HPS&ST NEWSLETTER

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FEBRUARY 2020

The HPS&ST NEWSLETTER is emailed monthly to about 8,400 individuals who directly or indirectly have an interest in the contribution of history and philosophy of science to theoretical, curricular and pedagogical issues in science teaching, and/or interests in the promotion of innovative, engaging and effective teaching of the history and philosophy of science. The NEWSLETTER is sent on to different international and national HPS lists and international and national science teaching lists. In print or electronic form, it has been published for 25+ years.

The NEWSLETTER seeks to serve the diverse international community of HPS&ST scholars and teachers by disseminating information about events and publications that connect to concerns of the HPS&ST community.

Contributions to the NEWSLETTER (publications, conferences, opinion pieces, &.) are welcome and should be sent direct to the editor: Michael R. Matthews, UNSW (m.matthews@unsw.edu.au).

The NEWSLETTER, along with RESOURCES, OBITUARIES, OPINION PIECES and more, are available at the website: http://www.hpsst.com/

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ISSN: 2652-2837

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Beckman Center, Science History Institute Fellowships

The Beckman Center at the Science History Institute offers fellowships on an annual cycle for scholars doing research on our collections or in the history and social studies of chemistry, chemical engineering, and the life sciences. Fellows are expected to participate in biweekly informal writing groups and give at least one Lunchtime Lecture. They also have the opportunity to take part in a variety of outreach activities while in residence at the Institute. About 20 fellowships are given out annually, making the Beckman Center the largest private fellowship program in the history of science in the United States. Researchers travel from all over the world to use our collections and take part in a vibrant scholarly community.

The research collections at the Institute range chronologically from the 15th century to the present and include 6,000 rare books; significant archival holdings; thousands of images and other graphic materials; memorabilia of various kinds; oral histories; and a large artifact and fine arts collection, supported by over 100,000 modern primary-source volumes and journals. Within the collections are many areas of special strength, including alchemy, mining and metallurgy, dyeing and bleaching, balneology, gunpowder and pyrotechnics, gas-lighting, books of secrets, inorganic and organic chemistry, biochemistry, food chemistry, and pharmaceuticals.

The library collections can be searched online at https://othmerlib.sciencehistory.org. Subject guides along with information on how to use the library can be found at https://guides.othmerlibrary.sciencehistory.org.

You can also explore a number of our digitized collections at digital.sciencehistory.org.

80/20 *Postdoctoral fellowships* (2 years):
Applicants for 80/20 postdoctoral fellowships must expect to have their PhD in hand before July 2020 and have earned that degree within the last five years. Postdoctoral fellowship stipends are US$45,000 paid in monthly installments, with an additional US$2,500 subsidy for health insurance and an annual grant for travel expenses.

Dissertation fellowships (9 months):
These fellowships are open to graduate students whose PhD dissertation proposals have been accepted by their respective university departments. We also encourage applications from candidates in dissertation- or thesis-only PhD programs outside of the United States whose funding does not extend to a fourth year. The stipend is US$26,000, with an additional one-off grant for initial travel expenses.

Short-Term fellowships (1–4 months):

These fellowships are open to all scholars and researchers irrespective of career stage, including doctoral students, who plan to work closely with the Institute's collections on an independent research project. The stipend is US$3,000 per month to defray the costs of travel, accommodation, and living expenses.

Contact: fellowships@sciencehistory.org

See our website for instructions on how to apply and the link to the online application.

Science Popularization as Cultural Diplomacy: UNESCO (1946-1958)

Session proposal for the HSS Annual Conference, 8-11 October 2020 | New Orleans

From its creation after World War II, UNESCO became a political battleground in which different visions of science and the world order fought for hegemony. As it is well known, Julian Huxley (1887-1975) and Joseph Needham (1900-1995) were the first General Director and the first Director of the Natural Sciences Division. Their administration stressed the "social implications of science" -through the influence of Bernalist Marxism- and the "periphery principle" in international relations. They also included science popularisation in its priorities, but UNESCO's popularisation program would only start once the Cold War increased in intensity and Huxley and Needham's policies were substituted by the leadership of the physicist Pierre Auger (1899-1993), as new head of the Natural Sciences Division.

The goal of this session is to explore the history of international science popularisation policies and practices at UNESCO as tools for governance and cultural diplomacy from the Huxley-Needham administration to the end of Auger's leadership in 1958. Who were the main actors behind the global science popularisation program at UNESCO? What were their political agendas? What were their specific approaches to science, internationalism, diplomacy and popularisation? How were UNESCO's popularisation policies actually implemented around the world in different national and local contexts? What was the role of science popularisation in the global reconfiguration of international relations? Historiographically, we would like to engage with the literature that has focused on the politics of science popularisation, the literature which is reassessing scientific internationalism as a historically and ideologically situated practice and the renovated interest in science and diplomacy. While our main focus is the period 1946-1958, we are flexible in terms of chronology: case-studies exploring the continuities and ruptures with the League of Nations, as well as the 1960s are also welcome.

If you are interested in participating, please send a title and a 250 words abstract before February 20 to: Jaume.Sastre@uab.cat, andree.bergeron@cnrs.fr, and agusti.nieto@uab.cat.

Biographical Memoirs of the Royal Society

The Biographical Memoirs of the Royal Society are now free to access from the date of publication. These are an invaluable resource - detailed biographies of leading scientists written by people who know the science and the person.

There's a blog about the new access here (along with a video from the Editor-in-Chief, physicist and astronomer Malcolm Longair).

The Biographical Memoirs can be accessed here.

6th European Advanced Seminar in the Philosophy of the Life Sciences, September 7-11 2020, KLI, Klosterneuburg, Austria

Dealing with Complexity in the Life Sciences

Directors: Guido Caniglia (Konrad Lorenz Institute) & Marcel Weber (University of Geneva)

From Sep. 7 to Sep. 11, 2020 the Konrad Lorenz Institute (KLI) will host the 6th European Advanced School in the Philosophy of the Life Sciences.

Young scholars (PhD students and early postdoctoral researchers) in the history, philosophy and social studies of the biological, biomedical, and environmental sciences are invited to apply.

Dates of event: **September 7-11, 2020**
Deadline for Application: **February 28, 2020**

If you are interested in applying to the summer school, you can find the full Call for Application here.

International Conference on Science and Technology Education STE 2020, Porto, October 8-9, 2020

The conference will take place in Porto, Portugal, 8-9 October 2020 (www.fe.up.pt/ste2020). The conference venue is Sheraton Porto Hotel.

The conference is co-chaired by António Ferreira (University of Porto, Portugal) and Claudio Brito (COPEC, Brazil). The Science and Education Research Organization (COPEC) and the International Institute of Education (IIE) support this conference. The focus is on education in science and technology.

The conference welcomes abstracts/papers related to the following topics:

- science and technology epistemologies (what makes science and technology thinking and knowledge),
- science and technology learning mechanisms (how people develop knowledge and competencies),
- science and technology learning systems (institutional practices),
- science and technology diversity and inclusiveness (how society in general contributes to science and technology processes and products), and
- science and technology assessment (development and use of assessment methods, instruments, and metrics).

Scholars who wish to make a presentation (oral or poster) are requested to submit a short abstract (one single A4 page possibly with a diagram and references) in English, by 4 May 2020. The abstracts should be sent electronically to lucas@fe.up.pt. The abstract template can be downloaded from the conference web site (www.fe.up.pt/ste2020).

The Inclusion Group for Equity in Research in STEMM

TIGERS The Inclusion Group for Equity in Research in STEMM) is an inclusive network of students and professionals in Science, Technology, Engineering, Mathematics and Medicine (STEMM) fields who are united in their commitment to achieving equity and improving diversity, inclusion, and accessibility in STEMM research. Diverse teams are important in science not only because we envision a more equitable society, but also because they produce better outcomes (1, 2, ;3). People of different backgrounds bring different ideas and perspectives, pushing forward the progress of scientific knowledge, and helping to deliver more impactful outcomes to society.

The systems and precedents prevalent throughout many STEMM disciplines mean they remain predominantly occupied and led by white, middle class, straight, able-bodied, cis-gendered men. Despite many discussions about (and increasing budgets for) improving diversity in science, at current rates this situation will take decades or longer to change (4).

TIGERS originally came together with a focus on science funding, an area which has the potential to impart rapid progress in diversifying our STEMM communities. Funding is essential both to individuals' careers and to provide resources for research to be carried out; without funding a researcher simply cannot progress. In many cases UK funding bodies lag behind best-practices for diversifying the STEMM workforce. Additionally, the data which UK funding bodies and universities currently collect, analyse, and publish regarding the diversity of their applicants (both successful and unsuccessful) is at best patchy. This creates a further barrier to change; without this information, we cannot clearly identify barriers nor identify successful strategies to combat those.

When the House of Commons Science and Technology Committee requested proposals for their #MyScienceInquiry initiative, Professor Rachel Oliver gathered over 200 signatories for a request the committee to investigate the ways in which science funding policy affects, and can improve, diversity and inclusion. A key principle of this request was that only once we can identify the ways in which funding policies, procedures, and cultures may lead to marginalisation and exclusion of individuals from a wide range of backgrounds, can we implement solutions to these issues and create a level playing field for the future of UK STEMM. Professor Oliver successfully pitched this enquiry to the Science and Technology Committee in January 2019, and the committee has begun the process of evidence gathering through requesting specific data from UKRI (5). Since the #MyScienceInquiry submission a core group of the original signatories came together to form TIGERS in order to continue to build momentum in this, and related, areas.

TigerinSTEMM is about to celebrate its 'first birthday', and we have so much more to celebrate than just the #MyScienceInquiry proposal. TIGERS works to promote equity and inclusion in a variety of ways, as well as forming a community of support and advice for individuals interested in, and working towards, equality.

TIGERS advocacy efforts have taken shape through writing articles and letters as well as leading discussions on twitter to spread information and gather ideas. We also find that this group has allowed many of us to take steps in our own institutions, backed with the evidence and mutual support that this group has fostered.

How can you get involved?

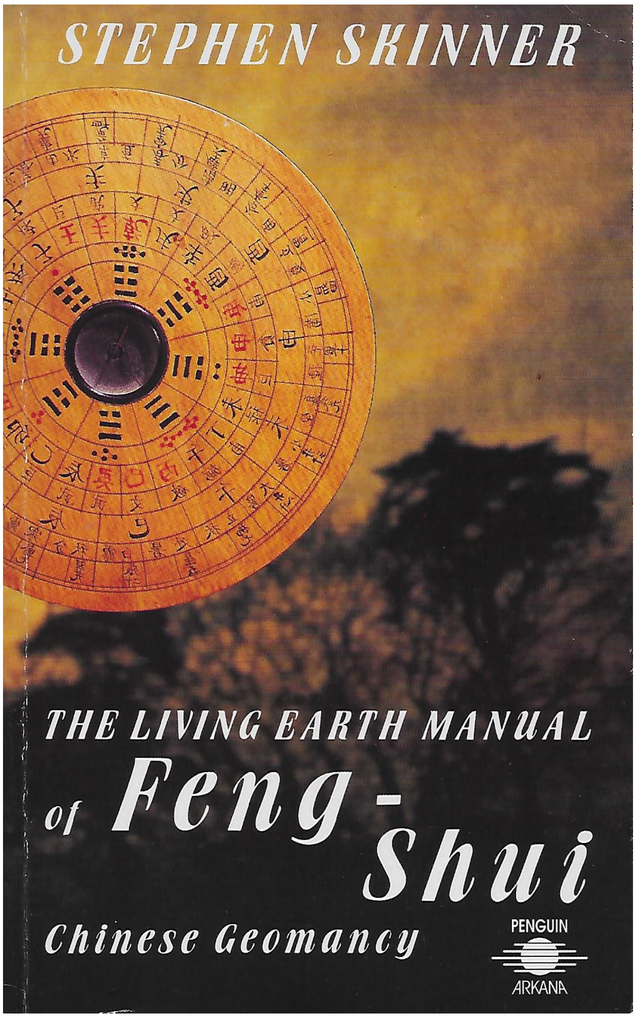
There are many ways to get involved with TIGERS. We tweet as @TigerInSTEMM and we find Twitter a rich forum to engage in broad discussions and share information and experiences. If you're interested in becoming part of the formal TIGERS group you can find all the relevant information at https://www.tigerinstemm.org/get-involved.

Although our focus is on STEMM, you don't need to be a STEMM researcher in order to get involved – we also need ideas or expertise in the ways that STEMM has historically excluded groups, as we'd be interested in learning more and seeing if this can be included through our evidence submission, future campaigns and broader activities. We also encourage everyone to 'be a tiger' in your own place of work and in your community. This work is challenging but if enough push for equity and inclusion wherever possible a significant change for the better can occur.

Hope Bretscher, University of Cambridge, hlmb2@cam.ac.uk
Candice Majewski, The University of Sheffield, c.majewski@sheffield.ac.uk

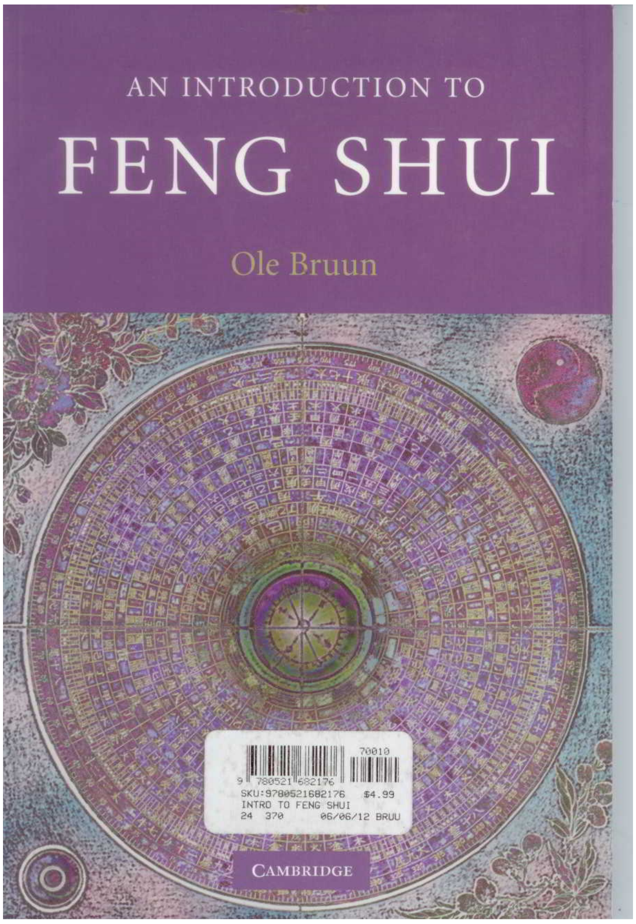
Feng Shui Project: Historical, Philosophical, Scientific, Medical, Cultural and Educational Considerations

Feng shui is an internationally significant and growing body of theoretical beliefs and associated architectural, health, medicinal, astrological, divination and geomantic practices. Its origins are in ancient China, but it now has a worldwide presence. Feng shui constitutes a thoroughly naturalistic worldview in which humans, nature, our planet, and the cosmos are unified. They each share a purported 'vital energy' or 'life force' *chi* or *qi* – and the well-being of each depends upon appropriate distribution of this energy or entity. Acupuncture releases blockages in bodily chi flow that causes illness and pains; tai chi exercise stimulates beneficial chi flow through the body, it is acupuncture without the needles; chi is the ontological foundation of all Traditional Chinese Medicine (TCM) including herbal and animal-part remedies.



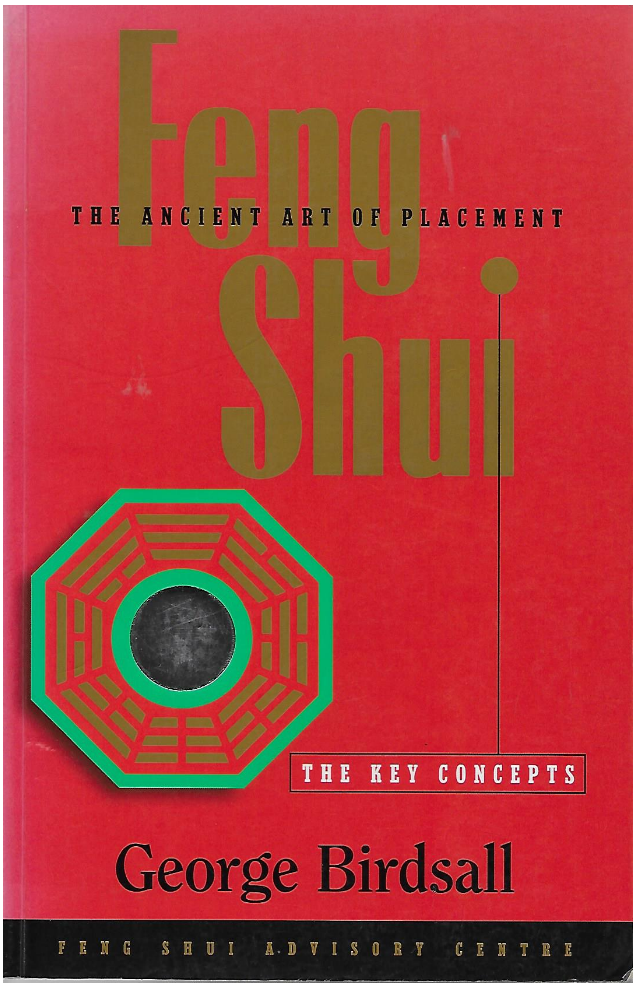
Feng shui has obvious cultural and educational ramifications, yet very little systematic attention has been paid to the educational responsibilities and opportunities feng shui provides for classroom examination by science teachers, or as a case study for historians and philosophers of science.

Philosophical and educational discussion of feng shui has some features in common with more common debate about astrology, about complementary or holistic medicine, arguments about treatment of special creation and evolution, and about social-psychological research on why people believe 'unusual', 'minimally-evidenced', or 'science-rejected' contentions.



More generally in feng shui discussion there is overlap with arguments about teaching the Nature of Science (NOS), the place of multi-cultural and indigenous science in school programmes, and with proposals for international STEM education. Is feng shui theory scientific? If feng shui is embedded in a culture should it be taught or at least not criticised? Does STEM education have any responsibility for addressing pseudoscientific belief and is feng shui in the latter category? Ideally, the general philosophical arguments and the localised ones concerning feng shui should inform each other. But this is not much done.

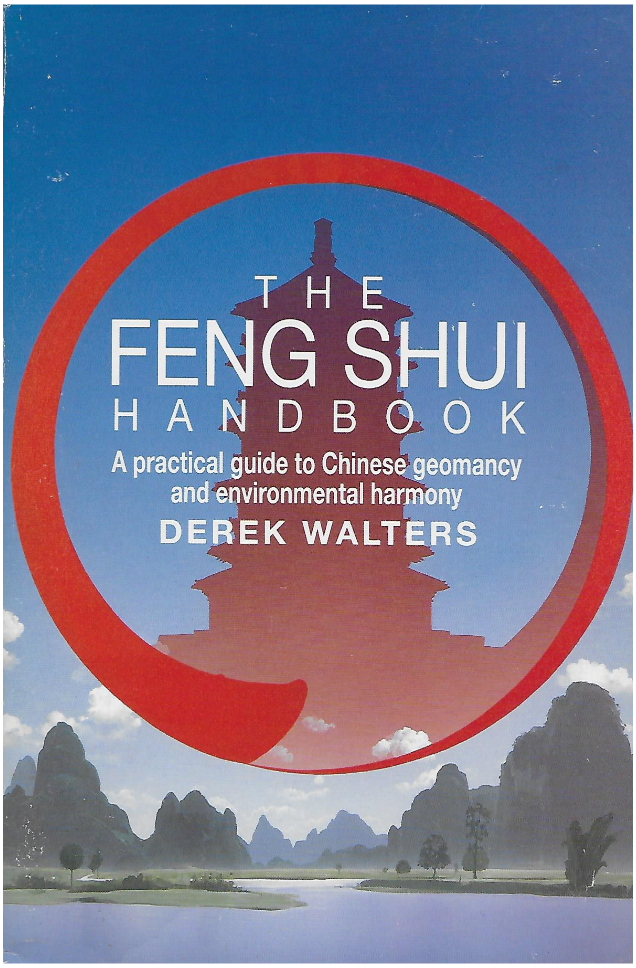
This feng shui project is a contribution to the larger endeavour of demonstrating how the history and philosophy of science can illuminate theoretical, curricular and pedagogical issues in science teaching. The beginning of this HPS&ST endeavour is associated with Ernst Mach in the late 19th century, it was furthered by John Dewey in the early 20th century, and subsequently advanced by countless others including Frederick Westaway, Joseph Schwab, and Gerald Holton.



To address the shortfalls in educational discussion of feng shui a collection of research papers is being overseen and edited. Currently 15 authors from

China, Hong Kong, USA, Korea, UK and Australia are contributing. Their backgrounds are education, philosophy, economics, anthropology, geology, physics and Chinese studies. The participation of other scholars is most welcome. The project has a web folder containing information and files HERE.

A brochure for the editor's recent book on the subject, giving its 14-chapter contents and some appraisals, can be read HERE. An overview of the book's argument can be read HERE. A 110-item select bibliography of writings on the subject is available HERE. A more comprehensive 840-item bibliography is available HERE.



A general invitation for educators, philosophers, anthropologists and historians to contribute to the project can be read HERE.

Project papers of 5-10,000 words need to be completed by the end of 2020, with reviews and revisions completed by mid-2011.

Indication of interest and possible participation should be sent to the editor (m.matthews@unsw.edu.au) by the end of this month (February 29). Further details can then be conveyed.

Opinion: *Is Reproducibility a Crisis for Science?*

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Many of us who follow developments in science have been alarmed to read in scientific journals and major national news media that science is suffering a "reproducibility crisis." Reproducibility, or replicability, is the property that allows scientific findings to be repeated. Reproducibility is a core value of science and the apparent widespread failure of prominent findings to be reproduced is seen as a serious threat to the integrity of the whole enterprise. The big fear is that irreproducible science is bad science. How can we accept the claims of climate scientists and vaccine developers if their science rests on shaky ground? It's a fair question, however reproducibility is a surprisingly subtle and complex topic, and judging the seriousness of the problem requires a good grasp of the details. In this essay, I'll examine reproducibility in its various forms, its significance, and its place in scientific thinking and reasoning. And I'll argue that, while true scientific claims will be reproducible, the pursuit of reproducibility *per se* is not always the best guide for conducting research. I'll consider challenges that bench scientists must grapple with when confronted with irreproducible results in their fields. The impact of either reproducibility or irreproducibility is often less than what we've been led to believe. Clarifying some practical issues should help lessen the anxiety about reproducibility and bolster our willingness to trust in science.

What is "reproducibility"?

To begin at the beginning: what do we mean by the "reproducibility" of scientific findings? I follow the American Society for Cell Biology in distinguishing four distinct senses in which the word is used, which I'll illustrate with a made-up example. Suppose you've done a study on how Drug X affects the ability of rats to learn to navigate a maze. Following best scientific practice, after the experiments you make your raw data, say the number of trials taken by each rat to master the maze, available on an accessible website. If I re-examine your data, subjecting it to the same or different statistical analyses, replotting it, etc. I am carrying out a test of *analytic* reproducibility. I don't do any new experiments, I am simply checking to see whether the conclusions that you've drawn from your data are accurate and valid.

Now suppose that I set out to repeat your exact experiment faithfully. I acquire rats, mazes, measuring instruments that are as like yours as possible and I redo your experimental procedures. This would be a test of *direct* reproducibility; it seeks to know whether your actual findings can be replicated. This is probably what most people think of when they hear about reproducibility.

Two other experimental approaches that are sometimes used in "reproducibility" studies differ markedly from analytic and direct reproducibility but are lumped together with them. This considerably muddies the waters surrounding the problem.

Imagine that I adopt most of your experimental conditions except one or two. Perhaps instead of rats, I elect to study mice because I hope eventually to take advantage of the greater opportunities for genetic analyses of behavioural phenomena that the mice afford. If the mouse results do not replicate the rat results, is this a failure of reproducibility? Obviously not: mice are not rats and differ from them in many ways. (Rats get up in the morning, grab their lunch pails, and get to work learning mazes. Mice are more free-spirited, less focused. After a bit of earnest maze-learning, they may suddenly go back and retrace a previously unrewarded path just because they're mice.) Maybe the drug simply affects mice differently than it does rats. Although there are myriad possible rational explanations for the divergent behavioural outcomes, follow-up studies in which original conditions are deliberately varied have been rated as failures of *systematic* reproducibility.

Finally, suppose that you've interpreted your results as meaning that the drug adversely affected the rats' ability to learn mazes because it caused them physiological stress. That's your hypothesis, and it would predict, for example, that the drug will alter the rats' stress hormone levels. If my follow-up study finds that rat blood levels of the appropriate hormones are unchanged, some writers would classify this as a failure of the *conceptual* reproducibility of your results. Your hypothesis was evidently false, and that's why I didn't get the results it predicted. Indeed, I might even have reproduced your empirical findings, while showing that your idea flunked the conceptual test.

Of the four supposed classes of "reproducibility," only the first two, *analytic* and *direct*, involve actual attempts to replicate prior observations. The latter two, *systematic* and *conceptual* reproducibility, plainly do not and should not be weighed in the reproducibility debate at all, if the goal is to assess the reliability of scientific findings. On the contrary, systematic and conceptual studies are explorations of inferences that are derived from original results; in fact, they expand knowledge. Ordinarily, they are tests of hypotheses that were explicitly or implicitly suggested by the earlier studies. Varying conditions or deducing and testing predictions is how scientists decide on the merits of their hypotheses. Hence, a failure of systematic or conceptual reproducibility is no cause for alarm; it is an illustration of the scientific method in action. When debating the reality of a "reproducibility crisis" we must be clear on what sort of experiments we're talking about and to zero in on only those that check for analytical or direct reproducibility. In the remainder of this essay, "reproducibility" refers to these two.

Unrecognised variability in experimental materials is a common cause of irreproducible results. Culprits include impurities or unwarranted differences in nominally the same chemical reagents, animal strains, in vitro "cell lines," antibodies, and so forth. It is no wonder if original results obtained from experiments done on, e.g., isolated brain cells are not duplicated in a would-be follow-up study carried out on mislabeled skin cancer cells. While deplorable, errors of this kind are essentially quality-control problems: fixable with proper attention to detail, analysis, screening, and improvement in the production processes. We must be aware of them and can work to eliminate them without losing confidence in science as a whole and I won't consider them here. Likewise, I will not deal with scientific misconduct, cognitive biases, or issues related to the distorted reward system of science. These are thorny psychological and policy issues that deserve their own coverage and are outside the scope of this essay.

What defines "reproducibility" and how much irreproducibility must we tolerate?

What does it mean to fail to reproduce a study? Perfection is not an option in science; there is no reasonable chance that a second study will obtain the exact numerical results, say the identical mean and standard deviation, of a group of measurements, as did the first study. The rich variability of the world, which encompasses investigators and measuring instruments as well as things measured, precludes exact reproducibility. To sidestep the problem, scientists decide that if two results are "close enough" then for all intents and purposes they are the same. And they use statistics to define "close enough;" in the current context, whether a second study has reproduced the first.

The main point here is that reproducibility is a statistically determined property, not something carved in stone. It follows as a corollary of the probabilistic framework that 100% reproducibility – every attempt succeeds – is unachievable. So how much irreproducibility is unavoidable; how much must we tolerate?

There are several ways of estimating the degree of reproducibility that we should expect. As an illustration, we'll review one that uses traditional concepts of *p-values* and *statistical significance*. To oversimplify greatly, scientists usually calculate the probability that a given experimental result would have arisen by chance alone given a few generally plausible assumptions about how random variability enters the picture. They use statistics to determine if the odds of the result's happening by chance. If the odds are small, they reject that idea and tentatively attribute the result to their experimental treatment. Similarly, since no two experimental groups will be absolutely identical, at some level of measurement precision they'll differ. Hence, scientists look for a difference that is *big enough* to persuade themselves and others that the apparent treatment effect is real. If the performance of the drug-treated rats is different enough, *significantly different*, from that of the untreated rats, experimenters conclude that the drug probably did something. How rare a chance event has to be before they make this leap is a matter of convention and judgement; it varies across scientific fields. Biologists are usually willing to consider a significant event as one that would occur by chance on only 1/20 of the trials or less (the probability, p-value, is ≤ 0.05); particle physicists are much more conservative, holding out for a probability of 1/3,500,000 ($p \leq 0.0000003$), before they'll acknowledge the discovery of a new physical entity (a standard the Higgs Boson famously met in 2012). The p-value is also called the significance level. No matter what its specific value, however, the p-value is merely an estimate of the probability that they're making a mistake in thinking they've discovered a real effect.

With $p \leq 0.05$ as a standard, even with correct methods and optimal conditions, there would be a 5% chance of wrongly concluding, e.g., that the drug affected the rats' maze-learning ability, and therefore these results are unlikely to be reproducible. The odds that another group would be victimised by the same bad luck is 1/20 x 1/20 = 1/400. In other words, given 100 studies that report results significant at $p \leq 0.05$, 5 should be irreproducible because they're false. This doesn't mean that the remaining 95 experiments will all be reproducible, however. That would be true only if the follow-up study were able detect all of the true results and it can't. Variability rears its head again. A statistical test has only a probability of identifying a true result when it occurs. Without going into details, the concept of *statistical power* rates the ability of a given experimental test design to detect genuine effects. Power varies from 0 to 1.0, where 0 means the test is wholly ineffective in finding true effects and 1.0 means the test is infallible; in practice a power level of 0.8 is considered to be very good.

Back to reproducibility. Less-than-perfect power implies that we must fail to reproduce a fraction of the true results and will incorrectly conclude that they are irreproducible. As applied to our remaining population of 95 true results (out of 100 and a p-value of 0.05), a follow-up study with a power of 0.8, could expect to reproduce only 76 (0.8 95) of them.

In sum, we anticipate being unable to reproduce 5 results because they are false and 19 (95-76) others because, although they're true, our tests are insufficiently powerful to reproduce them. Thus, statistical considerations alone suggest that, on average, we'll judge 24 of 100 studies to be irreproducible. And that number goes up as the power of our tests decreases. The anticipated irreproducibility of nearly one-quarter of published results has nothing to do with poor scientific practice, materials, or misconduct: it is baked into the math.

We reach a similar conclusion if, instead of p-values, significance levels, and statistical power, we use *effect sizes* and *confidence intervals*. The Reproducibility Project: Psychology (RPP) was an ambitious, meticulously planned, and diligently carried out effort to reproduce findings reported in 100 psychology papers. The RPP, often cited as hard evidence of a reproducibility crisis, employed several methods of assessing reproducibility and concluded that only approximately 40% of its attempts were successful. On the other hand, using a calculation based on effect sizes and confidence intervals, the RPP derived an expected reproducibility rate of 78.5%, implying that something closer to 50% of their attempts reproduced published findings.

Of course, the RPP was a scientific study, and as such, is itself the proper subject of scrutiny and criticism – metascience is still science! – and a debate about "crisis," "problem," or "nothing to worry about," continues. Nevertheless, it is generally agreed that there is a sizeable probability that a follow-up study will not succeed owing to factors inherent to science and statistics. Naturally, we can and should work hard to decrease the degree of irreproducibility that can be affected by improved practice. Still, a non-negligible, built-in failure rate has implications for understanding the reproducibility problem, as we'll see after looking into a few related factors.

Unforeseen impediments to reproducibility

Up to now, I've been assuming that optimal scientific procedures can be followed which include controlling for relevant variables among conditions. In reality, it is impossible to control for all influential variables, partly because many of them are unknown. Two recent examples from the literature make this point. In one, observant workers in one animal research laboratory noticed that when female investigators did the experiment their results regularly differed from those obtained by male investigators who did the same experiment. Working through possible hypotheses to account for the differences (e.g., they found that having the individual investigators wear new t-shirts overnight and placing the shirts near the animals' cages caused the same divergence of results as the people themselves did), the lab eventually identified a male hormone that was triggering stress responses in the animals. If a group of female investigators had published their results, it is likely that a group of male investigators, or even a mixed male-female group, would not be able to reproduce them. (Must we now list the gender of the experimenter in the Methods sections of our papers?)

In a second example, two groups of investigators, one in Massachusetts and one in California, had a long-distance collaboration to study gene-expression in single cells from human breast cancer tissue. Frustratingly, the groups couldn't get the same baseline gene profiles although they were starting with the same tumour samples. After a year-long effort, they discovered that a seemingly trivial technical difference was responsible. Needing to free individual cells from tumour sections floating in saline solution, one group used a device that gently rocked the solution containing the sections back-and-forth, while the other used a device that swirled them in circles in a beaker. Nobody knows why the methods caused such different outcomes.

In both cases minor, easily overlooked variables had effects that could cause a lab's results to be irreproducible. Reacting to these stories, a colleague of mine remarked that such cases were "one in a million;" i.e. so rare that they could safely be ignored. Perhaps. However, we know about these two examples solely because the groups involved went out of their way to track down peculiar anomalies. In fact, nobody actually knows how common such occurrences are. Absent that information, the mere suspicion that they can happen will be enough to dilute scientists' enthusiasm for undertaking thorough reproducibility studies. Other factors may do the same.

Should I do a reproducibility study?

Reproducibility is a virtue of science, whereas irreproducibility is a problem for science and a major headache for individual scientists. Consider, what is the immediate, tangible value of a positive experimental replication? There are a few things we can say: When a follow-up study successfully reproduces a published result, it is undeniably reassuring and suggests that we may be on the right track. A true result must ultimately be reproducible. Of course, the converse – that a reproducible result must be true – is the fallacy of *affirming the consequent*. Karl Popper defines scientific *objectivity* as a form of intersubjective agreement; an observation that can, in principle, be made by anyone is an objective one. For him, unrepeatable observations cannot be tested by anyone, and therefore, are not objective. On the other hand, a reproduced result is not necessarily truer than it had been before it was reproduced; induction is as inconclusive as ever. Reproducibility helps to corroborate, though not to confirm, a hypothesis. A corroborated hypothesis can serve as the basis for practical action, even though further testing might show it was wrong after all.

And there are many instances of empirical results that, although repeatedly reproduced, eventually turned out to be untrue. Newton's law of gravity is a textbook example of a theory that was tested and corroborated for hundreds of years, and yet, in the words of Nobel Prize winning physicist, Richard Feynman, is "just wrong." A wonderful and useful approximation at ordinary terrestrial scales; wrong at extremely large or small scales and at near-light speeds. Reproducibility alone is evidently not mandatory for progress. The real difficulty comes when a reproducibility trial fails; when a follow-up study does not reproduce the original. What conclusion does that lead to? Either the first or the second study could be wrong and the other right, both could be wrong or both right (with an unknown variable accounting for the differences). Apparently, the only things that are certain in this situation is that nature is more complicated than we had thought it was and that we need more data to sort things out. It is always good to be reminded of the vast intricacy of nature, but this is probably not the deep insight that is often assumed to follow from reproducibility studies. At first, an irreproducible result is just another problem to be solved. What's the next step? Try again? How many times is enough?

While reproducibility critiques tend to imply that every study should be reproduced, this cannot be done. Approximately 2.5 million science papers are published each year. Even if 90% were not high-quality original research reports, thoroughly reproducing approximately 0.25 million papers is hardly feasible either. Most papers re-late the details of more than one experimental manipulation or test – in neuroscience, a reasonable estimate would be 3 – 10 experiments per paper – and the paper's overall conclusion is derived by aggregating the results of all of them. Recognising the enormous difficulties presented by multi-experiment papers, the authors of the aforementioned RPP selected just one result from each paper for their replication attempts. Despite seeming sensible, this strategy is problematic. How should investigators decide which component experiment to replicate? The RPP authors chose the last one while admitting that it might not be representative. More generally and significantly, does the irreproducibility of one experiment necessarily invalidate the conclusion of an entire report? It is also worth reiterating that the reproducibility decision ultimately rests on a conventional statistical benchmark for acceptance; any single result might be false at some level of probability. Yet, in the end, the truth (or falsity) of the unified conclusion of the whole study is more crucial for science than any single result. Thus far, reproducibility critiques do not seem to have taken up this issue.

While the preceding considerations do not entirely undermine the value of reproducibility, they do illustrate the many hazards in the way of achieving it. Mindful of this practical complexity, the individual laboratory supervisor faces a serious conundrum, namely, whether to attempt a replication study at all. Everyone who runs a lab must balance the uneven, and occasionally abstract, rewards of doing a reproducibility study against its all-too concrete up-front costs which, given typically limited funds, time, and personnel, may be significant. How much to invest when faced with a non-trivial chance that there might be a rational, though not very exciting, reason – e.g., species differences in biology – for any discrepancy that arises?

And, finally, let's not forget the calculations outlined earlier that suggest that 25-50% of otherwise impeccably carried out experiments (at the $p < 0.05$ level) may fail for purely statistical reasons.

I suspect that these sorts of considerations, even if not explicit, help account for the reluctance of many scientists to take on thorough-going reproducibility studies. But then, say the reproducibility advocates, how can science progress? If findings are not reproduced, then what is the foundation of our trust in science?

If not reproducibility, what?

In spite of its value to science writ large, rigorously vetting someone else's results for reproducibility offers dubious benefits to those conducting science on a day-to-day basis. The reality of countless potential alternative explanations for an irreproducible result, constraints imposed by limited resources, and variable rewards attaching to reproducibility studies all militate against it. And reproducibility is not required for making progress. Science seeks Truth, for clear and complete explanations of nature. (In an Opinion piece in the August 2019 Issue of the HPS&ST NEWSLETTER, David Kennefick recounts the disappointing history of attempts to reproduce Eddington's measurement of the gravitational bending of light predicted by Einstein. The field moved on.)

Our confidence in a theory is often markedly increased by new observations that are consistent with it even prior to their replication. The recent detection of gravity waves and the photograph of a black hole, were welcomed as impressive corroborations of Einstein's theory even before they were reproduced.

Direct reproducibility *per se* is not the gold standard because science advances in the end by proposing, testing, rejecting, or refining, hypotheses. Stronger hypotheses force out weaker ones; the winnowing-out process can take a long time, and direct reproducibility plays a supporting role in it, but not the lead. A well-known example from neuroscience took place throughout the 1980s and was called, hyperbolically, "The LTP Wars." In this intellectual conflict, two opposing schools of thought clashed in their explanations of the cellular basis of learning in the mammalian brain. Cellular communication takes place via the diffusion of minute amounts of a chemical neurotransmitter across tiny junctions between neurons called synapses. Learning was believed to involve the physiological "strengthening" of synapses.. The LTP Wars were fought to determine whether the strengthening process took place at the signal-sending (pre-synaptic) side or the signal-receiving (post-synaptic) side of the synapse. The opposing hypotheses – pre- or post-synaptic – made entirely different predictions about what molecular changes formed the basis of learning. The Wars were contested by proposing and testing novel predictions of the two hypothesis. Staccato progress was made when one hypothesis accounted for observations that the other could not explain. After roughly a decade of contention, a kind of community consensus emerged that, at the synapses being studied, that the post-synaptic side won. Extensive, direct reproducibility studies never played a decisive role.

Thus, for many basic researchers, carrying out thorough reproducibility studies is normally on a back burner. When does reproducibility move to the front; when is it mandatory? There is no single set of circumstances, however, we should expect rigorously reproducible results in certain situations, especially those in which high costs – ethical, financial, societal – are involved. Examples include deciding to administer a therapeutic treatment to humans or incurring major costs in pursuit of a technology affecting wide swaths of society. In other words, reproducibility is of greatest significance to applied science problems where definitive, all-or-none, actions must be taken; where the option to postpone a decision by seeking further, independent evidence does not exist, as it does in much of basic science.

Why do we trust in science?

Science needs to be assured of the explanatory soundness of a hypothesis: of its ability to account for an array of conditions related to the phenomena in question, of its generality to other similar conditions, of its ability to predict future phenomena, and of the precision and specificity of its explanations. In short, the kinds of information provided by experiments that have been misleadingly subsumed under the umbrellas of *systematic* and *conceptual* reproducibility, but which, as I've argued, are actually tests of hypotheses. This point is so often overlooked by the critics that it deserves emphasis: anxiety over a "reproducibility crisis," depends in part on a failure to recognise that testing and rejecting false hypotheses does not indicate a flaw in science. It is the very essence of the scientific method; it is a feature, not a bug. We trust in science to provide us the best understanding of the world given the limitations of our current knowledge because we are willing to jettison a worse explanation when a better one comes along. This is not to say that the decision to get rid of a worse, falsified, hypothesis is a simple one.

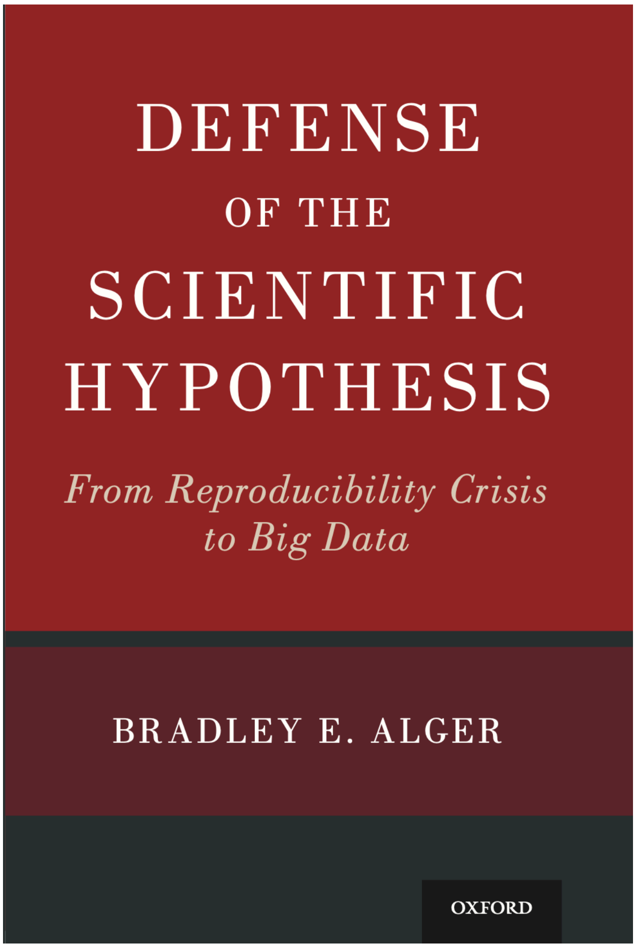
It is neither surprising nor irrational that scientists do not drop a well-corroborated hypothesis at the first sign of trouble. If we accept the dictum that no scientific fact can be established to be 100% true, we'd be foolish to do so. Science did not abandon Newton's theory of gravity because it could not obviously account for irregularities in the solar orbit of Uranus. Instead, the astronomer Urbain Le Verrier assumed Newton was right and correctly predicted that an unknown planet (which turned out to be Neptune) explained Uranus's orbit. As Popper cautioned, apparent falsification cannot be entirely certain either.

Be careful what you wish for: when insisting on reproducibility can be a problem. The concept that scientific confidence does not rest solely on reproducible results helps resolve another conundrum: how to evaluate investigations of events that cannot be reproduced? Geologists and geophysicists have done brilliant work in figuring out the phenomena that triggered the extinctions of the dinosaurs 66 or so million years ago. The leading contender, the hypothesis that an asteroid struck the earth near Chicxulub, Mexico, made predictions that have been tested and confirmed. Although dinosaur-extinction was a one-time-only event that precluded reproducibility testing in ideal detail, our present confidence in the hypothesis is high.

Indeed, an inflexible demand for reproducibility may backfire on those who support science. In 2015 Congress passed the Secret Science Reform Act that required federal agencies, including the Environmental Protection Agency (EPA), to base their decisions on the highest scientific standards; reproducibility, and its cousin "transparency," led the list of criteria of the best science. Despite its commendable emphasis on scientific evidence, some in Congress opposed bill because they feared it could be used to restrict the agencies' efforts. They were afraid that good science derived from fundamentally irreproducible studies would be excluded. For example, the catastrophic Deep Water Horizon oil spill in the Gulf of Mexico was a singular event that yielded a trove of invaluable scientific information. Would such studies of environmental damage be off-limits? Would the EPA be forbidden to rely on decades-long studies of tobacco smokers unless the studies were fully reproduced? However unrealistic you might think these concerns are, they proved to be prophetic. In 2019, the EPA rolled back a number of critical environmental regulations, justifying its decisions by pointing, e.g., to the failure of long-term health studies to meet rigid reproducibility and transparency requirements (1).

Conclusions

Reproducibility is a multifaceted and intricate issue, an undisputed scientific virtue, but ultimately, not the most important one. Reproducibility is hard to define and, frequently, harder to achieve. In its search for true explanations for natural phenomena, science uses many standards and subgoals besides reproducibility; explanatory completeness – the ability of a hypothesis to account for a variety of observations, including non-obvious predictions, more effectively than other hypotheses; consistency with existing well-established theories; success in making predictions about future events, and quantitative precision, to name a few. While reproducibility strengthens conclusions driven by these intellectual concerns, it does not guarantee scientific validity, nor does its absence prevent progress. A better appreciation of reproducibility will foster a more realistic view of science and, in addition, will help us avoid mistakes that can come from overestimating its influence.



The above essay is primarily derived from Chapter 7 of:

Alger, Bradley, *Defense of the Scientific Hypothesis: From Reproducibility Crisis to Big Data*, Oxford University Press, Oxford. See also https//www.scientifichypothesis.org.

NOTE: It is anticipated that a subsequent Opinion Piece will address the question of how issues raised in this essay bear upon comparable concerns in education research.

Invitation to Submit Opinion Piece

In order to make better educational use of the wide geographical and disciplinary reach of this HPS&ST NEWSLETTER, invitations are extended for readers to contribute opinion or position pieces or suggestions about any aspect of the past, present or future of HPS&ST studies.

Contributions can be sent direct to Michael Matthews or Nathan Oseroff-Spicer.

Ideally, they might be pieces that are already on the web, in which case a few paragraphs introduction, with link to web site can be sent, or else the pieces will be put on the web with a link given in the NEWSLETTER.

They will be archived in the OPINION folder at the HPS&ST web site: `http://www.hpsst.com/`.

Previous HPS&ST NEWSLETTER Opinion Pieces

Tom McLeish, Physics, University of York, Science + Religion, (January 2020)

Michael Corballis, Elizabeth Rata and Robert Nola, University of Auckland, The Defence of Science and the Status of Māori Knowledge, (November 2019)

Maurice Finocchiaro, Philosophy, University of Nevada, Las Vegas, Galileo's Legacy: Avoiding the Myths and Muddles (October 2019)

Michael R. Matthews, Education, University of New South Wales, Feng Shui: Philosophical Appraisal and Educational Opportunity (September 2019)

Daniel J. Kennefick, Physics Department, University of Arkansas, The Problem of Scientific Bias: The 1919 Astronomical Confirmation of Einstein's Theory, (August 2019)

Nicholas Maxwell, Philosophy, University College, London, The Metaphysics of Science and Aim-Oriented Empiricism (May 2019)

Ron Good, Louisiana State University, The Two Darwins: Erasmus and Charles on Evolution, (June 2019)

Lucie Laplane, Paolo Mantovani, Ralph Adolphs, Hasok Chang, Alberto Mantovani, Margaret McFall-Ngai, Carlo Rovelli, Elliott Sober, and Thomas Pradeu: Why Science Needs Philosophy (April 2019)

Thomas J.J. McCloughlin, School of STEM Education, Innovation & Global Studies, Dublin City University, Ireland, Beware the Greeks: Sources for the History of Gravity in Science Teaching (March 2019)

Bettina Bussmann, University of Salzburg, Austria & Mario Kötter, University of Muenster, Germany Between Scientism and Relativism: Epistemic Competence as an Important Aim in Science and Philosophy Education (February 2019)

Robin Attfield, Philosophy Department, Cardiff University, Climate Change and Philosophy (January 2019)

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Frederick Grinnell, Biology Department, University of Texas, Teaching research integrity – Using history and philosophy of science to introduce ideas about the ambiguity of research practice (November 2018)

New York Times, Creeping Bias in Research: Negative Results Are Glossed Over (October 2018)

Michael Matthews, School of Education, UNSW, An Occasion to Celebrate: Mario Bunge's 99th Birthday (September 2018)

Cormac Ó Raifeartaigh, Waterford Institute of Technology, Ireland, History of Science in Schools (July 2018)

Hugh Lacey, Philosophy Department, Swarthmore College, Appropriate Roles for Ethics and Social Values in Scientific Activity (June 2018)

Gerald Holton, Physics Department, Harvard University, Tracing Tom Kuhn's Evolution: A Personal Perspective (April/May 2018)

Monica H. Green, History Department, Arizona State University, On Learning How to Teach the Black Death (March 2018).

Stephen Pinker, Psychology Department, Harvard University, The Intellectual War on Science (February 2018).

Michael Ruse, Philosophy Department, Florida State University, Does Life Have Meaning? Or is it Self-Deception at Best and Terrifyingly Absurd at Worst? (January 2018).

Mario Bunge, Philosophy Department, McGill University, In Defence of Scientism (December 2017).

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Nicholas Maxwell, University College London, What's Wrong with HPS and What Needs be Done to Put it Right? (June 2017).

Heinz W. Drodste, An Interview with Mario Bunge (May 2017).

Nicholas Maxwell, University College London, The Crisis of Our Times and What to do About It (April 2017).

Eric Scerri, UCLA, Bringing Science Down to Earth (March 2017).

Robert Nola, University of Auckland, Fake News in the Post-Truth World, (February 2017).

Michael D. Higgins, President of Ireland, The Need to Teach Philosophy in Schools (December 2016).

Philip A. Sullivan, University of Toronto, What is wrong with Mathematics Teaching in Ontario? (July 2016).

Gregory Radick, Leeds University, How Mendel's legacy holds back the teaching of science (June 2016).

Matthew Stanley, New York University, Why Should Physicists Study History?

From *Aeon*: The "Politics of Logic" by Alexander Klein

Alexander Klein seeks to clarify Bertrand Russell's meaning of his scientific philosophy as applied to anti-nationalism or cosmopolitanism. He says Russell did not intend logic to become the language of literature and poetry, but did intend his scientific methods to "destroy a conception of philosophy as an articulation of a national mind." The international languages of logic and science can be used to minimise disputes and increase kindness among individuals and nations.

The essay is available here.

Alexander Klein is an associate professor of philosophy and director of the Bertrand Russell Research Centre at McMaster University in Ontario. His first book, *Consciousness Is Motor: Warp and Weft in William James*, is forthcoming.

Aeon (https://aeon.co/) is a charity committed to the spread of knowledge and a cosmopolitan worldview. It publishes a daily, free, open-access newsletter with articles from scholars, writers and journalists across the broadest spectrum of disciplines and backgrounds. Their essays often connect with debates and discussion that the HPS&ST community has had or should have. Other Aeon essays will be linked in subsequent newsletters.

PhD Theses in HPS&ST Domain

The HPS&ST NEWSLETTER is the ideal medium for publicising and making known submitted and awarded doctoral theses in the HPS&ST domain.

The following details should be submitted to the editor at m.matthews@unsw.edu.au:

- Candidate's name and email
- Institution
- Supervisor
- Thesis title
- Abstract of 100-300 words
- Web link when theses are required to be submitted for open search on web.

Assistant Editor Required

The monthly HPS&ST NEWSLETTER has been produced and distributed for the past 25+ years. It has served as a vehicle for keeping the wide and ever-growing international community of HPS scholars who have education interests and the equally wide community of science educators who have philosophical and historical interests in contact with each other and with research and activities in the HPS&ST field. Both communities recognise that the history and philosophy of science bears upon and illuminates myriad theoretical, curricular and pedagogical issues in science teaching.

Michael Matthews, School of Education, UNSW (m.matthews@unsw.edu.au) has edited the newsletter since its inception. For the past number of years there have been two assistant editors: Paulo Maurício (Education, Lisbon) with responsibility of the web site and for providing each month the invaluable 'Recent Articles' and 'Recent Books' listings; and Nathan Oseroff-Spicer (Philosophy, London) with responsibility for newsletter design, formatting, and the important task of sourcing suitable Opinion Page essays that are an appreciated resource for the diverse readership.

A third assistant editor is needed for enhancing the content and reach of the newsletter, and most importantly for identifying and editing Opinion Page essays. Applicants should have familiarity and interest in current HPS and/or science education research, and a keen interest in furthering the broad educational purposes of the NEWSLETTER. Please contact the editor for more details.

Recent HPS&ST Research Articles

Mètode Science Studies Journal (Issue 10, 2020) Topics: 'The Challenges of Science', 'Science and Nazism. The Unconfessed Collaboration of Scientists with National Socialism', 'The Memory of Bones. Science at the Service of History' and 'Endless Forms. Evolutionary Scenarios to Unravel Biodiversity' Available here.

Aditomo, A. & Klieme, E. (2020) Forms of inquiry-based science instruction and their relations with learning outcomes: evidence from high and low-performing education systems. *International Journal of Science Education*. doi:10.1080/09500693.2020.1716093 online first.

Charalampous,C. (2020) 'One common matter' in Descartes' physics: the Cartesian concepts of matter quantities, weight and gravity. *Annals of Science*. doi:10.1080/00033790.2019.1709899 online first.

Dias, J.R. (2020) Teaching of chemistry before and after the periodic table. *Foundations of Chemistry*,1-8. *10.1007/s10698-020-09354-8* online first

Guttinger, S. (2020) The limits of replicability. *European Journal for Philosophy of Science*. doi:10.1007/s13194-019-0269-1 online first

Müürsepp, P., Nurysheva, G., Ramazanova, A. *et al.* (2020). Chemistry as the basic science. Foundations of Chemistry, 1-15. doi:10.1007/s10698-020-09357-5 online first.

Navarro, P. L. & Machado, C. A. (2020). An Origin of Citations: Darwin's Collaborators

and Their Contributions to the Origin of Species. *Journal of the History of Biology*, 1-35. doi:10.1007/s10739-020-09592-8 online first.

Dessain, H-F. (2020). Resisting mechanisation? Reading Shortshanks' 'The March of Intellect' (c. 1828) through the lenses of Daniel and Edward Irving. *RRR: Romance, Revolution and Reform*, 2, 36-53.

Dresow, M. (2020) History and philosophy of science after the practice-turn: From inherent tension to local integration. *Studies in History and Philosophy of Science Part A*. doi:10.1016/j.shpsa.2020.01.001 online first.

Emran, A., Spektor-levy, O., Paz Tal, O. et al. (2020). Understanding Students' Perceptions of the Nature of Science in the Context of Their Gender and Their Parents' Occupation. *Science & Education*,1-25. *10.1007/s11191-020-00103-z* online first. George-Williams, S.R, Ziebell, A.L, Thompson, C.D. & Overton, T.L. (2020) Inquiry-, problem-, context- and industry- based laboratories: an investigation into the impact of large-scale, longitudinal redevelopment on student perceptions of teaching laboratories. *International Journal of Science Education*. doi:10.1080/09500693.2020.1714788 online first.

Isik-Ercan, Z. (2020) 'You have 25 kids playing around!': learning to implement inquiry-based science learning in an urban second-grade classroom. *International Journal of Science Education*. doi:10.1080/09500693.2019.1710874 online first

Mesci, G., Schwartz, R.S. & Pleasants, B.AS. (2020) Enabling Factors of Preservice Science Teachers' Pedagogical Content Knowledge for Nature of Science and Nature of Scientific Inquiry. *Science & Education*, 1-35. doi:10.1007/s11191-019-00090-w online first.

Park, W., Yang, S. & Song,J (2020) Eliciting students' understanding of nature of science with text-based tasks: insights from new Korean high school textbooks. *International Journal of Science Education*. doi:10.1080/09500693.2020.1714094 online first.

Tirapicos, L. (2019). Bibliographical Evolutions: From Archaeoastronomy to Astronomy in Culture. *ISIS: A Journal of the History of Science Society*, 110(S1), 1-12.

Willinsky, J. (2020). The Confounding of Race in High School Biology Textbooks, 2014–2019. *Science & Education*, 1-18. doi:10.1007/s11191-020-00104-y online first

Recent HPS&ST Related Books

Addis, Mark, Lane, Peter, Sozou, Peter D. & Gobet, Fernand (2019) *Scientific Discovery in the Social Sciences*. Cham: Springer. ISBN: 978-3-030-23768-4

"This volume offers selected papers exploring issues arising from scientific discovery in the social sciences. It features a range of disciplines including behavioural sciences, computer science, finance, and statistics with an emphasis on philosophy.

"The first of the three parts examines methods of social scientific discovery. Chapters investigate the nature of causal analysis, philosophical issues around scale development in behavioural science research, imagination in social scientific practice, and relationships between paradigms of inquiry and scientific fraud. The next part considers the practice of social science discovery. Chapters discuss the lack of genuine scientific discovery in finance where hypotheses concern the cheapness of securities, the logic of scientific discovery in macroeconomics, and the nature of that what discovery with the Solidarity movement as a case study. The final part covers formalising theories in social science. Chapters analyse the abstract model theory of institutions as a way of representing the structure of scientific theories, the semi-automatic generation of cognitive science theories, and computational process models in the social sciences.

"The volume offers a unique perspective on scientific discovery in the social sciences. It will engage scholars and students with a multidisciplinary interest in the philosophy of science and social science." (From the Publisher)

More information available here.

Byford, Andy (2020). *Science of the Child in Late Imperial and Early Soviet Russia*. Oxford, UK: Oxford University Press. ISBN: 978-0-198-82505-0

"Between the 1880s and the 1930s, children became the focus of unprecedented scientific and professional interest in modernising societies worldwide, including in the Russian Empire and then the Soviet Union. Those who claimed children as special objects of investigation were initially spread across a network of imperfectly professionalized scholarly and occupational groups based mostly in the fields of medicine, education, and psychology. From their various perspectives, they made ambitious claims about the contributions that their emergent expertise made to the understanding of, and intervention in, human bio-psycho-social development. The international movement that arose out of this catalysed the institutionalisation of new domains of knowledge, including developmental and educational psychology, special needs education, and child psychiatry.

"*Science of the Child* charts the evolution of the child science movement in Russia from the Crimean War to the Second World War. It is the first comprehensive history in English of the rise and fall of this multidisciplinary field across the late Imperial and Soviet periods. Drawing on ideas and concepts emanating from a variety of theoretical domains, the study provides new insights into the concerns of Russia's professional intelligentsia with matters of biosocial reproduction and investigates the incorporation of scientific knowledge and professional expertise focused on child development into the making of the welfare/warfare state in the rapidly changing political landscape of the early Soviet era." (From the Publisher)

More information available here.

French, Steven (2020). *There Are No Such Things as Theories*. Oxford, UK: Oxford University Press. ISBN: 978-0-198-84815-8

"*There Are No Such Things as Theories* considers the fundamental question: what is a scientific theory? It presents a range of options - from theories are sets of propositions, to theories are families of models, abstract artefacts, or fictions - and highlights the various problems they all face. In so doing it draws multiple comparisons between theories and artworks: on the one hand, theories are like certain kinds of paintings with regard to their representational capacity; on the other, they are like musical works in that they can be multiply presented.

An alternative answer to the question is then offered, drawing on the metaphysics of musical works: there are no such things as theories. Nevertheless, we can still talk about them, since that talk is made true by the various practices that scientists engage in. The implications of this form of eliminativism for the realism debate is then discussed and it is concluded that this may offer a more flexible framework in which we can understand both the history and the philosophy of science in general." (From the Publisher)

More information available here.

Griffiths, Devin (2020) *The Age of Analogy: Science and Literature between the Darwins*. Baltimore, MD: John Hopkins University Press. ISBN: 978-1-421-43632-6

"Erasmus Darwin and his grandson, Charles, were the two most important evolutionary theorists of eighteenth- and nineteenth-century Britain. Although their ideas and methods differed, both Darwins were prolific and inventive writers: Erasmus composed several epic poems and scientific treatises, while Charles is renowned both for his collected journals (now titled *The Voyage of the Beagle*) and for his masterpiece, *The Origin of Species*.

"In *The Age of Analogy*, Devin Griffiths argues that the Darwins' writing style was profoundly influenced by the poets, novelists, and historians of their era. The Darwins, like other scientists of the time, laboured to refashion contemporary literary models into a new mode of narrative analysis that could address the contingent world disclosed by contemporary natural science. By employing vivid language and experimenting with a variety of different genres, these writers gave rise to a new relational study of antiquity, or "comparative historicism," that emerged outside of traditional histories. It flourished instead in literary forms like the realist novel and the elegy, as well as in natural histories that explored the continuity between past and present forms of life. Nurtured by imaginative cross-disciplinary descriptions of the past–from the historical fiction of Sir Walter Scott and George Eliot to the poetry of Alfred Tennyson–this novel understanding of history fashioned new theories of natural transformation, encouraged a fresh investment in social history, and explained our intuition that environment shapes daily life.

"Drawing on a wide range of archival evidence and contemporary models of scientific and literary networks, *The Age of Analogy* explores the critical role analogies play within historical and scientific thinking. Griffiths also presents readers with a new theory of analogy that emphasises language's power to foster insight into nature and human society. The first comparative treatment of the Darwins' theories of history and their profound contribution to the study of both natural and human systems, this book will fascinate students and scholars of nineteenth-century British literature and the history of science." (From the Publisher)

More information available here.

Kourany, Janet & and Carrier, Martin (Eds.) (2020). *Science and the Production of Ignorance: When the Quest for Knowledge Is Thwarted*. Cambridge, MA: The MIT Press. ISBN: 978-0-262-53821-3

"An introduction to the new area of ignorance studies that examines how science produces ignorance–both actively and passively, intentionally and unintentionally.

"We may think of science as our foremost producer of knowledge, but for the past decade, science has also been studied as an important source of ignorance. The historian of science Robert Proctor has coined the term agnotology to refer to the study of ignorance, and much of the ignorance studied in this new area is produced by science. Whether an active or passive construct, intended or unintended, this ignorance is, in Proctor's words, "made, maintained, and manipulated" by science. This volume examines forms of scientific ignorance and their consequences.

"A dialogue between Proctor and Peter Galison offers historical context, presenting the concerns and motivations of pioneers in the field. Essays by leading historians and philosophers of science examine the active construction of ignorance by biased design and interpretation of experiments and empirical studies, as seen in the "false advertising" by climate change deniers; the "virtuous" construction of ignorance–for example, by curtailing research on race- and gender-related cognitive differences; and ignorance as the unintended by-product of choices made in the research process, when rules, incentives, and methods encourage an emphasis on the beneficial and commercial effects of industrial chemicals, and when certain concepts and even certain groups' interests are inaccessible in a given conceptual framework." (From the Publisher)

More information available here.

Lightman, Bernard (Ed.) (2019) *Rethinking History, Science, and Religion*. Pittsburgh, PA; The University of Pittsburgh Press

"The historical interface between science and religion was depicted as an unbridgeable conflict in the last quarter of the nineteenth century. Starting in the 1970s, such a conception was too simplistic and not at all accurate when considering the totality of that relationship. This volume evaluates the utility of the "complexity principle" in past, present, and future scholarship. First put forward by historian John Brooke over twenty-five years ago, the complexity principle rejects the idea of a single thesis of conflict or harmony, or integration or separation, between science and religion. Rethinking History, Science, and Religion brings together an interdisciplinary group of scholars at the forefront of their fields to consider whether new approaches to the study of science and culture–such as recent developments in research on science and the history of publishing, the global history of science, the geographical examination of space and place, and science and media–have cast doubt on the complexity thesis, or if it remains a serviceable historiographical model" (From the Publisher)

More information available here.

Thomas, John Meurig (2020). *Architects of Structural Biology: Bragg, Perutz, Kendrew, Hodgkin*. Oxford, UK: Oxford University Press. ISBN: 978-0-198-85450-0

"*Architects of Structural Biology* is an amalgam of memoirs, biography, and intellectual history of the personalities and single-minded devotion of four scientists who are among the greatest in modern times. These three chemists and one physicist, all Nobel laureates, played a pivotal role in the creation of a new and pervasive branch of biology. This led in turn to major developments in medicine and to the treatment of diseases as a result of advances made in arguably one of the greatest centres of scientific research ever: the Laboratory of Molecular Biology in Cambridge, which they helped to establish. Their work and that of their predecessors at the Royal Institution in London reflects the broader cultural, scientific and educational strength of the UK from the early 19th century onwards. The book also illustrates the nurturing of academic life in the collegiate system, exemplified by the activities of, and cross-fertilisation within, a small Cambridge college." (From the Publisher)

More information here.

Webster, Erin (2020). *The Curious Eye: Optics and Imaginative Literature in Seventeenth-Century England*. Oxford, UK: Oxford University Press.

"*The Curious Eye* explores early modern debates over two related questions: what are the limits of human vision, and to what extent can these limits be overcome by technological enhancement? In our everyday lives, we rely on optical technology to provide us with information about visually remote spaces even as we question the efficacy and ethics of such pursuits. But the debates surrounding the subject of technologically mediated vision have their roots in a much older literary tradition in which the ability to see beyond the limits of natural human vision is associated with philosophical and spiritual insight as well as social and political control.

"*The Curious Eye* provides insight into the subject of optically-mediated vision by returning to the literature of the seventeenth century, the historical moment in which human visual capacity in the West was first extended through the application of optical technologies to the eye. Bringing imaginative literary works by Francis Bacon, John Milton, Margaret Cavendish, and Aphra Behn together with optical and philosophical treatises by Johannes Kepler, René Descartes, Robert Hooke, Robert Boyle, and Isaac Newton, the volume explores the social and intellectual impact of the new optical technologies of the seventeenth century on its literature. At the same time, it demonstrates that social, political, and literary concerns are not peripheral to the optical science of the period but, rather, an integral part of it, the legacy of which we continue to experience." (From the Publisher)

More information available here.

Authors of HPS&ST-related papers and books are invited to bring them to attention of Paulo Maurício or Nathan Oseroff-Spicer for inclusion in these sections.

Coming HPS&ST Related Conferences

March 15-18, 2020, NARST Annual Conference, Portland OR, USA
More information available here.

March 30 – April 1, 2020, Rudolf-Carnap-Lectures & Graduate Workshop 2020. Ruhr-University Bochum. Germany.
More information available here.

April 3-4, 2020, Mid-South Philosophy of Science (MSPS) 2020 Meeting. Virginia Tech Blacksburg, VA, USA.
Inquiries to Justin Donhauser at jdonhau@bgsu.edu with "MSPS 2020" in the subject line.

April 16-17, 2020, Alternative Approaches to Scientific Realism, Munich Center for Mathematical Philosophy
Details available here.
And Joe Dewhurst (J.Dewhurst@lmu.de)

April 17-18, 2020, Joint Atlantic Seminar for the History of East Asian Science, Technology, and Medicine. John Hopkins University, Baltimore, MD, USA.
Details at: https://jaseastm.org/

May 11-14, 2020, Sixth International Conference on the Nature and Ontology of Spacetime. Albena, Bulgaria.
More information available here.

June 8-12, 2020, Philosophy of Biology at the Mountains (POBAM), Workshop, University of Utah.
Details available here.

June 16-17, 2020, International Workshop on Dis-

ciplinary Identity: Insights from the History and Philosophy of Chemistry. Hebrew University of Jerusalem, Israel.
Details available here.

June 17-19, 2020, Fourth International History of Physics Conference, Trinity College Dublin
Details available here.

June 29 – July 3, 2020, Objects of Understanding: Historical Perspectives on Material Artefacts and Practices in Science Education. Europa-Universität, Flensburg, Germany.
Inquiries at OoU-conference@uni-flensburg.de

June 29 – July 1, 2020, Measurement at the Crossroads 2020 – Measuring and Modeling. Milan, Italy.
More information available here.

June 30 – July 2, 2020, 7th annual conference of the International Association for Philosophy of Time. Barcelona, Spain.
Inquiries at iapt7barcelona@gmail.com

July 1-3, 2020, STEMM and Belief in Diverse Contexts: Publics, Praxis, Policy and Pluralism, Stellenbosch, South Africa
Details available here.

July 2-4, 2020, 4th International Conference on Science and Literature, University of Girona, Spain.
Details at: http://icscienceandliterature.com/

July 7-10, 2020, Society for Philosophy of Science in Practice (SPSP) Eighth Biennial Conference, Michigan State University, USA
Details available here.

July 8-11, 2020, British Society for History of Science Annual Conference, Aberystwyth University, Wales.
Information at: http://bshsaberystwyth2020.info/

July 9-11, 2020, 6th International STEM in Education Conference, Vancouver, Canada.
Details at: www.stem2020.ubc.ca

July 15-17, 2020, 8th Integrated History and Philosophy of Science Conference (&HPS8). Virginia Tech, Blacksburg VA.
Information: Lydia Patton (critique@vt.edu) or Jutta Schickore (jschicko@indiana.edu)

July 21-23, 2020, 24th Conference of the International Society for the Philosophy of Chemistry. Buenos Aires, Argentina.
More information available here.

November 19-22, 2020, Twenty-Seventh Biennial Meeting of the PSA. Baltimore, Maryland.
Details at: https://psa2020.philsci.org/

August 10-14, 2020, Bayesian Epistemology: Perspectives and Challenges. MCMP, LMU Munich.
Details available here.

August 31 – September 3, 2020, European Society for History of Science Biennial Conference, Bologna.
Details available here.

September 14-19, 2020, 39th annual symposium of the Scientific Instrument Commission, London
Details at: http://scientific-instrument-commission.org/

July 4-8, 2021, IHPST 16th International Conference, University of Calgary, Canada
Details from Glenn Dolphin:
glenn.dolphin@ucalgary.ca.

July 25-31, 2021, 26th International Congress of History of Science and Technology (DHST), Prague
Information: https://www.ichst2021.org/

September 20-22, 2021, 'Developing Mario Bunge's Scientific-Philosophical Programme', Huaguang Academy of Information Science, Wuhan, China
Details from Zongrong LI 2320129239@qq.com.

July 24-29, 2023, 17th DLMPST Congress, University of Buenos Aires Information: Pablo Lorenzano, pablo@unq.edu.ar.

HPS&ST Related Organisations and Websites

IUHPST – International Union of History, Philosophy, Science, and Technology

DLMPST – Division of Logic, Mathematics, Philosophy, Science, and Technology

DHST – Division of History, Science, and Technology

IHPST – International History, Philosophy, and Science Teaching Group

NARST – National Association for Research in Science Teaching

ESERA – European Science Education Research Association

ASERA – Australasian Science Education Research Association

ICASE – International Council of Associations for Science Education

UNESCO – Education

HSS – History of Science Society

ESHS – European Society for the History of Science

AHA – American History Association

ISHEASTME – International Society for the History of East Asian History of Science Technology and Medicine

BSHS – British Society for History of Science

EPSA – European Philosophy of Science Association

AAHPSSS - The Australasian Association for the History, Philosophy, and Social Studies of Science

HOPOS – International Society for the History of Philosophy of Science

PSA – Philosophy of Science Association

BSPS – The British Society for the Philosophy of Science

SPSP – The Society for Philosophy of Science in Practice

ISHPSB – The International Society for the History, Philosophy, and Social Studies of Biology

PES – The Philosophy of Education Society (USA)

The above list is updated and kept on the HPS&ST website HERE.

HPS&ST-related organisations wishing their web page to be added to the list should contact assistant editor Paulo Maurício (paulo.asterix@gmail.com)

The NEWSLETTER is typeset in XeLaTeX.
The font is Minion Pro.
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