Published online: December 21, 2015

EMBO reports

Science & Society

Free science under threat

The current revival of Bernalism and the use of market-based scientific practices are undermining science as we know it

Valentí Rull

Since its earliest origins in the ancient Greek academies, science has been based on the freedom of human intelligence, creativity and desire to try to understand the world and the human condition. However, this freedom was seldom granted: science and scientists alike have been subjected to religious or political pressures or censorship throughout history. The most popular—and somewhat misunderstood—example is Galileo Galilei, who was forced to renounce the heliocentric view of the solar system under pressure from the Catholic Church because it countered a literal interpretation of the bible that the sun revolves around the Earth. In the 1930s and 1940s, the Soviet agriculturalist Trofim Lysenko used his political influence to silence critics of his theory of vernalism—they were variously fired, imprisoned and executed—and genetics was declared a bourgeois pseudoscience. We might dismiss such events and similar other ones as impossible today, certain that the days of religious or political pressure on research are gone. But we should not be so sure: contemporary science seems again to be coming under pressure from political, social and religious actors. While they do not have the murderous intent of historical censors, they nonetheless threaten the freedom of science.

It is worthwhile to remember that the freedom of science as we know and enjoy it today is a recent accomplishment. Before the industrial revolution, research was mainly funded by rich individuals and universities—which relied on funds from private contributors—or the church: Isaac Newton was a fellow of Trinity College; Charles Darwin joined the crew of the Beagle as a self-funded naturalist; Gregor Mendel performed his experiments on inheritance in the confines of a cloister. These privately funded endeavours began to change with the rise of the modern university, where scientists were formally employed, and progress accelerated during and after World War II when the state became the main funder of research. This made the discovery of knowledge and access to it more open and gave scientists the freedom and the time to pursue their ideas and hypotheses. Moreover, modern democracies enshrined freedom of research together with freedom of speech in their constitutions, giving science an unprecedented protected status in society. The result was a truly astonishing explosion of knowledge in all research areas during the 19th century, which has translated in myriad new technologies and inventions.

> *"... contemporary science seems again to be coming under pressure from political, social and religious actors"*

However, the increased involvement in and funding of research by public money has fuelled demands for "returns" in the form of new discoveries and knowledge that solve practical problems and increase human wellbeing: medical and technological advances have always been most valued by society. Over time, this has increased the distinction between fundamental, basic or pure research, and applied research to a degree that the two are now considered to be separate. This is a risky development because pressure to solve societal, health or environmental problems could coerce politicians and funding agencies to focus money on what they understand as applied research to the detriment of fundamental research, thereby threatening the freedom of science.

The modern debate about basic versus applied science originated in the UK in the mid-20th century, when the physicist John D. Bernal contended that science should serve the state to satisfy the material needs of its citizens. He called for state control of research to maximise its utility [1]. Bernalism was thus clearly influenced by Marxism, a strong social and political movement at the time. To guide research and bring about the material benefits for the people, Bernal advocated a joint venture of scientists, government and economic organisations to work together. The main points of his doctrine were [2] "(i) science originated in attempts to satisfy the material needs of ordinary human life; (ii) the legitimate purpose of science is to meet these needs on an expanding scale; and (iii) scientists should not be left free to choose their own subjects of research, but must submit to central planning so that their work might be beneficially organised for the satisfaction of material needs."

The primary opponent of Bernalism was the zoologist John R. Baker [3], who defended the principal freedom of science to choose its own objects of inquiry. Baker's views eventually culminated in the formation of the Society for Freedom in Science (SFS) in 1940. Its foundations were "(i) great material benefits to mankind result from research in pure science along lines whose application to human affairs is not at the time obvious; (ii) the advancement of knowledge by scientific research has a value as an end in itself; (iii) so far as possible, research workers should be free to decide the objects of their own research; and (iv) those scientists who find that they do their

Institute of Earth Sciences Jaume Almera (ICTJA-CSIC), Barcelona, Spain. E-mail: vrull@ictja.csic.es
DOI 10.15252/embr.201541377 | Published online 21 December 2015

best work by themselves should not be forced to carry out research in organised groups." The SFS advocated that most funding for research should proceed to come from governments, but, at the same time, a large amount of money should be dedicated to collective research for the promotion of general welfare [4]. Nevertheless, this should be planned and executed by responsible scientists, not government authorities. Over time, the scientific community accepted and adopted the principles of the SFS and the society was eventually dissolved in 1963.

"... modern democracies enshrined freedom of research together with freedom of speech in their constitutions, giving science an unprecedented protected status in society"

Another influential scientist to defend free science was the Director of the Office of Research and Development in the USA, Vannevar Bush, who published his vision of research freedom in *Science the Endless Frontier*, in 1945. The chapter "Freedom Of Inquiry Must Be Preserved," advocates that: "We must remove the rigid controls which we have had to impose, and recover freedom of inquiry and that healthy competitive scientific spirit so necessary for expansion of the frontiers of scientific knowledge [...] Scientific progress on a broad front results from the free play of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for exploration of the unknown. Freedom of inquiry must be preserved under any plan for Government support of science...". Bush pushed for the establishment of a US National Science Foundation that follows the principles of free science, which became reality in 1950. His vision of science as "the free play of free intellects, working on subjects of their own choice," has guided research in the USA and, to some extent in Europe, until today.

Freedom of science is still recognised as the most successful path to generate benefits for and increase the welfare of society. The International Council for Science (ICSU) captures this attitude by stating that "academic freedom and scientific autonomy are vital for science to progress and best serve society" and that "political, religious and commercial pressures on both individual scientists and academic institutions are undermining the ability of researchers to work freely and without hindrance, threatening the Universality of Science Principle" (http://www.icsu.org/freedom-responsibility/academic-freedom).

However, this freedom is not a given and increasingly threatened by what seems to be a return of Bernalism, though this time it is not rooted in Marxism but in capitalism. Europe is possibly the best place to observe this rise of neo-Bernalism [5] through the Horizon 2020 (H2020) programme, the objective of which is to foster economic growth and make Europe a global economic leader based on science and innovation (http://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020). This objective inevitably transforms scientific research into a political and economic instrument. Fundamental science has its role and support under H2020, but it is reserved for a limited number of exceptional researchers and research teams and therefore not available for many other excellent scientists who might end up doing research that satisfies the immediate needs of society or industry in order to secure funding. One might argue that H2020 is only a fraction of the money that is invested in research in the EU or even globally, but the signs of neo-Bernalism are in fact everywhere. Many national funding agencies and schemes—from the US NIH to the UK's Medical Research Council to France's CNRS and many others—are under increasing pressure by politicians to at least justify their calls for higher spending for science that it may generate new cures, new products, new services, new business and new jobs. Even if the value of basic, free research is acknowledged, there is always the implicit notion that it does not come for free but, at the end, must somehow benefit nations, citizens and business.

In a neo-Bernalist scenario, the ultimate fate of universities and research institutes would be to transform into organisations that offer research services that support economic growth and address societal needs. This transformation is already occurring: universities and research institutes actively encourage intellectual property and the creation of spin-off companies in an effort to increase their income through licences or shares; others offer research services on a commercial basis to both public and private organisations. Even sharing material and information among scientists—a central tenet of free science—is becoming increasingly arduous with Material Transfer Agreements involved whenever there is a whiff of commercialisation.

"Even if the value of basic, free research is acknowledged, there is always the implicit notion that it does not come for free but, at the end, must somehow benefit nations, citizens and business"

Under Bernalism, discoveries such as the cosmic theory, the laws of gravitation, the theory of evolution and the rules of inheritance, general relativity or quantum mechanics would have been unlikely (Fig 1). None of these discoveries resulted from the investigation of a particular, immediate problem; they were the product of human curiosity and desire to understand the world in which we live. However, our world would be entirely different without these discoveries, which provide the basis for many social, cultural and technological achievements. In a slave-science scenario, in which immediate applicability is the norm, the progressive, long-term accumulation of knowledge that is characteristic of free, unguided research is at risk of being replaced by a disordered aggregate of short-lived, unconnected developments biased towards immediate needs [5]. This could impact science, as much as the Catholic Church's censorship did during the dark Ages or as Lysenkoism affected genetics in the Soviet Union, but this time for economic, rather than ideological reasons.

Neo-Bernalism is not the only threat to free science. Another equally dangerous development is "market science". During the past decades, scientific research has been transformed into a business-like activity guided by what looks like market rules. A classic and highly debated example is how researchers and

Published online: December 21, 2015

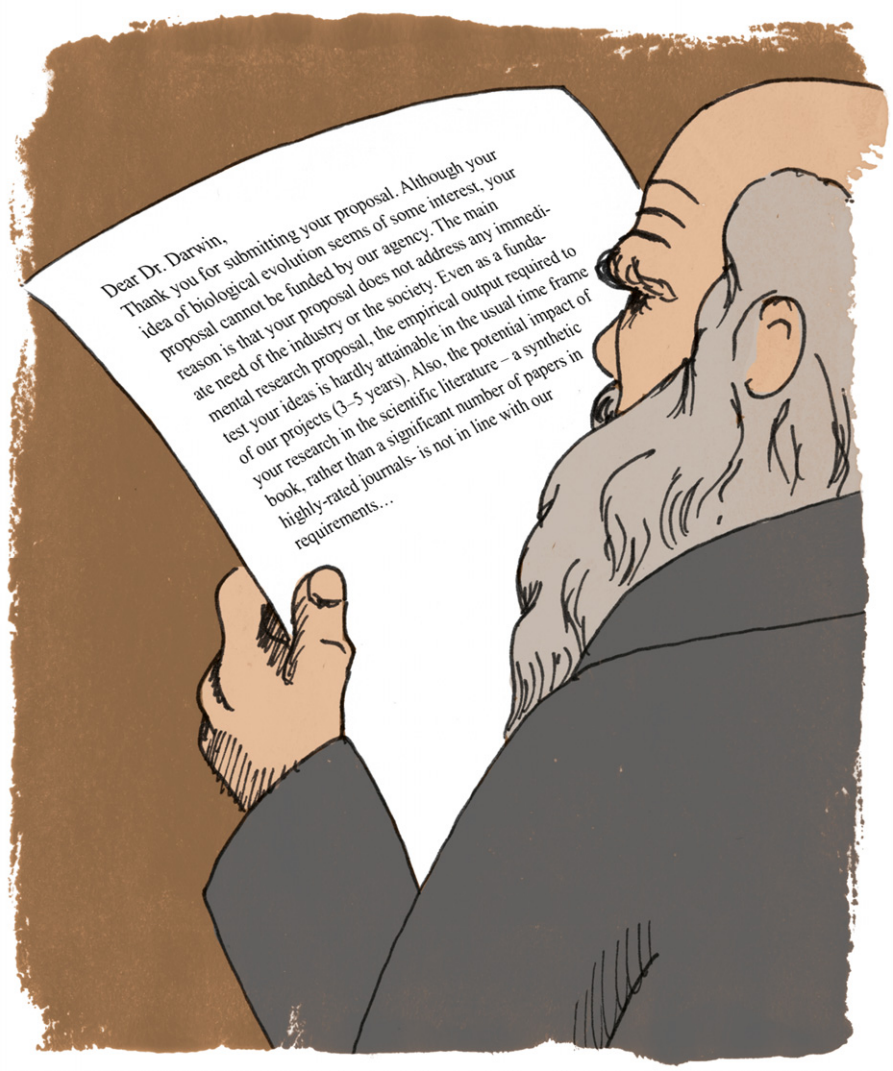

Figure 1. The potential effects of neo-Bernalism on basic research.

institutions are evaluated based on their publication records using indicators such as the Journal Impact Factor or the *h*-Index. This practice has scholars compete for citations in the same way that businessmen compete for money or politicians for votes; it has turned scientific research into a frenetic race for publications and citations.

Another measure is the level of funding, both in terms of the number of grants and the total budget that a researcher or an institution can obtain. The publication market and the funding market are coupled in a positive feedback and amplify each other. Many senior researchers are increasingly caught up in executive tasks and relinquish research to younger researchers, typically PhD students and postdocs. The publication/citation records of the senior researchers expand because in return for their management activities they are included as co-authors—typically as last authors—in the papers produced by their research group. Many scholars and administrators thus regard them as top scientists, although they are actually managers.

Market-based scientometrics and competitive fundraising tend to generate quantity over quality, which can divert scientists from the true purpose of research, which is not self-promotion but the generation of knowledge. Unfortunately, younger scientists have matured within this framework and consider these circumstances to be normal, which could be dangerous for future science. The more successful researchers will not be necessarily those who produce reliable and verified knowledge but those who adapt to the new market-like rules. Talented young researchers who conduct high-quality basic research might find it increasingly difficult to get a permanent position when competing with more market-adapted candidates.

> *"During the past decades, scientific research has been transformed into a business-like activity guided by what looks like market rules"*

In my experience, many scholars support the analysis that Bernalism and market science are affecting contemporary research, but remain silent for fear of being excluded from the current funding system. Nonetheless, a new movement called "slow science" has emerged over the past decade that tries to counter the increasing commercialisation of science and restore the freedom to conduct research without pressure. The term was coined by the American linguist Eugene Garfield in 1990 [6] as an alternative to "fast science"—ironically, Garfield was the father of bibliometrics and the founder of the Institute for Scientific Information (ISI), in 1955, which led to the creation of the Science Citation Index (SCI) and the invention of journal impact factors [7]. However, at the time, Garfield could hardly predict that his creation would become the main currency of market science.

In opposition to market science, slow science prioritises quality over quantity. Regarding publication practices, Joël Candau, an anthropologist at the University of Nice, France (http://lasmic.unice.fr/homepage-candau.html), wrote: "Because the appraisers and other experts are always in a hurry too, our CVs are often solely evaluated by their length: how many publications, how many presentations, how many projects? This phenomenon creates an obsession with quantity in scientific production. One result is that it is impossible to read everything, even within a narrow speciality. Thus, many articles are never cited and they may not even be read. In this

context, it is increasingly difficult to identify publications and presentations that really matter—those that a colleague has spent months, sometimes years, perfecting—among the thousands of others that are duplicated, sliced and recycled, or even more or less 'borrowed'" [7].

> *"The more successful researchers will not be necessarily those who produce reliable and verified knowledge but those who adapt to the new market-like rules"*

A basic tenet of slow science is that major discoveries are the result of years of patient work. An example is the elucidation of the structure of DNA by James Watson, Frances Crick and Rosalind Franklin, which altogether required ~40 years of painstaking research [6]. This discovery was made in a free-science environment without societal pressure because of the lack of immediately evident applications. Counter examples are the fights against cancer and AIDS. These research efforts have been the subject of substantial political and popular pressure and a major priority for public and private funding agencies for decades, but despite some battles won, victory against these diseases remains elusive [6]. The corollary is that scientific discoveries and developments require time. From a more personal angle, slow science defenders note that scientists also need time to live their lives, time for their families, friends, leisure, even for the pleasure of doing absolutely nothing [7], just like any other citizen.

Yet, the slow science movement is not an official organisation of scientists, nor a club or academy, and it is highly cryptic. Literature and information on slow science is surprisingly scarce. Apart from Garfield's comment, which was published in *The Scientist*, most of the available literature consists of a small number of unpublished documents available on Internet websites. A website by the Slow Science Academy in Berlin, Germany (http://slow-science.org/), has no information about members or its exact location or even a mailing address; it hosts "The Slow Science Manifesto", the core message of which is: "Science needs time to think. Science needs time to read, and time to fail. Science does not always know what it might be at right now. Science develops unsteadily, with jerky moves and unpredictable leaps forward—at the same time, however, it creeps about on a very slow time scale, for which there must be room and to which justice must be done. Slow science was pretty much the only science conceivable for hundreds of years; today, we argue, it deserves revival and needs protection. Society should give scientists the time they need, but more importantly, scientists must take their time. We do need time to think. We do need time to digest. We do need time to misunderstand each other, especially when fostering lost dialogue between humanities and natural sciences. We cannot continuously tell you what our science means; what it will be good for; because we simply don't know yet".

Isabelle Stengers, a Belgian philosopher who co-authored the book *Order out of chaos* with Nobel laureate Illya Prigogine, commented that even if some might view slow science as a utopian idea or a waste of time, it is worth cultivating it simply because fast science is unsustainable in the long run [8]. Stengers makes a call to action by arguing that life is "messy", and therefore needs patient, painstaking research without pressure to come up with results to understand it.

To date, neither scholars such as Garfield, Candau or Stengers, nor The Slow Science Manifesto have changed the attitude of the scientific community. However, there are some good examples of institutions that have implemented the basic idea, even though they do not explicitly mention "slow science". One example is the Janelia Research Campus of the Howard Hughes Medical Institute in Virginia, USA. At Janelia, scientists have "... no deadlines, no rules, no schedules, no tenure", and research "... is driven by passion, collaboration and creativity" (https://www.janelia.org/janelia-philosophy). Projects are risky and long-term and "... often fall outside the realm of most funding and academic goals". Scientists have "... time to ask the hard questions that others haven't been able to ask". The Janelia Campus was inspired by Bell Labs (New Jersey, USA), founded by Alexander Graham Bell in the late 19th century, which has made many technological breakthroughs during the 20th century. The Bell Works website heralds "The Transformer: the rebel, the trendsetter, the crafter of what's next" (http://bell.works/offering/collaborate). Other examples of highly successful research institutes where scientists are free to think, develop their own ideas and conduct experiments without pressure to perform are the Laboratory of Molecular Biology of the Medical Research Council (MRC-LMB) in Cambrige (UK) or the European Molecular Biology Laboratory (EMBL), both of which are world leaders in their areas.

> *"Perhaps it is time to revive the Society for Freedom in Science, after its 50-year slumber, as its task seems not to have been properly fullfilled"*

These examples and similar others could help convince others of the value of and need for a free/slow science approach, not only for the benefit of science itself, but also to preserve its ability to solve practical problems and to promote social welfare. However, the required change of mindset will not happen without the direct involvement of the scientific community. Scientists need to stop and think about scientific research itself and its current trends before Bernalism and market science take over. Perhaps it is time to revive the Society for Freedom in Science, after its 50-year slumber, as its task seems not to have been properly fullfilled. Perhaps the SFS should remain active indefinitely, given the historical recurrency of attacks on science from religion, politics or economy.

Conflict of interest

The author declares that he has no conflict of interest.

References

1. Bernal JD (1939) *The Social Function of Science*. London: Routledge
2. McGucken W (1978) On freedom and planning in science: the Society for Freedom in Science, 1940–46. *Minerva* 16: 42–72

3. Baker JR (1939) A counterblast to Bernalism. *New Statesman Nat* 18: 174 – 175
4. Tansley AG (1942) Letter to the Editor. *Electronic Eng* 15: 177
5. Rull V (2014) The most important application of science. *EMBO Rep* 15: 919 – 922
6. Garfield E (1990) Fast science versus slow science, or slow and steady wins the race. *Scientist* 4: 388 – 389
7. Garwood J (2012) Good science needs time to mature and ripen!. *Labtimes* 2: 20 – 27
8. Stengers I (2011) *Another Science is Possible! A Plea for Slow Science*. Belgium: Inaugural Lecture Chair Willy Calewaert, Vrije Universiteit Brussel