Writing in the sciences[1]

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I would not be surprised if readers of this journal who know my academic background wondered what a chemist is doing writing about English composition. My professional role is certainly not to teach writing. When discussions about writing and verbal aptitude began at the University of Michigan two or three years ago, I wondered about it too. Why should 1, a scientist, take time and energy away from an already full schedule of teaching, research, and administrative duties to worry about writing?

In truth, my response was ambivalent, I was brought up in an atmosphere in which literature and languages were encouraged, so that when we were asked whether the university should do something about the level of student writing, my emotional response was an immediate and emphatic yes. I chair the Chemistry Department at a major institution of higher education, however, and in that role I am not allowed the luxury of deciding issues at the emotional level. For this reason, and for others, I began to ask myself if there could possibly be a rational basis for my immediate, positive response to suggestions that we pay more attention to our students' writing-including students in science. In the end I concluded that there is a rational basis, and my purpose here is to explain these reasons to those in my audience who may not respond at an emotional level quite as positively as I did to the possibility of a new emphasis on competence in writing.

I began my analysis of the problem by asking the following three questions:

1. Is good writing desirable-or perhaps even indispensable-for today's and tomorrow's scientists? Does a scientist really need to be able to write well in order to be a good scientist?

2. If my answer to this first and basic question were to be affirmative, should we then add writing programs and certification in writing competence, to what is already a crowded curriculum, in a demanding professional subject such as chemistry?

3. Even if it turns out that my answer to the curricular question is affirmative as well, do I really believe that the university and my own department can afford to pay for the extra courses and faculty time that would be required, especially in a period of growing competition for shrinking funds *and* when everything in the curriculum, new and old, has to be considered on its own merits?

In an attempt to answer the first question, I asked myself yet another series of questions. (For a time, I had many questions and precious few answers.) These were perhaps the most basic questions one can ask about writing: What is the function of good writing? Is writing a unique human activity? From the point of view of the scientist, is there any alternative to verbal communication and conceptualization?

I had reached, from my point of view, the heart of the matter. At this point, I recalled a Chinese saying by Chuang Tzu, and the recollection disconcerted me.

> A basket-trap is for catching fish; but when one has got the fish, one need think no more about the basket. A foot-trap is for catching hares; but when one has got the hare, one need think no more about the trap. Words are for catching ideas; but when one has got the idea, one need think no more about the words. [2]

This tells us that ideas and conceptualizations may be completely nonverbal in character. I realize that there are at least two points of view on this issue, but it should at least *be obvious* from the existence of mathematics that nonverbal conceptualization is not only *possible* but frequent. My view has been strengthened by contact with other scientists over the past 30 years and, while not claiming that it is universal, I find that it is a point of view not always considered or understood by people who spend most of their lives in a highly verbal world.

Being a scientist and therefore only a part-time resident in that verbal world, I am not disturbed by the nonverbal nature of much scientific thought. From my point of view, what makes the idea of nonverbal thought easier to accept is, to go back for a moment to my Chinese proverb, what I understand by the word "catching." The proverb is not about the original conception or generation of ideas, which is the aspect of scientific thought most likely to be nonverbal. Baskettraps do not create fish. Basket-traps capture fish and place them in the hands of people who want to eat them. Likewise-the proverb tells us-words do not necessarily create ideas (or, correlatively, words are not always necessary to the generation of ideas). Words capture ideas and place them in the hands of people who want to know and use them. In short, our common concern in writing is the transmission of ideas rather than their initial conception. It is in this, the transmission of ideas, that the written word is so important to scientists and nonscientists alike.

What then is the function and purpose of writing? I am about to take a position here that may shock some of my *fellow* scientists and perhaps some of my colleagues in literary studies as well. My position is that in many respects *the* function and purpose of writing is very much the same in both literature and science.

In literature-that is, in fiction and poetry-writing seems to me to serve four functions. First, writing conveys perceptions from one person to another and thereby increases the collective experience of humankind without every individual having to have every possible experience him or herself. Second, I see writing as necessary in analyzing those perceptions so as to extract whatever may be universal in them. Third, writing serves as a kind of bait. It evokes the emotions that an idea is capable of generating. It involves readers by summoning up their emotions, emotions which resonate with similar situations, similar ideas, similar conceptual relationships experienced in the past. And fourth, writing is necessary in our attempt to tie all of these things together into some kind of coherent entity so that we leave the reader with an added dimension of understanding, an overall or gestalt sense of the subject at large.

So much for the purposes of literary writing. What about science writing? I would maintain, even in the face of considerable opposition, that science writing seeks to do much the same kind of thing, although not in exactly the same way.

Of course, the scientist seldom has the luxury of seeking to match the lyrical quality found in much of the best English literature, even that written by scientifically oriented writers. Take for example, this passage from the title essay in Aldous Huxley's collection, *Music at Night*.

> Moonless, this June night is all the more alive with stars. Its darkness is perfumed with faint gusts from the blossoming lime trees, with the smell of wetted earth and invisible greenness of the vines. There is silence- but a silence that breathes with the soft breathing of the sea and, in the thin shrill noise of a cricket, insistently, incessantly harps on the fact of its own deep perfection. Far away, the passage of a train is like a long caress, moving gently, with an inexorable gentleness, across the warm living body of the night. [1]

As beautiful as we may think this passage is, what scientist would write the same way in explaining the results of laboratory experimentation? On the contrary, the scientist must suppress the kinds of emotive responses which may prejudice the answers, or even the questions, that arise from the work. For this reason, scientific prose must be much more concerned with the precision and logic of language than with its ability to convey suggestive images and to woo us with sound. Precision and logic require no less mastery of vocabulary and syntax than does evocative writing.

It is difficult to choose a highly technical passage suitable for a mostly lay audience that will demonstrate my point. However, all of us in the sciences have at some time come across passages of unusual precision and depth of scientific understanding. Perhaps as an example I could quote some passages from Cyril Hinshelwood's *Structure of Physical Chemistry*, in which Hinshelwood manages to convey the approach he will take in describing natural phenomena in that book.

> It is in this spirit that we shall examine the scope and achievements of physical chemistry and see what views about the nature of things it reflects. We shall attempt to show the subject in continuous development which reveals its structure and displays the relation of its parts. We shall therefore not pay much attention to the accidents of history, but we shall be very much concerned with the methods by which an enquiring mind can penetrate the secrets of nature. In this sense, the treatment may reasonably be called humanistic.
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> We shall find it necessary to keep before us what is meant by a scientific explanation: It is, in effect, the representation of the unknown in terms of the known, but we shall find that the idiom in which the representation is expressible has to suffer some remarkable transformations as we proceed. In the early stages, to employ (yet again) the metaphor of the picture gallery, we spend some profitable time in a school of primitives: presently we find that more abstract schools command our attention. [4]

I recall being impressed, the first time I read Hinshelwood's book, by his unusual economy of expression, his clarity of intent, and the striking imagery of

his presentation. He seems to use language to do everything Huxley uses language to do. He conveys his conception of scientific method to us, suggests its universal nature, involves us emotionally in his powerful sense of its significance, and leaves us with a sense of its relationship with still larger intellectual issues; and he does all this through language which is both logical and precise. This precision is even more evident in the more technical portions of the book.

Having made these remarks about the logic and precision of scientific writing, however, let me now dispel what I perceive to be some myths about scientific writing. First, scientific writing is not inexorably logical! In fact, by its very nature it cannot be. It is after all an attempt to describe, at least in the case of many fields of physical science, submicroscopic moieties such as electrons, protons, atoms, and molecules, in words which were, as often as not, invented to express the more concrete perceptions of everyday life. Many times in science writing we take over common words, strip them of their emotive content in everyday language, and use them in entirely different ways. For this reason, the scientific reader and the lay reader alike must be aware in advance that science writing may take such liberties.

In addition, just as the very best works of literature are often allegorical in structure-and here I have in mind such authors as Stendahl and Kafka--so is the very best scientific writing. The allegories of science, however, must be more precisely correlated to the physical world than the allegories of literary writing. They must precisely define the phenomenological constraints within which their truth lies. But otherwise, scientific writing must not seek to limit the imagination of the reader. In fact, it is impossible to believe that one person's concept of an electron or a molecule is exactly the same as another's. Modern physics and chemistry have shown us that there is a great deal of room for the imagination to maneuver within the limits set by these disciplines. We can go still further. It is true that most analytical arguments in science are flawed by their lack of completeness. What many lay people (and some scientists) do not realize is that evidence of completeness may often be confidently regarded as signifying the presence of a tautological argument. In some cases, the tighter and seemingly more allencompassing the logic and precision of an argument is, the more likely it is ultimately to be proven false.

As for feeling in scientific writing, scientists do seek to evoke excitement and even wonder and awe in their work. One hopes though that these emotions do not run away with the reader and that writers do not evoke them in order to distract attention from conceptual weakness or an experimental flaw. The true excitement of scientific writing comes in the writer's ability to reduce our confusion about the natural world as we perceive it normally and enlighten us about it by managing, as Hinshelwood puts it, to "represent the unknown in terms of the known." To sum up, (hen, it seems to me that the role of writing is similar in science and literature in that both must faithfully transmit experiences from one person to another in a nonephemeral and therefore analyzable way. These experiences may be the emotional ones of literature, or they may be scientific observations. Our obligation in either case is to transmit these experiences as faithfully as possible to others.

For scientists, this is a serious obligation. The continued health and well-being

of our disciplines depends on our discharging it. Scientists have been called the "new Mandarins." The "old Mandarins" were a cultured and sophisticated people whose society fell because they lacked the ability, or the resolve, to transmit their experience to those who were not privileged to share this high Mandarin culture and sophistication. Ii science and scientists have erred in the past-and they have been accused of many offenses to which 1 do not plead guilty -that error is poor communication with the community of enlightened and enlightenable people at large.

To my mind, this gap in communication can be bridged only by excellence in writing. Other media, such as television and film, can certainly help us, but their ephemeral nature makes them unlikely, in the long run, to satisfy an introspective and discriminating public. As compelling as they often are, they are capable of merely scratching the surface of scientific understanding. In my view, therefore, whereas scientific concepts and ideas may indeed be nonverbal in their creation and growth, transmission and broad communication of them is, and will remain in the foreseeable future, dependent upon precise verbal expression.

To my first question, then, "should scientists be able to write well in order to be good scientists?," my answer is an unequivocal "yes." To my second question, " should we make way for writing in the university, even at the upper level of our professional curricula?," my answer is also an unequivocal "yes," and I would add, *particularly* at the upper level. It is there, in the final stages of scientific training, that the mechanics of writing provided in the early years of school and college can at least be applied to the transmission of substantive ideas in a clear, effective manner both to peers and to a lay audience alike.

As to whether we can afford to add these dimensions to our university curriculum, the dialogue about the importance of writing now going on in many colleges and universities among people in all disciplines demonstrates sufficiently to me that we not only can afford to do so but that we cannot afford not to do so. Not to teach our scientists to write would, in my opinion, restrict the future of our nation and the future of the whole human race: it is that serious a matter. In the future we will need to make use of all the ideas we can get even if we are to survive, let alone survive with honor. Our survival will depend on scientific ideas being available to, and understood by, everyone. Only excellence in writing can ultimately achieve this universal understanding.

Notes

[1] This article appeared in another form in *Proceedings: English Composition Board Conference.* 12 May 1978, University of Michigan.

[2] Arthur Waley, *Three Ways of Thought in Ancient China* (Garden City, N. Y.: Doubleday,
Anchor, 1939). p. x. The passage quoted is from Chapter 26 or the " Chuang Tzu."

[3] Aldous Huxley, Music at *Night* (Garden City, N. Y.: Doubleday, Doran, 1931) , p. 40.

[4] Cyril Hintedwood, The Structure of Physical Chemistry (Oxford: Clarendon, 1951), p. 4.