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EDITORIAL

Slowing Down

Age dulls the reflexes; slowing down seems inevitable. Nowhere is this more evident than on Indian roads, where both driving and walking seem hazardous, especially as the years advance. Nimbleness and lightning fast reflexes, invariably attributes of the young, seem necessary for survival on the roads of our cities and towns. Even placid academic campuses are rapidly being overrun by speeding vehicles, which hurtle along narrow roads. On my own campus I have often suppressed an urge to shout 'slow down' to drivers who seem to be in a great hurry in their apparently mindless desire to rush from place to place. There was a time when the pace of life was distinctly slower and a career in academic science proceeded at a leisurely pace, which seemed conducive to both study and reflection. Over the last few decades the pace has distinctly quickened, competition is more intense and the international scientific scene appears immensely crowded; at times resembling our streets where people appear to be rushing in every direction, often oblivious of their surroundings. The internet and instant connectivity have contributed greatly to speeding up communication and transmission of information, resulting in a situation where the average scientist can barely cope with the volume of information available in every discipline of science. Even as I have struggled to keep abreast of areas of science that interest me, the realization has dawned that the battle will eventually be lost. At times, I have wondered whether this feeling of inevitable defeat is only a result of aging or whether it is a feeling shared by others. I was, therefore, greatly heartened to stumble across an essay entitled 'Slow science', which asks 'whether chemists should slow down' (Lutz, J.-F., *Nature Chemistry*, 2012, 4, 588).

Lutz's essay is bound to strike a chord in older scientists who are uncomfortable with the headlong rush of modern science. Using Charles Goodyear's painstaking researches of the 1840s, which led to vulcanized rubber, as an example, Lutz notes that 'many breakthroughs of the nineteenth and twentieth centuries were made by one researcher – or a small group of dedicated researchers – after many years of patient investigation punctuated by rare, but meaningful publications'. The author draws attention to 'the recently founded Academy of Slow Science', which 'emphasizes that time, failure, reading and thought are needed to conduct relevant research'.

Encouraged by the fact that I had time on my hands and adequate experience of failure, I moved to the website of the Slow Science Academy, a task made easy by the power of *Google*. The Academy's 'manifesto' (a grand word that reminded me of Marx and Engels) begins captivatingly: 'We are scientists. We don't blog. We don't twitter. We take our time.' As one who does not blog or twitter, I read on. Was this an emerging group of European Luddites, striving hard to deny the power of modern communication technology? Or was this a group of aging scientists, like myself; naïve innocents cast adrift in the turbulent sea of technological change? Reading further, I realized that the new Academy was not espousing the cause of returning to a technologically simpler age. Rather, they seemed to say 'yes to the accelerated science of the early 21st century; ... yes to the constant flow of peer reviewed publications and their impact; ... yes to science blogs and media and PR necessities; ... yes to increasing specialization and diversification in all disciplines'. What cause was this new Academy espousing? They are in fact arguing for a 'slowing down' of the pace at which much of science is proceeding, even as the race for results, publications, rewards and recognition intensifies. They appear to hark back to an earlier era: 'Slow science was pretty much the only science conceivable for hundreds of years; we argue, it deserves revival and needs protection'. Their arguments may find an echo in the minds of those who are mildly uncomfortable with the changing ethos of science: '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 timescale, for which there must be room and to which justice must be done'. The new Academy reiterated its commitment to the world of social media by asking readers to express their 'sympathy on *Facebook*'.

Why is there this concern about the accelerating pace of science; a worry about overspeeding, leading to this call to slow down? In his column in the August issue of *Nature Chemistry*, Jean-Francois Lutz raises the provocative question whether chemists publish too much. He notes that 'scientists do not have anything close to the amount of free time that would be necessary to read all of

the literature in their field of research, even in specialized areas'. This is certainly true as the number of journals in chemistry and related areas has increased dramatically in the last few years, making it impossible to 'read' all the relevant literature. This situation is not unique to chemistry. Indeed the explosion of biological science literature, with biomedical research being the major contributor, has ensured that it is impossible even to scan the abstracts of all published paper even in a limited area. Lutz asks: 'Is ... all of this literature ... necessary.' The answer is clearly, no. However, there appears no way by which the flooding of the literature with repetitive, fragmentary and mediocre studies can be avoided. Scientists must publish in order to further careers. Institutions and countries are judged by the quantity of their scientific output. Quality and utility are harder to assess. It is indeed impossible to return to the more deliberate pace of the first half of the twentieth century. Lutz echoes an oft stated impression that 'progress is now much more incremental than it used to be 100 years ago'. Does the 'fast' culture of contemporary science raise other concerns? After all, with some effort it might be possible to separate the wheat from the chaff even in these days of an ever expanding scientific literature. Lutz suggests, and many others before him have implied, that the current acceleration in the pace of science 'may also be a factor in the prevalence of duplicate publication, plagiarism, irreproducible results and fraud'.

The drive to accelerate the pace at which research findings are published has been most noticeable in China. Indian policy drivers constantly cite the phenomenal growth of scientific output, measured by the number of publications, that emanate from China. In contrast, the rate of growth of scientific output from India has been modest; almost resembling a casually strolling pedestrian breaking into a gentle jog. Acceleration, however modest, is often accompanied by the problems of fraud, plagiarism and duplicate publication that appears to be becoming common place worldwide. A more serious problem, and one that is harder to address, is the irreproducibility of results described in hastily written papers. The biomedical literature is a specific example of an area where extravagant claims are not uncommon. Indeed, publications in 'very high impact' journals almost necessarily require authors to exaggerate the importance and applicability of their findings. A provocative column drew attention last year to 'an epidemic of false claims'. The author, John Ioannidis, argued that the problem of 'false positives and exaggerated results... is rampant in economics, the social sciences and even the natural sciences, but it is particularly egregious in biomedicine' (*Scientific American*, June 2011, p. 16). The author traces the origins of the crisis to 'the public's rising expectations of science'. He notes: 'Being human, scientists are tempted to show that they know more than they do. The number of investigators – and the number of experiments, observations and analyses they produce – has also increased exponentially in many fields, but adequate safeguards against bias

are lacking. Research is fragmented, competition is fierce and emphasis is often given to single studies instead of the big picture.' Biomedicine is also beset with issues of conflicts of interest, where the dividing line between scientific integrity and commercial considerations can be exceedingly thin. Ioannidis is perceptive when he concludes that 'the oligopoly of high-impact journals also has a distorting effect on funding, academic careers and market shares'. Distorted presentation of scientific results, by 'pharmaceutical and biomedical device industries, which may sometimes design and report studies in ways most favourable to their products', is a matter of concern. More recently, the need to 'raise standards for preclinical cancer research' has been emphasized. 'Methods, publications and incentives must change if patients are to benefit' (Begley, C. G. and Ellis, L. M., *Nature*, 2012, **483**, 531). In an earlier essay, Ioannidis – writing in the context of clinical trials – asserts that 'most published research findings are false'. This is an area where both study design and analysis of results are likely to be influenced by prevailing bias (*PLoS Medicine*, 2005, **2**, 0696). A later analysis emphasizes the distortion of science by current publication practices (Young, N. S., Ioannidis, J. P. A. and Al-Ubaydli, O., *PLoS Medicine*, 2008, **5**, 1418). The study uses an economic model to analyse science; treating scientific information as an 'economic commodity' and journals as 'a medium for its dissemination and exchange'. It must be disturbing to many to think of knowledge as a commodity being transferred 'from its producers (scientists) to its consumers (other scientists, administrators, physicians, patients and funding agencies)'. The commentary by Young *et al.* must be read by all those concerned with the role of journals in shaping and influencing science. Indeed, science today is necessarily viewed through the distorting prism of a stable of high impact journals.

The frenetic pace of modern science, often ruthlessly competitive, leaves little time for reading, thinking and even enjoying the practice of science. The transformation from an earlier and gentler age is evident in India. The art of grantsmanship must first be mastered by new investigators even as they set timetables for fellowships, awards and recognition, that have now become an essential catalyst to induce scientists to do what they should have normally enjoyed doing. The race for publication in high impact journals, the competition among colleagues and collaborators for listing as 'first authors' and the constant trumpeting of scientometric indices are signs of a profound and, apparently, irreversible cultural change. Science, even in India, is beginning to accelerate. The roads are crowded and the destination is largely unknown. Navigation through the traffic will be difficult in the years to come. For some scientists the pedestrian path may permit a gentle stroll, enjoying the sights and reflecting on the wonders of nature. For the majority, slowing down may be as difficult as it is for the speeding and reckless drivers on our roads.

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