gains were greatest and emerged earliest in what are now referred to as developed countries, most particularly those of Western Europe and North America but the phenomenon has now spread world-wide. Today, most prosperous countries share a common feature. Although far from perfect, they have developed or have adopted institutions in areas of law, politics, health, education and social institutions (such as universities and a free press) that place great value on evidence and fact. These institutions are the foundations of today's civil society. In such an environment, enquiry is rigorous and subject to review by one's peers. Key to this is our modern notion of knowledge: as the *Oxford English Dictionary* puts it, "the apprehension of fact or truth with the mind; clear and certain perception of fact or truth; the state or condition of knowing fact or truth". Why is this emphasis on truth so important? Because it led to the settling of disputes with evidence and reason, rather than by force, and this then became the foundation of institutions that people could trust.

The topic of this forum — truth, rationality and post-truth — is important because of the threat to these institutions posed by the emergence of "post-truth". What is meant by the term "post-truth"? Simply that objective facts are less influential in shaping political debate or public opinion than appeals to emotion and personal belief. One might be tempted to say that Twitter trumps fact.

I will discuss truth and then examine rationality. Then I will briefly outline why I believe post-truth is so dangerous.

But, first, I will make three statements upon which my subsequent remarks are based.

First, there is a physical world independent of human thought. Second, from birth, every human acquires a body of knowledge that represents the physical world they experience through their senses. This is their subjective knowledge. And, third, there is an independent body of knowledge that has been developed through human thought and communication. This includes the full range of shared ideas, such as stories, writings, art, music, mathematics and so on. As far as I know, the first philosopher to bring this together quite so succinctly was Karl Popper (Popper 1972). It was not original — Popper drew upon philosophical thinking that has emerged over the last two millennia — but he did put it very clearly. He referred to these as the Three Worlds and claimed that they are three distinct ontological states. Some philosophers would dispute this, but it is a good way to think about things in the context of today's discussion.

Truth

In considering truth philosophers generally look at two issues: what is meant by the words "is true" (referred to as the "truth predicate"); and the criteria for truth (for example, if I say the book is blue, how do I determine whether the book really is blue?).

An example might show why this distinction is important. Pontius Pilate was famously reported to have asked the question "what is truth?". He should have asked "is he guilty?". The point is that it is important not to mix

up the question of what truth is with what we mean when we try to establish whether something is true or false.

The concept of truth only has relevance to self-conscious, linguistic beings, capable of understanding and using concepts of truth and falsity. Theoretical approaches to what is meant by "truth" fall into two broad groups. Those that consider truth to be some genuine property of a proposition, assertion or belief — these are substantive approaches — and non-substantive approaches that argue that such a property or relation does not exist. Non-substantive approaches argue that we should not be misled by the similarity of the truth predicate "is true" to other predicates (such as, for example, "is blue") into thinking that similarly it denotes something real. In other words, it is wrong to interpret the truth predicate as representing a genuine property (truth) of a thing, proposition, or belief in the same way as blueness might be considered to be a property. These deflationary approaches (Lowe 1995, Schmitt 2004b) propose that the truth predicate exists to fulfil a purely linguistic function enabling speakers to do certain things, such as express agreement with one another.

Another distinction that can be made regarding theories of truth is between linguistically- and epistemically-oriented approaches. Modern, linguistically-oriented approaches attempt to analyse the meaning of words and grammar to logically identify and describe the nature of truth. In contrast, epistemic approaches argue that the linguistic approaches fail to give an account of truth that allows us to understand how the notion of truth contributes to our efforts to know and thus give an inadequate account of our quest for knowledge.

The linguistic approach became influential with the analytical philosophy of Russell and Wittgenstein in the early 20th century and was at its most influential with the logical positivists' interpretation (in particular, the semantic treatment by Tarski) of the correspondence theory of truth in the 1930s (Davidson 1990). There have been two major epistemic approaches to truth, both of which have their origins in Spinoza, Hegel and other traditional philosophers. These are the pragmatist theory of truth, proposed by C.S. Peirce, James, and Dewey in the late 19th century (Haack 1976) and the coherence theory of truth, heavily influenced by the British idealist Bradley in the early 20th century (Schmitt 2004a). The coherence theory of truth has been the more influential, particularly within the decision sciences.

The correspondence and coherence theories of truth have been particularly influential in the last century or so and these will be contrasted here. Both are substantive approaches in that both hold that truth exists and that it is a property of, or a relation involving a "truth-bearer" (that is, a proposition, sentence, or belief-state) and a theoretical, omniscient "cogniser". Correspondence approaches propose that truth is correspondence with "the way the world is" and is independent from the cogniser, whereas coherence approaches argue that truth is coherence between truth-bearers and include relationships between the truth-bearer and the ideal cogniser (Schmitt 2004c). Thus, truth is not independent from the cogniser and contains elements of subjectivity. Correspondence theories have their origins in Greek philosophy, whereas coherence theories are more modern, emerging in the late 19th and early 20th centuries.

In the discussion below, two theories will be discussed primarily in the context of providing criteria for truth but some passing observations will be made regarding their usefulness in determining the nature of truth.

If you subscribe to the view that a physical world (Popper's World One) does exist, independent of the human mind, then it follows that there must be truth-bearers that can be independently and objectively evaluated. That is, observations about the physical world must be viewed from a correspondence perspective. Hence, science is predominantly about correspondence: making propositions and evaluating them, independent of the observer. Now there are all sorts of philosophical objections to this. There is a strong argument that much scientific enquiry is socially determined — even down to questions that scientists decide to investigate — but it is difficult to avoid the conclusion that there should be able to be truth-bearers formulated that can be objectively evaluated, even if we can never really achieve observer independence.

On the other hand, Popper's World Two and many World Three phenomena cannot be dissociated from the cogniser, because they are entirely products of human thought. Thus, they can only be evaluated using a coherence approach.

It is important to note that this conclusion is not based on the claim that acceptance of realism requires the correspondence theory of truth. It is simply that if a real world independent of human thought exists, human thought needs a way to form accurate representations that in some way correspond to these independent real-world phenomena. Nor is this to argue that the correspondence theory of truth as commonly formulated is satisfactory. Indeed, in a notable exchange between Austin and Strawson in 1950, (Austin 1950, Strawson 1950), the generally accepted view is that Strawson largely dismissed the commonly articulated correspondence theory of truth as a means for understanding the meaning of truth, demonstrating that the argument was circular (Hamlyn 1962, Sainsbury 1998, Searle 1995). However, Strawson did not deal with the usefulness of the correspondence theory as a criterion for determining truth.

Surprisingly, in the philosophical literature of the last century or so, the correspondence and coherence approaches have generally been placed in opposition to one another. But even if you accept the dubious claim that the two are opposed, this is only the case when they are used as definitional theories of truth (that is, the meaning of the truth-predicate). When considered just in the context of being criteria for truth, the two approaches can be complementary and provide valuable insights into issues. The theoretical limitation is only that they cannot provide sufficient justification to determine truth with absolute certainty.

Perhaps this might be clearer with an example. I can make a statement, "the book is blue," and assert that this statement contains the truth. The coherence theorist might then ask: how do I sense and perceive blue light? Is my perception of blueness the same as someone else's? The correspondence theorist argues that the statement does not require someone to think about it: it is either true or it is false. I can use a spectrophotometer to see whether the wavelength of the light being reflected by the book is about 475 nanometres: if it is, the statement is true. The most complete answer lies in a

combination of both the coherence and correspondence approaches: if the light is at 475 nm, it is blue light, so the book is blue. But the perception of blueness may be different from person to person. I am colour-blind and I am fairly confident that my perception of blueness is different to about 93% of the men and about 99.5% of the women in this room. We cannot be certain how another person perceives blueness but science provides us with the means to finding an objective answer to the question.

This distinction, I think, is at the heart of the point that C.P. Snow tried to make in his controversial essay, "The two cultures" (1959). The scientific method is largely based on the correspondence approach (but recognising that some questions are socially influenced), whereas the social sciences and the humanities refer more to the coherence approach because of the subjectivity in most of the issues they consider. The problem is that scientists and technologists are reluctant to recognise the social determinants that influence their investigations and outcomes, while those in the humanities and social sciences can be dismissive of expert opinion, even when it is based on overwhelming scientific evidence. If we really want to see knowledge advance, we should recognise the importance of both approaches to truth and use them together.

In summary, the important point is this. The coherence approach (in its criteriological sense) is useful as a criterion of truth for beliefs, statements, or theories about things that are subjectively determined, that is, about norms, values, morals, ethics, aesthetics and so on. But there are some beliefs, statements, and theories about things where the aim of inquiry is for them to be objectively determined (for example, mathematics, quantum mechanics, astrophysics, chemistry, and biology) and should be considered correspondence-theoretically. And, as noted above, the correspondence approach provides the means for determining whether our understanding of real-world phenomena is true. Hence, in structuring the highly complex problems of the 21st century, it is important to establish as much of the problem content as possible within an objective domain so that it can be tested using correspondence criteria, without compromising the need to utilise coherence criteria in relation to those things that are subjectively determined.

Let us now turn to the subject of rationality.

Rationality

All conscious animals need to make sense of the uncertainty they encounter in the world, and must either adapt to it or control it. To do this they form mental representations of the world, based on the information they receive through their senses. They then react and behave accordingly (Polanyi 1957). As Epstein (1994) puts it, they form a theory of reality — a world theory — by which they relate their own existence to the real-world phenomena they encounter. This form of cognition is intuitive. In humans, intuitive thought is experiential: it relies heavily on visual insight and the recognition of patterns that emerge from complex systems. It is oriented toward immediate action and it leads to the formation of images that are persistent and slow to change. Intuition is experienced both passively and subconsciously and is affected by emotion. Judgements arising from intuition are compelling and bring with them a feeling of certainty and infallibility: they appear to be self-evident. Indeed, we often see as irrational people who disagree

with our intuitively-determined judgements. Intuitive cognition is often thought of as being imaginative, creative and even mysterious. (Hammond 1996).

But humans have also developed a second form of thought that is rational and analytical in nature.

This form of cognition is logical and derives from conscious understanding and appraisal of real-world phenomena in the context of the individual's own thoughts. Analytical thinking is slower to process but can change rapidly: eureka moments. It exists in the abstract and is denoted through language and other symbols, such as numbers. Unlike intuition, analytical cognition is active and conscious: the individual controls its own thoughts and has the capacity for self-awareness and to be self-reflective. It is based on evidence and logic (even if the logic might be flawed). Importantly, the argument is retraceable. Epstein (1994) refers to this as the "self theory". Thus, the complete theory of reality for a human is a cognitive system consisting of a world-theory that emerges from intuitive thought and a complementary self-theory that comes from analysis and reason.

Such a concept of a bimodal system of cognition is by no means new. The ancient Greek philosophers distinguished between scientific knowledge and intuition (Aristotle 350BCE), as did early philosophers of the modern era, for example, Pascal (1660) in noting the difference between the mathematical and the intuitive mind. More recently various versions of a bimodal system of cognition have been developed, for example, Polanyi (1957) (problem-solving/heuristic), Simon (1983) (bounded rationality/intuitive rationality), Tversky and Kahneman (1983), (extensional/intuitive), Bruner (1991) (narrative/propositional), Hammond (1996) (analytical/intuitive) and Stanovich and West (2000) (system 1/system 2), to name but a few.

These have generally been taken to be dichotomous, rather than a complementary "cognitive continuum", that recognises the importance of both forms of cognition. But if we do consider the two as a continuum, they give a much greater insight into the "commonsense" nature of human thought. Humans seem to be the only species to have developed such a sophisticated analytical reasoning capacity and this has made our species very successful. It is the combination of these two aspects of human thought upon which our view of rationality is constructed. Our belief systems are largely a product of intuitive thinking and it takes a great deal of effort to undertake the rigorous analytical thinking needed for us to be truly rational.

Ultimately, the purpose of all this is to determine whether a judgement, a choice, or a decision is likely to be successful. There are two essential aspects to this. First, is the judgement coherent with the prevailing paradigm? And, second, is the judgement accurate? Does it correspond to established, accepted facts? Both are necessary but neither is sufficient. For example, a rationally-determined judgement may not be accurate because it is based on a wrong paradigm. And a judgement made through erroneous thinking (or is based on a wrong paradigm) may be accurate purely by chance. In other words, for a judgement to be ultimately successful, it needs to correspond with observed facts and phenomena and it must be coherent with our best objective understanding of the way the world works.

This sounds quite straightforward but cognitive psychologists have found we are

prone to major errors in both our intuitive and analytical thinking. I will discuss briefly two of the more influential areas of research into this. An early pioneer in the area was Kenneth Hammond, who, in the 1950s, developed a theory by Egon Brunswik on perception. He observed that people respond to various cues that they perceive and interpret. Each individual receives different cues and interprets them differently. This gave rise to what Brunswick called the "lens model". Just as an optical lens presents a different image to observers, depending on their relative position, in much the same way, people form different perceptions of situations because the cues they receive are different and so their interpretations also differ. Hence, it is to be expected that people reach different conclusions about the nature of the problem from apparently identical observations.[1]

The second stream of research that has become particularly influential in the last couple of decades relates to bias and error, particularly in intuitive thinking. The work of Tversky and Kahneman was particularly influential. (For example, Tversky and Kahneman (1974), Tversky and Kahneman (1986), and Kahneman and Tversky (1984) found that both laymen and experienced practitioners were subject to these biases.) They investigated why people make apparently simple mistakes in estimating probabilities. Further investigation in several areas of professional practice confirmed the existence of bias (for example, in finance, the judicial system, medical diagnosis and choice of treatment, and public policy formulation).

In the first of these papers, Tversky and Kahneman found that both layman and experienced practitioners were subject to these biases "when they think intuitively". Furthermore, they noted that "the inherently subjective nature of probability has led many students to believe that coherence, or internal consistency, is the only valid criterion by which judged probability should be evaluated". They go on to say, "for judged probabilities to be considered adequate, or rational, internal consistency is not enough. The judgements must be compatible with the entire web of beliefs held by the individual ... the rational judge ... will attempt to make his probability judgements compatible with his knowledge about the subject matter, the laws of probability, and his own judgemental heuristics and biases" (Tversky and Kahneman 1974: 1130).

What Tversky and Kahneman referred to as "heuristics" are biases introduced through the application of intuitive rather than analytical judgement. Further work was done in a number of areas of professional practice, confirming the existence of bias in intuitive thinking (for example, in finance (Slovic 1972), the judicial system (Carroll 1978), medical diagnosis and choice of treatment (McNeil et al. 1982), clinical diagnosis (Arkes 1981, Kleinmuntz 1984), and public policy decision-making (Thaler 1983). This has led to a particularly pessimistic view regarding human judgement: that it is irrational and untrustworthy. But many of these researchers appear to have overlooked the caveat noted above, that Tversky and Kahneman (and others, for example, Arkes (1981)) identified: bias is primarily a problem with intuitive judgement, not with rational judgement.

Indeed, a comprehensive review of decision-making errors presented by Fraser et al. (1992) suggests that, by understanding the

[1] See also Enfield (2018) - Ed.

source of bias, often it can be removed from the problem situation. For example, bias due to the practitioner not understanding the problem adequately, erroneous assumptions regarding problem data (such as probability data), differences in assumptions between the practitioner and the observer, can give the appearance of bias where, upon closer examination, none exists. More specifically, Nisbett et al. (1987) demonstrated that training in inference enhances rational thinking; Gigerenzer et al. (1991) showed that when carefully analysed, some biases actually did not contravene probability theory and Lopes (1991) showed that with more rigorous application of methodology, some biases are reduced or disappear.

But there is another important issue that emerges from this work on the rationality of human decision-making. Examples from law, medicine, science, and engineering show that where intuition encroaches upon the domain where analysis is required, the application of intuition can lead to blindly over-confident judgements and decisions (Hammond (1996) p106). But to set aside the value of intuitive thought based on this would be to overlook the great benefit that derives from the creativity and insight of intuition across all aspects of human creativity, from mathematics and science, to the arts and humanities. A more optimistic interpretation of the relationship between intuition and analysis is that in specific instances, people may appear irrational but are less so in the context of the entire problem situation; and that bias can be reduced if appropriate steps are taken, such as training the individual and appropriate selection of analytical methodologies.

Very successful people seem to meld the insight and creativity that derives from intuitive thought with the power of analysis to recognise the differences in perception and the bias introduced due to our intuitive thinking. This process of creativity, combined with rigorous criticism, enables them to develop deep and rich subjective and objective knowledge and thereby form a more comprehensive understanding of the world.

In this brief review, I have argued that there is a remarkable consistency and convergence in the philosophy and psychology around both the nature of truth and criteria for distinguishing between truth and falsity. Both are important in understanding the way in which humans make complex decisions and try to form rational judgements.

Post-Truth

Let me now turn to post-truth and why I think it poses such a threat to free, open societies. If you look back over history, whenever there has been a major change in the technology of communication, social disruption and change follows. Sometimes this is for the better but often for the worse. The printing-press was used to great effect during the Reformation, with the distribution of drawings and pamphlets. The first English newspapers were started in London in the 1660s at a time of great social upheaval that gave birth to many of our modern institutions.

Large-scale, automated printing-presses were developed in the 1850s and the daily newspaper became possible. Together with photography, which was also invented at about this time, newspapers were major influences in the American Civil War. Not long after the invention of motion pictures, they were seized upon as a propaganda tool and were used to sway public sentiment during World War I. Russia and Germany both embraced motion pictures and estab-

lished government-sponsored film industries. In 1933, Hitler created the Reich Ministry for People's Enlightenment and Propaganda, run by Joseph Goebbels. It was used to great effect in the Holocaust. Wherever you find a totalitarian regime, you will find a state-sponsored ministry of information.

The difference between totalitarian propaganda machines and the free press of open societies is that the free press aims for truth in reporting, however imperfectly. This holds the establishment and its institutions to account and thereby helps to maintain our trust in them. Totalitarian propaganda units create false trust by deliberately producing disinformation and misinformation to conceal aspects of the truth, to support the regime.

The development of the World Wide Web in the 1990s and the 24-hour availability of news has marginalised the established news media. The emergence of social media with the extraordinary penetration of Facebook and Twitter has brought about a fundamental change in the way in which news is delivered to consumers and the political discourse unfolds. News is no longer distributed via universally-accessible media. Rather, algorithms used by Facebook, Twitter and Google deliver news, based on your search preferences. These companies do not uncover news themselves but parasitically harvest information from established companies that invest in the human and financial resources needed to report it and many other sources as well. This so-called news is not about the dissemination of objective information. It is about marketing a commodity called "content", regardless of its truth, to an audience segmented down to the individual, driven solely by data analytics, marketing strategies and search engines. By their very nature, these appeal to and reinforce personal bias and prejudice.

Shrewd communicators, from shock-jocks to politicians can now exploit this to directly target the individual, play to influence and sentiment, and to shape public opinion. In such an environment, truth becomes one of the first casualties as the sheer volume of disinformation and misinformation drowns out rationally-determined knowledge. This has much the same effect as totalitarian propaganda ministries: it erodes people's trust in established institutions, replacing it with a false trust in belief-centric half-truths and falsehoods that are loaded with disinformation and misinformation and carefully avoid critique. For evidence of this, look no further than the misleading innuendo and deliberate lies that were propagated through social media in the Brexit referendum, the 2016 US Presidential election, virtually every election in Australia of the last decade and the endless discussion around climate change.

Conclusion

So, what can we do about it? The challenge is predominantly one of leadership. Leaders should critically evaluate propositions in the light of fact and reason, while at the same time recognising their own fallibility. We should be clear on what we mean by "truth". We should insist that the criteria we use to distinguish truth from falsity are clear. We should recognise the shortcomings of human cognition. We should insist on the same rigour from others. We should be vocal in our criticism when we see truth being compromised. We must not let public policy-making enter the domain of unsubstantiated, untrue dogma and belief. We must protect the institutions of our society by holding those who run them to account and supporting them in adversity. The more

we strengthen these institutions, the more people will be inclined to place their trust in them, rather than the ill-informed and deliberately misleading chatter they find on the internet.

Two centuries ago, Keats wrote, "truth is beauty"; last November, the leader in *The Economist* said, "truth is hard work". Both were right.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 39–44. ISSN 0035-9173/18/010039-06

Wind Turbine Syndrome: a communicated disease

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Introduction

The world faces an existential threat from climate change, and the transition to clean, renewable energy is front and centre of global hopes for avoiding some of the worst forecasts. Today, remarkably, Australia has no peak national body or commission for climate change. Yet thanks to the efforts of four cross-bench politicians whose votes were courted by an appeasing government, we do have a Commissioner for Wind Farms. The National Health and Medical Research Council has no dedicated program of research focused on climate change, but it has a dedicated research fund for research on wind-farm disease (NHMRC 2015) which, as we shall see, is demonstrably a non-disease.

This paper considers how this happened and what it says about the erosion of truth in the post-factual era. But, first, some historical context because it is important to understand that what we today call "fake news" has long been part of popular culture in the form of factoids: items of unreliable information that are reported and repeated so often that they become accepted as fact.

Social media has massively facilitated the contagion of factoids. Bogus statements passed around face-to-face social networks in the pre-digital era moved at glacial pace compared with the speed at which claims circulate today.

Previous Anxieties

New technology has a long history of attracting prolonged, impassioned and often crackpot attacks from those both fearful of and hostile toward mephistophilean artifice that offends the existing order of things. Linda Simon's history of electricity, *Dark Light: Electricity and Anxiety from the Telegraph to the X-ray* (Simon 2004), notes that, although the discovery of electricity generated excitement and electricity companies worked hard to build the market for electrical power: "more than thirty years after Thomas Edison invented the incandescent bulb in 1879 and soon afterwards installed a lighting system in a business section of lower Manhattan, barely 10 per cent of American homes were wired. Even after the First World War that percentage rose only to 20 per cent."

One reason for this was that community anxiety about the safety of electricity was widespread, with many news reports being published about the calamities that electricity caused those foolish enough to embrace it. Some also worried about going blind from reading by electric light. On 10 May 1889, *Science* noted:

> A new disease, called photo-electric ophthalmia, is described as due to the continual action of the electric light on the eyes. The patient is awakened in the night by severe pain around the eye, accompanied by an excessive secretion of tears. (Simon 2004, xvii)

On 24 September in the same year, the *British Medical Journal* carried a report that the newly popular telephone could cause "telephone tinnitus," claiming that victims "suffered from nervous excitability, with buzzing noises in the ear, giddiness, and neuralgic pains" (Simon 2004, xvii).

The article contextualised the perils of these new contraptions:

> As civilization advances, new diseases are not only discovered, but are actually produced by the novel agencies which are brought to bear on man's body and mind ... almost every addition which science makes to the convenience of the majority seems to bring with it some new forms of suffering to the few. Railway travelling its *amari aliquid* in the shape of slight but possibly not unimportant jolting of the nervous centres; the electric light has already created a special fear of ophthalmia; and now we have the telephone indicted as a cause of ear troubles, which react on the spirits, and indirectly on general health.

George Miller Beard, the prominent US neurologist, promoted what became the common diagnosis of neurasthenia from around 1869 (Beard 1881). His central thesis was that modern living and the pace of life among the well-to-do was causing a proliferation in a range of progressive symptoms.

Among the causes of all this nervousness, Beard included several new-fangled inventions: "wireless telegraphy, science, steam power, newspapers and the education of women; in other words, modern civilization".

I am old enough to have lived through evidence-free public anxieties about television sets, electric blankets, microwave ovens, power lines and computer screens. In recent years, we've seen apocalyptic predictions made about mobile phones doing to brain cancer what smoking did to lung cancer. Unfortunately for these forecasters, the incidence of brain cancer has flat-lined for over thirty years while mobile phone use has been almost universal for about 15 years (Chapman et al. 2016)

In 2006, two authors writing in *Electromagnetic Biology and Medicine* (Hallberg and Oberfeld 2006) predicted that by the end of 2017, 50% of the world's entire population would be suffering from electrosensitivity and hoping to beat a retreat to the world's ever-retreating electricity-free havens. Alarmingly, at this Society's 2017 Forum there were only about 30 days to go.

The most recent panics about "modern worries" include Wifi, smart electricity meters, solar panels on roofs and my focus today, wind turbines.

Wind Turbines

My new book with Fiona Crichton, *Wind Turbine Syndrome: a Communicated Disease*, is published by Sydney University Press (Chapman and Crichton 2018). I now summarise why it is clear that adverse reactions to wind turbines are case-book examples of psychogenic illness which spread by exposure to negative publicity. I will then focus on the opposition to wind farms in Australia and the forlorn factoid "science" that has driven it.

In our book, we list 247 different diseases and symptoms in humans and animals which have been attributed by wind-farm opponents to wind farms and particularly to sub-audible infrasound. These include lung cancer, skin cancer, haemorrhoids, gaining weight, losing weight and my favourite, disoriented echidnas. But most are classic symptoms of anxiety: things that can happen to you when you are very worried.

From at least the time of Francis Bacon in the 15th century, scholars have observed that people can worry themselves sick. ("infections…if you fear them, you call them upon you") (Bacon 2005). The nocebo effect, the evil twin sibling of the healing placebo effect, has been documented in a vast research literature in both clinical and real-world settings, including in relation to wind farms (Crichton et al. 2014). When some people are exposed to frightening information about agents or exposures, expectancy effects just as powerful as placebo effects can operate to make people feel sick with worry or anxiety.

However, 25 scientific reviews published since 2003 (Chapman and Simonetti 2015) have concluded that there is very poor evidence for any claim that wind turbines are the *direct* cause of any disease. For any social scientist, there is a herd of uncontested elephants in the room that points unavoidably to a conclusion that "wind turbine syndrome" is a *communicated* disease: you catch it by hearing about it and then worrying about it.

In our book, we summarise what we know:

- A small minority of wind farms have a small minority of residents who claim to be affected. The direct causation hypothesis would predict that *all* wind farms should affect some people;
- The great majority of complaints occur in English-speaking nations, despite the proliferation of wind farms in Europe, China, and many other non-English speaking nations. Somehow, it is a disease that only speaks English?
- Wind farms with a history of being targeted by opposition groups are more "affected" by wind turbine syndrome. Just 6 farms in Australia have had 74% of all complaints (Chapman et al. 2013);
- Those with negative views about wind farms are more likely to report symptoms than those with positive views;
- Those being paid to host turbines very rarely complain, suggesting that the drug "money" may be a powerful preventive;
- Claims about only "susceptible" individuals, like those who get motion sickness while others don't, struggle to explain why there are apparently no susceptible people in, for example, all of Western Australian or Tasmania, where they are wind farms but no records of health complaints;
- Claims about "over 40" Australian families having to abandon their infrasound affected homes have never been validated, with those making the claims saying that many of the "wind-farm refugees" do not want publicity;
- While some complain of acute effects within minutes of exposure, the first known complaints about wind farms date from 2002, although many wind farms were operational for many years prior to that. So why then were there no reported acute effects occurring prior to 2002?
- Experimental subjects randomised to be exposed or not exposed to negative news footage about wind farm harms and then exposed to infrasound and sham infrasound show that prior exposure to anxiety-producing messages increases reporting of symptoms (Crichton et al. 2014) even to sham infrasound.

We devote a chapter to exploring the eccentric views of several of Australia's most prominent opponents of wind farms, including what courts have said about their professed expertise. For example, Sarah Laurie, an

unregistered doctor told a South Australian court in 2011 that wind turbines can make people's lips vibrate "from a distance of 10 kilometres away" (Barnard 2014). That's about the distance from downtown Sydney to the northern suburb of Chatswood. Indeed, she believes these vibrations are "sufficient to knock them off their feet or bring some men to their knees when out working in their paddock". The television program "Myth Busters" may find that an interesting claim to put to the test.

Laurie also *claims* some people are "so exquisitely sensitised to certain frequencies that their perception of very, very low frequency is right off the shape of the bell curve, such that they can, for example, from Australia, perceive an earthquake in Chile." Chile is a mere 11,365 kilometres from Australia's east coast.

Mr George Papadopolous, a rural pharmacist, may be such a person. He has written that, "On another occasion, and by far the worst of all days, the problem had dissipated when arriving at Young about 100km from the closest turbines … Truly these figures appear subjective, outrageous, and for most, impossible to believe. However, I am reporting my findings that have taken hours and days to determine. I'm not just plucking figures out of the air" (Papadopolous 2012). Mr Papadopolous for a time worked as an "assessor" for something called the Geovital Academy, an entity which sells blankets, shields, paints and pillows to protect gullible people from the evils of electromagnetic radiation invading their houses. Its website once had an endorsement from "Noble [sic] Prize winner Ivan Engler Dr.med.univ., PhD." No one named Ivan Engler ever won a Nobel Prize in any category. He may have won a Noble prize, whatever that might be. (Chapman and Crichton 2017: 216).

Mr Noel Dean, an objector from the Waubra area in Victoria, once told an anti-wind-farm meeting at Baringhup in Victoria in 2013 that wind turbines started charging his mobile phone without it being plugged in (Chapman and Crichton 2017: 216): "I've had my … mobile phone go into charge mode in the middle of the paddock, away from everywhere."

This extraordinary claim would certainly be of great interest to manufacturers of mobile phones, who to date have apparently not advised that this remarkable charging ability is something all phone users should be aware of.

Ann Gardner, perhaps Australia's most prolific wind-farm complainant, believes she is adversely affected by wind turbines even when they are switched off (Chapman and Crichton 2017: 120).

And finally, Bruce Rapley, who in 1995 publicised the visit to New Zealand of a prominent Australian anti-immunisation advocate, worked up to a farrago of outrage in his oral evidence to the 2015 Senate wind farm committee:

> In the future, I believe that the adverse health effects of wind turbines will eclipse the asbestos problem in the annals of history. In my opinion, the greed and scientific half-truths from the wind industry will be seen by history as one of the worst corporate and government abuses of democracy in the 21st century (Chapman and Crichton 2017: 218).

The World Health Organization estimates that 125 million people are today occupationally exposed to asbestos and that about half of all occupational cancers are asbestos-caused (WHO 2017).

The sort of claptrap I have described is what passes for science and evidence in the imaginary "debate" that has now caused the Australian parliament and two state parliaments to investigate wind farms on no fewer than five occasions between 2011 and 2015.

By far the most egregious of these was the 2015 Senate enquiry (Commonweath 2015) headed by ex-Senator John Madigan, a blacksmith before entering parliament. The Madigan Committee's report is a travesty of science. It failed to even mention what is universally acknowledged to be the largest, most robust and important longitudinal study of wind farms and health run by Health Canada (2014). This study provided no support for the direct cause hypothesis.

The $2.5m Office of the Wind Farm Commissioner released its first annual report (ONWFC 2017) in 2017. As anyone following this issue closely could have predicted, it was not stampeded by complainants.

Wind-farm opponents have grasped the straw that the evidence that wind turbines are dangerous is poor, and argue that we therefore need to invest in research that they just *know* will prove their point. There's also "poor evidence" that UFOs, the Loch Ness monster and leprechauns exist, but no serious scientific body thinks investing research in such claims is sensible, other than the politically pressured NHMRC which in 2015 allocated $2.5 million into wind and health research.

A senior NHMRC official wrote that the decision to allocate funding to wind turbine and health research reflected the "macro-political environment."

Let me finish by describing the tactics that have been used against my efforts to ask awkward questions about the claims made by anti-wind-farm interests.

These have included:

- Serial complaints to senior officials in my university that I was belittling wind-farm victims. Their claims were apparently beyond question;
- Taunts that I refused to ever meet victims and "see for myself" (I was never invited);
- Taunts that I should get a wind turbine in my own garden;
- Complaints to my institutional ethics committee that I was conducting research without ethics approval;
- Constant false claims that I am in the pay of the wind industry;
- Regular attacks on my academic credentials;
- Attacks under parliamentary privilege (by two politicians);
- Two defamation suits;
- Regular slander on an anonymous website.

Conclusion

The history of social panics over new technology shows they have a natural history. There are doubtless a few people left who still fear television sets and microwave ovens. The heyday of fearing cell phone towers came and went in the 1990s. Wind-farm anxiety is now thankfully rapidly receding, with the desultory complaint volumes submitted to the Wind Commissioner [24] showing the phenomenon has all but passed.

But the delays this panic caused in driving Australian renewable energy harvesting were major. Our book's final chapter explores the

lessons in how we might avoid the next wave of "modern health worries."

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 45–49. ISSN 0035-9173/18/010045-05

The Brexit experience — evidence, expertise, and post-truth politics

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Abstract

In this brief talk, Wilsdon explores, first, what happened in 2016 and why; second, what Brexit tells us about the relationship between evidence, expertise and policy; third, is this the beginning of the end of UK evidence-informed decision-making; and, fourth, what are the prospects for evidence and expertise in post-Brexit Britain?

Introduction

Over the past 20 years, the UK has built up a strong reputation for the quality of its scientific advisory system, as exemplified by its network of scientific advisers in almost every department of government and by its willingness to experiment and innovate with new approaches to evidence-based policy making. Its early adoption of "nudge" approaches to behaviour change and What Works evidence centres being two recent examples.[1]

What happened in 2016?

But this seemingly progressive arc towards the ever-greater uptake of evidence and expertise in decision-making took a major knock in June 2016 with the result of the referendum on UK membership of the European Union swinging narrowly, 52% to 48%, in favour of Brexit. This was despite a mountain of evidence and the near unanimous support of experts of all kinds for remaining in the EU. Long lists of business leaders, economists and scientists all argued for the UK to remain in the EU.

The referendum process itself was marred by exaggeration and the use of dubious facts and figures on both sides, but particularly by the Leave campaign, and by accusations of outside interference in the democratic process by a range of murky and unaccountable actors, including the Russian government. More evidence on the scale of this interference is coming to light on a daily basis, with clear parallels to aspects of the 2016 US Presidential election. But were the activities of Russian Twitter trolls enough to swing the outcome? This seems less likely and we also know a lot about the underlying economic and social insecurities, dislocations and inequalities that gave rise to the 52% vote for Brexit.

Concern about mass migration, post-financial-crisis austerity, combined with more inchoate desires to strengthen UK sovereignty and "take back control," all played their part. As opinion polling shows, what the vote highlighted more than anything was two very different value sets held by almost equal proportions of the UK public. It was

[1] https://www.gov.uk/guidance/what-works-network; https://www.behaviouralinsights.co.uk/

possible to predict whether voters would go for leave or remain based on their background views about the value of multiculturalism, social liberalism and feminism. The older you were, the more likely you were to vote for Brexit. The more educated you were, the more likely you were to vote for remain.

The relationship between evidence, expertise and policy

Another striking feature of the EU referendum campaign was the prominence it gave (unusual in mainstream British politics) to a critical stance on the value and legitimacy of evidence and expertise, most notably in the now infamous remark by Government Minister Michael Gove that people have had "enough of experts". To be fair to Michael Gove, the full version of his quote was a bit more nuanced: "I think the people of this country have had enough of experts, from organisations with acronyms saying that they know what is best and getting it consistently wrong." Nonetheless, his remarks were seen by many, particularly in academia, as a sign that something had shifted in the British body politic, that this was more than just an ongoing and gradual decline in deference to authority; it was more visceral, more angry.

Other episodes in recent months have heightened such concerns. For example, the reactions back in January 2017 by British newspapers to a ruling by the Supreme Court that Parliament needed to vote before triggering the Article 50 clause that initiates the process of leaving the EU. Even in the tabloid press, it's been alarming to see senior judges and MPs branded enemies of the people simply for doing their job.

So is this all a sign of a new "post-truth politics" that we inhabit? This has been the topic of numerous books in recent months by academics, journalists and political commentators. In some ways, things have changed. The combination of vested interests, whether Moscow or Murdoch, the echo chamber effects of social media, powerful yet unaccountable algorithms all pose significant challenges for the operation of liberal, evidence-informed democracy.

But while "post-truth" was the word of the year in 2016, it is hardly a new problem. Politics has always had a relationship of convenience with empirical reality, and science was never pure, as the historian of science, Stephen Shapin reminds us (Shapin 2010). What Brexit and Trump have jolted is not the status of truth, but the assumption that liberal, rational, cosmopolitan democracies, informed by relevant evidence, will lead a majority to options that appear self-evidently preferable to those who have benefited from that same liberal, rational, cosmopolitan order (EU membership being an obvious example).

But the alternative truths experienced by many in our society, especially in socioeconomic terms, are very different. So, while assumptions of a rising tide of evidence-informed decision-making in the UK have taken a knock, I think this is less a crisis of truth or of expertise and more a crisis of democracy. In seeking to renew the legitimacy of expertise and scientific advice, our starting point should not be to dismiss populist movements or reassert the self-evident superiority of rational decision-making. We need instead to start by repairing our democratic institutions and the cultures that support them. Part of this requires greater humility on the part of scientists and experts, acknowledging that we as a community have too often uncritically aligned ourselves with the winners at the expense of the losers, as

a prescient piece by Colin Macilwain in *Nature* argued six months before Trump was elected (Macilwain 2016).

Returning to the Michael Gove quote, for many people, the idea that expert views align with their interests or reflect their own experience is highly debatable. In Newcastle just before the referendum, a Kings College London professor invoked the views of leading economists before inviting the audience to imagine the likely plunge in UK gross domestic product after Brexit. Back yelled the woman: "That's your bloody GDP, not ours." Her brutally simple criticism has a point and populist politicians or social media warriors can too easily tap into these anxieties caused by globalisation and rising inequalities and channel them towards resentment.

The beginning of the end of UK evidence-informed decision-making?

But we shouldn't despair. In the UK, as in Australia and elsewhere, evidence and expertise are being sought with growing urgency across a proliferating array of policy and public questions. At the same time and often on the same issues, the legitimacy of evidence and expertise has rarely been so fiercely contested, the Brexit referendum being an acute case in point. Paradox coexists with the possibility of evidence-formed decision-making. We need to better understand what lies behind the former and forge alliances to advance the latter. This is why the International Network for Government Science Advice (INGSA[2]) was set up.

Operating under the auspices of the International Council of Science, ICSU, the INGSA's membership now includes almost 5000 practitioners, academics, knowledge brokers and policy makers. Its focus is on assisting the development of effective advisory systems and the individual skills and institutional capacities that these require, irrespective of particular structural arrangements, through workshops, conferences and a growing catalogue of case studies and other guidance.

In delivering Brexit, decoupling structures for scientific and technical advice can at first glance seem deceptively simple. In many areas, UK institutions map onto EU counterparts, the UK Food Standards Agency coexists with the European Food and Safety Authority. The European Medicines Agency coexists with the UK medicines and healthcare products regulatory agency. Why not shift responsibility from Brussels to London and let us Brits get on with the job? However, as I argued in this *Nature* piece (Wilsdon 2017), the difficulty is that UK and EU networks of expertise, guidance and oversight are complementary and have developed in tandem over many years. Generations of British scientists and experts have shaped EU frameworks and vice versa. Around every issue that is codified in law or regulation, there exists a softer sphere of influence, information exchange and standard setting.

So, in animal health, the European Food Safety Authority plays an important role in coordinating data and evidence about emerging livestock diseases. The UK benefits from being part of a network of EU reference laboratories which coordinate surveillance, risk assessment and epidemiology on a range of transboundary diseases, such as avian flu. The Food Standard Authority has drawn heavily on the European Agency's meta-analyses and sophisticated protocols around risk and uncertainty.

[2] http://www.ingsa.org

In the life sciences, the UK's 3% share of the global pharmaceutical market is dwarfed by the EU's 25%. This brings significant benefits from regulatory harmonisation through the European Medicines Agency. If EMA licensing was no longer to apply, the association of the British pharmaceutical industry warns of a delay for up to a year in British patients looking to access innovative treatment.

Finally, turning to environmental protection, a recent inquiry by the UK Environmental Audit Committee estimates that up to a third of EU legislation will be difficult to transpose into UK law and those protections for wildlife, for habitats, for biodiversity that can be transferred will then be detached from the underpinning sources of expert advice, no longer updated, with no UK body to enforce them. Over time, the UK can build up new advisory and regulatory capacity, but this won't be quick or easy.

So, as a community, committed to strengthening evidence-informed decision-making, we need simultaneously to work on the structural, social and political dimensions of the problem, to rebuild and develop new capacity at the evidence–policy interface, but also to address the underlying causes of disaffection with experts. Drawing on the latest "evidence of evidence use," of which this review is a good example (Langer et al., 2016), can steer us towards what we in the INGSA network like to call the science and art of scientific advice.

Providing scientific advice in a reflective way that requires learning from mistakes, and is humble in the way it makes its case often requires a shift from scientific advice to knowledge brokering. Brokering requires persistent interaction with decision-makers and their context. Brokering necessitates diversity of perspectives: epistemic, institutional and cultural diversity, diversity in disciplines, in methods, in mechanisms, in sectors and institutions, in experiences, ideologies, background, culture and so forth. Brokering means keeping it complex; there is no single privileged view of a complex problem and, finally, brokering means providing multiple alternatives. Given uncertainties and diversity of knowledge and values, there are usually multiple plausible pathways into the future and choosing amongst them is inherently political. There is a strong focus on experimentation and learning in this approach to scientific advice.

Evidence and expertise in post-Brexit Britain

So, can Brexit become for the UK, or indeed Trump for the US, less a moment of undoing or unravelling of all that has been achieved, and instead a point of disruption from which we pause, learn and regroup? In a thoughtful new paper, the Science and Technology Studies scholars Sheila Jasanoff and Hilton Simmet (Jasanoff and Simmet 2017) make this cautiously positive case, asking whether "the post-truth moment can be reframed as a moment of revelation that neither facts nor values can stand alone in a government founded on the principles of truthfulness and inclusive public debate." They suggest that: "without renewed attention to the norms that shape the practises of public science and public reason, it would not be possible to guide fortune's wheel expertly along the arc of justice."

On a bad day, of which there are too many right now in British public and political life, the views I've just presented may come across and naïve, as wishful thinking. But much as I lament the result of the EU referendum and wish it could be halted or reversed, I also

refuse to believe it is the death of democracy or the beginning of the end of evidence-informed decision-making. That story still has many chapters to be written.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 50–58. ISSN 0035-9173/18/010050-09

Why are scientists so quiet? Cultural and philosophical constraints on the public voice of the scientist

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Abstract

In this post-truth era of virulent attacks on science and online trolls, we scientists find ourselves scrambling for a foothold in an environment in which everyone has a voice —- and in which the truth can be virtually impossible to distinguish from "fake news," and everything else in between. How do we react as a profession to shore up our own standing, and the importance of our work and of evidence-informed decision making, when the public is struggling to recognise credible scientific knowledge within this information free-for-all? I believe we are at a turning point that will serve as the catalyst for the remaking of much of what we have long understood as the culture and "rules" of science. First, we need to turn our attention to, and seek to understand, the profound impact of new information technologies on how we "communicate science." We need to critically analyse our own culture of knowledge-making and acknowledge and challenge the constraints that have long discouraged scientists from speaking out, leaving many of us now stranded ineffectually on the edge of public discourse. But this is just the first and most obvious step. If we challenge our entrenched culture, we will also be forced to rethink science education and, ultimately, how we "do science;" that is, how we create knowledge, our ultimate goal. This means recognising and embracing the new opportunities that change is throwing up, rather than bemoaning the inevitable pain of disruption. To do this, we need to loosen the academic hierarchies that have "quietened" scientists, we need to teach science students to speak out and to speak up and learn how to do so ourselves. Most importantly, we need to drive the restructuring of knowledge-making by overcoming our tendency to huddle in silos, and work collaboratively instead. This paper argues that by collaborating not only across disciplines, but also in genuine partnerships with communities, businesses and industries, we can go a long way to retaining trust in, and appreciation of, the power and validity of science and the scientific process.

Introduction

I am a practising scientist and science communicator. Not one well-versed in the dissection of the practices. As such, I present my comments as "Notes from the field".

Charles Darwin

As a young marine scientist, I was fascinated by rather strange organisms, barnacles; upside down prawns stuck on their back in a concrete cage, grasping at waves for a lifetime. Much later I discovered that Charles Darwin had been an even bigger fan of barnacles. I read of his meticulous, painstaking study of the world's barnacles, an effort that consumed eight years of his life and ended in a serious bout of ill health.

As an ecologist and sometime evolutionary biologist myself, Darwin's theory of natural selection has influenced everything I've investigated and interpreted. It is part of my lens on the world.

But, it was Darwin's *reason* for embarking on his global barnacle study — while leaving his sensational idea for *On the Origin of*

Species by Means of Natural Selection locked in a drawer at home in draft form, unseen and unread for eight years — that touched a nerve.

Darwin's obsessive journey from 1846 to 1854 into what Rebecca Stott (2003: 206) calls 'barnacle darkness' in her wonderful book was partly driven by curiosity. Of the more than a thousand species he'd brought back to London on the *Beagle* there was only one he had not been able to catalogue and describe. This soft, small, dun-coloured creature he'd found many years earlier inside a conch shell on a Chilean beach would turn out to be a rare, burrowing barnacle.

But it was not just this troublesome scientific loose end that drove Darwin to spend so long finessing his books on barnacles. Darwin had an "instinct for postponement". He realised he needed to prove himself as a scientist, and a systematizer if he was to be listened to when he did, finally, publish his most important work, *On the Origin of Species*. So, he gave his wife detailed instructions on how to handle publication of *Origin* should he die before his barnacle study was complete.

But the first book, *Living Cirripedia, A Monograph on the Sub-class Cirripedia*, with figures of all the species meticulously detailed won him the Royal Society Medal in 1853. He still had the Balanidæ to go! Together with his geological treatise on Coral Reefs, the barnacles books established Darwin as a scientist "who had won his spurs". Stott (2003: 167) argues that, "Without his barnacle spurs and barnacle contacts, *On the Origin of Species by Means of Natural Selection* would have been very differently received."

When Darwin finally published his theory of natural selection in 1859, he had a global web of scientific contacts forged through his barnacle work, a ready-made community of colleagues ready to recognise the importance of his new theory. He was taken seriously, not, as we know, by everybody, but by a sufficient number of his peers.

That was almost 160 ago, but the story is still relevant today, and particularly so in this apparently confounding post-truth era we find ourselves living in. I say confounding because we, as academics, have all played our part in building or reinforcing our global culture of "knowledge-making".

Knowledge-making today

The many different hurdles and gateways we've put in place to weed out unreliable, biased, ill-conceived and incomplete information are designed to ensure that by the time we present our knowledge to the world it is a close to complete as possible. As senior academics, most of us are probably confident in the authority with which we publish and in the credibility of our work.

But this structure and culture have also had perverse consequences which go back to Darwin's story and, in some ways, to my own. We have built a knowledge hierarchy — and a similarly strict professional hierarchy — which has not only protected the veracity of what we produce, but has actively discouraged scientists from taking part in public debates, particularly young scientists who are, as Darwin noted, yet to win their spurs.

The result, I have observed, has been to quieten our profession. Many successive generations of scientists have assumed that the discovery process is mostly about generating "research outputs," that their job is only to generate new knowledge, not to advocate or argue, but to let the facts speak for themselves.

There are very few scientifically trained public intellectuals because our structures do not support them, and scientists rarely see themselves as public intellectuals, or advocates. Indeed, many scientists understand that to actively seek the public spotlight risks drawing the contempt of their peers. In fact, despite the many passionate arguments and discussion behind the scenes — and some notable exceptions of internationally recognised science voices — the public face of the scientific community is mostly hesitant and tight-lipped.

In my own case, I was acutely aware of the scientific hierarchy as a young academic. I felt just as compelled to speak publicly about science then, as I do today, but I made a concerted effort to remain quiet, to recognise, and behave in accordance with my then junior standing. If I spoke out, I spoke strictly within the direct realm of my active research. I did not use my expertise to comment on other matters of the day, even if they were marine in nature.

In Darwin's time the *quiet* that this hierarchy engendered was perhaps not such an obvious a problem as it is today. The ability to contribute ideas was already limited to those with access to a printing press, a stage, a pulpit, or a soap box. And audiences too were relatively small.

Even in my own early career, during the early rise of the internet, there were no "broadcast media" available to anyone with an opinion and access to a keyboard or phone and an internet connection. We still had many reliable mass media gateways, through which pre-vetted information flowed. Many publications had specialist science writers whom we could trust to do our communication for us and who also investigated the investigators.

Media today

Now, as scientists, we find ourselves scrambling to find a foothold in an environment in which everyone has a voice, and in which the truth can be virtually impossible to distinguish from "fake news," and everything else in between. As the Yale science communication theorist, Dan Kahan recently wrote (2017), the problem is not the much-maligned lack of scientific literacy in many of our societies. Although scientific literacy is highly desirable, it is not essential for the public to recognise what it is that science "knows."

The real difficulty for audiences, Kahan argues, is "identifying who knows what about what… and distinguishing the currency of genuine scientific understanding from the multiplicity of counterfeit alternatives" (Kahan, 2017). Everybody appears to be peddling facts.

But what does it mean for scientists if the "cream" does not necessarily rise to the top in an information free-for-all, as we had optimistically postulated in the early days of the internet? Personally, I think we need to recognise that we are at a turning point.

We may, in future, look back at the dynamic changes we are witnessing as the catalyst for the remaking of some of what we have long understood as the "rules" of scientific practice.

First, we need to turn our attention to, and seek to understand, the profound impact of new information technologies on how we "communicate science."

But that is just the most obvious issue. I'd like to explain why I believe this must also challenge us to rethink what we teach in science education and, ultimately, how we "do science:" how we create knowledge, our ultimate goal.

I am not pessimistic: change always throws up new opportunities. But we need to be able to recognise and grasp them. So, what is the future of rationality in a post-truth world?

Fake news, propaganda and barefaced lies are, of course, not new. More than three centuries ago Jonathan Swift famously noted that "falsehood flies, and truth comes limping after it" (9/11/1710)[1]. The British novelist, best known for *Gulliver's Travels*, was also an astute political commentator and published various pamphlets expressing his concerns about what we might today recognise as post-truth facts. But in Swift's time the distances and speeds at which "falsehoods" could travel were very limited, so too was the size of the audience they could reach.

Today, falsehoods do more than fly: they seem to arrive fully formed in our consciousness via our screens. The internet has dramatically accelerated and amplified the sensational, the unreliable and the blatantly untrue — we all know that. But there is something else we need to consider about the design, or the shape, of the virtual world. Before instant digital communication, in many countries we had gateways: we chose news and views via publishers we trusted to have vetted them first.

In researching this paper, I came across the multiple websites and Facebook pages for the Flat Earth Society. They claim to be places "for free thinkers and the intellectual exchange of ideas,"[2] and their latest crowd-funding campaign is raising funds to launch a satellite to prove that we "round earthers" have been conning the masses all along. The websites look professional enough and the satellite plan has all the hallmarks of a scientific investigation. A ridiculous example, perhaps, but one that goes to Kahan's concerns about the challenges of recognising credible scientific information. This is especially so when the "tools" of science (in this case a satellite) confuse the issue, or as he puts it "pollute the scientific communication environment."

One thing troubled me most. In the virtual world, the glossy claims of the "flat earthers" or anyone else without knowledge or authority are only one click away from the CSIRO or NASA, or any of the Academies.

We know this "flat virtual space" is fuelling some troubling communication practices, like "false balance." When one "side" of an argument is just as accessible, vocal or visible as the counter view, we are at risk of assuming an equivalence: that they are the two sides of a "balanced debate."

For scientists, the obvious example is the way in which this faux duality has bogged down the climate change debate in Australia, and beyond. We see Professor Brian Cox seated alongside the former One Nation Senator and vocal climate change denier Malcolm Roberts on ABC TV in the name of "balance," and within minutes a lifetime of study and research becomes equivalent to an ill-informed conspiracy theory.

We also know that any opinion, bias or prejudice can find validation somewhere on the internet, and that automated content-selection algorithms reinforce particular views. It is difficult to counter 'selective exposure', 'selective perception' and 'selective retention'; others have talked in detail and with considerable insight and knowledge of such matters today. In the domain of science, research shows that genuine science news initially spread quickly online, but

[1] https://www.thoughtco.com/art-of-political-lying-by-swift-1690138

[2] https://www.tfes.org/

that rumours have greater staying power and persist for much longer on platforms like Facebook (Cook et al., 2007).[3]

For climate change mitigation, something very close to my heart, this means we find ourselves stuck in a repetitive and redundant debate, when we should be channelling our intellectual energies into solutions. This is not, of course, a circumstance *caused* by new communication technologies — these are just tools — but there are many with vested interests who are exploiting them. And there appear to be just as many with pre-conceived ideas of how the world works, and conspiracy theories, who want to use them. As scientists trained to be quiet, we find ourselves on the margins, rarely being heard above the din.

At the same time, another factor has come into play. As a public advocate for evidence-based action to offset, mitigate and ultimately reverse climate change, I am regularly on the receiving end of various trolls' extraordinary views. Trolls use the kinds of insults we would not consider hurling in person, but with the anonymity of the online space their inhibitions seem to melt away.

So, to our long-standing cultural constraints that discourage advocacy and agitation, I would add the undeniable pressure from trolls.

So, what, as scientists, do we do?

Get in the communication game

First and foremost, "get in the (information/communication) game." Again, that might seem obvious, but how we do that is a bit more complicated.

If we scrutinise the way our knowledge system has evolved over the centuries, it wasn't a bad model for the circumstances of the past. Discouraging researchers from speaking out until the knowledge they were generating had been vetted and verified, and they had built a considerable cache of context, was a powerful way to build our credibility. Our quiet culture did help strengthen the knowledge system.

Now, however, everything has been turned on its head, and the silence and hesitancy of scientists are putting our knowledge system at risk. The question becomes, how do we raise our voices while retaining the rigour and the reliability of our knowledge creation?

I don't want to depress anyone, but I am sure many readers are familiar with the emerging interest in citations analysis. A decade or so ago, a library and information science researcher from Indiana University put many academic noses our of joint when he revealed that 90 per cent of journal papers are never cited by anyone and that half are never read except by their authors, referees and journal editors. Publishing in *Physics World,* Lokman Meho (2006) called this a "sobering fact". And, approximately one article a minute is added to PubMed. Are its 26 million or so papers to date a knowledge triumph or a tragedy? While we've become very good at adding to the global knowledge vault, we are not very good at getting that high-quality information out.

In the face of today's sometimes savage and frequently ill-informed attacks on science, scientists and our findings, I think that speaking out, well beyond our conventional outlets, can strengthen our position.

Yet we are so accustomed to building our careers on the back of peer-to-peer communication that we may not regard talking to the public as part of our remit. We need to

[3] See also Cook (2017) — Ed.

build this into our promotion and rewards process and training.

We really do need to be able to translate complex concepts for diverse audiences, and we do need to engage much more with other academic fields, so we can begin to understand a bit more about things like the power of message framing, and that even the font we choose influences how people view the information we are presenting. There is no shortage of empirical research that points to the best ways to convince an audience that our information is valuable and genuine.

This goes back to the ways scientists can help make it easier for the public to distinguish between credible information and the "flat earth society."

We may need to make a concerted effort to "brand" ourselves as credible, engaging, interesting sources. To do so, we must be able to explain what we do, why we do it, and why it matters to anyone. That is, the "so what?" of our work.

But branding and communications won't win this battle alone. What, then, would it actually take to turn this quiet culture around?

Analysing the sociology of science

I feel incredibly fortunate to have chosen to major in the Philosophy and Sociology of Science, alongside Ecology, at university and what I learnt then informs what I do today.

However, most scientists of today, our scientific elite, and most science students, our scientific community of the future, have not studied any aspect of our Western scientific culture or how systems of knowledge-making have been built. Scientists are mostly unaware of all the hard work that has been put in by successive generations of philosophers and sociologists to situate scientific knowledge within our cultural and social mesh. Most scientists would deny that science has a political element, or that observations can be biased.

When we begin to look deeply at how knowledge has been constructed, we can no longer think of science as pure. When we understand that the cultural pressure *not to engage in public debate* begins to appear deliberate and duplicitous. It also invites us to consider other ways of knowledge-making, which I believe can only make us better scientists. This would give us room to rebalance the biases in Western scientific culture that have, for example, largely excluded women and non-Western forms of knowledge. I believe that the social/philosophical/historical study of science and knowledge production should be an integral and integrated part of the science curriculum. This will help us evolve our practices.

How should we be doing science?

This goes to my ultimate point. If we begin to think about how we make knowledge — not just how we communicate that knowledge in this post-truth era — this throws up a fundamental challenge. That is, to examine the way we *do* science, indeed to look at the way we do all research.

It is a rare and marvellous opportunity to have all the academies together to suggest a new way forward.

The process of research has long tended to prioritize isolated development. It is fundamental science that wins Nobel Prizes, and we understand the importance of this research because history has taught us that from fundamental knowledge much else —much of it unanticipated and unimagined — flows. That is certainly true.

But as scientists we are also solving complex contemporary problems. And to do this effectively we know we need to work across

academic disciplines and we need to collaborate with a whole range of professions and industries and decision-makers, who have an intimate understanding of, and a stake in solving, the many multi-faceted problems we are seeking to address.

This provides us with an opportunity to think about creating knowledge differently. Research practices are evolving. Collaboration and interdisciplinary research are about the co-creation of knowledge. If you co-define and co-create research, you involve your partners — those with a stake in the problem you are solving — in the process of discovery. You may find your work is taken up even before it is published, so your research may have an impact even before the first paper comes out. And this real-world impact plays an important part in public debate: it is visible, tangible evidence of the value of an evidence-based approach.

The very relationships necessary for collaboration create valuable new pathways along which credible information and ideas automatically flow. When we involve our partners in the scientific process, they learn the strengths of our method and the rigour of our approach. They develop respect for this form of knowledge creation and can explain the process to their friends.

That's one part of the answer. But, what about taking even another step back and asking ourselves to think more deeply about *how* we identify the gaps in the knowledge and problems we could like to solve.

Likewise, we tend to look at them in isolation, when I believe we — all our many disciplines — could, and should, be working much more closely together.

I see this all the time in my own field. We ask a contained question, we attend to what is "up close," then produce the new knowledge, then wait for it to be taken up. We may be identifying important problems, but without a plan for finding a workable, economically and socially acceptable solution.

A new form of collaboration

Over the past decade or so, successive Federal Governments have recognised the value of co-creating knowledge, but mostly in terms of collaboration between academia and industries, as a means of driving innovation (AG, 2009) and, in turn, of securing Australia's future economic prosperity.

Personally, I think the issue of collaboration is about more than facilitating industrial translation; it is about reimagining everything we do in science within a social, cultural and economic context, as part of the big picture. It is about doing science differently. Facilitating engaged science, funding more diverse partnerships, doing research together.

For us pre-interneters this might seem like a huge challenge, in terms of our academic culture, our skills and our practices. But over the many years I have been teaching, I have seen waves of changes moving slowly through our system.

Today's students and early career researchers are digital natives — and they are more open in the way they do science — this means they are expressing online, in real time, their enthusiasm for something they are discovering, in much the same way as they might report on a social event. They are tweeting from the lab. And suddenly their friends, family and followers are commenting and contributing: they are engaged with the very practice of science. "Next gen" scientists are crowd-funding their research. They are running citizen science projects.

Their professional organisations are engaging with communities.

Next-gen researchers do, of course, understand the importance of verification, but they don't feel the constraint of the cultural "muzzle" in the same way as did Darwin, or even myself. Generational change is already underway.

Interestingly, the World Economic Forum (WEF) identified the spread of misinformation online as a major risk in its *Global Risks* Report as early as 2013 (Stroppa & Hanley 2017) and it has since responded with a series of conferences and workshops about science communication, canvassing how we might counter "fake news."

Recently, the WEF Young Scientists — a select group of the world's most promising scientists under 40 — have been drafting the WEF's Universal code of Ethics for Researchers. The very first responsibility on the list for researchers and the organisations they represent is "to engage with the public." This, in my mind, represents very significant cultural change. The code goes on to exhort scientists to pursue the truth, maximise benefit and minimise harm, engage with decision-makers, support diversity, be mentors, and be accountable. Its message is that we must talk and engage, agitate and argue.

Conclusion

I am confident the three matters of which I have spoken represent a positive way forward for science in the post-truth era. First, lifting our voice; second, critically analysing our history, culture and practice; and, third, evolving our knowledge production to engage communities in the entire practice.

In the past we have mostly converged on the best evidence for, say, the value of adding fluoride to water. But we're now operating in a polluted science communication environment, with lots of toxic messages muddying the waters. Research tells us that people acquire their scientific knowledge by consulting others whom they identify with, who share their values and whom they therefore trust and understand.

That, in my view, is good reason for us to take stock, to take steps to address the limitations of our own culture and begin to dismantle our silos and to build diverse partnerships; all of which can make us part of those trusted conversations.

At the very least, my life-long interest in barnacles suggests a place we definitely don't want to find ourselves: stuck to the same old science rock, increasingly irrelevant, and drowning in a sea of noisy change.

Acknowledgements

Louise Williams assisted with the drafting and research for this paper.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 59–68. ISSN 0035-9173/18/010059-10

Influences on evidence: putting the cart before the horse

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Abstract

Conflicts of interest, particularly those related to financial gain, can influence policymaking, and mechanisms exist to try to minimize their impact on decisions. There has been a great deal of investigation and concern about the role of evidence in policymaking compared to other influences. But have we been putting the cart before the horse? Should we be paying more attention to what influences the evidence? Conflicts of interest can bias the design, methods, conduct, interpretation and publication of research. These biased findings deviate from the truth and have led decision makers to underestimate harms or overestimate effectiveness of interventions. The research community has responded by increasing transparency about the research enterprise. But this is not enough. We should strive to reduce the influence of conflicts of interest on research so we can have trustworthy evidence.

Introduction

Putting the cart before the horse is an analogy for doing things in the wrong order. In the Post-Truth world discussed in this issue of the *Journal*, concerns have been raised about the role of evidence in policymaking. But have we been putting the cart before the horse? Should we be paying more attention to what influences the evidence itself? Bias occurs when generating or interpreting evidence is not neutral: it leads to deviation from the truth.

One important cause of systemic bias lies with powerful groups who have a financial interest in a particular version of the truth. Such groups may fund employees, academic researchers or key opinion leaders to create or spread biased evidence, thus perpetuating fake news. These groups or individuals who have financial interests in a particular version of the truth are often said to have a financial conflict of interest. Conflicts of interest can lead to bias in evidence if the people carrying out or disseminating research do so in a manner that leads to deviation from the truth. Conflicts of interest that bias the design, methods, conduct, interpretation and publication of research have led decision makers to underestimate harms or overestimate effectiveness of interventions.

Conflicts of interest, particularly those related to financial gain, are also a powerful influence on policymaking, and mechanisms exist to try to minimize their impact on decisions. The research community has done less to minimize the effects of conflicts of interest. The community has responded primarily by increasing transparency about the research enterprise. But this is not enough. We should strive to reduce the influence of conflicts of interest on research so we can have trustworthy evidence.

What is a conflict of interest?

A conflict of interest is a circumstance that creates a risk that professional judgments or actions regarding a primary interest will be unduly influenced by a secondary interest (Lo and Field, 2009). In the case of research, the primary interest is conducting

unbiased research while a secondary interest may be personal financial gain of the researcher. Conflicts of interest should not be confused with other interests that affect research. Research is not value free and is conducted in a social context (Bero and Grundy, 2016). Researchers have personal beliefs, experiences and opinions that may influence their choice of research topic or paradigm. These interests make a researcher who they are and are not conflicts of interest. Interests are ubiquitous, unlike conflicts of interest which are unevenly distributed among researchers (Bero and Grundy, 2016). In addition, conflicts of interest have a "megaphone effect" as multiple researchers can have the same conflict of interest that influences research in the same direction. For example, multiple investigators with ties to the same pharmaceutical company could bias research to favour the company's products (Bero, 2017). In sum, conflicts of interest are a *risk*: they do not necessarily produce biased judgments or actions. Conflicts of interest are not "potential" but real; whether they result in bias is the question.

Conflicts of interest are well understood in the realm of politics. For example, United States President Donald Trump's conflicts of interest have been documented. His failure to disclose his income tax statements prevented the evaluation of his conflicts of interest related to tax reform. Nepotism within his staff and the impact of US policies on his stocks, leasing of government property, and foreign holdings all present conflicts of interest. Simon Chapman's paper in this issue (Chapman, 2018) addresses misconceptions about the hazards of wind farms. Mr. Trump's response to wind farms was influenced by his conflicts of interest. Mr Trump owns two golf courses in Scotland and asked UK politicians to oppose wind farms. This was not because he believed they were bad for health, harmed animals, or contradicted US/UK energy goals, but because they would lower the value of his golf course property.

Biomedical researchers have trouble recognizing and acknowledging conflicts of interest. Disclosures of funding sources and conflicts of interests in scientific articles are now more common, but they can still be confusing (Dunn et al., 2016). Disclosure statements may refer to "actual" and "potential" conflicts of interest in the same statement, or to multiple funding sources with some listed as "dualities of interest." Some conflict of interest disclosures note that research article authors were "given an opportunity" to disclose, but it is not clear to readers what, if anything, was disclosed.

Or meaningful conflict of interest disclosures can be obfuscated if journals drown us in too much, or irrelevant, information. A growing trend among medical journals is to list pages of financial ties with companies for each article author. These long lists, however, fail to provide information on the relevance of the tie to the research being conducted, the financial amount of the tie, or the length of the relationship between the researcher and the company. Disclosures of "non-financial conflicts of interest" create confusion about what is a conflict of interest vs. a scientist with interests (Bero and Grundy, 2016). A systematic review examining the association of neonatal herpes simplex infection with Jewish ritual circumcision examined 6 published studies on this topic (Leas and Umscheid, 2015). The paper included this disclosure from the authors:

> B. F. L. is an adherent of Orthodox Judaism, and he is not affiliated with the religious sects that commonly practice direct oral suction during circumcision, nor is he affiliated with any of the organizations represented in the legal case addressing the New York City informed consent rule. B. F. L. and his sons underwent ritual Jewish circumcision, without direct oral suction. C. A. U. is a nonpracticing Roman Catholic whose wife affiliates with secular Judaism. C. A. U. and his son were circumcised by pediatricians in the hospital setting.

It is unclear how these personal characteristics would be considered conflicts of interest rather than values and preferences that could influence the research.

While conflict of interest disclosure is a necessary first step, it is not a solution for managing or reducing bias associated with conflicts of interest (Bero, 1999). In published biomedical research, disclosure is difficult to enforce or simply not required. Experiments have shown that, in the financial sector, disclosure makes those giving advice more biased (Cain et al., 2005). Finally, as shown later in this paper, disclosure does not prevent bias in research.

Conflicts of interest and bias

Researchers are likely to deny that conflicts of interest could bias their research. Quotes from interview studies with biomedical researchers illustrate this point (Boyd et al., 2003), (Lipton et al., 2004):

- "I'm not influenced." "My colleagues are influenced, but I'm not."
- "I have ties with all the companies, so I'm not influenced by any."
- "I'm just helping out my patients."
- "I recognize that I am in conflict, but believe that I can handle it. If I couldn't handle the conflict I wouldn't have gotten involved."

These investigators fail to recognize that preventing bias is not an issue of personal responsibility. Instead, we need institutional and cultural changes to reduce bias stemming from conflicts of interest. By studying the types of bias that are associated with conflicts of interest, we can develop institutional strategies to mitigate the biases.

Meta-research studies that examine research across an entire body of evidence have demonstrated that conflicts of interest are associated with bias. Bias occurs when some study characteristic, such as the study funding source or author conflict of interest, is associated with the outcome of the study. This association is observed even when controlling for the effect of the intervention or exposure being tested or the methods of the study. For example, a 2017 meta-analysis of studies that examined the association of drug industry sponsorship with the outcomes of drug studies found that studies sponsored by the makers of the drugs being tested were about 30% more likely to find that the drug was effective compared to studies with other sponsors (Lundh et al., 2017). This association was observed even though the studies had similar methodological characteristics (eg, randomization or blinding). Similar relationships between funders and favourable outcomes have been observed for research in other fields such as nutrition or tobacco research (Chartres et al., 2016), (Barnes and Bero, 1998).

So what is going on… how does this bias happen? There are a number of ways that a study can be biased (Odierna et al., 2013). Bias can be introduced in the questions that

are asked, including whether a question is asked at all or how a question is framed. Bias can also be introduced in the methods of a study, or in how a study is conducted behind the scenes, even if the method is rigorous. Lastly, bias in a body of evidence can occur if only some studies get published or only some outcomes from a study get published.

Conflicts of interest can affect research agendas

Funders and authors with conflicts of interest can bias entire research agendas, thus influencing the questions that are asked in a way that makes them less relevant for public health interests and more relevant for commercial interests. For example, in a sample of 213 randomized controlled trials in nutrition research, we found that 67% of the food-industry-sponsored studies focused on interventions involving manipulations of specific nutrients (Fabbri et al., 2017b). The non-food industry-funded trials addressed different levels of dietary composition, including whole foods and combinations of foods and nutrients. A similar pattern was observed among observational studies (Fabbri et al., 2017a). Thus, the food-industry-funded studies were more likely to assess formulated products that could be marketed for benefits related to a certain nutrient. Critical public health questions regarding the benefits of whole foods and interactions of foods were not addressed.

In addition, food companies have funded research that detracts attention away from the harms of certain food ingredients. For example, Coca-Cola has funded research on the benefits of exercise rather than the harms of sugar, and the sugar industry funded research on the association of fat intake, but not sugar intake, with cardiovascular disease (Kearns et al., 2016). The tactic of funding research was also used by the tobacco industry to distract attention away from the harms of second-hand smoke exposure. The tobacco-industry-supported Center for Indoor Air Research funded research on the effects of indoor air substances such as carpet fumes or oxygen from green leafy plants, rather than research on the health effects of second-hand smoke. The results of these studies were used in policy arenas to suggest that substances in indoor air other than tobacco smoke were more likely to influence health and should be regulated instead (Barnes and Bero, 1996).

Bias in methods

Methodological risks of bias occur when components of a study design allow a systematic error in the assessment of the magnitude or direction of the results (Higgins and Green, 2008). In clinical trials testing the efficacy of drugs, studies lacking randomization or blinding falsely inflate the efficacy of the drugs compared to studies that have these design features (Page et al., 2016). They also are less likely to report statistically significant adverse effects (Nieto et al., 2007). Thus, biased methods can shift effect estimates to be larger or smaller. Inappropriate randomization and a lack of blinded outcome assessors can also bias the outcomes of animal studies (Crossley et al., 2008). Industry-sponsored studies, and those with conflicted authors, tend to use methods very similar to those in studies without financial ties. The differences in outcomes observed between industry- and non-industry-sponsored studies are more likely due to biases in how the questions are asked as discussed above, or the next source of bias in the research cycle: selective reporting bias.

Selective reporting bias

Selective reporting bias occurs in different ways (Dwan et al., 2011). Selective analysis bias occurs when the same outcomes from a study are analysed in different ways and only some of the analyses are published. For example, different statistical tests could achieve different levels of statistical significance and only the analyses with statistically significant findings are published. Selective outcome reporting occurs when some, but not all, of the outcomes of a study are published. For example, a study with depression as an outcome may use a scale to measure depression following 3, 6, 12 and 18 months of treatment. Selective reporting bias occurs if data from only one time point is reported. Or if depression was measured using different scales, selective outcome reporting would occur if only the data from one scale was reported. Publication bias occurs when an entire study is not published.

We conducted a series of studies demonstration selective reporting bias in the publication of drug and tobacco research where bias in reporting was associated with industry funding or financial conflicts of interest of the authors (Rising et al., 2008), (Hart et al., 2012). In one of these studies, we asked the simple question, "Are all drug studies that are submitted to the US Food and Drug Administration as the basis for drug approval published?" Publication of these studies would mean that doctors and other prescribers would have access to the same information as the regulator. Prescribers could then base their treatment decisions on the best available evidence rather than information provided by pharmaceutical companies.

The simple answer to this question was no. Of 128 trials that were used as the basis for regulatory approval of 33 new drugs, 78% were published within 5 years of approval. However, all trials were published for only 52% (17) of the drugs; no trials were published for 2 of the drugs. One of the drugs with no published data was for a pediatric indication. All of the trials were sponsored by the companies who made the drugs and submitted the applications for regulatory approval to the FDA (Rising et al., 2008).

We also found evidence of selective outcome and analysis reporting. Forty-one primary outcomes reported to FDA were missing from the papers. None of these was favourable to the drug being tested (Rising et al., 2008). Interestingly, 15 outcomes that were not reported to the FDA appeared in the publications. All of these were favourable to the drug being tested. Lastly, the analysis and resulting statistical significance of 5 outcomes changed between the FDA data and published data. Four out of five of these changes favoured the test drug. The bottom line is that all of the selective reporting meant that the scientific publications about each drug made the drug look more effective than it actually was.

Things get really interesting when we look at how studies are conducted behind the scenes. Litigation has given us glimpses into how conflicts of interest can introduce bias in the way a study is conducted, even when it has a rigorous methodology. As part of settlement agreements, courts have released previously confidential documents that were used as evidence in cases investigating harm from tobacco, drugs, or chemicals. These documents, which are freely available to the public, are a goldmine of information about how corporations influence research agenda, as well as the design, conduct and publication of research (White and Bero, 2010).

Internal documents from pharmaceutical companies have given us particular insight into how industry sponsorship or conflicts of interest affect the publication of science. Drug industry documents described scientific publication as part of their marketing strategy, with the goal of disseminating favourable information about their products (Steinman et al., 2006). Pfizer and Parke-Davis sponsored trials of a drug called gabapentin to test the drug's efficacy for a variety of unapproved ("off-label") indications. Demonstrating that a drug works for an unapproved indication could expand the use of the drug and increase its sales. Internal documents describe how company executives managed the publication of every trial. Directions were given that trials with "positive" results were to be published and trials with "negative" results were not (Steinman et al., 2006).

We tracked the publication of the 20 clinical trials of gabapentin for which internal documents were available by comparing the protocols for the trials found in the internal documents to the final publications (Vedula et al., 2009). The publication outcomes of these trials showed a very similar pattern to the publication outcomes of the 164 trials where we compared what was submitted to the FDA with what was published. Of the 20 trials of gabapentin, 12 were reported in publications. For 8 of the 12 reported trials, the primary outcome defined in the published report differed from that described in the protocol. Of the 21 primary outcomes described in the protocols, 6 were not reported at all and 4 were reported as secondary outcomes. Of 28 primary outcomes described in the published reports, 12 were newly introduced. Trials that presented findings that were not statistically significant for the protocol-defined primary outcome in the internal documents were not reported in full or were reported with a changed primary outcome. The primary outcome was changed in the case of 5 of 8 published trials for which statistically significant differences favouring gabapentin were reported.

Bias can also occur in the interpretation of results, otherwise known as "spin." Spin refers to reporting practices that distort the interpretation of results and mislead readers so that results are viewed in a more favourable light. Spin is a familiar concept in the media and politics, but is also prevalent in the scientific literature. Spin was defined in many different ways, but the most common manifestations were making the results look larger than they were, claiming statistical significance when there was none, and inappropriate claims of causality. We conducted a systematic review of 35 studies of spin (Chiu et al., 2017). The occurrence of spin differed by study designs. A median of 86% of observational studies had spin, 58% of controlled trials, and 26% of meta-analyses and systematic reviews. Spun interpretations meant that efficacy was inflated and harms suppressed. Nine studies examined the association of spin with conflicts of interest or industry sponsorship. No differences in spin were detected, possibly due to the high occurrence of spin overall.

Why conflicts of interest matter and what we can do about them

Valid evidence is the foundation for systematic reviews, public health and clinical guidelines, and health policies. Bias can be difficult to detect, but the evidence that conflicts of interest bias research cannot be ignored. If the evidence is not solid in its question, design, methods or publication, the whole foundation for health policy crumbles. In

addition, we have a problem of trust that is particularly relevant in the Post-Truth era, when people do not know what to believe. Conflicts of interest not only hurt the integrity of research, but also damage trust in science and medicine (Lo and Field, 2009). It is important to note that the effects of conflicts of interest on research are not a problem of 'bad apples' or the moral failings of individuals, but an undesirable situation that requires structural solutions.

Disclosure is an essential first step in identifying conflicts of interest, but does not reduce or eliminate bias. As noted above, financial disclosures in journal articles are often inaccurate, incomplete, or obscured with irrelevant information. Rates of non-disclosure in journal articles remain high, so journals should penalize authors who fail to disclose financial ties. Disclosure can also have adverse consequences. For example, experimental psychology studies found that disclosure by individuals in an advice-giving role benefited the advice givers, but not those receiving the advice (Loewenstein et al., 2012). Lastly, disclosure of funding source or an author financial tie may not reveal the full control of the sponsor over the question formulation, design, conduct or publication of the research (Lundh et al., 2012), (Bero et al., 2005). Additional disclosures regarding the true role of the sponsor are necessary.

A number of structural reforms in clinical research are aimed at reducing reporting and analysis biases. Study registration has become mandatory for publication of clinical trials. Study registries have evolved from including minimal information about a trial's design to now including details of the methods and the results for primary outcomes (Dickersin and Rennie, 2012). Protocols published in registries can be checked to find out if a study has been published. Comparison of published trials with registered protocols enables the detection of deviations in conduct of the study and reporting biases. Clinical research registries permit the registration of observational studies, as well, although registration of these types of studies is not common practice. Registries also exist for systematic reviews and animal studies (Chien et al., 2012), (Jansen of Lorkeers et al., 2014). Registry of all these types of studies should become the norm.

Open access publication of datasets, through journals or data repositories, is a reform aimed at combating reporting and analysis biases, as well as spin. When full datasets are available, different research teams can analyze the data to determine if the findings are reproducible. Given the well documented influence of industry funding and conflicts of interest on selective outcome reporting, open access publication of data should be a requirement for industry-supported researchers and studies. Researchers should participate in industry-funded studies only if all the data are made publicly available.

Reporting guidelines, when required by journals, achieve completeness of reporting so that biases in published articles can be assessed. Over 380 reporting guidelines, covering most types of human and animal studies, can be found at the EQUATOR website (Gould, 2016). Ironically, reporting guidelines do not include detailed templates for improving the reporting of conflicts of interest. To improve study of the impact of conflicts of interest, they should be reported in a structured fashion.

Consumers should approach research conducted by private companies or by

investigators with financial ties with scepticism. Critical appraisal skills can be taught to health professionals, consumer, and even primary school children (Odierna et al., 2015), (Semakula et al., 2017), (Nsangi et al., 2017). Or consumers could leave the evaluation of research to someone else. Rigorous evidence synthesis, conducted by independent organizations such as Cochrane include an assessment for risk of bias for all studies included in the analyses.

The best option for eliminating bias stemming from conflicts of interest is to eliminate the financial conflict of interest. This is not a utopian ideal, as other professions require that key decision makers (such as a judge) have no conflicts of interest. Dependence on industry funding could be lessened by eliminating studies that are conducted to produce alternate facts for marketing or political purposes. The money diverted from these activities could be invested in more meaningful research. Companies could be charged fees, based on the amount of money they spend on advertising, to conduct research that they would normally not fund (Italian Medicines Agency (AIFA) Research & Development Working Group, 2010). Publishers of research could just say no to the publication of industry sponsored studies and extend this to include research conducted by investigators with financial conflicts of interest (Lundh and Bero, 2017). Lastly, industry funding for research could be pooled, although there is little incentive for companies to do this as they could not be guaranteed that the money would be spent showing that their particular products are superior.

The ideas for most of these reforms are not new, but the political will to enact them has been lacking. Decision makers should give greater weight to research that is free of financial conflicts of interest. If we want to protect consumers from biased facts and restore their trust in science, real reform across the research and regulatory sectors, must be undertaken. We need to put the horse back in front of the cart and prioritize structural solutions to minimize the influence of conflicts of interest on evidence itself.

Acknowledgements

There was no financial support for the preparation of this manuscript.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 69–81. ISSN 0035-9173/18/010069-13

Algorithms of hate: How the Internet facilitates the spread of racism and how public policy might help stem the impact

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Abstract

Complex multicultural societies hold together through effective and interactive communication, which reinforces civility, enhances information sharing, and facilitates the expression of interests while permitting both diversity and commonality. While trust is an important cement in the building of social cohesion, multicultural societies face continuing challenges as their ever-extending populations test the trust necessary to constitute supportive, bridging social capital. The Internet, which has become a crucial component of the communication systems in modern societies, offers both opportunities and challenges, especially in the generation and circulation of race hate speech which attacks social cohesion and aims to impose singular and exclusive racial, ethnic or religious social norms. The Internet in Australia remains problematic for four key reasons. The underlying algorithms that produce social media and underpin the profitability of the huge domains of Facebook and Alphabet also facilitate the spread of hate speech online. With very limited constraints on hate speech, the Australian Internet makes it easy to be racist. Human/computer interactions allow for far greater user disinhibition, which suits the proclivities of those more manipulative and sadistic users of the Internet. All of this is occurring in a post-truth world where racially, religiously and nationalistically inflected ideologies spread fairly much unchecked, and discourses of violence become everywhere more apparent. Australia has opportunities to do something about this situation in this country, yet we see around us a lethargy and acceptance of technological determinism. The paper assesses these claims and proposes some ways forward that are evidence-based, and collaborative, scholarly and social.

Post-truth and Internet racism: knowledge and power

The Forum on Post Truth organised by the Royal Society of NSW and the scholarly academies, held in November 2017, focuses our attention on the concept of truth, its meanings in the "hard" and social sciences, and the manipulation of public comprehension of the realities in which we live. As a sociologist with humanist tendencies I have long held that truth *claims* are just that: propositions that can be tested empirically. However what counts as evidence can more often be a question for vigorous debate, though simple assertion cannot win the day. We have seen in this Forum a variety of approaches to this issue, with particular focus on the interfaces between science and power, between scholarship and politics. Perhaps one of the most complex interchanges – between knowledge and prejudice, freedom and constraint, emotion and rationality, and policy and ideology – can be found in the rapidly burgeoning space of on-line racism.

On-line racism is a comparatively new phenomenon, maybe a generation old, given its dependence on the invention of the Internet and the development of the World Wide Web (Brown, 2017). Racism, of course, has a much longer timeframe, drifting back into

the mists of pre-history. Together racism and the Internet have produced a phenomenon that requires a truly interdisciplinary scholarship to describe and analyse, drawing on physical, economic, political and social sciences. Beyond my analysis in this article lies a prognosis on the one hand, and suggested programs for intervention on the other. This paper draws on a larger collegial work (Jakubowicz et al., 2017a) to make some specific claims about the way in which on-line racism serves the purposes of the expansion of "post-truth". The Internet facilitates this expansion by feeding a societal discourse in which race is given a false scientific realism, racism confirmed as an acceptable mode of social relationship, and the politics of racial prejudice allowed to permeate arguments about appropriate public policy (Nicholas and Bliuc, 2016).

Why cyber racism matters

Modern Australia has been described as a multicultural society, the most successful in the world according to Prime Minister Malcolm Turnbull, a perspective only possible if the Indigenous presence in Australia is ignored (Jakubowicz, 2015). Whether Australia in fact stands first in line — and I dispute this claim even in relation to the cultural diversity of immigrant descendants: Canada is far ahead on many criteria (Tierney, 2007) — multicultural societies all depend on a pro-active building of trust between disparate peoples, usually prompted and promoted by government. Trust, often described as though it were the glue that anchors social cohesion (Markus, 2015), can be fragile in a multicultural milieu, where people do not go back many generations together, and the intimate ties of kin and communal sharing among strangers are less evident. Moreover, the subtleties of cultural participation and understanding take time to evolve and modify the emotional and intellectual portfolios people draw on to interact with others different from themselves. Thus multicultural societies require active interventions in the public sphere to build community and resolve conflicts (Kymlicka, 2007). With the advent of the Internet, digital technologies are now deeply implicated in nearly all spheres of social interaction.

The issue of cyber racism has particular relevance for scientists, humanists and policy makers, as the phenomenon depends on the state of the social relations of multicultural societies, public policy perceptions and responses to those relations, and the affordances of the digital technologies. It thus "pitches" at a point where the academies intersect, the world-views and technical skills of the different branches can be applied, and the social advancement that the Royal Society seeks to nurture is being challenged. On the other hand citizens might ask why Australian society should be concerned about the spread of race hate speech on the Internet (Bernardi, 2016). Surely, in a liberal democracy, freedom of speech, no matter how objectionable, must be defended as a higher-order value, one linked directly to the pursuit of truth and therefore an underpinning of science? While people may take offence at what other people say about them, so long as the language does not seek to trigger or actually triggers criminal behaviour, do we not all have an interest in allowing its free expression?

In answer to these questions, let me begin with a short personal anecdote. Late last year I wrote a piece for *The Conversation* reviewing the question of whether the concept of ethno-political hierarchy or ethnocracy (Jakubowicz, 2016) — used to examine how

race, religion or creed was either actively or unconsciously reflected in structures of sectarianised democratic power — could be usefully applied to Australian multiculturalism. My argument was attacked by a post-truth advocate who alleged its thrust would erode the importance of White Anglo-culture as the underpinning of Australian moral order. In addition, the individual pointed me and other readers towards a website, twitter feed and Facebook page (Di Stefano and Esposito, 2016) in which my article and myself as its author were the primary targets. The authors of that piece had headed the article with a photo of the ceiling of the Yad Vashem memorial hall to the slaughtered of the Holocaust in Jerusalem, while the article attacked me as Jewish and therefore implacably fixated (it appeared to them) on a project to destroy White Australia by advancing multicultural ideas. There were many other subtle and not so subtle references to the benefits of Nazism and the appropriate end for a Jew, to which the ceiling image of thousands of dead referred.

It is one of the uncomfortable consequences of being a Jewish intellectual and social scientist in the era of post-truth that the new Nazis and other ultra-nationalists find us particularly attractive as targets, both for the views to which we can be attached, and as individuals who can be made to suffer emotionally through activation of Holocaust tropes. Ultimately, I decided to take no action other than use the intervention as a standing case study in how the Internet has allowed the resurgence of race hate and the difficulties the system creates for any action to seek either redress or removal in a sea of global anonymity.

Four reasons Australia is a good place to be an online racist

Four main elements make the Australian experience of race hate on the Internet quite specific, though perhaps only slightly more intense or focused compared with its spread elsewhere. After all, the Internet has become a global network of interconnectivity, with instantaneous communication facilitating interactions between people who might in the past have never come into contact. This facilitation depends on both the physical/technological connections, and the technical languages and calculations that allow messages to flow and reach their targets. These algorithms or sets of rules have been layered over the short history of the Internet into vast portfolios of instructions, often requiring millions of calculations, with consequences both intentional and unintentional (Parish, 2017) (Buni and Chemaly, 2016).

The inventor of the World Wide Web, Tim Berners-Lee, has increasingly been worried by these unintended consequences. Early in 2017 he noted "And the thing that worries me most is that whatever it is we've created we've licensed racism to run free across the planet and the consequences of that for civilisation and democracy are very, very sordid if they're not addressed" (Berners-Lee, 2017). Near the end of 2017 he persisted with these concerns. "My vision for an open platform that allows anyone to share information, access opportunities and collaborate across geographical boundaries has been challenged by increasingly powerful digital gatekeepers whose algorithms can be weaponised by master manipulators" (Solon, 2017).

There are two sets of algorithms that are most implicated in this process, apart from the ones "weaponised" in spheres of civil contestation and those activated in "hot

war" situations. Racism can be served either by directing Internet users to racist sites, or delivering racist messages to other sites. Both of these procedures are triggered by agglomerating data from multiple sources, and looking for patterns — patterns that are known to be profitable, though often cloaked in the language of enhancing user experience. The tie-in of the algorithms to the business models underpinning the Google empire (including YouTube) and Facebook makes them extremely difficult to change. In these circumstances, the platforms have been trying to find ways to limit the use of expensive human staff to monitor breaches of their user codes of conduct, while discovering that they have often been gamed by extremist Internet users and hackers who trip the faults deep inside the algorithmic hold-alls (Greenberg, 2016).

The specific interventions by extremists have both gender and class dimensions, as well as race. For example, the audiences most attuned to racist material in Western societies tend to be younger White males, a somewhat affluent category with disposable incomes, highly sought after by mainstream advertisers for products such as Coca-Cola and the UK military recruitment. Affluent males are also sought by media outlets such as *The Guardian*. These were the types of advertisers that in March 2017 found their messages appearing on racist, sexist and violent sites, and those associated with extremist White Power and Islamist organisations (young males not necessarily White). Many advertisers withdrew their campaigns from YouTube and Facebook, and tried to have Google change its ranking algorithms to avoid their placement in unacceptable locations during online searches (Statt, 2017) (Mostrous, 2017) (England, 2017).

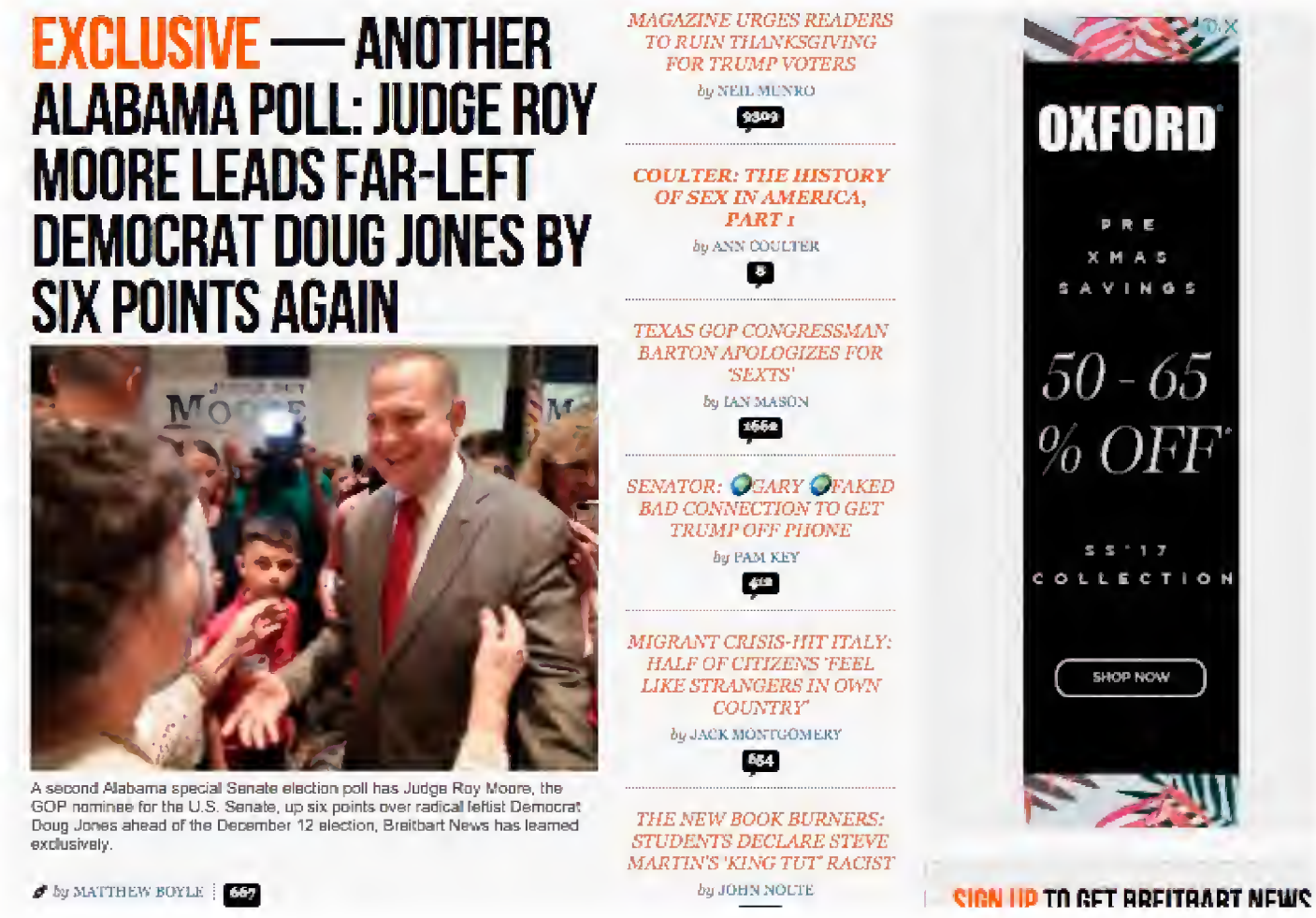

Figure 1.

Readers can try this experiment themselves as I did. I am an occasional customer for a well-known men's clothing brand; I buy in-store although the company has my email for marketing purposes. When I searched the U.S. White Power Breitbart site for information using Google and Chrome, I was served advertisements for that clothing brand (see Figure 1). I also received arthritis treatment information, suggesting that Chrome had been logging my online therapy visits following my recent knee replacement operation. Both advertisements relate to White males: both Breitbart and the arthritis pill target older White males amongst their primary targets. Breitbart was intent to increase the spread of alt-right post-truth and pro-White Power discourses among its visitors, a process that both the advertiser and Alphabet were facilitating and helping to fund (through click-through visit payments where these occurred) (Amend and Morgan, 2017) (Anglin, 2016).

In other situations, algorithms may learn or be programmed to exclude people of colour from access to more highly valued user experiences. A review article in *Science* recently reported how "machine learning of semantics automatically shapes itself to human biases in language, in terms of race gender and disability" (Caliskan et al., 2017). In another instance, some facial recognition software cannot "read" the faces of people of colour and thus excludes them or their responses. In discussing these instances, the U.S.-based advocacy group, the Algorithmic Justice League, conceptualises the issue as "the bias of the coded gaze" (Algorithmic Justice League, 2016, Buolamwini, 2016).

Facebook has been alleged to have been involved in "multicultural affinity targeted advertising" by offering redlining algorithms that identify people on the basis of their race and restrict their access to offers of housing, employment or loans, thereby segmenting markets and populations into those who are

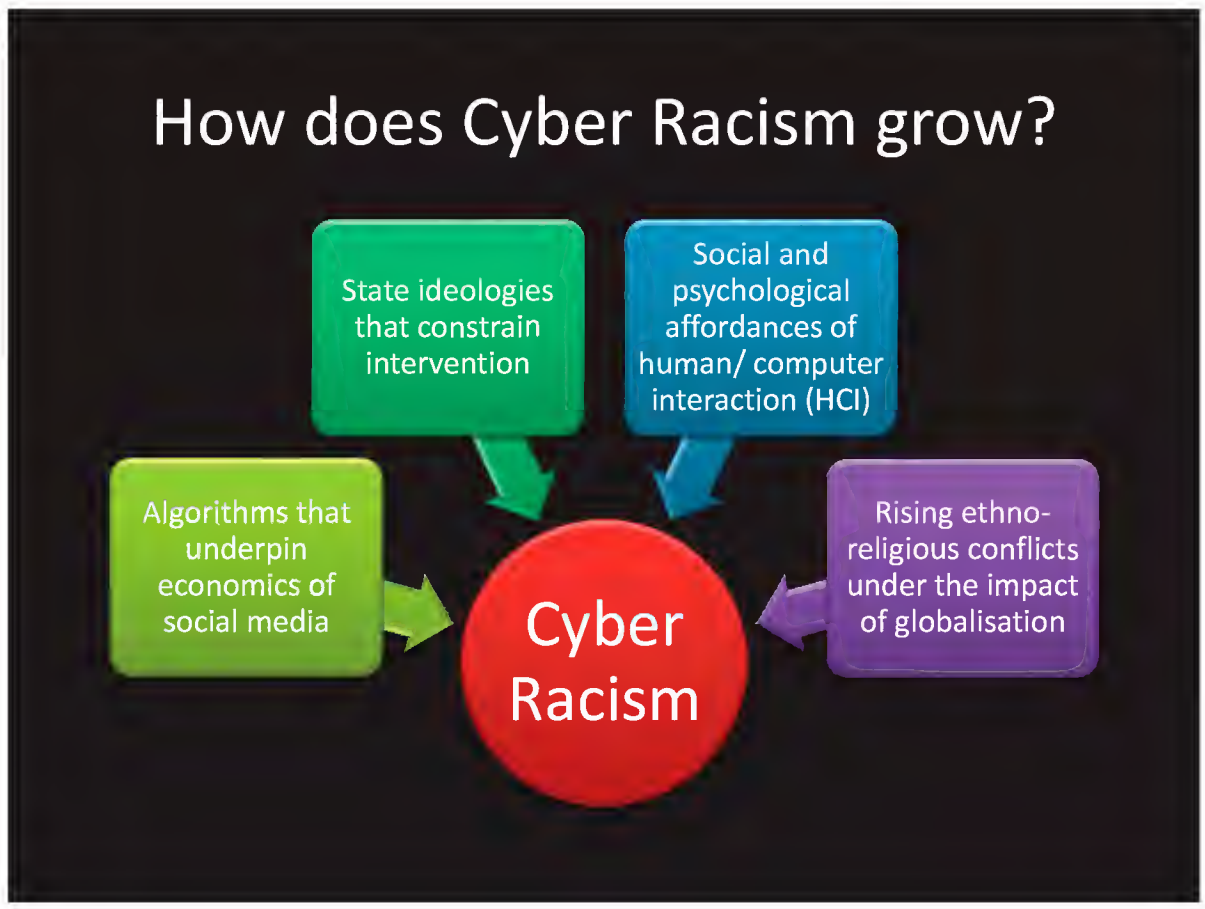

Figure 2.

acceptable and exploitable, and those who are rendered unacceptable and discardable. (Chaykowski, 2016)

The four factors that contribute to the extent and composition of cyber racism in specific jurisdictions can be summarised through the four "feeders" portrayed in Figure 2. All four are necessary to allow cyber racism to flourish, although the extent of each may vary across the globe. However, global, national, scientific and individual factors all play a role, while political action can have some impact on raising or reducing the "volume" of each parameter.

Racism on line

Racism has a long and controversial relationship to science. In 1875 Charles Darwin wrote that, as the science of humanity improves, so then human kind (and especially his peers of white European men of wealth and social status) would be drawn to "extend our sympathies to all men" (Paul, 1988). However, we know the actual trajectory of human history drew exactly the opposite perspective, creating from Darwin's insights the most cruel and vicious separations between peoples. The differences that Darwin saw within humanity became hierarchies of superordination in the ideologies of racism, where the empires of his time drew on poorly understood "truths" to generate overwhelming technologies of destruction. If "race" in all its manifestations finally proved to be an unacceptable framework for building human societies, it did not depart human consciousness at the end of the Second World War.

When UNESCO in 1950 first sought to deal with the science of race, it concluded that races were real categories of differentiation, though quite "inter-breedable" (UNESCO, 1950/1954/1957/1969). At the time the empires of the European centuries of expansion had not quite dissolved and their subordinated racially-justified colonial subjects had not yet reached independence. When the UN once more addressed what racism was in 1967, the world had changed. A global convention against racial discrimination had been passed, any notion that race had a scientific meaning had been abandoned, with UNESCO concluding "Racism stultifies the development of those who suffer from it, perverts those who apply it, divides nations within themselves, aggravates international conflict and threatens world peace" (UNESCO, 1950/1954/1957/1969).

If we take this to be a widely verifiable truth about the effects of racism, then the next factor that effects the extent and nature of racism in Australia lies in the ideologies that are expressed through legislation and action by the state that might follow such laws (McGonagle, 2012). Unlike many other countries, race hate speech is not criminalised in Australia at the national level. Indeed, Australia shares with the USA the reality that one can say anything about other ethnic and racial groups up to the point where advocacy of a crime or of violence is expressed. Australia in 1966 followed the lead of the US (Harris, 2008) to include a reservation in its ratification to article 4a of the International Convention on the Elimination of All Forms of Racial Discrimination (ICERD). Throughout 2016 the Federal Government sought for a second time in recent memory (previously in 2013/2014) to reduce the coverage of the Racial Vilification provisions of the Racial Discrimination Act, which had been introduced (as Section 18c) in 1976 (Baxendale, 2017).

While both those moves failed, the clear message from government was that racial

vilification would be an acceptable practice to be defended behind the rubric of freedom of speech. However research by the CRaCR team (Jakubowicz et al., 2017b, Jakubowicz, 2017) in 2013 and 2016 demonstrated that only a small minority of Australians wanted there to be unrestricted freedom to vilify people on the basis of their race or ethnicity (Parliament of Australia, 2017). Even so, Australia remains one of the easiest places to be racist online (Hunyor, 2008), providing only slow and difficult systems to file complaints, a reluctant and resistant set of corporate providers of Internet services, and a confusing and overlapping set of regulatory regimes.

All these interactions take place in a global environment of heightened fear and tension associated with distinctions based on ideas about race, religion, ethnicity and nationhood. In large part these tensions have grown far beyond the earlier penetration of such issues during epochs dominated by print, audio or even television communication, because of the omnipresence of the Internet and the surge of post-truth propaganda and dissimulation. Thus, the technology and the circumstances have interacted and exponentially expanded the impact of hatred on fearful communities. Over the past decade or more, such divisions have become normalised in stereotypical and increasingly hostile and hurtful encounters, the veracity of which has become impossible to test.

The Internet depends on the easy anonymity of its users, the effective asynchronicity of its interactions, and the isolated circumstances under which most people engage with others online. Such human/computer/human interaction allows for social and psychological opportunities that would be far more difficult in the everyday world. So using the Internet intensifies "disinhibition" (Martin, 2013) (Suler, 2004), by allowing sadistic, egoistic and manipulative behaviour to spread more fluidly (Brown, 2017, Stein, 2016). There is considerable evidence that such dynamics are reflected in the small number of people who apparently "produce" racism online, with a large number of people encountering it, in its many forms, as bystanders.

Extent of racism	**Online:**	**Target**	**Perpetrator**	**Bystander**
Opponent of racism/ not prejudiced		2.2% Often seen as carrying responsibility; opposes racism online; defends from attack.	0.7% Asserts own ethno-religious group superiority while decrying racism.	15.3% Once alerted to issues, becomes more aware; often seen as main bulwark against racism.
Unconcerned/ moderately prejudiced		7.9% Alerted to racism when targeted; tends to withdraw from exposure.	2.8% Unaware amplifier; likes racist joking etc; drawn to swarm.	63.1% Doesn't recognise or withdraws from exposure; can be unaware supporter.
Proponent of racism/ strongly prejudiced		1% Activist responder engaged in fight with perceived harassers.	3.7% Sharp end of racist propaganda; seeks to build following; advance racist agendas.	5.7% Lurks to like; aware amplifier; not pro-active but strong supporter.

Table 1. Algorithms of Hate tables etc.

A 2000+N online survey undertaken for the CRaCR project in 2013 (Jakubowicz et al., 2017a, ch.3) provided data for an exploration of the relationship between the range or type of encounters online, and the attitudes of the subjects on issues associated with racism. Six items from a 20+ compilation of items eliciting responses to attitudes on ethnic and cultural differences on a seven-point original scale, provided a three-point scale of attitudes. Target, Perpetrator and Bystander were discrete categories, although a few individuals were in two or all.

From this distribution, it is possible to have a sense of how different users of the Internet, based on their own levels of prejudice, deal with encounters with racism. The picture is quite complex, demonstrating the interactive nature of the web and the changing position of people who are activist. About 10% of Targets show high levels of prejudice while most Targets show little (71%) or none. Over 50% of Perpetrators are strongly prejudiced, while only 10% show no signs of prejudice. The largest group in relation to racism by far are Bystanders, who make up over 80% of Internet users. Of their number about 7% are highly prejudiced, about 75% moderately so, and 18% show very low levels of prejudice.

The distinctions, based on the level of prejudice and type of encounter, point to the online activities associated with each category, and thereby, what policy and practice responses may be appropriate. These are summarised in each cell. The dynamic of the Internet world of race hate becomes evident — users are making decisions, engaging or withdrawing, being harassed or harassing, in a constantly moving environment. For the Perpetrators one of the goals is to "game" those defences that platforms provide, while seeking to normalise hate speech and thereby transform the social relations of the Internet into one infused with racist ideology and perspectives. Each Internet user category is positioned in specific ways in relation to the expansion of online racism.

However, Targets are often expected to carry the burden of response, or are abandoned to that fate. In the Australian context agencies such as MulticulturalNSW have been charged by their political managers in recent times with implementing an anti-racism/pro-multicultural agenda online; however, these can easily be wound back under ministerial direction should ideologies change and predilections for addressing racism become less pressing. In the federal sphere there have been no such agencies, as political attacks on the Australian Human Rights Commission from the Government have limited its capacities to do so. However, the AHRC has been active in the Racism It Stops With Me campaign, and associated online and broadcast advertisements about racism. Even so the Commission cannot intervene in the online world without direct complaints to pursue. However, the Children's E Safety Commissioner has begun to initiate workshops and strategies to build capacity among threatened communities to defend themselves and advance alternative "truths" against racist attacks.

Increasingly, Bystanders are recognised as extremely important potential defenders of Targets and crucial participants in pushing back against racist hate speech (Nelson et al., 2012). Given that racists want to ensure that every space they enter becomes infected and then permeated by their ideology and discourses, resisting such entry-ism and denying racists these local victories, how-

ever appalling, cruel and foul their language, contributes to a more open Internet.

Strong proponents of racism who are Perpetrators make up less than 4% of users, yet they generate and stimulate the vast array of hate speech in its text, meme and video forms. They are supported by a larger group of Bystanders, who "lurk to like", and want to extend the reach of their swarm leaders into the moderately prejudiced huge bulk of Bystanders. Their attachment to such discourses is closely associated with their belief that their views are widely shared, a position reinforced when they find the sites they like carry no opposition messages or signs of antiracist arguments.

The complexity of the field indicates the need for more coherent and science-based policy; government and civil society interventions in such situations would help reassert both the value of truth, and the right to a democratic and civil Internet (Daniels, 2010). Without an Internet in which truth can be asserted and demonstrated, the overall edifice of evidence-based argument and policy continues to crumble, and issues far removed from racism are caught in a wave of beliefs in which truth and science have no hold (Miller, 2016).

We can summarise the current nexus in Australia through these CRaCR project findings. The basic technologies underlying the spread of race-hate filled social media and related technologies are not easily amenable to state action, especially where the algorithms are so rooted in the profitability of the platforms. Governments fail to realise how much the social cohesion they promote constantly faces attacks that seek to unwind the trust and social capital upon which it depends.

The bad behaviour that promotes the spread of race hate can be quickly and widely replicated (Phillips, 2015). In the process the Internet emotionally and often financially rewards the dark triad behaviour of narcissism, manipulation, and lack of empathy (Binns, 2012). The Perpetrators gain emotional reinforcement, a sense of purpose, and a continuing stream of supportive followers when they are left unchecked and unrestricted; even more so when they are morally castigated but effectively allowed to continue unconstrained. Yet, for anti-racists, taking on the Perpetrators and inventively resisting racist hate speech remains a challenging and wearying activity, with little of the emotional reinforcement that sustains and rewards the Perpetrators (Gagliardone et al., 2015).

The resistance to racism can be further weakened where political leaders are averse to taking courageous positions on difficult issues, being more likely to be drawn to the pressures from conservative post-truth groups that they celebrate freedoms rather than constraints (Group of Eminent Persons of the Council of Europe, 2011).

The major corporations such as Facebook and the Alphabet stable (Google, Facebook, Instagram etc.) appear more interested in protecting their economic interests than in resolving the questions of social impact generated by their business models (Levine, 2013) (Zuckerberg, 2017). For example, they are reluctant to expose themselves to critical scholarly research. They will respond to Parliamentary interrogation, however, when they perceive their interests may be served (Garlick, 2017, Garlick, 2018). Despite widespread criticism by organisations such as the Simon Wiesenthal Institute in the USA (Simon Wiesenthal Center, 2017) and the Online Hate Prevention Institute in Aus-

tralia (Online Hate Prevention Institute, 2015), the two great Internet behemoths have gone to great lengths to protect their underlying business models from changes that might be thought necessary by critics to address the pervasiveness of racism throughout their services.

In 2017 and into 2018 the Australian Senate Standing Committee on Legal and Constitutional Affairs undertook an examination of the adequacy of Australian criminal offences in relation to cyber-bullying. While racist hate-speech is often part of cyber-bullying, it is far less likely to attract attention than do other dimensions of bullying and harassment. Facebook made two written submissions in addition to its oral evidence. In the first (Garlick, 2017) the company stressed that platforms should be excused from any responsibility for material published in their pages by their users, as the company was not a publisher in the traditional pre-Internet sense, and that it already responded quickly to requests from affected parties, or the police, for bullying material to be taken down. In a return submission responding to questions on notice from the Committee, the company representative described the strategies adopted to deal with complaints and problematic users: Facebook noted it had 14,000 people working worldwide on community operations in 2017, and was planning to increase this number to 20,000 in 2018.

That is, one key area was human intervention, leaving the fundamental algorithms tweaked but not significantly changed. Discussing Facebook's "removal of hateful content in Europe," the company pointed to the agreement between social media firms and the European Commission to tackle the "problem of hate speech in Europe". Pushing back against the German law that criminalises activities of companies that fail to meet take-down standards, Facebook believed that "There is no place on Facebook for hate speech … industry codes are a more collaborative and effective [way] of achieving the results we all want to see" (Garlick, 2018). Australia has nothing like the European Commission Code of Conduct; Facebook made no offer that they would collaborate with civil society and government to ensure that one could be established.

Building resilience

However, associations that bring together people concerned with both civility and truth do have avenues open for them. They can be part of the move to build civil society alliances that abhor racism, and seek to push back against the acceptance or legitimisation of racism and racist discourses. Where initiatives in the legal sphere are opening, as a consequence for instance of the decision of the E Safety commissioner to recognise racism as a problem, then innovations such as the New Zealand Harmful Digital Communications Act could be considered (New Zealand Law Commission, 2012). The Australian Human Rights Commission could be both permitted and resourced to identify and pursue particularly egregious cases of cyber racism where no Target would otherwise be prepared to come forward. Civil society groups could call out and publicise, through social media, advertisers who allow their names to be associated with race hate sites, thus putting pressure on the large platform providers to find strategies to reduce such associations.

Perhaps the Royal Society and the Academies, with their aspirations to link science with human prosperity and well-being, might well take on strategy development that looks

to public policy based on science as a way forward (Came and Griffith, 2017). A small group of mathematicians, philosophers, social scientists and others might workshop such ideas to contribute to crowd-sourcing resilience strategies, so that the algorithms that underpin social media in the future are not so conducive to the proliferation of hate: indeed, algorithms if not of love then at least of peace might eventuate. Ultimately resilience requires strong networks that build active cells of knowledge, where racism can find no place to flourish.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 82–90. ISSN 0035-9173/18/010082-09

Mind, language, and rational discourse

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Introduction

When Pope Francis banned the sale of cigarettes in the Vatican in 2017, his announcement stated: "The Holy See cannot be cooperating with a practice that is clearly harming the people." The World Health Organisation tweeted their support—"WHO welcomes the Vatican's decision to ban the sale of cigarettes as of next year"—with an infographic summarizing some deadly facts about tobacco, including "12% of deaths of all people aged over 30 are due to tobacco", "global annual costs from tobacco use are US$1.4 trillion in healthcare expenditure and lost productivity", and "tobacco kills more than 7 million people every year". This in turn attracted a response from Nigel Farage, a politician and businessperson with no qualifications in medicine or health science. To his many thousands of social media followers, he wrote: "The World Health Organisation is just another club of 'clever people' who want to bully and tell us what to do. Ignore." If the scientific findings behind WHO's infographic are sound, then Farage is potentially endangering the lives of his hundreds and thousands of followers by literally instructing them to disregard WHO's expert advice. At least Farage practices what he preaches. During the Brexit campaign, journalist Michael Deacon noted that Farage had taken up smoking again, and asked him why. Farage's response, delivered with cigarette in hand, was, "I think the doctors have got it wrong on smoking."

Scientific evidence shows conclusively that tobacco smoking is extremely dangerous (see Bero, this issue). Why would a person promote smoking to citizens who would be voting for him, and for whom he is campaigning to serve and protect? Farage's statements are irrational. They disregard reality, which is, as author Phillip K. Dick defined it, "that which, when you stop believing in it, doesn't go away". No matter what Farage says or believes about the effects of smoking, the toxic fumes will have their effects on his respiratory and circulatory systems, and beyond. You can dismiss expert testimony, you can persuade people to do dangerous things, but your words won't make the dangers of reality disappear.

In recent times, scientists have had to publicly defend this point, for example, in the recent global March for Science. Many initiatives have been launched to draw attention to the post-truth problem. For example, the website https://www.protruthpledge.org/ allows you to pledge your earnest efforts to share, honour and encourage truth. Among other things, you pledge to fact-check information to confirm that it is true before accepting or sharing it; to distinguish between your opinion and the facts; to re-evaluate if your information is challenged; to retract if you cannot verify. Most importantly, you agree to be accountable to the pledge, encouraging others to hold you to the pledge in case you transgress it at any point.

Cognitive biases

These commitments are not only crucial to rational discourse, they are central to sound science. But at the same time, our cognition is biased in ways that make it hard for us to understand and process things methodically or dispassionately (see Hector, this issue). Decades of research have uncovered numerous cognitive biases that help explain why the Pro-Truth Pledge is so challenging to uphold.

An example is the Checkershadow illusion, shown in Figure 1:

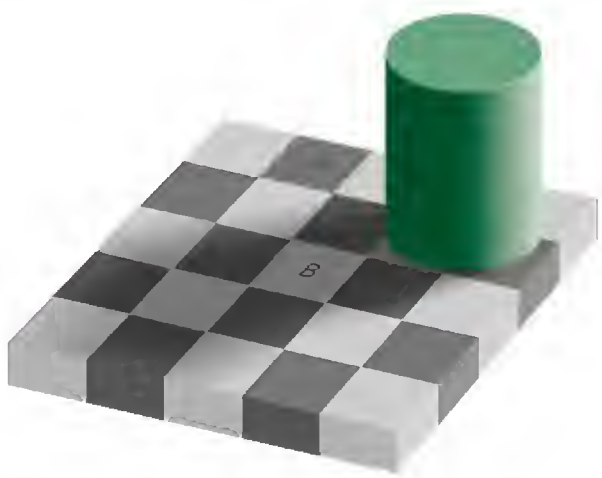

Figure 1.

People are surprised to learn that the squares A and B are identical in colour and shade. This is demonstrated in Figure 2, where a bar of the same shade joins the two squares, revealing the exact match in surface quality:

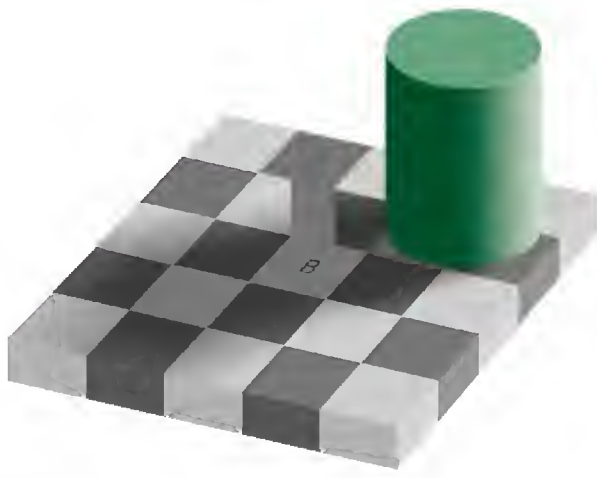

Figure 2.

In this illusion, our perceptual systems encounter exactly the same local input, but our cognitive systems add inferences and interpretations of what we're seeing, based on assumptions about where light is coming from, and what we believe about the colour of the object itself. Even in our lowest-level perceptual experience of reality, our firm beliefs about what we see do not necessarily correspond to what is demonstrably there.

At higher levels of cognitive processing, there is the *availability heuristic*, a cognitive principle that minimizes processing effort, but that leads us to confidently make wrong decisions. In a study of this heuristic, Tversky and Kahneman (1973) asked people to estimate the proportion of words in the dictionary that have the letter R as their first letter versus those that have R as their third letter. People tend to guess that more words in English will begin with R. But, with systematic testing of the question, we find that the ratio is actually about 2:1 in the other direction. Roughly, for every word in the dictionary that starts with R there are two words that have R as their third letter. A belief that more words start with R is false, but it makes sense from the point of view of the locally-rational agent who is trying to answer the question that was posed in Tversky and Kahneman's study. The error is a side-effect of the availability heuristic. Words that start with R are simply more available to us—a fact that has to do with how our vocabulary is mentally organized—and they come more readily to mind, so we are led to imagine that there must be more of them. By using the availability heuristic in this way, people minimize their effort in coming to a conclusion about what they believe, but through this, they can arrive at a false belief, which in turn may lead to poor decision-making.

The example of words beginning with R illustrates the trade-off between effort and accuracy that is the essence of biased cognition. The upside is that we have methods by which to quickly come to a conclusion and lock off our processing of a problem at hand, thus freeing ourselves to move on to the next pressing matter. The downside is that we may be wrongly confident about conclusions that turn out not to be supported by empirical data.

Another example is the *confirmation bias*. More than half a century ago, pioneering cognitive psychologist Peter Wason (1960) presented subjects with triplets of numerals, such as 2-4-6. He told subjects that each triplet was generated by a specific rule, and that their task was to discover the rule. Subjects were allowed to devise their own novel triplets and ask the experimenter whether their made-up triplets fitted the rule or not. Then, based on the evidence they received, they would state what they thought the rule was. Wason found that people would often approach this task by starting with a hypothesized rule, generating novel triplets using that rule, and asking for confirmation as to whether the new triplets fitted the experimenter's rule. For example, if Person A hypothesizes that the string 2-4-6 is generated by the rule "increase by 2 at each step", they might offer strings that are generated by that rule—for example, 4-6-8—and ask for confirmation as to whether these strings fit the rule. Or if Person B hypothesizes that the string 2-4-6 is generated by the rule "increase by the first numeral's value at each step", they might ask whether 4-8-12 fits the rule. After they are both told "yes", they each become more confident that their hypothesis is correct (although of course they cannot both be correct). What Wason found was that people in his experiment literally seek only confirmation, and when they get it they take this to be sufficient to support their hypothesis.

This apparently natural approach is antithetical to the scientific method. As Popper (1959) defined it, what we must seek is not confirmation but *falsification* of our hypotheses. "My proposal is based upon an *asymmetry* between verifiability and falsifiability; an asymmetry which results from the logical form of universal statements. For these are never derivable from singular statements, but can be contradicted by singular statements" (Popper 1959:19).

In Wason's experiment, the rule for 2-4-6 was 'each numeral is greater than the previous'. Both 4-6-8 and 4-8-12 fit this rule and so simply asking for confirmation does not provide evidence to test between the two competing hypotheses mentioned above. As Popper advised, to seek falsification, we would have to check triplets that are *not* generated by the rule. Were Person A to check only strings that were generated by her own hypothesized rule—such as 4-6-8, 8-10-12, 23-25-27—a confirmation would not be ruling out other possible rules, such as Wason's actual rule in the experiment. If she were to check strings that she did *not* expect to fit, she would quickly learn that her hypothesis needs revision. The confirmation bias, which leads us to take mere confirmation to be evidence that we are correct, is one of the most powerful contaminants of our thinking.

In July 2017, author J. K. Rowling tweeted a 23-second film clip of Donald Trump hosting visitors at the White House. The clip shows Trump shaking hands with members of a group standing in line. At the bottom of the frame we see the raised arm of a little boy

who is in a wheelchair. It looks like he wants Trump to shake his hand. In the clip, Trump keeps his gaze up, greeting people who are standing in line behind the boy. He walks past the boy, strides off, and leaves the room. To her 14 million social media followers, J.K. Rowling wrote: "Trump imitated a disabled reporter. We all saw that in the election cycle. Now he pretends not see a child in a wheelchair, as though frightened he might catch his condition." The post received more than 12,000 retweets and more than 50,000 likes. But the next day a longer clip from the same video was circulated, showing what had happened in the moments immediately prior to the scene circulated by Rowling. In the longer clip, we see Trump directly addressing and chatting with the little boy, not only shaking his hand but kneeling down to talk to him face-to-face. Rowling's error (for which she later apologized) was the result of confirmation bias in action. She started with a firm belief that Trump is a bad person, she saw something that seemed to confirm this, and she came to a conclusion that matched her belief, then locking off further consideration of the situation. We all regularly fall prey to this bias.

A final bias I want to consider here is an *identity bias*. This is where a decision or judgment about a person, and particularly about a statement that the person makes, is affected by one's beliefs about the social identity of that person. The heuristic involved here assumes that a person's identity, as evidenced for example by a visible sign such as their clothing or other aspect of their appearance, allows us to predict a range of things about them, including their knowledge, background, beliefs, and aspirations. Suppose that you observe a young man at a Sydney beach with a tattoo of the Southern Cross—the constellation that appears on the Australian flag—covering his entire back. From this you might infer that he identifies as a patriotic Australian, but you might also expect certain other things to be true. For example, you might expect him to lean towards conservative stances on issues that are not necessarily or logically connected to pride in the nation: for example, being against same-sex marriage, in favour of coal mining, anti gun-control, or sceptical of climate change. You might also form clear assumptions about his level of education and likely place of upbringing. These expectations and assumptions might be wrong. There is no necessary or logical connection between a flamboyant stance of patriotism and any of those other views or qualities. And yet many people are confident in using a person's social identity as a reliable indicator of a set of fundamentally unrelated things.

The identity bias underlies the crisis of identity politics in public discourse today. We not only make assumptions about a person's beliefs based on their professed or assumed social identity, but even stronger, one's social identity can be used as a criterion for citing greater, or lesser, rights to introduce a given proposition into an otherwise rational argument. If unchecked, an identity bias leads to an inability to distinguish between an argument and the person making it. When we equate an argument and a person, to attack a point is to attack the person making it, and thus it can be grounds for disallowing or disregarding arguments, and ultimately shutting down logical discussions before their logical conclusions. This is a threat to rational discourse, and may be a threat to free speech.

The effects of identity bias have been increasingly visible in university life in North America. In 2017, Master's student Lindsay Shepherd was teaching a class at Wilfrid Laurier University in Toronto to undergraduate students in relation to issues of free speech, language use, and human rights.[1] The Canadian Parliament's Bill C-16 added gender expression and identity to grounds for discrimination under the Canadian Human Rights Act, requiring people to use non-gendered pronouns (for example 'they' to refer to singular persons) as a way of avoiding possible offence to those who do not identify with either male or female gender assignment. Shepherd played her students some segments from a public debate on TV Ontario between two academics, psychologist Jordan Peterson and historian Nicholas Matte. She was later called to a meeting by her supervisor and a representative of the university's diversity office, among others, who said that a complaint had been made by one or more students. She was told that she should not have played the recording of the debate, as it risked traumatising her students, by exposing them to hateful ideas, based on the view that Peterson was a hateful person. On the recording of the meeting that Lindsay Shepherd gave to the media, her supervisor can be heard saying that playing a clip of Jordan Peterson arguing against C-16 was the same as uncritically playing a video of Adolf Hitler giving a speech. Here, an assessment of Peterson as a person was given as grounds for silencing the arguments that he was offering.

Lindsay Shepherd identifies as politically liberal in as many ways as you can think of. But by airing arguments against the C-16 bill—not endorsing them but asking her students to evaluate them together with the pro C-16 arguments—she has been accused of siding with political conservatives, condoning violence, and hurting students. This is the identity bias in action. It can confuse, derail, and stifle ideas and debate.

[1] http://www.macleans.ca/lindsay-shepherd-wilfrid-laurier/

Overcoming cognitive biases

As individuals, we are all subject to the kinds of cognitive biases reviewed above, among many more. Why do we have these biases given their apparently maladaptive nature? Could biased forms of thinking have had advantages in our evolutionary context? Why do they seem damaging in today's context? What's fascinating about human cognition is that we are able to focus on our own biases, and, in some cases, override or outsmart them. A recent initiative set up at Harvard called Outsmarting Human Minds is promoting this idea, following insights of pioneers like Herbert Simon, Amos Tversky, Daniel Kahneman, and Gerd Gigerenzer. The idea is that with effort we can detect these problematic biases in our own cognition and we can overcome them, we can outsmart them, and we can do better. These biases not only result in us coming to wrongful conclusions in everyday life, but they present a personal challenge for every scientist. When we apply the scientific method, we are designedly working to avoid falling prey to our own natural biases, such as the confirmation bias, among many others. To do science well, we must work against ourselves to minimize bias.

Reasons for action

Language plays a key role in all of this. When we try to support our arguments with evidence, we seldom if ever supply the evidence in pure form. We take that evidence and put

it into words, and into utterances, or at the least we point to some sign of the evidence and frame it in verbal form, such as when a bar chart is used in a scientific paper. And when we use words, we introduce a host of collateral effects.

To understand these collateral effects, think about what it means to make a simple assertion using language. Consider a sentence like "This material expands when it comes into contact with hydrogen." When I say this in English I make certain sounds. With these sounds, I'm coding a proposition. I'm making a statement about the world which you could attempt to falsify. But I am inevitably doing more than this. When a person makes an assertion, it is never heard as a completely independent, standalone, disembodied statement. People will always look for motivations. People will always perceive a statement as a *reason*. This phenomenon is like a Checkershadow illusion in the realm of reasoning. We are presented with something but we are wired not to take it at face value. We cannot help but project structure onto what is given, compensating so as to match our expectations. One of our key assumptions about people is that they must have reasons for the things they do and say, and we cannot help but try to infer those reasons. So, if I say to you, "This material expands when it comes into contact with hydrogen," I might be giving you a reason not to use the material (e.g., because we know that hydrogen will be present but we need the structure to remain fixed in shape and size) or I might be suggesting that we *should* use it (e.g., if we are building a hydrogen sensor). But we are never "just saying" something. A statement always gives a possible reason for action, and this imports much else into the discourse.

When, as Prime Minister of Australia, Tony Abbott stated that "Coal is good for Humanity,"[2] it was in the context of opening the multi-billion-dollar Caval Ridge mine in Central Queensland in 2014. The statement was given as a vindication or justification of the government's support of the mine, to give reason to think it was a good thing. Abbott's present-tense statement was false, given what we now know about the link between fossil fuels and climate change, and the effects that this is having, and will have, on humanity.[3] To be sure, as Gittins (this issue) suggests, a charitable reading of Abbott's statement is possible (though tangential, given Abbot's reference to "the future of the coal industry"), if taken out of its context to refer to a beneficial role that coal may have played in the history of human technological progress. But on that reading, the statement could not stand as a reason to believe that investing in coal production is a good idea today. Statements get their full meanings only in context, and a crucial part of that context is the role any statement plays in giving reasons for action.

Consider the statements made by the George W. Bush administration in 2003 that Saddam Hussein's government in Iraq possessed weapons of mass destruction (see Colin Powell's Feb 5, 2003, address to the UN Security Council). What was important for the Bush administration was that the statement be made, not because it was true (it was not), but because it would stand as a reason for US forces to invade Iraq. It has since been acknowledged that there were

[2] http://www.abc.net.au/news/2014-10-13/coal-is-good-for-humanity-pm-tony-abbott-says/5810244

[3] https://www.theguardian.com/commentisfree/2017/nov/17/were-in-a-post-truth-world-with-eroding-trust-and-accountability-it-cant-end-well

no weapons of mass destruction. In trying to interpret this in hindsight, people do not conclude that there was, therefore, simply no reason for the military action. People will either assume that those who made the assertion were mistaken, or that they were lying, and if they were lying, then there must have been another reason for the US military actions in 2003. Alternative reasons that have been suggested include revenge or duty to respond to what happened on 9/11, or a desire to possess and control Iraq's oil. Other reasons can be imagined.

Another example is that of Veronique Pozner, mother of six-year-old Noah Pozner, who was slaughtered along with 19 other first grade children, and 7 adults, at the Sandy Hook shooting in December 2012 in Newtown, Connecticut. Noah's mother gave public testimony in relation to her son's death, and has since campaigned for gun control in the US. Conspiracy theorists claim that the Sandy Hook incident is a hoax, and have mounted a campaign to expose the parents of slain children as actors. In June 2017, Lucy Richards was convicted by a Florida court for harassing and threatening Noah Pozner's parents. Hoaxers such as Richards have alleged that Veronique Pozner is not who she says she is, that she is a Swiss government agent, that there was no massacre at Sandy Hook, and that her son never existed. The key idea behind this theory is that it proposes an alternative reason why Pozner has made anti-gun statements: it dismisses her stated reason — that her son was murdered, along with other first-graders — and suggests that she independently wanted to promote gun control, for political reasons. In a photo of her posted online, conspiracy theorists refer to Veronique Pozner as a "long-time gun grabber".

We will always look for reasons behind people's words and actions, and if the claimed reasons are in doubt, unclear, or not to our liking, we will imagine new reasons (typically in line with our existing biases). This infects much of our thinking, and it drives conspiracy theories.

Choice of words

In sum, whenever someone makes a statement, it will be interpreted as a reason for action. I want to go further, and suggest that our incorrigible tendency to seek and propose reasons is not just a property of human cognition, but it is centrally entwined with our capacity for language. Without language, we would be unable to thematize reasons, which is to say we would be unable to introduce reasons into a collective focus of attention, in order to justify or question people's (including our own) actions and decisions. This is one important sense in which facts have to go through language to get to us.

A final sense in which facts have to go through language to get to us has to do with the words that we choose when we describe a state of affairs. Because we can choose our words, this means that natural facts—while in themselves independent of human language—are necessarily framed in a particular way in discourse, and therefore not in the many other ways they might have been framed on that occasion.

The philosopher Gottlob Frege famously pointed out that a single entity can be described in different ways (Frege 1892). His example was "the morning star" versus "the evening star". Both descriptions pick out the planet Venus, but they do so by means of different "modes of presentation". This is the principle behind all framing differences, from "dog" versus "mutt" to "terrorist" versus "freedom fighter".

When 25-year-old Freddie Gray died from spinal injuries incurred while in police custody in April 2015 in Baltimore, the resulting civil unrest was linguistically framed in different ways, depending on the political leaning of the news outlet. A study of the language used by different websites to describe the same events compared frequency of word use: specifically, the choice of words between "riot" and "protest".[4] Conservative outlet Fox News used the word "riot" more often than liberal outlet CNN. This might be expected, given the political leanings of the two outlets and their likely different stance toward the legitimacy (or not) of those taking action on the streets.

But choice of words is more than a matter of connotation or style. When words frame a proposition, they drive yet another bias that demonstrably affects our thinking. Dean (2017:18) gives the following example. "Suppose a deadly epidemic has broken out and the disease is expected to kill 600 people. Which drug is better: Drug A, which will save 200 people for sure, but only 200 people; or Drug B, which has a 1/3 probability of curing everyone and a 2/3 probability of saving no one? Given this choice, most people will choose Drug A, the drug that will certainly save 200 people. Yet if Drug A is described as dooming 400 people for sure, most people choose Drug B." Different descriptions of a scene can be equally true, but can point people's reasoning processes in different directions.

Memory is especially susceptible. Elizabeth Loftus and John Palmer (1974) played a film clip of two cars colliding to two different groups of people and later tested them on their memory of the scene. For one group, the test question was "How fast were the cars going when they *bumped into* each other?" For the other group it was "How fast were the cars going when they *smashed into* each other?" The people who were asked about the cars' speed using the phrase "smashed into" estimated a higher speed than those who were asked using the phrase "bumped into", even though both groups saw the exact same scene. This shows that linguistic framing is not a nicety. It literally affects what people believe about a scene, even when they have witnessed the scene directly.

Conclusion

The points I have made here about reality, cognitive biases, language, and rational discourse have implications for how we should understand critical thinking around truth. Any question about truth starts with a statement being made by someone, to someone, in a context. We need to ask what motivates the person. What is their reason for making the statement? What words are they using, and what words could they have used but chose not to? What biases may they be subject to, and what biases are we, as interpreters of their words, subject to? Our cognitive biases, combined with the limited tools of language, put a veil over reality. But reality is there whether we like it or not. Behind any relativism of perspectives or alternative framings there is a brute reality that provides sound reasons for action. The challenge is to know that brute reality when we see it, and to keep it in view, without falling prey to the many biases that conspire to obscure the truth.

I want to conclude on an optimistic note. In a recent panel discussion about the post-truth crisis, an audience member asked: "If online information is to be regulated, who will be the gatekeeper?" The answer is that

[4] https://linguisticpulse.com/2015/04/29/covering-baltimore-protest-or-riot/

it cannot be regulated in any top-down way. Not even the best fact-checking, nor the most well-intentioned filtering, could stem the tide of falsehood and spin. But as individuals, we can be the ultimate gatekeepers. There is an economy of information, and our brains and minds are conduits and filters for its circulation. To take control of that economy, we need to develop a culture of discerning, rational thought, by promoting and valuing cognitive literacy. If we are aware of our biases, and are willing and able to recognize and pre-empt them, both in others and in ourselves, then together we can put a stop to this age of irrational discourse.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 91–101. ISSN 0035-9173/18/010091-11

The role of evidence and expertise in policy-making: the politics and practice of science advice

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Abstract

What is the role of the institution of science in a world where trust is declining? How do we ensure respect for scientifically derived knowledge in this environment, and particularly for policymaking? How do we ensure that policymakers are more likely to take into account the role of scientifically derived evidence in their decision-making?

Introduction

I'm going to focus on three questions, which, in many ways, follow on from Emma Johnston's talk (Johnston 2018). What is the role of the institution of science in the world where trust is declining? How do we ensure respect for scientifically derived knowledge in this environment, and particularly for policymaking? How do we ensure that policymakers are more likely to take into account the role of scientifically derived evidence in their decision-making?

Post-trust, post-elite, post-truth

I'm not going to dwell on the post-truth, post-trust, post-elite, post-whatever world we're in now because others have addressed this. Let's just remember that the manipulation of facts and evidence is not new: it's been going on since religion was invented, since various forms of power structures developed ten thousand years ago in villages and in cities. What we have rather is a massive amplification of the effect because of the powers of digitalisation, which have got many effects which I won't go into now. It's also had this dramatic effect of changing the positioning of the different publics in relationship to the policy community and it is increasingly affecting the way the policy community operates.

The science-policy nexus

For virtually every government at any level, every issue they face has a scientific component to it. I must emphasise I'm using science in the broadest definition you can imagine to include the knowledge-based humanities as well.

We also need to remember that science will never alone make policy, which is why I've eradicated the words "evidence-based policy making" from my lexicon, because, while evidence can inform, it cannot be the only construct in which policy was made.

And where science is of most use is actually where the science is most contested. Governments are usually making decisions in situations where the science is not complete; it can never be complete and it's often most contested. And we now face this challenge that the science of the most interest to governments is actually in areas which are most contested in terms of public values.

The issue is: how do we ensure that the science is reliable, robust and how will it be used? Will it be used well or will it be misused or ignored altogether?

What is evidence?

I think we need to remember that science is not the only form of evidence. For most people, science is not their primary source of evidence. For them, evidence is tradition and folk knowledge, evidence is the knowledge that's within their peer community: it's religion for some people and it's anecdote, experience and observation. And certainly, for most politicians, anecdote and observation are the primary things that influence them. So where does science sit in that hierarchy and how do we work to ensure privilege for science in that hierarchy?

Science and values

As discussed by other speakers, science is defined largely by its processes. Science is not a collection of facts; science is a collection of *processes* which are defined to eliminate bias to the extent they can. That's not to say that science is value free, as Nick Enfield spoke about, of course there are values involved in what we choose to study and how we study it. But in the context of my talk the most important value judgement within science is the sufficiency of evidence on which to reach a conclusion. We will come back to that, because I think many of the debates that we have are really over the quality of evidence and its sufficiency on which to draw a conclusion.

As Heather Douglas (2009) wrote about in her brilliant book, it's this inferential gap between what we know and what we conclude which is of so much importance in policy space. And within all this we are really talking about the changing nature of science.

The changing nature of science

Science has changed dramatically in the last 50 years and it's going to change much more in the next decade or two, as we see the shift from linear to complex science, from deterministic to probabilistic science. And from normal to what Jerry Ravetz (2005) calls post-normal science, that is science where we're dealing with systems, where it's complex, there are many unknowns, and no matter how much science we do there'll still be unknowns left at the end of the day, and residual uncertainties.

Science should not be a proxy for values debates

Here the stakes are high, decisions are urgent and it intersects dramatically with community values, and those community values are in dispute: climate change, environmental matters, public health matters. Virtually every contentious issue that government considers actually falls into this definition. It's complex, we don't have all the answers, it intersects with public values, which are in dispute and of course that's where a lot of the conflicts emerge and where the difficulties of how policy and science intersect are so great.

And now we're seeing a new phase of development, which again was talked about by Nick Enright (Enright 2018). How do we address these conflicts? The emergence of extended peer review involving the community rather than just professionals to review science. The true development of co-design and coproduction are all part of the solution. But that's not my talk for today, that's another talk.

But because we are engaging in science which engages with disputed public values, science can easily become the proxy for debates which are not about science. We've seen that in climate change, where the real debate is an economic debate and it's about intergenerational and north-south economic issues, not about the science of climate change. We've seen it in relation to genetically modified organisms, GMOs; we've seen it in fluoridation of water; we've seen it in the United States about stem cells and about reproductive technologies.

There are many issues in which it's easier for people to debate complex science and cherry-pick the odd observation, rather than deal with the true issues that underlie the debate. In my experience the best way to deal with climate change sceptics has been to challenge them and say, "You know this is not a scientific debate. You know this is really a debate about values and you're not being honest and having a debate that you should be having." And we have now a lot of evidence, particularly from the GMO and from the climate-change literature, of course, that just pushing more science on people with different world views will not resolve the matters and indeed might make matters worse.

Trust in science as an institution?

The issue of *trust* in science as an institution, which two other papers in this meeting also allude to, has become more complex in an environment where science is now dealing with these complex issues where societal values are in dispute. But there are other issues we must acknowledge; some of them have been alluded to. The other side of the endeavour: three million papers last year, seven million authors, many allegedly peer-reviewed journals, and papers which are likely never to be read.

Think about this system. We've had a massive utilitarian transition in public science, which we've all welcomed because it's invited governments to put more money into science, but that science has now been positioned in a much more utilitarian way and that's led to this raft of incentives, particularly on universities, which have led to a "bibliometric disease", which I would love to treat although I'm not sure how.

We're seeing the overt politicisation of science in many places. We're seeing increasing numbers of these proxy debates reflecting the issue of the relationship of science to the publics. If I'd had a chance to ask a question of Nick Enright, I would suggested that a challenge we now have is actually what guidelines and ethics should surround public communication by scientists, because on the one hand as citizens they've got the right of free speech, but on the other hand they're standing up and saying they are speaking for science and there are some real issues there that we may need to grasp. I encourage you to look at the Science Council of Japan (2014) work done after the Fukushima debate to see how they are struggling to deal with this.

And then we have — again it's been mentioned — intellectual silos and the real challenge of trans-disciplinarity. How do we marry the humanities and social sciences with the natural sciences? We say we do it, but very few people do it.

Science and policy making

Science and policy are very different cultures: they have distinct methods and epistemologies. The arrangements between them are influenced very much by societal culture. What has become clearer is that there's a need

for boundary structures to act as translators between these two communities. I spend much time helping countries through my chairmanship of the International Network and Government for Science Advice (INGSA)[1] discussing these issues.

Policy is rarely determined solely by evidence. Policy is really made around a whole lot of considerations, public opinion, political ideology, electoral contracts et cetera. But what science can do, and uniquely do if it's well presented, is deal with the issues of the evidence of need, the possible solutions and the impacts and the multiple impacts of any possible solution chosen.

Science at the policy-society nexus

There are challenges at the interface: too much science of varying quality, the changing nature of science, the post-normal nature of science, the different perceptions of risk that scientists have — which is often actuarial as opposed to the perceptions of risk the public have — and the perceptions of risk that politicians have, which are largely about the ballot box. And as all of this plays out, there are different perceptions of expertise: increasingly policymakers or policy analysts think that Wikipedia or Google searching is enough on which to come to a scientific conclusion. We have hubris on behalf of the scientists, we have hubris on behalf of the policymakers, and there are all sorts of issues at the interface and I could go on. Now I have found that many scientists imagine that policy works through a well-defined cycle as shown in Fig. 1, but it's a total myth.

Figure 1. The 'policy cycle'

Policy works far more like Fig. 2, which is itself somewhat simplified, because how policy emerges is often unclear. It comes from the work of both formal and informal actors, elected and unelected actors that somehow coalesces to influence — in this case — the executive of government. One can see how confused and complicated policymaking really is.

[1] https://ingsa.org/

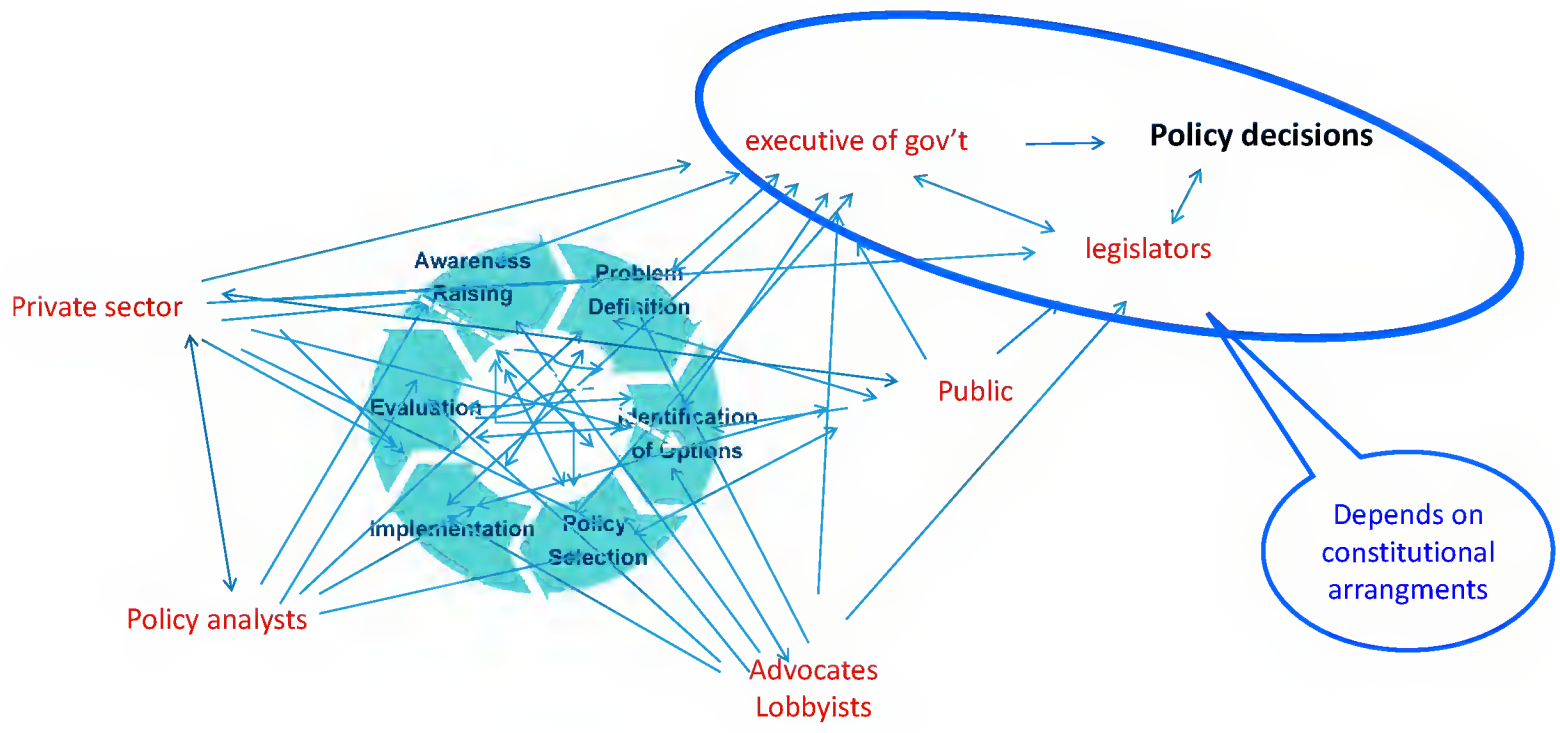

Figure 2.

The issue is: how and where does evidential input work? Well, evidential input has to work all over the place in this system (Fig. 3) and I think this is a really important point, which is often forgotten, that it needs a concerted effort to maintain evidence in front of the policymakers.

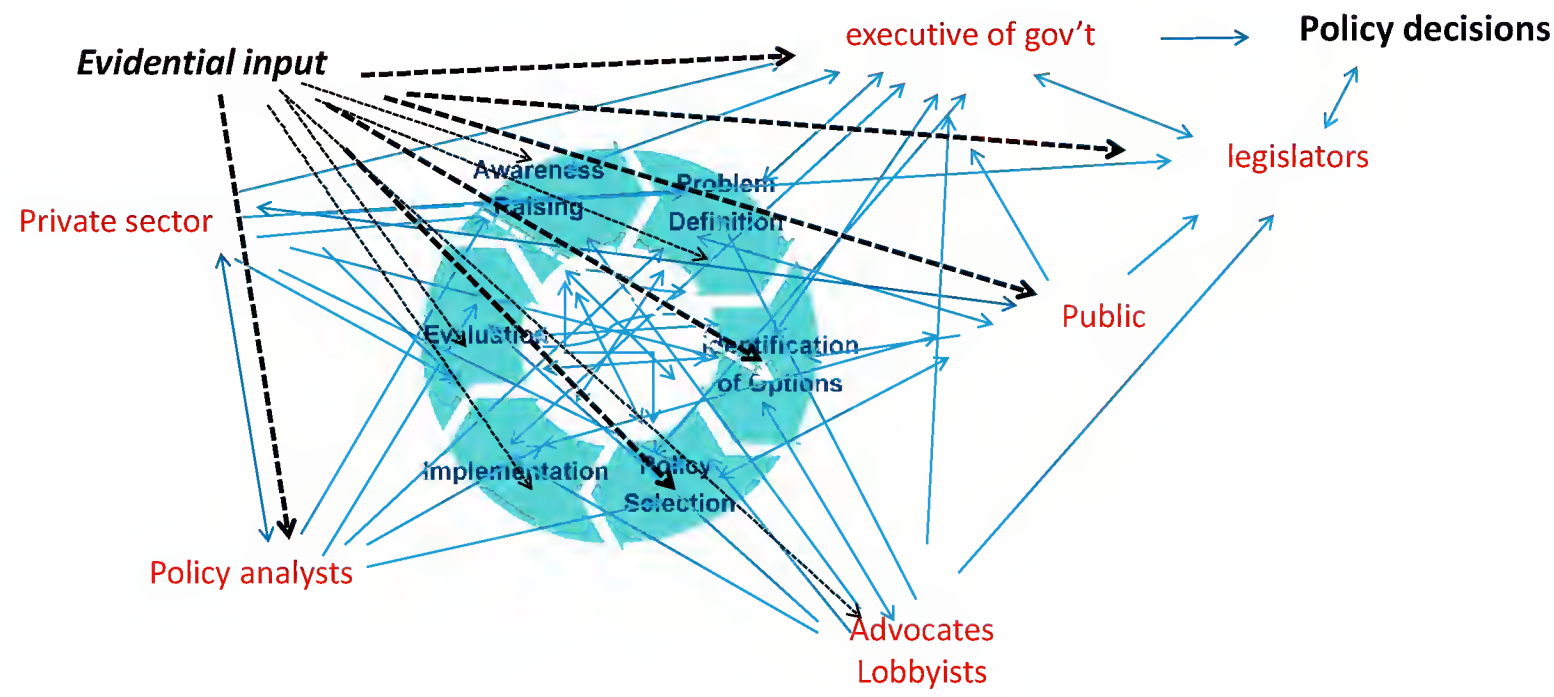

Figure 3.

The primary functions of science advice

What are the primary functions of science advice? First of all, I think it's to help the policy community actually understand a complex system; be it a social problem, be it an environmental problem, be it a transport, an urban issue. Often, they have only seen bits of the system and system thinking by scientists can help in clarifying what can possibly be done.

Scientific input to policy-making

Second, it's about helping policymakers see the range of options that could be applied and understanding the implications of each of those options, because policymakers always have options: they always have the option of doing nothing, which is often their default position. and from that they have got a range of options, each of which will have spill-over effects. Third, there's a role in evaluating policies that have been implemented.

And then there is a distinct role in emergencies. Most emergencies, be they natural disasters or a terrorist event, have a scientific or a technological component. Often there is a need to make sure the policymakers understand what the evidence is saying in such situations.

Then you have the issue of technology assessment and forecasting. Then there is the diplomatic dimension as seen in the global challenges that we face and are encapsulated in the Sustainable Development Goals. Most have a scientific dimension and science diplomacy is going to be critical at both national and global levels in making progress.

Policy makers

At its simplest, policymaking is about making choices between different options which affect different stakeholders in different ways, with different consequences, many of which are not certain. I think that the major role and the core presumption of scientific advice is that it's more likely to allow government to choose between the options in a way that will result in better outcomes. It is not always appreciated that policymakers have limited bandwidth. The policy cycle is short and getting shorter because of the impact of digitalisation. The science they need is usually incomplete and much ambiguous and yet the words "more research is needed" are not the words that help the policymaker.

Governments must make decisions; if they don't have a policy-acceptable solution to them at a point in time, they will usually move on to another issue. And you cannot expect politicians to be scientific referees; you can see contested science being argued in a way that can be very confusing.

Scientists and policy making

What are scientists good at? We are very good at problem definition. Climate science has done a great job. We're less so at finding the solutions that the science tells us about because usually it involves different disciplines from the disciplines that define the problem in the first place. Climate change was all about physical scientists, but climate change solutions is about economics, about social science, about different technologies et cetera; it's got a whole different basis to it. Too often scientists approach the policymaker with a fixed solution in mind, one that is not policy-acceptable and are surprised when it is rejected.

Elements in a science advisory ecosystem

There are many potential elements in a science advisory ecosystem. I've listed them in Fig. 4, from the role of individual scientists and universities, research institutes, through to the national academies, the government advisory boards, to science advisors such as myself, the role of parliamentary libraries and so forth. There's an immense number of possible players in this ecosystem and you don't need just one, you need several elements.

Individual academics, universities, research institutes
Academic societies/professional bodies
Government employed practicing scientists
Scientists within policy agencies
Scientists within regulatory agencies
Independent think tanks
What works units
National academies
Government advisory boards/science councils
Science advisors to executive of government
Parliamentary libraries, parliamentary advice units

Figure 4. Many potential elements in a science advisory ecosystem

	Knowledge generators	Knowledge synthesizers	Knowledge brokers	Policy Evaluation
Individual academics	+++	++		+
Academic societies/professional bodies		+		
Government employed practicing scientists	+++	+		++
Scientists within policy agencies		++	++	++
Scientists within regulatory agency		++	++	
Independent think tanks		++		+
What works units etc		+++	+	++
National academies		+++	+	
Government advisory boards/science councils		++	+	
Science advisors to the executive of government		+	++++	
Science advice to legislators		+	++	

Figure 5. Different roles in a science advisory ecosystem

Different roles in the ecosystem

In Fig. 5 I have broken this up into what I think are the four categories of roles in this interface. There are the knowledge generators, the scientists who generate knowledge; there are the knowledge synthesisers such as we heard from in the last talk (Bero 2018). There are scientists and units that aggregate the knowledge and try and make sense of what it means. And then there are the knowledge brokers who have to translate that science to the policymaker and translate the policymakers' needs to the scientists. And then there are the policy evaluators. You can see that you need more than one structure in your interface if it's to be effective.

The nature of science advice

Then you can think about other ways too. You can think of another set of dimensions (Fig. 6): policy for science, that is how the science system operates. Then there's evidence for policy development, implementation and evaluation, and the functions of crisis management and horizon scanning. And again you can see that there's a raft of structures and institutions that can assist and are needed to achieve a fully effective interface.

The concept of brokerage

I've used this word "brokerage" and I want to talk about it a little bit more. Roger Pielke wrote a book, *The Honest Broker* (2007), in which he defined that there were different ways we can communicate. We can be advocates who want a particular solution or a particular outcome, or we can be brokers where we actually transmit the knowledge in an appropriate, reasonably values-free way — because it can never be absolutely values-free — to the policy community, allowing

	Policy for science	Evidence for policy: options	Evidence for policy implementation	Evidence for policy evaluation	Horizon scanning	Crises
Individual academics	+	±	±	±	±	
Academic societies/profess'l bodies	+++	+	+	±	±	
Gov't employed scientists		+	++	+	+	+
Scientists within policy agencies	+	++	++	+	++	+
Scientists within regulatory agencies		+	++	++		
Independent think tanks		++	±	±	+	
What works units			++	±		
National academies	+++	+			+	
Gov't advisory bds/science councils	++	+	+		+	
Science advisors	+	++++	++	++	++	+++

Figure 6. The nature of science advice

them to overlay the values dimensions they have responsibility for. Brokerage is largely about what is known, what the consensus is; if advice goes beyond the consensus, why so? It is also about what is not known. Often the most important thing you can say to a government is, "We do not know." Other caveats may be needed to put on the data, the inferential gap between what we know and what we don't know needs to be clarified, as do the risks involved. What are the options and trade-offs? What are the consequences outside the science that each option might bring? I prefer not to make a recommendation, I'm always talking about what the implications of each option are. It's for the policymakers to make the value judgements, weighing up all those other considerations that come into play.

Internal v. external inputs

And then you have this other classification. People like myself are inside the system. I can talk to the prime minister or ministers any day. I talk to the cabinet office regularly and that means that I can see the many different interactions that are in play within the complex policy process. That is the advantage of science advisors and scientists within the system: they can often see what is possible in a policy sense. On the other hand, they're not as fully independent as an academy or academics on the outside. But the latter are often better placed to do the deliberative reports on complex issues, but here the advisor may still have a key role in ensuring the academy understands the question government is asking. Effective science advice needs a balance between internal and external inputs.

Informal and formal mechanisms

Another way to look at this division is to think about informal and formal mechanisms. Informal mechanisms are what advisors do when they brainstorm with the prime minister or a minister or suggest they may like a report on this, or suggest, "There's a problem with their thinking." Such interactions and challenges rely on trusted relationships between science advisors and the executive of government.

This is distinct from the writing of the formal reports. It matters whether such reports are requested or proffered unsolicited. It is important that reports are not written to show off the intellectual brilliance of the report writers but are designed to answer the questions that policymakers and society need. This realisation is leading academies to change their style of report writing.

Academies and science advice

This brings me to the role of Academies, since this Forum is being conducted by the Royal Society of New South Wales. Academies have a critical role. They are a place at which multiple disciplines can come together and write a critical report, a report on any subject. But sadly too many academy reports are not read and that is because most are not, shall we say, negotiated before they're started with the government of the day to see if the government actually wants to get it. Because if you put a question forward that the government doesn't want to hear the answers to, it's probably not going to succeed. Often even when they are given a question by the government, academies do not always realise what the government will find useful by way of response. There are a

whole lot of other issues and I think academies will have a challenge in this post-trust world of how they'll reinvent themselves, but that's another story.

The skillset needed, underlying principles

Summing up, the skillset needed at the science-policy interface, whether it's outside from academies, from other think-tanks, or whatever, and that needed from those inside the system such as science advisors are compatible but differ in emphasis. I have focused largely in this talk on what I think are really key for those who are inside the system.

I think anybody who's engaged in the interface needs to understand the complexities of policymaking. They need to get beyond single disciplines and realise that virtually everything that a government deals with in science has a social component to it as well as a natural science component. They need to employ brokerage rather than advocacy. Hubris must be avoided. If you go in there saying, "You must do that," you'll find a tribe of policy analysts soon writing briefing papers as to why that's not the case and why the scientists don't understand the nuances of policy making.

It needs diplomacy, it needs policy entrepreneurship, it needs good and trusted communication to the four distinct audiences: the politician, the policymaker, the public and media, and the science community. Humility is the most important skill you can have in talking to a policymaker. You must never try and take their role away from them — they are the ones who are there to judge the trade-offs that each option suggests. They are the ones that need to opine on values and consequences, not us.

One needs to maintain integrity and trust with all four audiences and there's obviously a hierarchy of trust. I can't do my job if I don't have the trust of the prime minister, the ministers, the policymakers but it's also critical to have the trust of the public.

The most important thing academies can do is to maintain the trust of the academic community, otherwise they lose their standing as an academy. So, you see there are different hierarchies of trust involved.

One needs an ecosystem; few countries have a comprehensive ecosystem. Britain does reasonably well, I think New Zealand does very well, I'm not going to comment on Australia.

We have real challenges: what is a fact? Is robust science available? Who decides whether the knowledge is robust and reliable? We have this huge emerging issue of social licence for new technologies. As the innovation and science machine gets faster and faster with the nanotech, biotech, digital tech, geo-tech, wherever it will be, there'll be more and more issues of social licence emerging. The natural scientist community and the innovators need to think more about how to develop and maintain social licence and they cannot do this without engaging social science. I'm heavily involved with the OECD on the issues of what the impact of digitisation will be and all that's associated with it on the concept of human wellbeing. What does it mean at a level of individual, the level of society, at the level of the nation state?

And what I've argued for in this talk is that any effective advisory system needs to have an informal, that is, an internal component, but it cannot work unless there's an effective external deliberative component coming from the broader science community, and particularly from academies.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 102–105. ISSN 0035-9173/18/010102-04

The view from Grubb Street—has it all just been fake news?

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Abstract

As the rapporteur of the Forum, Ross Gittins FRSN gave the concluding address.

We have had a lot of interesting and varied contributions on the topic of Truth, Rationality and Post-Truth, and I know from what people have said to me during the breaks how much you have enjoyed them. In summarising the various talks, I will try to draw out the range of views pertaining particularly to the central topic.

Opening proceedings, Don Hector asked us what had happened to reason, then told us that the post-modernists and relativists were in the ascendency, rejecting established sources of reason and accepting that belief should have equal sway with fact, and thereby putting an open, free society in great danger.

Simon Chapman, hero of the long-running battle against the tobacco companies to get restrictions on smoking and the harm it does, told us about his latest crusade, against the unfounded fear of wind turbines. Here, rather than battling powerful industrial interests, he's been battling uninformed individuals, whose fears have been taken far too seriously by a conservative government containing many climate-change deniers.

James Wilsdon's written contribution (spoken by the forum's chairman, Paul Griffiths) told us about the Brexit experience, with its many fanciful claims and rejection of evidence and the views of experts. He quoted the leading Tory Brexiteer Michael Gove's line that some have regarded as spine-chilling: "People in this country have had enough of experts."[1] As a political scientist he put a lot of our worries about truth and post-truth into a more realistic context, making them less spine-chilling.

Emma Johnston said we were in a post-truth era of virulent attacks on science and online trolls, in which the truth can be virtually impossible to distinguish from fake news. As a profession, scientists needed to shore up their standing in the community, asserting the importance of their work in contributing to evidence-informed decision-making. They needed to help the public recognise credible scientific knowledge within the new "information free-for-all". They needed to change the culture that discourages scientists from speaking out. Genuine partnerships with communities, businesses and industries could go a long way to re-establishing trust in science.

Lisa Bero, from pharmacy, took a different, more professionally self-critical tack, reminding us of the way conflicts of interest arising from financial gain can reduce the influence of research evidence in policymaking, but then asking whether we should be paying more attention to the way conflicts of interest can bias the design, methods, conduct, interpretation and publication of research.

[1] *Financial Times*, 4 June 2016.

We need to make our research trustworthy, she concluded. I conclude that some scepticism about the findings of scientific papers may indeed be justified.

Then Peter Gluckman spoke about the role of evidence and expertise in policymaking, making a host of realistic and enlightening points drawn from his extensive experience as New Zealand's chief science advisor. He observed that science is not the only source of evidence political leaders take notice of (with a lot of attention given to advice from those less scientific beings, economists). And evidence is not the only thing policymakers take into account in the decisions they make. In a democracy, it's not surprising they take account of public opinion. Nor that their attitudes are influenced by ideology. And, of course, their decisions often involve a degree of compromise in the face of conflicting interest groups.

Andrew Jakubowicz explained how the internet facilitates the spread of racism and reduces trust, damaging the functioning of multicultural societies. He proposed ways to reduce the problem.

Nick Enfield argued it was not remotely in the community's interests to dismiss expert testimony from scientists, in the process diminishing our trust in them, in this "post-truth era" where we feel free to substitute "alternative facts". Rather than simply criticising the things anonymous people say on social media, he singled out Tony Abbott's assertion that "coal is good for humanity",[2] when "the overwhelming majority of people who are professionally qualified to evaluate scientific evidence on the matter know otherwise". (Economists are trained to weight the costs of actions against their benefits; taking account of its contribution to our material living standards since the Industrial Revolution, I would have thought that coal, too, has benefits as well as costs.) But then Nick made a very pertinent contribution, joining Don Hector in reminding us of the findings of the psychologist Daniel Kahneman, who won the Nobel *memorial* prize in economics for his role as a founder of behavioural economics. Kahneman demonstrated that, most of the time, humans are unthinking, emotion-driven, non-rational animals notorious for their poor reasoning, even though they can, at times, reach the heights of rational reasoning we see our scientists attaining in, for instance, Newtonian physics and Einstein's theory of relativity. Which of those two, by the way, is or was the truth?

So, what are my thoughts about all this? Sorry, but the *journalistic* scepticism which is my substitute for *scientific* scepticism leaves me unconvinced by much of it. As a journo would put it, I think it's a beat up. I can understand how frustrating scientists must find it to discover there are uninformed people who simply reject the scientific evidence of global warming, and are impervious to counter argument. Indeed, the psychologists tell us, the more dire the scientists' warnings about how little time we have left to prevent hugely damaging climate change, the more the deniers are reinforced in their denial. I can understand how shocking many scientists find it to be told to their face that they're not believed, not telling the truth, but are making up crises to get more research funding. But I don't find this evidence-denying, unreasonable, irrational behaviour, this refusal to use one's brain, all that surprising. I've lived with it every week of the 40 years I've been a commentator on economics. It

[2] ABC, 13 Oct. 2014.

strikes me that hard scientists know a lot about how the physical world works, but not a lot about how humans work.

Nor do they seem to know much about how the political game is played. Did you know, for instance, that people are given a vote regardless of how uneducated they are, how unthinking they are, how willing they are to give free rein to their instant, emotional reactions to developments, and their refusal to use their grey matter for anything other than enhancing their encyclopaedic knowledge of cricket scores and reality television? Did you know that humans are prone to tribal behaviour? That politicians have, for their own venal reasons, turned climate change into a tribal issue, where your tribe believes in it, but my tribe doesn't? That I can close my mind to all your incomprehensible arguments, can simply refuse to accept that your professed expertise means you know the truth but I don't, for no reason other than that I and my tribe don't believe that sh*t?

I'm not convinced we live in the post-truth era. As we have heard, the Oxford dictionary defines "post-truth" as "circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief". And this is something new, is it? We used to live in a world where rational analysis reigned supreme, where no one ever used facts selectively, no one quoted a fact that needed checking, and all the policy decisions politicians made were based strictly on evidence, where anything said by someone wearing a lab coat was accepted without question, but then along came the internet and social media, and suddenly all respect for the truth, and facts and evidence and experts went out the window. Really? I think we've always lived in a world where a lot of people are pretty dumb, where many chose not to use their brains for the purposes scientists think they should, where they much prefer to give their emotions free rein, where anti-intellectualism is common. To me, this isn't something new, it's a description of the human condition. To attribute it to the ascendancy of post-modernist intellectualising rather than the prevalence of mug punters is to engage in intellectual delusion.

What's changed is that the internet and social media have given the anti-intellectuals and tribalists and racists a *microphone* through which to broadcast. One effect of this is to make *our* tribe far more *aware* of the terrible things other tribes have always thought and said about us while out of our hearing. This does mean there's now a lot more scope for people to be shocked and hurt by the new knowledge of the terrible things other people think and say about them. The internet and social media have also made it far easier for disparate members of particular tribes (including the science tribe) to find each other and engage in orgies of confirmation bias. To rev each other up. As has been observed today, social media has facilitated the development of many and varied echo chambers. What's less obvious to me is how much real difference this upsurge in preaching to the choir makes. It probably does contribute to the other forces making our politics and our community more polarised. Many speakers today have implied that there's been a big increase in the community's anti-intellectual attitudes and behaviour. This may or may not be true. Ironically, no one produced any hard statistical evidence that it is. One *alternative* explanation for the trends we think we see and attribute to the digital revolution, but which hardly rated a mention today, is the longstanding decline

in standards of political behaviour by the mainstream parties, which is prompting increasing numbers of voters to flirt with various strains of populism.

I think I detected a fair bit of tribal, ra-ra thinking by the science tribe in what was said today. Science and scientists are being disrespected as never before and we must lift our game and fight back. I suspect I heard echoes of nostalgia for the good old days when the pronouncements of scientists were accepted with respect and without question, much as people in olden times wanted their priests just to tell them what to do, and not do, to live moral life. Let me remind you that our population is better educated than it's ever been, and one of the things they try to teach you at uni is to think critically about the pronouncements authority figures make, even those who tell you they're experts. Don't just nod when your doctor tells you something, put them through their paces.

The digital age has made us more conscious of the anti-intellectualism and intolerance that has always been with us. It may also have added to the quantity of that dysfunctional thinking and behaviour. In any event, it has made us more conscious of the need to find new and more psychologically effective ways of getting through to those we believe need the benefit of our enlightenment.

Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 106–107. ISSN 0035-9173/18/010106-02

Thesis abstract

An empirical analysis of the investment and profitability effects

Brendan P. Elliot

Abstract of a thesis for a Doctorate of Philosophy submitted to the University of Newcastle, Callaghan, Australia

Asset pricing factors formed on the level of firm investment and profitability are shown to have significant *ex post* explanatory power in the cross-section of stock returns. Whilst asset pricing models incorporating these factors exhibit improved explanatory power in the cross-section of returns, conjecture exists as to the underlying drivers of the investment and profitability effects. This thesis contains three empirical asset pricing studies examining the investment and profitability effects, providing tests of the efficacy of these factors. The results presented consider the pervasiveness of these factors across global equity markets, as well as examining two key theoretical explanations for these anomalies: shocks to the discount rate, and state variables containing information on the future investment opportunity set.

The first empirical chapter examines whether asset pricing models that incorporate investment and profitability factors should be considered *ex ante* predictors of stock returns. The study focusses on the Australian stock market, as it is characterised by small, high-investing, and low-profitability firms. This subset of the investment opportunity set has proven problematic for US investment and profitability factors. The results in this chapter demonstrate that the investment factor is persistently and pervasively related to Australian stock returns, whilst the profitability factor is not. These results are robust to the choice of asset pricing model, as well as a battery of robustness tests.

The second empirical chapter examines the relationship between discount rates[1] and the returns attributable to portfolios formed on either investment or profitability. Theoretical explanations for the investment and profitability effects suggest that the level of discount rates, relative to macroeconomic conditions, drives the premium attributable to the investment and profitability factors. It is expected that the returns of high-investment and low-profitability stocks will experience greater changes as a result of shocks to the discount rate. The results in this chapter are supportive of these theoretical explanations, indicating the underlying market state is a significant factor in explaining the relationship between unexpected changes in the discount rate and the returns attributable to portfolios formed on investment and profitability.

The third empirical chapter examines whether the returns of investment and profitability hedge portfolios are explained by return dispersion. This assertion is tested on portfolio returns formed on stocks segre-

[1] Monetary policy shocks are used as a proxy for unexpected changes to the discount rate.

gated by region, as well as a global portfolio of stocks. The results of this chapter support the assertion that return dispersion explains future investment and profitability hedge portfolio returns across all regional and the global portfolios. The results demonstrate that the explanatory power of return dispersion relates to hedge portfolio returns up to twelve months in the future, indicating that return dispersion may be a proxy for a state variable that captures the time-varying investment opportunity set.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, p. 108. ISSN 0035-9173/18/010108-01

Thesis abstract

Extending and testing the components of evidence accumulation models of decision-making

Nathan Evans

Abstract of a thesis for a Doctorate of Philosophy submitted to the University of Newcastle, Callaghan, Australia

Past decades of research within the area of decision-making have had a large focus on advancing process models, which contain theoretically meaningful parameters, in order to better understand the processes that underlie decision-making. One of the most popular types of process models in decision-making research have been evidence accumulation models (EAMs), which propose that decision-making is made up of some process where evidence for the various alternatives accumulates over the course of a decision, until it reaches some threshold value, where the decision is triggered. Importantly, EAMs have enjoyed a great deal of success in being fitted to empirical data, being able to successfully account for a wide range of phenomena and helping to answer theoretical questions that would have been nearly impossible to answer without the use of a process model. This thesis aims to accomplish three main goals: to extend EAMs to new research areas to help solve novel empirical questions, to test newly proposed components that could potentially be added to existing EAMs, and to propose a new method of how to test between models in the EAM framework to answer empirical research questions. The first goal is addressed in Chapters 2 and 3, which apply the linear ballistic accumulator (LBA) to personality and genetics research, respectively, which are two areas previously unexplored with EAMs. The second goal is addressed in Chapters 4 and 5, which assess whether a newly proposed component of EAMs, a threshold that decreases over the course of a trial (collapsing threshold; or a mathematically similar urgency signal) can be justified in empirical data. The final goal is addressed in Chapter 6, which presents a new method of calculating Bayes factors — a method of selecting between competing models — for the LBA using Monte-Carlo integration and general-purpose graphics processing unit computing. Generally speaking, the findings indicate: that EAMs are capable of extending to the fields of personality and genetics, that the proposed component of a collapsing threshold is not necessarily justified within the EAM framework, and that the use of Bayes factors through Monte-Carlo integration improves upon previous methods of model selection.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 109–110. ISSN 0035-9173/18/010109-02

Thesis abstract

Entrepreneurial decision-making and expertise acquisition: A study among Sri Lankan microfinance borrowers

Nadeera Ranabahu

Abstract of a thesis for a Doctorate of Philosophy submitted to University of Wollongong, Wollongong, Australia

Microfinance institutions (MFIs) — organisations that provide small-scale loans, savings, insurance and other financial services to individuals who lack access to traditional banking services — are often criticised for not being able to create viable and profitable new ventures among their borrowers. Although the ability to create and manage businesses also depends on the social and human capital of the borrowers, little is known about how microfinance lending principles and procedures contribute to MFI-funded entrepreneurs' business decision-making and their human and social capital development. Using data collected from a mixed method approach (i.e., a survey, interviews, daily activity journals, group discussions, focus groups, and observations), this thesis examined MFI-funded entrepreneurs' business decisions, their venture start-up and development process and expertise acquisition.

The study findings demonstrate that MFI-funded entrepreneurs, in their business start-up and development, used both means-driven (i.e., effectuation) and predictive (i.e., causation) decision-making logics. They thought about available means such as the knowledge they have, available resources, relied on social networks for support, and attempted to minimise financial losses by using inexpensive resources and personal savings during business start-up and development. With the microfinance loan, entrepreneurs considered losses beyond financial aspects, such as their reputation within the community, business and personal assets, and time required to borrow money and repay loans. Entrepreneurs also formed agreements with customers and suppliers and adapted products to meet seasonal, technological, and economic changes. Specifically, women entrepreneurs were careful to adapt their business practices according to social, cultural and gender norms. Similarly, consistent with predictive thinking, MFI-funded entrepreneurs set short-term goals, calculated returns, and considered market and competitor information.

To acquire expertise, entrepreneurs practised and rehearsed both means-driven and predictive thinking using unstructured and self-regulated business tasks. Less often, they used structured tasks, such as attending training programs, meeting experts and obtaining feedback to sharpen their expertise. These business tasks included pre-venturing activities, such as experimentation, and then sharpening business skills gradually by conducting technical, "tangible" business establishment tasks, "abstract" management tasks, and business complexity management tasks.

This study contributes theoretically and practically to the entrepreneurship and microfinance domains by linking means-driven and predictive thinking to continuous practice and task rehearsal, highlighting how MFI-funded entrepreneurs use social and other factors in business decision-making, and constructing a conceptual model for the development of entrepreneurial expertise. This study also outlines how MFIs can use microfinance lending to enhance entrepreneurial expertise among borrowers and enhance their social and human capital.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, p. 111. ISSN 0035-9173/18/010111-01

Thesis abstract

Self-sensing, estimation and control in multifrequency Atomic Force Microscopy

Michael G. Ruppert

Abstract of a thesis for a Doctorate of Philosophy submitted to the University of Newcastle, Callaghan, Australia

Despite the undeniable success of the atomic force microscope (AFM), dynamic techniques still face limitations in terms of spatial resolution, imaging speed and high cost of acquisition. In order to expand the capabilities of the instrument, it was realized that the information about the nano-mechanical properties of a sample are encoded over a range of frequencies and the excitation and detection of higher-order eigenmodes of the micro-cantilever open up further information channels. The ability to control these modes and their fast responses to excitation is believed to be the key to unravelling the true potential of these methods. This work addresses three major drawbacks of the standard AFM setup, which limit the feasibility of multi-frequency approaches.

First, microelectromechanical system (MEMS) probes with integrated piezoelectric layers is motivated, enabling the development of novel multimode self-sensing and self-actuating techniques. Specifically, these piezoelectric transduction schemes permit the miniaturization of the entire AFM towards a cost-effective single-chip device with nanoscale precision in a much smaller form factor than that of conventional macroscale instruments.

Second, the integrated actuation enables the development of multimode controllers which exhibits remarkable performance in arbitrarily modifying the quality factor of multiple eigenmodes and comes with inherent stability robustness. The experimental results demonstrate improved imaging stability, higher scan speeds and adjustable contrast when mapping nano-mechanical properties of soft samples.

Last, in light of the demand for constantly increasing imaging speeds while providing multi-frequency flexibility, the estimation of multiple components of the high-frequency deflection signal is performed with a linear time-varying multi-frequency Kalman filter. The chosen representation allows for an efficient high-bandwidth implementation on a Field Programmable Gate Array. Tracking bandwidth, noise performance and trimodal AFM imaging on a two-component polymer sample are verified and shown to be superior to that of the commonly used lock-in amplifier.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 112–113. ISSN 0035-9173/18/010112-02

Thesis abstract

Critical reflections on the vital importance of soft skills, and the strategies for the integration of essential soft skills into the curriculum of higher education business institutions in Vietnam

Hang Thi Thu Truong

Abstract of a thesis for a Doctorate of Philosophy submitted to University of Newcastle, Callaghan, Australia

Investing in human capital is one of the most relevant factors affecting the economic growth of a country, and one of the most important aspects of this investment is education. Thus, in developing countries such as Vietnam it is imperative that the government supports policy priorities committed to strategies for creating a knowledge foundation for the development of a skilled and adaptable workforce capable of contributing to the goals of business competitiveness at the local and especially the global level. Within Vietnam's system of higher education, its schools of business do play a vital role in supporting the country's economic objectives. However, one of the major objectives in this thesis is to show that the crucial contribution which soft skills are capable of making to achieve maximal success within the business sector has to date not been adequately recognized by its business schools. This being so, the development of the business school curriculum in Vietnam has not been able to "catch up," so to say, with the requirements of the local and global business market. This being so, the central argument of my thesis is that in Vietnam there is a burgeoning need to provide students with comprehensive a soft skills program designed to meet the national and global business standards increasingly exhibited within the current objectives of their potential employers. This being so, it is essential that the formal curriculum of Vietnam's business schools be restructured to incorporate an up-to-date and effective coursework component for the delivery and development of business soft skills.

To fulfil the requirements of curriculum reform, the thesis focuses on three objectives. First, to assess the status of soft skills proficiency possessed by tertiary business graduates, thereby revealing the presence and quality of any soft skills programs in Vietnamese business higher education institutions. The second purpose is two twofold: the first task is to make explicit the extent to which major Vietnamese stakeholders acknowledge and value the potential role which soft skill competencies can play in maximizing business success. Through that, the second task is to determine which particular soft skills these stakeholders discern as best serving to improve Vietnam's economic competitiveness within the national and global marketplace. Third, to identify the most efficacious strategies for the development of soft skills programs in Vietnamese business schools.

A Sequential Exploratory Mixed-methods Approach was deployed in which in the first phase semi-structured telephone interviews were conducted, with 15 business employers representing the reputedly largest business enterprises across Vietnam. In the second phase, a questionnaire was conducted with 577 business educators from three major universities of business, representing different regions of the country.

The study makes four main contributions: First, this is the first comprehensive exploration and collation of the literature exploring the definition and importance of soft skills in the field of business, thereby accumulating a legacy of valuable information for employer and educational stakeholders in Vietnam to better understand the status of soft skills in the local business workplace and global market. Second, the results of the study identified the essential soft skills for success selected by Vietnamese business employers which can be integrated into the formal business curriculum of business higher education institutions. This contribution also serves as a benchmark skill checklist for staff development and recruitment for employers. Third, preferred approaches to soft skills development were identified by employers and business educators that are suitable for the current status of the country's higher education system, culture and economy. Finally, the findings indicate that increased collaboration between educational institutions and business enterprises in the development of soft skills for Vietnamese business schools is more likely to result in accrued benefits to the economy. This has been achieved by focusing on the development of the specific soft skills needed to increase the employability of business graduates and upon a shared utilization of resources to enhance the effectiveness of soft skills training.

In summary, this study represents a comprehensive investigation of strategies for soft skills curriculum development which draws upon the contributions of relevant key stakeholders, namely, those Vietnamese business employers who are most likely to hire business school graduates, and the university educators of business who are responsible for their soft skills training in accord with the reformed curriculum of Vietnamese business schools. Thus, the study bridges the hiatus between the soft skills competencies required by Vietnamese employers on the one hand, and the adequate provision of soft skills development programs by soft skills educators in Vietnam's higher education business institutions on the other. Findings from this study could be used productively to inform and shape the nature of the curriculum reforms and pedagogic interventions that need to be undertaken collaboratively by knowledgeable staff from both tertiary business universities and business employment organizations.

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Journal & Proceedings of the Royal Society of New South Wales, vol. 151, part 1, 2018, pp. 114–121. ISSN 0035-9173/18/010114-08

Awards 2018

The following awards are offered by the Royal Society in 2018. Please see the specific page for details of each award.

Award	Eligibility		Closing date
Clarke Medal	Field: Seniority: Work considered: Location of work: Application by:	Botany Any "Significant contribution" Australia Nomination[1]	30th September, 2018
Edgeworth David Medal	Field: Seniority: Work considered: Location of work: Application by:	Any < 35 "Distinguished contribution" Australia Nomination	30th September, 2018
James Cook Medal	Field: Seniority: Work considered: Location of work: Application by:	"Science & human welfare" Any "Outstanding contribution" Southern Hemisphere Nomination	30th September, 2018
Warren Prize	Field: Seniority: Work considered: Location of work: Application by:	Engineering or technology In professional practice "of national or international significance" NSW Paper submitted to Journal	30th September, 2018
History and Philosophy of Science Medal	Field: Seniority: Work considered: Location of work: Application by:	History and philosophy of science Any "significant contribution to the understanding of the history and philosophy of science" Any Nomination or direct submission	30th September, 2018
RSNSW Scholarships Jak Kelly Award	Field: Seniority: Work considered: Location of work: Application by:	Any Enrolled research student on 1 July Research project NSW or ACT Application by student/endorsed by supervisor	30th September, 2018

Note

1 Nomination by a senior member of the nominee's organisation (for example Dean, Pro Vice Chancellor of a university, Section or Division Head of CSIRO), or a member of the Royal Society of New South Wales.

Each year, the Royal Society of New South Wales makes a number of awards, mainly in the sciences, but also in the history and philosophy of science. They are among the oldest and most prestigious awards in Australia.

These awards are now open for nomination. *Nominations close on 30 September 2018*. They should be sent to the Presiding Member of the Awards Committee at: royalsoc@royalsoc.org.au.

The awards and the criteria for nomination are described below. All nominations must include:

- A letter of nomination setting out the case for the award;
- The nominee's full curriculum vitæ;
- Other supporting material as specified for the description of the award.

A nominator does not need to be a member or fellow of the Society. For some awards, researchers may nominate themselves. Awards allowing self-nomination will be noted below.

The awards will be presented at the Society's next Annual Dinner, tentatively in May 2019.

Clarke Medal 2018

The Clarke Medal was established to acknowledge the contribution by Rev William Branwhite Clarke MA FRS FGS, Vice-President of the Royal Society of New South Wales from 1866 to 1878. The Medal is awarded annually for distinguished work in the natural sciences conducted in Australia and its territories.

The Medal is awarded by rotation in the fields of geology, botany and zoology. This year's award is in the field of Zoology in all its aspects, and nominations are called for the names of suitable persons who have contributed significantly to this science. The recipient may be resident in Australia or elsewhere.

The Council requests that every nomination should be accompanied by a list of publications, a full *curriculum vitæ*, and also by a statement clearly indicating which part of the nominee's work was done in Australia and which part was done overseas. Agreement of the nominee must be obtained by the nominator before submission and included with the nomination.

The winner will be expected to write a review paper of their work for submission to the Society's *Journal & Proceedings*. In cases where the Council of the Society is unable to distinguish between two persons of equal merit, preference will be given to a Member of the Society.

Nominations and supporting material should be submitted by email to the Royal Society of New South Wales (royalsoc@royalsoc.org.au) marked to the attention of the Honorary Secretary, not later than 30th September 2018.

The winner will be notified in December. The winner will be announced and the Medal presented at the Annual Dinner of the Royal Society usually held in May in the year following the award.

Edgeworth David Medal 2018

The Edgeworth David Medal, established in memory of Professor Sir Tannatt William Edgeworth David FRS, a past President of the Society, is awarded for distinguished contributions by a young scientist.

The conditions of the award of the Medal are: The recipient must be under the age of 35 years at 1 January 2018; and the Medal will be for work done mainly in Australia or its Territories or contributing to the advancement of Australian science.

Nominations are called for the names of suitable persons who have contributed significantly to science, including scientific aspects of agriculture, engineering, dentistry, medicine and veterinary science.

The Council requests that every nomination should be accompanied by a list of publications, a full *curriculum vitæ*, and also by a statement clearly indicating which part of the nominee's work was done in Australia and which part was done overseas. Agreement of the nominee must be obtained by the nominator before submission and included with the nomination.

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The winner will be notified in December. The winner will be announced and the Medal presented at the Annual Dinner of the Royal Society to be held in the year following the award.

James Cook Medal 2018

The James Cook Medal is awarded at intervals for outstanding contributions to science and human welfare in and for the Southern Hemisphere.

The James Cook Medal was established in 1947 with funding by Henry Ferdinand Halloran. Halloran, who had joined the Society in 1892 as a 23 year-old, was a surveyor, engineer and town planner. He did not publish anything in the Society's Journal, but he was a very enthusiastic supporter of research. Halloran funded what were to become the Society's two most prestigious awards, the James Cook Medal and the Edgeworth David Medal, the latter medal being for young scientists.

The Council requests that every nomination should be accompanied by a list of publications, a full *curriculum vitæ*, and also by a statement clearly indicating which part of the nominee's work was done in Australia and which part was done overseas. Agreement of the nominee must be obtained by the nominator before submission and included with the nomination.

The winner will be expected to write a review paper of their work for submission to the Society's *Journal & Proceedings*. In cases where the Council of the Society is unable to distinguish between two persons of equal merit, preference will be given to a Member of the Society.

Nominations and supporting material should be submitted by email to the Royal Society of New South Wales (royalsoc@royalsoc.org.au) marked to the attention of the Honorary Secretary, not later than 30th September 2018.

The winner will be notified in December. The winner will be announced and the Medal presented at the Annual Dinner of the Royal Society to be held in May in the year following the award.

Warren Prize (Medal & Lectureship) 2018

William Henry Warren established the first faculty of engineering in New South Wales and was appointed as its Professor at the University of Sydney in 1884. Professor Warren was President of the Royal Society of New South Wales on two occasions. He had a long career of more than 40 years and during this time was considered to be the most eminent engineer in Australia. When the Institution of Engineers, Australia was established in 1919, Professor Warren was elected as its first President. He established an internationally respected reputation for the Faculty of Engineering at the University of Sydney and published extensively, with many of his papers being published in the *Journal & Proceedings*.

The Warren Prize has been established by the Royal Society of NSW to acknowledge Professor Warren's contribution both to the Society and to the technological disciplines in Australia and internationally. The aim of the award is to recognise research of national or international significance by engineers and technologists in their professional practice. The research must have originated or have been carried out principally in New South Wales. The prize is $500.

Entries are by submission of an original paper which reviews the research field, highlighting the contributions of the candidate, and identifying its national or international significance. Preference will be given to entries that demonstrate relevance across the spectrum of knowledge — science, art, literature and philosophy — that the Society promotes.

The winning paper and a selection of other entries submitted will be peer-reviewed and are expected to be published in the Society's *Journal & Proceedings*. Depending on the number of acceptable entries, there may be a special edition of the *Journal & Proceedings* that would be intended to showcase research by early- and mid-career Australian researchers.

The paper should be submitted by email (royalsoc@royalsoc.org.au) to the Royal Society of New South Wales marked to the attention of the Honorary Secretary, not later than 30th September 2018. The manuscript will be passed on to the Editor of the *Journal & Proceedings* for peer review.

The winner will be notified in December. The winner will be announced and the Medal presented at the Annual Dinner of the Royal Society to be held in May in the year following the award.

History and Philosophy of Science Medal 2018

The Royal Society of NSW History and Philosophy of Science Prize was established in 2014 to recognise outstanding achievement in the History and Philosophy of Science, and the inaugural award was made to Ann Moyal in 2015. It is anticipated that this Prize, like the

Society's other awards, will become one of the most prestigious awards offered in Australia in this field. The winner will be awarded a medal.

Persons nominated will have made a significant contribution to the understanding of the history and philosophy of science, with preference being given to the study of ideas, institutions and individuals of significance to the practice of the natural sciences in Australia.

Entries may be made by nomination or direct submission. All entries should be accompanied by a full *curriculum vitæ* and include a one-page statement setting out the case for award. In the case of nominations, the agreement of the nominee must be obtained by the nominator before submission and included with the entry.

The winner will be expected to submit an unpublished essay, drawing on recent work, which will be considered for publication in the Society's *Journal & Proceedings* during the following year.

Nominations and supporting material should be submitted by email to the Royal Society of New South Wales (royalsoc@royalsoc.org.au) marked to the attention of the Honorary Secretary, not later than 30th September 2018.

The winner will be notified in December. The winner will be announced and the Medal presented at the Annual Dinner of the Royal Society to be held in May in the year following the award.

Royal Society of NSW Scholarships 2018

The Royal Society of New South Wales is the oldest learned society in Australia, tracing its origins to 1821. It has a long tradition of encouraging and supporting scientific research and leading intellectual life in the State. The Council of the Society funds the Royal Society of New South Wales Scholarships in order to acknowledge outstanding achievements by early-career individuals working towards a research degree in a science-related field.

Three scholarships of $500 plus and a complimentary year of membership of the Society are awarded each year in order to recognise outstanding achievements by young researchers in any field of science. Applicants must be enrolled as research students in a university in either NSW or the ACT, and must be Australian citizens or Permanent Residents of Australia.

The winners will be expected to deliver a 20-min presentation of their work at the monthly meeting of the Society on 6 February 2019.

Scholarship recipients will be asked to submit an original paper to the Society's *Journal & Proceedings*. Submissions should be sent to the Editor (journal-ed@royalsoc.org.au). Manuscripts should conform to the "Information for Authors" <*http://www.royalsoc.org.au/society-publications/information-for-authors*>. Manuscripts will be peer reviewed.

Nominations for a 2018 awards will close on 30 September 2018. Self-nominations are allowed for this award. The following documents should be sent as a single package to the Awards Committee at royalsoc@royalsoc.org.au:

- The letter of nomination should clearly state the significance of the student's project.
- The student's *curriculum vitæ* containing a list publications, details of the student's undergraduate study, and any professional experience.
- An abstract of 500 words describing the project

- A statement of support from the student's supervisor, confirming details of the student's candidature.

The applications will be considered by a selection committee appointed by the Council of the Society and the decision will be made before the end of November. The decision of the committee is final. The scholarships will be awarded on merit.

The award will be presented at the Society's monthly meeting at the State Library of NSW on Wednesday, 6 November 2019, at which time the winners will deliver their presentations about their work.

Jak Kelly Award 2018

The Jak Kelly Award is awarded jointly with the Australian Institute of Physics to the best Ph.D. student talk presented at a joint meeting with the AIP.

The award consists of an engraved plaque, a $500 prize and a year of membership of the Society. The successful applicants will present their work to a meeting of the Royal Society in 2017, and will be asked to prepare a paper for the Society's *Journal & Proceedings*.

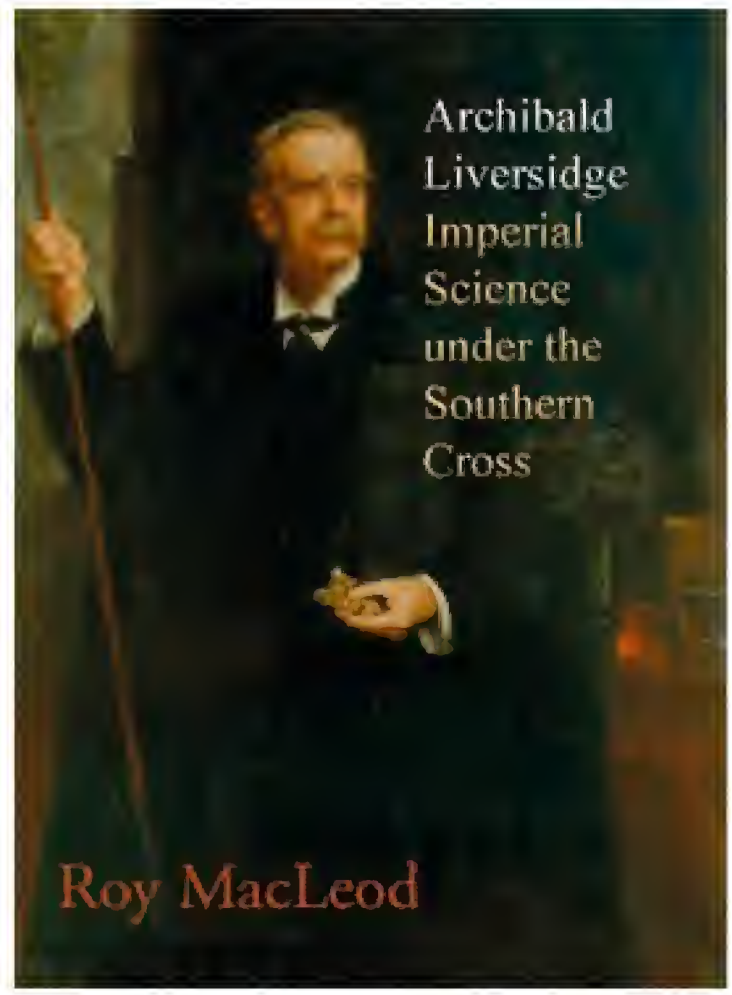
The winners of both awards will be notified in December.

The Royal Society of New South Wales Medal

The Society's Bronze Medal is awarded from time to time to a member of the Society who has made meritorious contributions to the advancement of science, including administration and organisation of scientific endeavour and for services to the Society.

Archibald Liversidge:
Imperial Science under the Southern Cross

Roy MacLeod
Royal Society of New South Wales, in association with Sydney University Press
ISBN 9781-9208-9880-9



When Archibald Liversidge first arrived at the University of Sydney in 1872 as Reader in Geology and Assistant in the Laboratory, he had about ten students and two rooms in the main building. In 1874, he became Professor of Geology and Mineralogy and by 1879 he had persuaded the University Senate to open a Faculty of Science. He became its first Dean in 1882.

In 1880, he visited Europe as a trustee of the Australian Museum and his report helped to establish the Industrial, Technological and Sanitary Museum which formed the basis of the present Powerhouse Museum's collection. Liversidge also played a major role in establishing the *Australasian Association for the Advancement of Science* which held its first congress in 1888.

This book is essential reading for those interested in the development of science in colonial Australia, particularly the fields of crystallography, mineral chemistry, chemical geology and strategic minerals policy.

To order your copy, please complete the Liversidge Book Order Form available at:

http://royalsoc.org.au/publications/books/McLeod_Liversidge_Order_Form.pdf

and return it together with your payment to:

The Royal Society of NSW,
(Liversidge Book),
PO Box 576,
Crows Nest NSW 1585,
Australia

or contact the Society:

Phone: +61 2 9431 8691
Fax: +61 2 9431 8677
Email: info@royalsoc.org.au

The Royal Society of New South Wales

Information for authors

Details of submission guidelines can be found in the on-line Style Guide for Authors at: https://royalsoc.org.au/society-publications/information-for-authors

Manuscripts are only accepted in digital format and should be e-mailed to:
journal-ed@royalsoc.org.au

The templates available on the Journal website should be used for preparing manuscripts. Full instructions for preparing submissions are also given on the website.

If the file-size is too large to email it should be placed on a CD-ROM or other digital media and posted to:

The Honorary Secretary (Editorial),
The Royal Society of New South Wales,
PO Box 576,
Crows Nest, NSW 1585
Australia

Manuscripts will be reviewed by the Editor, in consultation with the Editorial Board, to decide whether the paper will be considered for publication in the Journal. Manuscripts are subjected to peer review by at least one independent reviewer. In the event of initial rejection, manuscripts may be sent to other reviewers.

Papers (other than those specially invited by the Editorial Board) will only be considered if the content is either substantially new material that has not been published previously, or is a review of a major research programme. Papers presenting aspects of the historical record of research carried out within Australia are particularly encouraged. In the case of papers presenting new research, the author must certify that the material has not been submitted concurrently elsewhere nor is likely to be published elsewhere in substantially the same form. In the case of papers reviewing a major research programme, the author must certify that the material has not been published substantially in the same form elsewhere and that permission for the Society to publish has been granted by all copyright holders. Letters to the Editor, Discourses, Short Notes and Abstracts of Australian PhD theses may also be submitted for publication. Please contact the Editor if you would like to discuss a possible article for inclusion in the Journal.

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ISSN 0035-9173

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Published June 2018