

Word perfect

"I try never to write more clearly than I am able to think." This was the personal dictum, apparently, of Niels Bohr. You wouldn't suppose that writing too clearly could ever be a problem, but Bohr seems to have worried about it. Perhaps, concerned as he was with the philosophical peculiarities of quantum physics, he suspected that precise language would give false clarity to descriptions of quantum phenomena. His dictum also drips with paradox, which Bohr loved so well.

Bohr seems to have stuck to his principle. Take, for example, this not-so-memorable passage from his 1935 response to Einstein, Podolsky and Rosen over their famous challenge to the completeness of quantum theory: "... even in this stage there arises the essential problem of an influence on the precise conditions which define the possible types of prediction which regard the subsequent behaviour of the system. ... the [quantum] description can be characterized as a rational use of the possibilities of an unambiguous interpretation of the process of measurement compatible with the finite and uncontrollable interaction between the object and the instrument of measurement in the context of quantum theory."

Shreds of meaning flicker here, but in trying to understand the whole I can't help but think of Einstein's quip about philosophy: "When I read philosophy I feel as if I'm trying to chew on something that isn't in my mouth."

Many scientists, like Bohr, struggle to write digestible prose. This usually has less to do with high principle and more with a simple lack of practice, although some may feel that dense writing makes their work look more impressive. In any event, it's certainly odd, given the dominant role of the scientific paper in research communication, that young researchers rarely get any formal training in how to write one, or how to avoid passages such as the one above. Writing is a skill apparently to be picked up by experience alone, without training; although often it is not picked up at all — with amusing, and sometimes not so amusing, consequences.

It's certainly amusing when an experimental paper directs readers, if attempting to reproduce the results, to "stand in boiling water for ten minutes, then examine the flask". More troubling are those errors of logic leading authors to say things they never intended to say, as



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in the first sentence from a recent paper in this journal: "When a metal is subjected to a strong magnetic field B ," the sentence asserts, "nearly all measurable quantities show oscillations periodic in $1/B$." Nearly all measurable quantities? Including length, for example, mass and net electric charge? Of course not. The paper probably meant to refer to 'many electronic properties' or something similar. Still, it's unlikely that any reader was really confused for very long.

Much worse are those Bohrian constructions that present the reader with logical puzzles that have to be solved before meaning can be safely extracted. A paragraph within a text on earthquakes begins with the remarkable sentence: "Large earthquakes along a given fault segment do not occur at random intervals because it takes time to accumulate the strain energy for the rupture." Think about this. It takes time for strain to accumulate along a fault. Hence, one might reason, there must (in a simple picture of the process) be some delay between large earthquakes. But where does the notion of 'random' come in? Only after about two hours of pondering did I conclude that the author could not possibly have meant this. He or she meant to talk about earthquakes occurring 'periodically' along a fault zone, not 'non-randomly'. There's a big difference.

Poor writing of this kind, as the zoologist Peter Medawar noted, leads naturally to suspicion. "Either the writer is unskilled in writing", as he put it, "or is up to mischief."

One of the problems, perhaps, is that analyses of writing rarely seem to be very scientific. Advice is qualitative and descriptive; there's no objective way to test which of two essays or two scientific papers is crafted more effectively. I've learned the difficulties of teaching good writing in some recent seminars I've given, with a colleague, to PhD students and postdocs. It's easy to point out good and bad examples, less easy to identify the principles of effective written communication. Break your thoughts up into manageable pieces and express them in simple sentences. Ensure each paragraph

expresses one coherent point. Let more complex arguments emerge by stringing simpler points together. And try to write more or less as one speaks, with ideas arriving sequentially, rather than in parallel.

The former quality, in fact, has often been suggested as a secret of good writing. The essayist Clive James argues that the real secret to writing skillfully lies in the ability to turn internal speech into the written word. Speech is inherently linear and sequential, as is clear writing; confused writing by contrast tends to lapse into parallel constructions, demanding a reader keep several ideas and possibilities in mind. Effective writing, and admirable style, James suggests, comes from "extending natural speech rhythm over the distance of a complex sentence".

Our seminars have taught me that today's students lack neither talent nor interest. What they do lack is practice, and any form of instruction, especially aimed at demystifying the process of writing. Some also seem to have absorbed the bizarre idea that writing can be better if it makes ideas more obscure. After rewriting a few sentences of one student, his reaction was "but doesn't that make it look too obvious?"

Many scientists do write clearly. Richard Feynman, for example, wrote wonderfully, and captured as well as anyone the qualities of spoken communication in his writing. Even Paul Dirac, notorious for his abstract approach to mathematical physics, wrote a beautifully clear text on quantum theory. He seems to have approached language with the same eye for logic as he did mathematics. A story goes that a journalist once contacted Dirac about a sensitive paper he had written on the process of isotope separation. A colleague, helping Dirac deal with the situation, scribbled an instruction to the journalist: "Do not publish in any form." Dirac thought quietly for several minutes before saying "Aren't the words 'in any form' redundant in that sentence?"

Perhaps we should pay a little more attention to writing, and especially to the education of young scientists, whose difficulties might undermine more good science than we think. According to Werner Heisenberg, Bohr cut short the active period of his own scientific career in large part because of his immense difficulties in writing. For science to suffer from simple lack of expression really is a shame. □

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