The secret ways of scientists

As scientists, we take our way of working for granted. We do not recognise how unusual it really is. But the public sees only the media's interpretations, which evoke a completely false picture of the scientific process. As a consequence of misrepresentations and promises that apparently have not been kept, the public increasingly regards science as a competition for the sake of vanity or money rather than the gruelling quest for answers that it really is.

We scientists accumulate data from carefully designed experiments in the laboratory until we gain some new insights into nature. The next steps are the meetings in the group leader's office where the data are carefully scrutinised. The work is subsequently elevated to presentation quality and paraded for inspection at an in-house seminar. Again, the data are challenged and new aspects or interpretations are discussed. During this process we share our information with colleagues before we can build on it to gain any benefit for ourselves. Finally, we draft, correct and polish a manuscript that we submit to a journal where we believe its publication will bring our work to a broad and interested readership. When blessed with a positive verdict, we ultimately share our knowledge with the world-wide scientific community.

We also share our reagents because we believe in the free exchange of information, even if it may reduce our advantage in the race to publish first. As a group, we are altruistic, generous, trusting and transparent. Our collective behaviour is not that of a business, where information output is dictated by the need to impress the market or the analysts. Nor is it the behaviour of sportsmen where gamesmanship usually wins over sportsmanship. Poets and writers also would balk at a system of constant cross-examination, correction by anonymous referees and demands for rewriting or adding an extra chapter or verse.

During the many steps from the first glimpse at what we believe to be a new

understanding of nature to the final published version, there are countless checks and balances. With time, our work is cross-examined by competitors and co-explorers who are helpful or may have a different or even rival interpretation of our work. Most frequently, this occurs in the review process of the submitted manuscript—an anonymous exchange between referees and authors. Tough questions are asked and failure to respond convincingly leads to the rejection of the paper.

And a result's life does not end when it reaches print. Available at that point to all scientists, it is read in many laboratories around the world and compared with the data of others. If the facts do not fit, then questions are asked, and ultimately the truth wins out. Of course, over a short time span it is inevitable that conflicting data on any topic may arise, but ultimately, clarification comes from a further set of experiments. Indeed, challenging the work of others is at the heart of the scientific process. As scientists, we are not afraid to accept a new viewpoint if novel approaches show the inadequacies of our interpretation. How many knock-out experiments have shown that the one gene seemingly responsible for carrying out a physiological task is in fact only one among several other possible candidates? Occasionally, even text books have to be rewritten as further research proves theories and dogmas to be wrong.

Unfortunately, the outside world does not understand just how robust the pillar of knowledge created by these layers of examination really is. This gives rise to great disquiet among those who have never been close to the mechanics of scientific discovery. The interdigitation of our work, the openness with which we expose our research to the critical review of others and the general intellectual honesty of our interactions is hidden from the non-scientific community. Instead, the media report about conflicting opinions of experts in legal battles, write about the 'silencing' of

alternative views on topics such as AIDS or genetically modified food, or spotlight different scientific egos locked in combat through debate of topics often only peripheral to their own areas of expertise.

In such a climate, it is no surprise that there is a growing belief that scientific 'facts' are just the result of a debate in which the cleverness of presentation is the crucial element, rather than the validity of the scientific argument. Worse, there is the suggestion that scientists reach a consensus about important scientific topics instead of basing their views on cross-referenced experimental data. This view undermines not only science itself, but all of the elements in our society that increasingly depend on it. As scientists, we must add to our long list of responsibilities the task of explaining at dinner tables, to our friends or to the media exactly how we work, how we challenge each other's assertions and how we struggle to untangle the complicated questions that nature poses.

Of course, we must continue to share our data and our reagents. Those who work within industry may respond to different criteria, but those of us working in the public-funded arena should not get confused about our responsibilities. Competition is at the heart of scientific progress. Nonetheless we must carry out research with openness, which is exactly the way we know will ultimately lead to knowledge and truth. The matrix of tests to which we must submit our results ensures that we are forced to consider all possible explanations for our data, and to engage in the intellectual discourse that is needed to explain the complexity of nature. We are well served by this rigour and ultimately—through us—so is society.

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