

Course at the Joint Research Centre of Ispra:

'Sensitivity analysis, sensitivity auditing and beyond' Lesson 3: Ethics of quantification

Andrea Saltelli Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen (UIB) and Institut de Ciència i Tecnologia Ambientals (ICTA) –Universitat Autonoma de Barcelona (UAB)

Ispra March 29-31



sensitivity analysis, sensitivity auditing, science for policy, impact assessment





## = more material on my web site



## = discussion time

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#### rsos.royalsocietypublishing.org



**Cite this article:** Colquhoun D. 2014 An investigation of the false discovery rate and the misinterpretation of *p*-values. *R. Soc. open sci.* **1**: 140216.

http://dx.doi.org/10.1098/rsos.140216

# An investigation of the false discovery rate and the misinterpretation of *p*-values

#### David Colquhoun

Department of Neuroscience, Physiology and Pharmacology, University College London, Gower Street, London WC1 6BT, UK "If you are foolish enough to define 'statistically significant' as anything less than p=0.05 then... you have a 29% chance (at least) of making a fool of yourself.

Who would take a risk like that? Judging by the medical literature, most people would. No wonder there is a problem"

Colquhoun D. 2014 An investigation of the false discovery rate and the misinterpretation of p-values. R. Soc. Open sci. 1: 140216. http://dx.doi.org/10.1098/rsos.140216

## P values by way of an example

- Two groups, one with a placebo, one with the treatment
- Random allocation to groups (+more!)
- The difference *d* between the means of the two groups is tested (is it different from zero?)
- *p*=0.05 implies that if there were no effect the probability of observing a value equal to *d* or higher would be 5%

"At first sight, it might be thought that this procedure would guarantee that you would make a fool of yourself only once in every 20 times that you do a test"

Colquhoun D. 2014 An investigation of the false discovery rate and the misinterpretation of p-values. R. Soc. Open sci. 1: 140216. http://dx.doi.org/10.1098/rsos.140216

"The classical p-value does exactly what it says. But it is a statement about what would happen if there were no true effect. That cannot tell you about your longterm probability of making a fool of yourself, simply because sometimes there really is an effect. In order to do the calculation, **we need to know a few more things**"

Colquhoun D. 2014 An investigation of the false discovery rate and the misinterpretation of p-values. R. Soc. Open sci. 1: 140216. http://dx.doi.org/10.1098/rsos.140216

### A classic exercise in screening

You test positive for AIDS (one test only). Time for despair?

Only one 1 in 100,000 has AIDS in your population

The test has a 5% false positive rate

Already one can say: in a population of say 100,000 one will have AIDS and 5,000 (5% of 100,000) will test positive

➔ Don't despair (yet)

Another exercise in screening (Colquhoun 2014)

You test positive for mild cognitive impairment (MCI) (one test only). Time to retire?

MCI prevalence in the population 1%, i.e. in a sample of 10,000 then 100 have MCI and 9,900 don't

The test has a 5% false positive rate; of the 9,900 who don't have MCI 495 test (false) positive and the remaining 9,405 (true) negative

The test does not pick all the 100 MCI but only 80; there will be 20 false negative. So we see 80+495=575 positive of which only 80 (a 14%) are true and the remaining 86% false

 $\rightarrow$  It does not make sense to screen the population for MCI!

The number 86% = 495/(495+80) is our false discovery rate



Colquhoun D. 2014 An investigation of the false discovery rate and the misinterpretation of p-values. R. Soc. Open sci. 1: 140216. http://dx.doi.org/10.1098/rsos.140216

The same concept of false discovery rate applies to the problem of significance test

#### We now consider tests instead of individuals



Colquhoun D. 2014 An investigation of the false discovery rate and the misinterpretation of p-values. R. Soc. Open sci. 1: 140216. http://dx.doi.org/10.1098/rsos.140216

#### **Unlikely results**

How a small proportion of false positives can prove very misleading

False True False negatives False positives 3. Not knowing 1. Of hypotheses The tests have a what is false and false positive rate interesting of 5%. That means what is not, the enough to test, perhaps one in they produce 45 researcher sees ten will be true. false positives (5% 125 hypotheses as of 900). They have true, 45 of which So imagine tests on 1,000 a power of 0.8, so are not. hypotheses, they confirm only The negative 100 of which 80 of the true results are much are true. hypotheses, more reliable-but producing 20 false unlikely to be negatives. published.

The false discovery rate is ~the dark divided by the light green

→ We see 125 hypotheses as true 45 of which are not; the false discovery rate is 45/125 = 36%

Significance  $p=0.05 \rightarrow$  false discovery rate of 36%

We now know that p=0.05 did not correspond to a chance in twenty of being wrong but in one in three

How many numbers did we need to know to reach this conclusion?





WRORG.

#### Unreliable research Trouble at the lab

Scientists like to think of science as self-correcting. To an alarming degree, it is not

Oct 19th 2013 | From the print edition





#### Essay

#### Why Most Published Research Findings Are False

John P. A. Ioannidis

J. P. A. Ioannidis, Why Most Published Research Findings Are False, PLoS Medicine, August 2005, 2(8), 696-701.



генатопопро ртоюса посаен зекстание field. In this framework, a research finding is less likely to be true when the studies conducted in a field are smaller; when effect sizes are smaller; when there is a greater number and lesser preselection of tested relationships; where there is greater flexibility in designs, definitions, outcomes, and analytical modes; when there is greater financial and other interest and prejudice; and when more teams are involved in a scientific field in chase of statistical significance.



# Statisticians issue warning on *P* values

Statement aims to halt missteps in the quest for certainty.

"Misuse of the P value — a common test for judging the strength of scientific evidence — is contributing to the number of research findings that cannot be reproduced"

Baker, M., 2016, Statisticians issue warning on P values, Nature, 531, 151



732 North Washington Street, Alexandria, VA 22314 + (703) 684-1221 + Toll Free: (888) 231-3473 + www.omstat.org + www.twitter.com/AmstatNews

#### AMERICAN STATISTICAL ASSOCIATION RELEASES STATEMENT ON STATISTICAL SIGNIFICANCE AND P-VALUES

Provides Principles to Improve the Conduct and Interpretation of Quantitative Science March 7, 2016

## ... and twenty 'dissenting' commentaries

Wasserstein, R.L. and Lazar, N.A., 2016. 'The ASA's statement on p-values: context, process, and purpose', The American Statistician, DOI:10.1080/00031305.2016.1154108.

See also Christie Aschwanden at http://fivethirtyeight.com/features/not-even-scientists-can-easily-explain-p-values/

**Special Issue:** Bayesian Probability and Statistics in Management Research Journal of Management Vol. 41 No. 2, February 2015 421–440 DOI: 10.1177/0149206314547522 © The Author(s) 2014 Reprints and permissions: sagepub.com/journalsPermissions.nav

**Editorial Commentary** 

# Surrogate Science: The Idol of a Universal Method for Scientific Inference

Gerd Gigerenzer

Max Planck Institute for Human Development

Julian N. Marewski

University of Lausanne

There is no universal method of scientific inference ...

... it is better to have no beliefs than to embrace falsehoods...

Statistical methods are not simply applied to a discipline; they change the discipline itself, ...

**Special Issue:** Bayesian Probability and Statistics in Management Research Journal of Management Vol. 41 No. 2, February 2015 421–440 DOI: 10.1177/0149206314547522 © The Author(s) 2014 Reprints and permissions: sagepub.com/journalsPermissions.nav

**Editorial Commentary** 

Surrogate Science: The Idol of a Universal Method for Scientific Inference

Gerd Gigerenzer

Max Planck Institute for Human Development

Julian N. Marewski University of Lausanne How was it possible that this important statistical tool was misused for several decades with grave consequences for science? The Great Endarkenment. Philosophy for an Age of Hyperspecialization By Elijah Millgram





Describes a world in which all knowledge and products are the result of some form of extremely specialized expertise, and in which expertise is itself highly circumscribed, since experts depend in turn on other experts whose knowledge claims and styles of argumentation cannot be exported from one discipline to the next.  $\rightarrow$  "serial hyperspecializers" (p. 26)

Experts thus become "logical aliens" (p. 32)

## **Replicability-Index**

Improving the replicability of empirical research



# Reconstruction of a Train Wreck: How Priming Research Went off the Rails

③ February 2, 2017 Kahneman, Priming, r-index, Statistical Power, Thinking Fast and Slow

Authors: Ulrich Schimmack, Moritz Heene, and Kamini Kesavan



Reconstruction of a Train Wreck: How Priming Research Went off the Rails





"[…]questions have been raised about the robustness of priming results … your field is now the poster child for doubts about the integrity of psychological research…

https://replicationindex.wordpress.com/2017/02/02/reconstruction-of-a-train-wreck-how-priming-research-went-of-the-rails/comment-page-1/



Reconstruction of a Train Wreck: How Priming Research Went off the Rails



THINKING, FAST...SLOW DANIEL KAHNEMAN

"... people have now attached a question mark to the field, and it is your responsibility to remove it... I recently wrote a book that emphasizes priming research ... My reason for writing this letter is that I see a train wreck looming" (Kahneman, 2012)

https://replicationindex.wordpress.com/2017/02/02/reconstruction-of-a-train-wreck-how-priming-research-went-of-the-rails/comment-page-1/

# P-hacking; a smoking gun?



Shanks et al. (2015) JEP:General

J Exp Psychol Gen. 2015 Oct 26. "Romance, Risk, and Replication: Can Consumer Choices and Risk-Taking Be Primed by Mating Motives?", Shanks DR, Vadillo MA, Riedel B, Clymo A, Govind S, Hickin N, Tamman AJ, Puhlmann LM.: http://www.ncbi.nlm.nih.gov/pubmed/26501730 LEADER 13 April 2016

# Science isn't as solid as it should be – but science can fix it

Unconscious biases and data-torturing are weakening our knowledge base – but unlike politicians and bankers, scientists aren't covering up their failings



Crisis? Fix it... Stanislav Chernivchan/EyeEm

New Scientists talks of "statistical sausage factory" FEATURE 13 April 2016

# Why so much science research is flawed – and what to do about it

Dodgy results are fuelling flawed policy decisions and undermining medical advances. They could even make us lose faith in science. **New Scientist** investigates



An alarming amount of research is flawed Brett Ryder



# Just it just about statistics?

## What if even she is wrong?



On TV series over series where lab-based forensics (science) adjudicates cases

Forensics [as well as medicine, biology, economics, health, nutrition ...] has produced serious misdiagnoses





National Academy of Sciences (NAS) report "Strengthening Forensic Science in the United States: A Path Forward", https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf



# Science in crisis: from the sugar scam to Brexit, our faith in experts is fading

September 27, 2016 4 43pm AEST



https://theconversation.com/science-in-crisis-from-the-sugar-scam-to-brexit-our-faith-in-experts-is-fading-65016

Context: A matter of opinion

- 1. Science is in a deep existential crisis which has ethical, epistemological, methodological and even metaphysical dimensions
- 2.Likewise democracy which has with science a legitimacy arrangement
- 3. Science and its institutions are committed to the status quo & attempt to evade a critical reflection
- 4. Solutions aren't forthcoming anytime soon
- 5. There are yet few areas of 'Reformation' where science and society work together

**First thesis:** Science is in a deep existential crisis which has ethical, epistemological, methodological and even metaphysical dimensions. This was neatly predicted by E. de Solla Price, Jerome R. Ravetz and others five decades ago







Jerome R. Ravetz

de Solla Price, D.J., 1963, Little science big science, Columbia University Press. Ravetz, J., 1971, Scientific Knowledge and its Social Problems, Oxford University Press. In 1963 Derek J. de Solla Price prophesized that Science would reach saturation (and in the worst case senility) under its own weight, victim of its own success and exponential growth (pp 1 - 32).





Derek J. de Solla Price

de Solla Price, D.J., 1963, Little science big science, Columbia University Press.


Science/knowledge degenerates when it becomes a commodity for Ravetz (1971), Lyotard (1979) and Mirowski (2011).

Ravetz, J., 1971, Scientific Knowledge and its Social Problems, Oxford University Press, p. 22.

Lyotard, J.-F. 1979. La Condition postmoderne. Rapport sur le savoir, Paris : Minuit, Chapter 10.

Mirowski, P. 2011. Science-Mart: Privatizing American Science, Harvard University Press.



Jerome R. Ravetz



Jean-François Lyotard





Philip Mirowski p.22: "with the industrialization of science, certain changes have occurred which weaken the operation of the traditional mechanism of quality control and direction at the highest level.









Ravetz, J., 1971, Scientific Knowledge and its Social Problems, Oxford University Press, p.22.

p.22: […] The problem of quality control in science is thus at the centre of the social problems of the industrialized science of the present period."



Jerome R. Ravetz

Ravetz, J., 1971, Scientific Knowledge and its Social Problems, Oxford University Press, p.22. p.22: "If [science] fails to resolve this problem [...] then the immediate consequences for morale and recruitment will be serious; and those for the survival of science itself, grave"



Jerome R. Ravetz

Ravetz, J., 1971, Scientific Knowledge and its Social Problems, Oxford University Press, p.22. After the eighties neoliberal ideologies succeeded in decreasing state intervention in the funding of science, which became increasingly privatized … Knowledge as a monetized commodity replaces knowledge as public good...

Mirowski, P. 2011. Science-Mart: Privatizing American Science, Harvard University Press.





Philip Mirowski

In house science labs of major corporation were closed and research outsourced to universities which  $\cdots$  became more and more looking as profit seeking organization (technology transfer offices in every campus)  $\cdots$  then research ended up outsourced again to contract-based research organizations (CRO's) $\cdots$ 



Philip Mirowski

Mirowski, P. 2011. Science-Mart: Privatizing American Science, Harvard University Press.



### **Summary Points**

• Currently, many published research findings are false or exaggerated, and an estimated 85% of research resources are wasted.

Ioannidis, J. P. (2014). How to Make More Published Research True. PLoS medicine, 11(10), e1001747

For Lancet (2015) an estimated US\$200 billion were wasted in the US in 2010.

Lancet, Editorial, 2015, Rewarding true inquiry and diligence in research, 385, p. 2121.

Ioannidis JPA, 2016, Why Most Clinical Research Is Not Useful, PLoS Med 13(6): e1002049. doi:10.1371/journal.pmed.1002049



John P. A. Ioannides



NATURE | NEWS FEATURE

### 1,500 scientists lift the lid on reproducibi

Survey sheds light on the 'crisis' rocking research.

#### Monya Baker

25 May 2016 | Corrected: 28 July 2016



http://www.nature.com/news/1-500-scientistslift-the-lid-on-reproducibility-1.19970

# International weekly journal of science Home News & Comment Research Careers & Jobs Current issue Archive Audio & Video For Archive Volume 533 Issue 7604 News Feature Article

NATURE | NEWS FEATURE

## 1,500 scientists lift the lid on reproducibility

Survey sheds light on the 'crisis' rocking research.

#### Monya Baker

25 May 2016 | Corrected: 28 July 2016

### WHAT FACTORS CONTRIBUTE TO IRREPRODUCIBLE RESEARCH?

Many top-rated factors relate to intense competition and time pressure.



http://www.nature.com/news/1-500-scientistslift-the-lid-on-reproducibility-1.19970



## THE RIGHTFUL PLACE OF SCIENCE: SCIENCE ON THE VERGE

#### CONTRIBUTORS

Alice Benessia
Silvio Funtowicz
Mario Giampietro
Ângela Guimarães Pereir

Jerome R. Ravetz Andrea Saltelli Roger Strand Jeroen P. van der Sluiis



A crisis looms over the scientific enterprise. Not a day passes without news of retractions, failed replications, fraudulent peer reviews, or misinformed science-based policies

## **Thesis 2:** Likewise in crisis is democracy which has with science a legitimacy arrangement



## ➔ today post-BREXIT, post-Trump, post-truth brouhaha, the demise of expertise …

**Thesis 3:** Science and its institutions are committed to the status quo & attempt to evade a critical reflection with:

Denial Dismissal Diversion Displacement

Economy and Society Volume 41 Number 1 February 2012: 107–125 Uncomfortable knowledge: the social construction of ignorance in science and environmental policy discourses

Steve Rayner

## Denial

**OECD**publishing

Please cite this paper as:

OECD (2015), "Scientific Advice for Policy Making: The Role and Responsibility of Expert Bodies and Individual Scientists", OECD Science, Technology and Industry Policy Papers, No. 21, OECD Publishing, Paris. http://dx.doi.org/10.1787/5js3311jcpwb-en

OECD Science, Technology and Industry Policy Papers No. 21

#### Scientific Advice for Policy Making

THE ROLE AND RESPONSIBILITY OF EXPERT BODIES AND INDIVIDUAL SCIENTISTS

OECD

<image><section-header>

2015



## We can solve it!

nature.com > nature human behavi	our > perspectives > article		
MENU V nature human behavi	our		
<b>8 2 8 2 2 4</b> Altmetric: 1,978	Views: 40,227	More detail »	
Perspective   OPEN			
A manifesto for re	producible sci	ence	
Marcus R. Munafó 🧮 Brian A. Nosek, Doro	thy V. M. Bishop, Katherine S. But	ton, Christopher D.	
P. A. Ioannidis	nonsonn, Eric-Jan Wagenmakers,	Jenniter J. Ware & John	
Nature Human Behaviour 1,	Published online: 10	Published online: 10 January 2017	
Article number: 0021 (2017) doi:10.1038/s41562-016-0021			

"[…] measures [to] improving the transparency, reproducibility and efficiency of scientific research" Diversion (There is a problem, and this is due to an ongoing war on science between the educated liberal left and the ignorant conservative right)

### THE CONVERSATION

Arts + Culture Business + Economy Education Environment + Energy Health + Medicine Politics + Society Science + Technology Brexit



#### Authors



B. Shard and the descent of

Andrea Saltelli Adjunct professor, University of Bergen



#### Silvio Oscar Funtowicz

Adjunct Professor Centre for the Study of the Sciences and the Humanities, University of Bergen

https://theconversation.com/science-wars-in-the-age-of-donald-trump-67594

## Displacement (This is the post-truth era)



Academic rigour, journalistic flair

Arts + Culture Business + Economy Education Environment + Energy Health + Medicine Politics + Society Science + Technology Brexit

## To tackle the post-truth world, science must reform itself

January 27, 2017 7.33am GMT



Authors



Andrea Saltelli Adjunct professor, University of Bergen



Silvio Oscar Funtowicz Adjunct Professor Centre for the Study of the Sciences and the Humanities, University of Bergen

#### https://theconversation.com/to-tackle-the-post-truth-world-science-must-reform-itself-70455

Thesis 4: Solutions aren't forthcoming anytime soon, but:

Church / indulgencies =

Science / [predatory publishers, citation cartels, trade in authorship, sugar-cholesterol scandal …]



Martin Luther



Johann Tetzel

A combination of corruption, rage and new technology could mobilise major social change (Silvio Funtowicz)



Martin Luther



Johann Tetzel

**Thesis 5:** Areas of resistance and 'Reformation' where science and society work together – emergence of a new polity of science, including citizen scientists and scientist–citizens



Jeffrey Beall

Lois Gibbs

Timothy Gowers Marc Edwards

http://scholarlyoa.com/2015/01/02/bealls-list-of-predatory-publishers-2015/#more-4719 https://www.bu.edu/lovecanal/canal/ http://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0127502 https://en.wikipedia.org/wiki/Flint\_water\_crisis; http://flintwaterstudy.org/; http://www.nytimes.com/2016/08/21/magazine/flints-water-crisis-and-thetroublemaker-scientist.html

## An even newer sort of heroes?



John and Laura Arnold



Brian Nosek, the Reproducibility Project.







John Ioannidis, Meta-research innovation centre at Stanford

Ben Goldacre, alltrials.net

Gary Taubes, The case against sugar

https://www.wired.com/2017/01/john-arnold-waging-war-on-bad-science/



Yoshiki Sasai

http://www.nature.com/news/stem-cell-pioneer-blamed-media-bashing-in-suicide-note-1.15715

The Cartesian dream



Francis Bacon (1561-1626)

We call the Cartesian dream the idea of man as master and possessor of nature, of prediction and control, of Bacon's wonders of science and of Condorcet's mathematique sociale…



René Descartes (1596-1650)

Discourse on Method (1637)

Magnalia Naturae, in the New Atlantis (1627), 'Wonders of nature, in particular with respect to human use'



Nicolas de Caritat, marquis de Condorcet (1743-1794)

'Sketch for a Historical Picture of the Progress of the Human Spirit'



Francis Bacon (1561–1626)

Magnalia Naturae, in the New Atlantis (1627), 'Wonders of nature, in particular with respect to human use'

The prolongation of life; The restitution of youth in some degree; The retardation of age; The curing of diseases counted incurable; The mitigation of pain; More easy and less loathsome purgings; The increasing of strength and activity; The increasing of ability to suffer torture or pain; The altering of complexions, and fatness and leanness; The altering of statures; The altering of features; The increasing and exalting of the intellectual parts; Versions of bodies into other bodies; Making of new species; Transplanting of one species into another; Instruments of destruction, as of war and poison; Exhilaration of the spirits, and putting them in good disposition; Force of the imagination, either upon another body, or upon the body itself; Acceleration of time in maturations; Acceleration of time in clarifications; Acceleration of putrefaction; Acceleration of decoction; Acceleration of germination; Making rich composts for the earth; Impressions of the air, and raising of tempests; Great alteration; as in induration, emollition, &c; Turning crude and watery substances into oily and unctuous substances; Drawing of new foods out of substances not now in use; Making new threads for apparel; and new stuffs, such as paper, glass, &c; Natural divinations; Deceptions of the senses; Greater pleasures of the senses; Artificial minerals and cements.



Francis Bacon (1561-1626)

Magnalia Naturae, in the New Atlantis (1627), 'Wonders of nature, in particular with respect to human use'

The prolongation of life; The restitution of youth in some degree; The retardation of age; The curing of diseases counted incurable; The mitigation of pain; [...]

Drawing of new foods out of substances not now in use; Making new threads for apparel; and new stuffs, such as paper, glass, &c; Natural divinations; Deceptions of the senses; Greater pleasures of the senses; Artificial minerals and cements. The study of letters leading to "doubts and errors";

Comparing "disquisitions of the ancient moralists to very towering and magnificent palaces with no better foundation than sand and mud";

Condemnation of humanities and exaltation of mathematics.



René Descartes (1596-1650)

Discourse on Method (1637) "I perceived it to be possible to arrive at knowledge highly useful in life; and in room of the Speculative Philosophy […], to discover a Practical, by means of which, knowing the force and action of fire, water, air, the stars, the heavens, and all the other bodies that surround us, […] we might also apply them  $[\cdots]$ , and thus render ourselves the lords and possessors of nature."



René Descartes (1596-1650)

Discourse on Method (1637)

## In the formulation of Condorcet:

"All the errors in politics and in morals are founded upon philosophical mistakes, which, themselves, are connected with physical errors" (Ninth Epoch)



Nicolas de Caritat, marquis de Condorcet (1743- 1794)

'Sketch for a Historical Picture of the Progress of the Human Spirit' Overpopulation? War due to scarcity of resources? Will not happen because technical progress and ethical progress will go hand in hand. Man will understand that his duty "will consist not in the question of giving existence to a greater number of beings, but happiness." (Tenth Epoch)



Nicolas de Caritat, marquis de Condorcet (1743- 1794)

'Sketch for a Historical Picture of the Progress of the Human Spirit' 'Mathématique sociale':

We still use today terms such as 'Condorcet method', 'Condorcet winner', 'Condorcet-ranking procedure'



Nicolas de Caritat, marquis de Condorcet (1743- 1794)

'Sketch for a Historical Picture of the Progress of the Human Spirit' Condorcet's algorithms and Descartes' Geometry

Feldman, J., 2005, Condorcet et la mathematique sociale: enthousiasmes et bemols, Mathematics and Social Sciences, 172(4), 7-41, http://www.ehess.fr/revue-msh/pdf/N172R955.pdf Munda G. (2007) - Social multi-criteria evaluation, Springer-Verlag, Heidelberg, New York, Economics Series



Condorcet's algorithms and Descartes' Geometry, the dream always had a quantification agenda





## Auguste Comte and the hierarchy of science

Daniele Fanelli's work: "Positive" Results Increase Down the Hierarchy of the Sciences PLoS ONE, 2010, 5,(4) e10068







Making the dream true: Gravitational waves; from J. Weber's cylinder to LIGO

A Madman Dreams of Tuning Machines: The Story of Joseph Weber, the Tragic Hero of Science Who Followed Einstein's Vision and Pioneered the Sound of Space-Time, By Maria Popova, https://www.brainpickings.org/2016/04/25/black-holeblues-janna-levin-joseph-weber/



Closer to our times the dream was couched in the 'Endless Frontier' metaphor by Vannevar Bush, 1945:

"One of our hopes is that after the war there will be full employment.  $[\cdots]$  To create more jobs we must make new and better and cheaper products […] founded on  $[\cdots]$  basic scientific research.  $[\cdots$ the] Government […] opened the seas to clipper ships and furnished land for pioneers. Although these frontiers have more or less disappeared, the frontier of science remains."





Vannevar Bush (1890-1974)



## Cargo Cult Science

by RICHARD P. FEYNMAN

Some remarks on science, pseudoscience, and learning how to not fool yourself. Caltech's 1974 commencement address.



"[...] there is one feature I notice that is generally missing in cargo cult science. That is the idea that we all hope you have learned in studying science in school [...].


It's a kind of scientific integrity, a principle of scientific thought that corresponds to a kind of utter honesty--a kind of leaning over backwards. [...] Details that could throw doubt on your interpretation must be given, if you know them. [...] give all of the information to help others to judge the value of your contribution."

A plea for a rediscovery of ignorance – especially ignorance generated by science itself;

Ravetz, J., R., 2015, Descartes and the rediscovery of ignorance, in Guimarães Pereira, Â., and Funtowicz, S., Eds., 2015, The end of the Cartesian dream, Routledge's series: Explorations in Sustainability and Governance.





Robert K. Merton, sociologist of science, 1910-2003, the father of Science and Technology Studies

#### CUDOS

Communalism - the common ownership of scientific discoveries, according to which scientists give up intellectual property rights in exchange for recognition and esteem ...

Universalism - according to which claims to truth are evaluated in terms of universal or impersonal criteria, and not on the basis of race, class, gender, religion, or nationality;

Disinterestedness - according to which scientists are rewarded for acting in ways that outwardly appear to be selfless;

Organized Scepticism - all ideas must be tested and are subject to rigorous, structured community scrutiny.

The same R.K. Merton realized later in life that norms have corresponding counter norms ... see Mitroff, I. I. 1974, *Am. Soc. Rev.* 39, 579-595.

[We must] consider, first, how potentially contradictory norms develop in every social institution; next, how in the institution of science conflicting norms generate marked ambivalence in the lives of scientists; and finally, how this ambivalence affects the actual, as distinct from the supposed, relations between men of science (Merton, 1963a:80).

## • Solitariness (secrecy, miserism) is often used to keep findings secret in order to be able to claim patent rights, ...

- Particularism [...] a real issue, particularly when you consider the ratio of researchers in rich countries compared with those in poor countries [...]
- Interestedness arises because scientists have genuine interests at stake in the reception of their research. [...]
- Dogmatism because careers are built upon a particular premise (theory) being true ...

#### The Republic of Science: Its Political and Economic Theory Michael Polanyi

[This article originally appeared in *Minerva* 1:54-74, 1962 and is put on WWW with kind permission from Kluwer Academic Publishers (http://www.wkap.nl) and John C. Polanyi.]

Science as a market driven by higher priciples

Which feeds society's thirst for self improvement

Science as a community of practice

Problematic quantifications?



Home / Pathways Leading to a More Sustainable and Healthy Global Food System

Topics Agriculture & Food Food Security Health

#### Pathways Leading to a More Sustainable and Healthy Global Food System

Volume 7 | Issue 5 | Page 10-12 | September 2016 By Krishna Bahadur KC, Evan D.G. Fraser, Samantha Pascoal, Goretty Dias, Trudi Zundel



"What follows is a hypothetical executive summary from an imagined Food and Agriculture Organization (FAO) report on the state of the world's food systems, written from the perspective of the 2050s"

https://www.thesolutionsjournal.com/article/pathways-leadingsustainable-healthy-global-food-system/

### Executive Summary: FAO State of World Agriculture in 2050 Draft Report

"[…]this FAO report presents evidence that the international food system of the second half of the 21st century is more sustainable than the food system of the late 20th or early 21st centuries.

 $[\cdots]$  today more people are being fed on less land and agriculture is requiring fewer inputs"

Executive Summary: FAO State of World Agriculture in 2050 Draft Report

Three digits

"[…] despite there being 10 billion people on the planet, today agriculture requires
438 million hectares\* less land than it did in 2015, yet produces more adequate nutrition for all."

\*Authors' estimate

# This [438 Mha] figure was arrived at by assuming that:

- Agriculture shifts away from over production of cereals, oils, and sugars, but increases fruit and vegetables;
- Agricultural yields increase ~1%/y between now and 2050.
- Protein consumption shifts from 86% animals and 14% plants to 50% animal and 50% plant.

*"Please contact the authors for references etc. pertaining to these calculations"* 



#### The Washington Post

## 107 Nobel laureates sign letter blasting Greenpeace over GMOs

https://www.washingtonpost.com/news/ speaking-ofscience/wp/2016/06/29/more-than-100-nobel-laureates-take-ongreenpeace-over-gmo-stance/



tille Greenpeace and littler organizations oppose genetically engineered food, more than 150 Nobel lawrates are taking a stand on the side (GMOs. Here's a look ut each side's arguments. (Jenny Stars/The Washington Past)

"While Greenpeace and other organizations oppose genetically engineered food, more than 100 Nobel laureates are taking a stand on the side of GMOs. Here's a look at each side's arguments. (Jenny Starrs/The Washington Post)" From the Noble laureates' letter:

"Greenpeace has spearheaded opposition to Golden Rice, which has the potential to reduce or eliminate much of the death and disease caused by a vitamin A deficiency (VAD), which has the greatest impact on the poorest people in Africa and Southeast Asia.

[…] a total of one to two million preventable deaths occur annually as a result of VAD, […] VAD itself is the leading cause of childhood blindness globally affecting 250,000 – 500,000 children each year. Half die within 12 months of losing their eyesight" From the Noble laureates' letter:

"[…] Opposition based on emotion and dogma contradicted by data must be stopped.

How many poor people in the world must die before we consider this a "**crime against humanity**"?"

http://supportprecisionagriculture.org/nobel-laureate-gmo-letter\_rjr.html

### Opposing evidence

Nutritionally: not enough beta carotene

Golden rice not authorized yet

More politically viable alternative successful

Dangerous colour

Low yield of the modified variety …

http://www.ecowatch.com/greenpeace-to-nobel-laureates-its-not-our-fault-golden-rice-has-failed-1896697050.html

See also Tiziano Gomiero, Andrea Saltelli and Mario Giampietro, The complexity of science for policy: the case of the delayed commercialization of the Golden Rice, Submitted October 2016.

Evidence based policy or its opposite? **PETRUCHIO:** I say it is the moon. **KATHERINE:** I know it is the moon. **PETRUCHIO:** Nay, then you lie. It is the blessèd sun. **KATHERINE:** Then God be blessed,

it is the blessed sun.

Shakespeare, the Taming of the Shrew, Act IV.

And the moon changes even as your mind.

But sun it is not, when you say it is not,

The expression 'Policy based evidence' has entered the public discourse.

Warring parties accuse one another of the sin.

"Greenpeace […] wants is policy based evidence making not evidence based policy making" (Sanderson, 2015) …

Wilkes, G., 2015, Free Lunch: Policy-based evidence-making, Financial Times, July 3. Sanderson, A.B., 3 Feb 2015, Breitbart, see <u>http://www.breitbart.com/london/2015/02/03/academic-attacks-greenpeace-for-ignoring-the-</u> <u>evidence-on-gm-crops/</u>; the politician is UKIP Energy Spokesman Roger Helmer MEP.

### Critiques of evidence based policy

"This need [for evidence] has been reified in the UK and elsewhere, as routines of 'evidence-based policy'making have been hardwired into the business of Government.

[…]such approaches are fundamentally flawed [because] Government […] seeks to capture and control the knowledge producing processes to the point where this type of 'research' might best be described as 'policy-based evidence'."

Boden, R. and Epstein D., 2006, Managing the Research Imagination? Globalisation and Research in Higher Education. *Globalisation, Societies and Education*, 223-236.

Accepted Manuscript

Title: What is wrong with evidence based policy, and how can it be improved?

Authors: Andrea Saltelli, Mario Giampietro



DOI: Reference: http://dx.doi.org/doi:10.1016/j.futures.2016.11.012 JFTR 2195

EBP = arbitrary framing (closure,  $\rightarrow$  PBE), rhetorical use of mathematics, reductionism & hypocognition, power asymmetries,  $\cdots$  need to explore wider set of frames

## Discussion points



• Are we (my team, my organization) into evidence based policy or policy based evidence?

Trust in science, trust in quantification Is science always right? Karl Pearson (a social Darwinist) suggests not wasting resources on social programs as:

"No degenerate and feeble stock will ever be converted into healthy and sound stock by the accumulated effects of education, good laws, and sanitary surroundings"

> THE GRAMMAR OF SCIENCE

> > Ratt Dearson



Karl Pearson



## Think Tank Scholar or Corporate Consultant? It Depends on the Day

Acting as independent arbiters to shape government policy, many researchers also have corporate roles that are sometimes undisclosed.

By ERIC LIPTON, NICHOLAS CONFESSORE and BROOKE WILLIAMS AUG. 8, 2016

The New York Times

http://www.nytimes.com/2016/08/09/us/politics/think-tank-scholars-corporate-consultants.html?\_r=0

## Lobbyists recruit laws firms which in turn recruit scientific services for their customer;

http://www.publicintegrity.org/2016/02/08/19223/meet-rented-white-coats-who-defend-toxic-chemicals



"Nearly half of Gradient's articles that are peer-reviewed are published in two journals with strong ties to industry, *Critical Reviews in Toxicology* and *Regulatory Toxicology and Pharmacology*" [Gradient is the research services company enrolled by law firms]



http://www.publicintegrity.org/2016/02/08/19223/meet-rented-white-coats-who-defend-toxic-chemicals

## **JAMA Internal Medicine**

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 Sugar Industry and Coronary Heart Disease
 Research

A Historical Analysis of Internal Industry Documents



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Cristin E. Kearns, DDS, MBA<sup>1,2</sup>; Laura A. Schmidt, PhD, MSW, MPH<sup>1,3,4</sup>; Stanton A. Glantz, PhD<sup>1,5,6,7,8</sup>

#### [+] Author Affiliations

JAMA Intern Med. Published online September 12, 2016. doi:10.1001/jamainternmed.2016.5394

Text Size: A A A

See also https://www.theguardian.com/society/2016/apr/07/the-sugar-conspiracy-robert-lustig-john-yudkin, and the story of US President Dwight Eisenhower heart attack,...

"our findings suggest the industry sponsored a research program in the 1960s and 1970s that successfully cast doubt about the hazards of sucrose while promoting fat as the dietary culprit in CHD [coronary hearth disease]"



#### Voices of concern:

"science has taken a turn towards darkness" (Richard Horton, editor-in-chief of The Lancet, 2015)

"If Donald Trump were to trigger a crisis in Western democracy, scientists would need to look at their part in its downfall" (Macilwain, 2016)

Horton, R., 2015, Comment, Offline: What is medicine's 5 sigma? The Lancet, 385, 1380. Macilwain, C., 2016, The elephant in the room we can't ignore, Nature, 531, 277. Economics?

## The Mathiness discussion in Economics

"The style that I am calling mathiness lets academic politics masquerade as science. Like mathematical theory, mathiness uses a mixture of words and symbols, but instead of making tight links, it leaves ample room for slippage between statements in natural versus formal language and between statements with theoretical as opposed to empirical content."



Paul Romer Since July 18 2016 Chief Economist of the World Bank



## Cargo Cult Science

by RICHARD P. FEYNMAN

Some remarks on science, pseudoscience, and learning how to not fool yourself. Caltech's 1974 commencement address.



Appeals to Richard Feynman's famous speech https://paulromer.net/feynmanintegrity/



#### The Trouble With Macroeconomics

PAUL ROMER Stern School of Business New York University

Wednesday 14th September, 2016

- 2 Post-Real Models
- 6 Questions About Economists, and Physicists
- 7 Loyalty Can Corrode The Norms of Science
- 9.1 The Norms of Science
- **10** The Trouble Ahead For All of Economics

https://paulromer.net/wp-content/uploads/2016/09/WP-Trouble.pdf

A different diagnosis for a diseased economics: for Erik Reinert's: economics has reverted to scholasticism

··· forgetting an important continental tradition

··· implications for developments

http://www.andreasaltelli.eu/file/repository/Full\_Circl e\_scholasticism\_2.pdf







Should natural sciences enroll economics in their advocacy to save the planet?


Evidence as the currency of lobbies



#### **Sylvain Laurens**

#### Les courtiers du capitalisme

**Milieux d'affaires** et bureaucrates à Bruxelles





Lee Drutman



Sylvain Laurens

Some quick read: http://www.nybooks.com/articles/2016/04/07/how-lobbyists-win-inwashington/ http://www.contretemps.eu/lectures/lire-extrait-courtiers-capitalismesylvain-laurens

Both works (resp. US, EU) make the point that evidence is the currency of lobbies

In the use of evidence actors with deepest pockets may prevail. A worrying asymmetry A truly black pearl: a candid admission in a book <u>written for the lobbyists</u>: The regulation game, Owen & Braeutigam, 1978





<u>Book written for the lobbyists</u>: The regulation game, Owen & Braeutigam, 1978



"This activity requires a modicum of finesse; it must not be too blatant, for the experts themselves must not recognize that they have lost their objectivity and freedom of action"

Owen B. M. and Braeutigam, R., Regulation Game: Strategic Use of the Administrative Process, page 7, Harper Business (1978)

### Trust and quantification.





Theodore M. Porter, Trust in Numbers, The Pursuit of Objectivity in Science and Public Life, Princeton 1995

## Trust, authority and styles of quantification: two different stories









Porter's story: Quantification needs judgment which in turn needs trust …without trust quantification becomes mechanical, a system, and systems can be played







The myth of scientific quantification via risk or cost benefit analyses, including of the impact of new technologies, has been at the hearth of the critique of the ecological moment (e.g. Schumacher, 1973; Winner, 1986; Funtowicz and Ravetz, 1994)

E. F. Schumacher, 1973, Small Is Beautiful. Economics as if People Mattered, Penguin Perennial,

Winner, L., 1986. The Whale and the Reactor: a Search for Limits in an Age of High Technology. The University of Chicago Press, 1989 edition.

Funtowicz, S.O. and Ravetz, J.R. (1994). The worth of a songbird: Ecological economics as a post-normal science. Ecological Economics 10(3), 197-207.

[…] quality is much more difficult to 'handle' than quantity, just as the exercise of judgment is a higher function than the ability to count and calculate.



Ernst Friedrich "Fritz" Schumacher

Quantitative differences can be more easily grasped and certainly more easily defined than qualitative differences: their concreteness is beguiling and gives them the appearance of scientific precision, even when this precision has been purchased by the suppression of vital differences of quality.

E. F. Schumacher, 1973, Small Is Beautiful. Economics as if People Mattered, Penguin Perennial,

## Discussion points



- Do I see a relationship between trust and quantification?
- Are we (my team, my organization) more like the 'corps des ingénieurs des ponts et chaussées' or the US Army corps of Engineers?



# END

### Twitter: @andreasaltelli