Scientists and the marketplace of opinions

Scientific credibility takes on a different meaning when reaching out to the public

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Science and the general public often have differing views on what makes a statement or a theory relevant and credible. For scientists, relevance and credibility are the result of a logical chain of arguments that are supported by experimental proof. By contrast, plausibility and general agreement play central roles in public debates. It is possible that a plausible public statement contains no truth whatsoever, whereas a scientific theory backed by a wealth of research data is not credible to a nonscientific audience. Anyone who wants to communicate science to the general public needs to be aware of this conflict and must learn how to deal with it in public debates. This involves knowing and following certain rules that are often contrary to the general beliefs of the scientific community.

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The increasing public interest in and scrutiny of scientific research is the direct result of an exponential increase in the knowledge of Nature, mankind, society and history that science has produced since the nineteenth century (Weingart, 2001). This huge amount of knowledge has profoundly changed our natural and social environment through its manifold technological, medical and other applications. No one ever seriously doubts the validity of scientific knowledge—the daily successful use of technical products and technology attests to this. We rely on machines, believe in the daily weather forecast, use cars and planes for transportation and have faith in medical

diagnoses as well as the stability of giant skyscrapers. The basis for all these technologies is knowledge, which comes from research—through observation, experimentation, computer simulations and other methodologies. This creation of knowledge and its subsequent practical applications, which is analogous to the creation of value in economics, have profound meanings for the relationship between science and society. It constitutes public acceptance of science but also encompasses distrust, reservation and even abuse by politics.

However, the public is often not aware of another intellectual quality that is probably even more important to scientific endeavour and the creation of robust and reliable knowledge: the scientific debate. It plays such a central role in science that Werner Heisenberg once commented: “Science emerges from debate” (Heisenberg, 1969). From formulating a problem, devising a research strategy, and planning and conducting experiments to interpreting and publishing the results—none of these steps takes place without intense discourse. Scientists talk to their colleagues in the laboratory; they may ask colleagues from other disciplines or even consult their competitors. This systematic scepticism aims to prevent subjective views and errors and to produce the most robust interpretation of data. “It is not his possession of knowledge, or irrefutable truth that makes the man of science, but his persistent and critical quest for truth,” Karl Popper (1959)

commented. This discourse follows the rules of “good scientific practice” (Kreutzberg, 2004)—it is open, relies on the participants’ trustworthiness and is critical—which means that the research strategy, the methods used and the results thus produced are, as a matter of principle, all doubted until proven otherwise. This debate first takes place “in house” but is soon carried out in the larger scientific community at conferences and progresses until the interpretation is eventually

subjected to anonymous peer review as part of the publication process. Popper’s postulate of falsifiability is the basic credo, even if it is not applicable in biology as rigorously as in physics. The doubting Thomas is the scientist’s idol. “Science is perhaps the only human activity in which errors are systematically criticized and in time corrected,” Popper wrote in *The Logic of Scientific Discovery* (1959).

In the 1980s, a scientific publishing house in the USA distributed buttons at various congresses that read “Trust me, I’m a scientist” (Fig 1). They were very popular and I have seen them on campuses for years. Their message was somewhat incongruous, as trust in the honesty and credibility of scientists has always been high in all technological or scientific civilizations. This faith rests on the reliability and resilience of the knowledge that scientists produce and the fact that they constantly submit it to internal quality control. As every researcher depends on the validity of others’ information, the basic rules of

Fig1 | “Trust me, I’m a scientist” button

good scientific practice are widely followed. Any cases of fraud, falsification, theft or plagiarism do not change these rules, but they are seen as particularly unacceptable by both scientists and the public. They erode a basis of trust and credibility on which every scientist must rely when building theories, data and conclusions. Openness, trust and honesty are thus the basic characteristics of the process of knowledge production, and there is no other profession in which these are as fundamental as in science. In politics, disinformation, secrecy, half-truths and refusal to help are part of the game. Creating knowledge obviously follows different rules than creating value or power (Weingart, 2001).

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However, the process of knowledge creation, based on debate and discourse, not only results in credibility, but also in irritation and misuse, which arise particularly in the context of expert knowledge. The explosive growth of knowledge since World War II and the establishment of new scientific disciplines, abilities and applications have radically changed modern research. Science and art, which were previously rather disconnected from society, are now integrated in a network of social and political relations which sociology has termed “contextualization” (Nowotny *et al.*, 2001). Despite an increased level of education and a growing interest in scientific and technological topics, society still needs expert advice in nearly all areas of life. In addition to improving and renewing our knowledge, we need experts to provide competent and disinterested advice in order to make our own individual judgements. Consequently, many experts have gained considerable influence over public opinion and policy making. This is not a new development—Lord Cherwell, Winston Churchill’s personal scientific advisor during World War II, wielded more influence on British politics than many cabinet members, although he held no official position at the time. What has changed since, however, is that the media now offers an adequate podium for any serious or self-appointed expert on any matter.

But when exposed to the media, the renowned expert is suddenly fully exposed to the agora—the public marketplace of opinions. There, animal rights activists tell him that his research on the pathology of paraplegia is completely irrelevant because any results gained from mice or rats cannot be transferred to humans. Environmental groups paint a bleak image of genetically modified crops devastating the environment and threatening consumer health. Such statements, which are not subject to peer-review, are often disguised as “expert knowledge”. The public does not realize that an impostor participates in the discussion and his convincing appearance makes the scientific expert look pale. A good scientist who is used to the rules of scientific discourse is thus in an unfortunate position. “The moment the scientist leaves the laboratory he is like a soldier on the battlefield without a weapon,” Louis Pasteur once commented. After such an experience, the scientist vows never to take part in such a debate again, thus reducing the number of experts who are willing to publicly discuss science. But such debates can take place without a scientific expert if politicians and lobbyists use arguments from scientific studies that represent differing views but cannot be compared in terms of material and methodology.

A particularly difficult situation arises if two experts are asked to comment on a new problem, which occurred frequently at the peak of the BSE crisis in the United Kingdom during the late 1990s. Zimmerli & Sinn (1990) analysed this “dialectics of scientific-technical expertise” and gave typical examples for the “transfer of expert knowledge” in such situations. In times of crisis, the lay public expect assurances which science often cannot provide. Experts are therefore forced to give short categorical judgements while critics insinuate that the expert is influenced by economic interests, has no real grasp of the problem and is subject to “community pressure”—in other words, they are more concerned about their peers than about public opinion. Another problem is “assuming expert knowledge”, if experts are forced to make statements far beyond their professional expertise. Whether media training is sufficient to avoid these traps is not clear. But it is obvious that as soon as a scientist leaves the laboratory and enters the agora, he or she must be ready to play under completely different rules.

This is particularly true if a scientist is asked to take a position in a conflict that involves conservative values, such as biotechnology, research with human embryonic stem cells, organ transplantation, evolutionary theology or animal experimentation. The scenario is always the same. Research has successfully come up with a possible solution to a social problem. This new knowledge triggers futuristic expectations in the media, and critics and lobbyists enter the debate. Hopes and fears are created: the agora has its new conflict. The public views the scientist as a representative of technological progress, thus eliminating his role as an objective and honest expert. The media claims that “Scientists play God”, “Researchers do not want to abandon cruelty against animals”, “Scientists want to kill human embryos” and genetically modified maize becomes “Frankenfood”. All kinds of false statements abound, and politicians, economists and scientists are all accused of wrong-doing. This has led to the image of the “mad scientist” (Fig 2): overambitious, power-hungry, greedy and addicted to fame, often with sadistic traits. Even the highest representatives of science, including Nobel laureates, are not safe from this demonization.

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On the other hand, physicians and university professors are still among the most trusted professionals and usually rate highly on the scale of social esteem. The public obviously knows how to differentiate between social reality and media distortion. A poll by the Allensbach Institute (Allensbach, Germany) found a surprising understanding and high esteem for science among the German public (Noelle-Neumann, 1999), which was not expected in the light of various campaigns against modern science. Science was regarded as an important factor for future development, and as trustworthy, reliable and beneficial; it was also seen as a profession that involves hard work and long working hours. Obviously, German citizens do not agree with the polemic defamation of scientists as “lazy professors” by some politicians.

Scientific research and the ensuing knowledge are therefore understood as values in themselves that do not necessarily need to be usable. They benefit everyone and often become the basis for new and valuable applications. In addition, knowledge is a public good, not something that one can refuse to share with others. The results of publicly funded academic research belong to society after publication and are not the personal property of the individual scientist. Consequently, scientists have an obligation to reach out to the populace and explain what they are doing, why they are doing it and what implications it will have on daily life. However, explaining their work and their results to a general audience is a problem for scientists in terms of content as well as language. A non-scientist is simply not able to understand scientific results by reading the original publication, even if it is freely available. As research becomes more focused and branches into more fields that require even more specialized knowledge, reading and understanding a scientific paper become difficult even for scientists.

From the point of view of communicating science to the public, the traditional model of the scientific text is the least effective method

Another obstacle to understanding is the scientific language itself. I am not complaining about scientific jargon, the pervasive plague of abbreviations or the change in meaning of many words, but about basic writing style. To create maximum objectivity, scientific language has evolved a unique style and rules. The first person singular "I" must not be used; first person plural "we" is only rarely used. The preferred style is passive. As a consequence, scientific texts are depersonalized, which is amplified by the fact that authors are not allowed to "tell a story", although there is often a personal tale behind the discovery. Another limitation is the ban on metaphors, which makes scientific texts particularly hard to read as our brain needs such images to understand complex facts. In addition, a scientific paper is very formally structured into materials and methods, results and discussion sections. From the point of view of communicating science to the public, the traditional model of the scientific text is the least effective method.

Fig2 | Roy Lichtenstein "Mad scientist" 1963, Magna on canvas. © Museum Ludwig, Cologne, and VG Bild-Kunst, Bonn, Germany.

These rules only apply to written texts—a scientific talk makes use of rhetoric, and didactic and literary principles. Talented and experienced speakers often ignore the rules that apply to written text; they tell stories, give examples from real life, use images, metaphors and humour, and personalize their presentation. They convey their own fascination in their research and thus communicate authenticity, competence and emotion. These scientists can inspire a lay audience who will gratefully accept this chance to understand a piece of the complex world and will go home without feeling that their time has been wasted. Although only a few scientists may have the ability to grasp the audience's attention, this form of science communication and popularization will become more important in the future.

These performances by gifted science communicators are necessary. The public, as taxpayers, have a right to know what science is doing even if not every taxpayer wants to know. But science communication is rewarding in any case, because it meets a demand from the public that can help to shape expectations, overcome fears, resolve controversies and inspire young people to pursue a scientific career. Most scientists do

not know that, according to Allensbach, only 21% of the public have ever had contact with a "professor".

It is therefore a good sign that the relationship between scientists and science journalists, and the quality of science journalism, is improving, as the media remains the most important communication channel for science. This is a notable change from the early 1990s when the public and the media showed little sympathy for scientific progress. Environmental problems were politicized, the miracles of modern medicine were denigrated as "soulless technological medicine", the use of biotechnology in medicine and pharmacology was vilified and space research was dismissed as expensive hubris. As a consequence, many young scientists from European countries emigrated to the USA and did not return. In the meantime, some have won Nobel prizes—for the USA. During this period, scientists have tried to influence politicians in order to prevent this brain drain and improve the conditions for young scientists in Europe to give them an incentive to return from the USA. They also worked hard to improve the relationship with the media, which,

without doubt, has had a huge influence on public opinion.

In 1991, Byron Waksman and I started a programme to give science journalists from European countries the possibility to work 'hands on' in a scientific laboratory for a limited time. Waksman is from New York University (NY, USA), and visited the Max Planck Institute in Martinsried, Germany, with the support of a grant from the Humboldt Foundation. Our course originally took place in Martinsried but soon expanded to other leading European research laboratories and is now located at the Max Planck Institute of Biophysical Chemistry in Göttingen, Germany. We had both realized that many journalists who cover science know neither the reality of a research laboratory, nor any active scientists and their daily work. The idea behind the programme was that both sides would find it exciting to experience research and journalistic work directly. Each year we select 12 European science journalists to work in the Max Planck Institutes in Martinsried as if they were postdocs. They take part in the daily routine work, not just sterile demonstrations and prepared experiments. Over the past few years, almost 200 European science journalists have participated in the European Initiative for Communicators of Science (EICOS). Some of them now have leading editorial positions in journals and magazines that are devoted to science. For many of them, it was their first opportunity not only to experience research work, but also to meet colleagues from another country. This is equally important, as most European science journalists are only aware of the science in their own country and the USA, and rarely know what is going on in other countries.

Our experience with EICOS has demonstrated how important it is to build a lively relationship between science and the media. For many scientists involved in the programme it was also an opportunity to get some feedback from the writing guild. In fact, many misunderstandings could be avoided if scientists learned more about the art and rules of journalism. Journalists and editors do not work for scientists, but for a public that needs to be informed and entertained. In a similar way to science, the

quality of their product also gives them an edge in the competition for airtime and page space. This merits the help of scientists rather than censorship. On the other hand, scientists need to be aware of journalists' professionalism and reputation. Unfortunately, there are rotten apples in journalism and it does happen that little experience and naivety result in bitter disappointment.

Such initiatives to close the gap between science and the public will become even more important because scientific research is undergoing a transition. In a traditional sense, the credibility of science seems to be linked to its task and its commitment to seek the truth. But this relationship between science and truth, a heritage from the European history of science, is put into different perspectives by science itself. Even the best experimental data can be very short-lived, and researchers have learned to regard this data as true only until new data become available. In biology, and in particular in the neurosciences, scientists are used to working with parallel realities as a result of complex, self-organizing systems that can be described on different levels, such as molecular and cellular systems or behaviour. In this way, the quest for absolute truth is increasingly replaced by establishing robust or reliable knowledge.

It is too early to say if this means a paradigm shift in scientific research. My impression is that the process of knowledge production is changing. Research is conducted more and more under the influence of nonscientific organizations and industry, which is not necessarily a bad development as it allows science to increase its efficiency with limited funds. However, it is not correct to assume that scientists live a blessed life in an ivory tower, in which they have all necessary resources to hand. An active researcher is an entrepreneur who has to manage production, research, personnel, finances, marketing and the sale of his or her product in an international and highly competitive market. My personal experience has shown me that the new generation of young scientists accepts and masters these

changes in the process of knowledge production while still experiencing the same elementary joy of unravelling knowledge, and following the same traditional rules of good research, of which honesty and credibility rank highest. But they now have to learn the additional task of conveying this joy and experience to the public, who have come to expect science to offer solutions to their problems.

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REFERENCES

- Heisenberg W (1969) *Der Teil und das Ganze*. Munich, Germany: R. Piper
- Kreutzberg GW (2004) The rules of good science. *EMBO Rep* 5: 330–332
- Noelle-Neumann E (1999) Wissenschaft in der öffentlichen Wahrnehmung. *Forschung & Lehre* 5: 228–232
- Nowotny H, Scott P, Gibbons M (2001) *Re-thinking Science*. Oxford, UK: Polity Press
- Popper KR (1959) *The logic of scientific discovery*. New York, NY, USA: Basic Books
- Weingart P (2001) *Die Stunde der Wahrheit?* Weilerswist, Germany: Velbrück Wissenschaft
- Zimmerli WC, Sinn H (1990) *Die Glaubwürdigkeit technisch-wissenschaftlicher Information*. Düsseldorf, Germany: VDI

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