

COMMITTEE IV
The Relationship Between Science
and The Arts and Its Relevance to
Cultural Transformation

DRAFT - 8/15/86
For Conference Distribution Only

THE "I" IN SCIENCE LITERATURE: A BASIS FOR UNITY?

by

Dr. Michael Shortland
Department of External Studies
University of Oxford
Oxford, ENGLAND

The Fifteenth International Conference on the Unity of the Sciences
Washington, D.C. November 27-30, 1986

© 1986, Paragon House Publishers

THE 'I' IN SCIENCE LITERATURE: A BASIS FOR UNITY?

ICUS XV
Committee IV
November 1986

Dr Michael Shortland
University of Oxford

One of the more self-sustaining assumptions of modern Western culture has been that literature and science do not mix. Both have a function, each has its place, but never the twain shall meet - such has been the current consensus. The labours of C.P. Snow notwithstanding, attempts to bridge the "two cultures" have conspicuously, or rather unobtrusively, failed. As Snow's barbed exchanges with the critic F.R. Leavis illustrated, there has been little room here for compromise and much for mutual hostility and incomprehension. The "two cultures" debate now seems relegated to history, an artefact to be picked off the shelf, dusted down and peered at quizzically on study courses devoted to the 1960s. This neglect is unfortunate, particularly so since many of the important issues raised during the debate seem to have fallen with it into darkness. The result has been that observers have tended to think that all that could be said on the relations between science and literature has already been said. Talk of the "two cultures" debate today is likely to bring otherwise agreeable intellectual discussions to a rapid and embarrassing halt. That debate, one is tactfully made to realize, has been well run and has run its course.

That contemporary thinkers often pass hurriedly over the debate may suggest that it has been well thought-out; but perhaps instead that it is now unthinkable. After all, the notion of one rather than two "cultures" has all too often been conceived in a totalitarian sense, as a means for the assertion of either the scientific or the literary viewpoint. Worse still, it has been asserted that one particular science, say physics, or one branch of literature, say the novel, can lay claim to a privileged access to the truth. This accepted, it has apparently followed that the solution to the "two cultures" problem lies in a hegemony, in a form of imperialism which would settle the agenda, formulate the methods, and devise the problems for other peripheral colonies to debate at leisure, and probably to little effect. Without wishing to be over-pessimistic, this perspective on the "two cultures" debate does serve to suggest why an issue of such obvious importance could so quickly have fallen into neglect. This makes the opportunity afforded by ICUS XV to reopen the issue, or rather the set of issues, particularly welcome and necessary. Dr Goldsmith's discussion paper, for its part, is an excellent catalyst: it injects a useful measure of historical perspective, critical reflection and bold hypothesis into the kinds of discussions Committee IV may be hoped to undertake.

A more appropriate time to cast a collective eye over the many dimensions of the relationship between science and literature - or rather, as the title of Committee IV has it, "Science and the Arts" - could not have been chosen. I have a strong sense that in the past few years a revival of

great interest and direct relevance to this relationship has occurred. Science writing (that is, writing about science) has progressed in my view to a stage which may well be qualitatively new, though one may be tempted to suggest that it has yet to reach the heights attained by such figures as T.H. Huxley and John Tyndall a century or more ago. Leaving aside the historical comparisons and contrasts one might be inclined to make, it remains that the kind of science writing now practised by such figures as Stephen Jay Gould, Lewis Thomas and Oliver Sacks is now often said to constitute a literature of its own; one able to withstand even the harshest judgements of that erstwhile foe of science - the literary critic.

It should be noted that the writing we are dealing with here is the work of active scientists, indeed, of highly distinguished scientific figures holding positions of high office whose properly scientific work is well-regarded by fellow researchers. In other words, the views espoused in the various articles and books produced by this new breed of science writers springs from active and continued involvement in scientific investigation. This in itself distinguishes the work of Gould, Thomas and Sacks from that of scientific journalists, whose commentaries are two, three or four removes distant from the level at which discoveries and inventions are made. Many scientists, suspicious though they are of journalists, nevertheless admit that the new science writing for the first time in living memory "rings true" and "feels right".

What else links together this new science literature? The question of its style or styles is one on which I feel unqualified to comment, though I note a number of obvious differences within the writing: for example, Sacks' prose is lush and lyrical, at times even gushing, while Gould's is more formal and restrained. The issue of subject matter is easier to settle: here there do seem to be some common themes. The three authors mentioned address issues wholly within the life sciences from evolutionary theory, through psychology to medicine. If bridges are to be thrown across the divide that separates "science" from the "arts", or "science" from the "public", the choice of the life sciences seems a sensible one from which to build foundations. Medical and biological issues come far closer to people's active interests than issues arising from chemistry or physics; it is easier and more attractive for the poet, musician or artist to dwell on the status of the body or the progress of life than on the interaction of molecules of the constituents of matter.

Immediately, then, the new science writing by its choice of themes may be said to have anticipated the interest and attention of the artistic and public communities. But, of course, not all "biology watchers" (as Lewis Thomas dubs himself) are themselves watched and their writing read. Before this can occur, a common language or accessible level of discourse needs to be developed. This does seem to have occurred. The treatment of "life themes" in the new science writing is resolutely non-reductionist. It neither begins with the basic constituents of matter (as textbooks conventionally do), nor ends with them (as do many scientific popularisers). The overall effect, in

other words, is not to subsume the "vital" to the mechanical or the material. The aim is not to institute a "totalitarian" discourse, in the sense described above, but to emphasise that there exists about living things something which cannot be retrieved and resolved by recourse to molecular biology, nuclear physics, or biochemistry.

This, the reader will interject, is hardly a new perspective; and it is quite correct that, though the links new science writers have with "vitalism" are very faint, their writing does call forth a variety of well-rehearsed responses to the "nothing but" school of science. Indeed, one rather senses that this is an "anything but" school in the process of formation: a collection of authors for whom many developments, but none alone, in the arts, sciences and humanities are equally pertinent to the "scientific" matter at hand.

This reassuringly liberal attitude to source materials is matched by what may seem to be a rather unexceptional recourse to the notion of creative activity in this science writing. It hardly needs saying that to the musician, poet or artist creations result from the creativity of creators. It hardly needs saying because it is almost a truism. In the arts, the formal constraints on creativity are relatively weak and concealed, but this is not the case in the sciences. There are, of course, individual creators aplenty in science - everyone admits as much. But their creations, their discoveries or inventions, only become so once they have been accepted by the scientific community; until such a time they are viewed with a suspicion, not to say hostility, which scientists are wont to label "healthy". The process of acceptance of scientific "creations" is highly complex - a function of peer review, corroboration, and various forms of testing. At the heart of the process, however, is the assumption that what has been discovered by one scientist can be discovered by another: indeed, the whole structure of science rests on the reproducibility of results. But can creativity be reproduced in this way? Is not the impact of the scientific model to deny the role and the relevance, certainly the importance, of the individual creator?

To some degree, it might be said that science allows full rein to individual creativity but with the proviso that the results of that creativity are open to community testing. Yet the work of sociologists of science, from T.S. Kuhn onwards, has revealed that the constraints on the innovator imposed by "normal" science are far greater than this suggests. Besides, even if we accept the first position, that only the results of creativity are scrutinised, one may ask what kind of creativity it is that can flourish in an atmosphere where it is known that all its fruit must be handed over immediately to open, anonymous, routine testing and appraisal.

I should like to spend a little longer on this theme, extending and deepening it in various ways. My general point, to which I shall return, and which I hope will be revealed in the form of a stark contrast, will be that the new science writing is a powerful and, especially to the non-scientist,

stimulating and attractive, form of literature in large measure because it restores the individual creative self to a key role in scientific work. The contrast by which I intend to make clear this point is necessary because the 'I' in science has so often been denied or decried.

The effacement of self is nowhere more startlingly apparent than in the one form of science writing where it might have been expected to thrive: the scientific autobiography. As a source for the generation and circulation of potent images of science, the scientist and scientific communities, the scientific autobiography has few rivals. This being so, I hope that my claims about the genre, though they will be based on a limited range of materials, will be perceived as having a reach beyond the confines of the scientific autobiography itself.

In turning to scientific autobiography I find myself launched upon extensive but largely uncharted waters, for this is a form of writing often read but seldom studied. It is interesting to ask why this might be so. It cannot be for lack of materials: from the late nineteenth century onwards, it has become almost customary for scientists, once they feel unable to contribute anymore to science, to imagine that they can begin contributing to literature. They no sooner renounce the test-tube than scientists pick up the pen. So if the silence which has greeted these productions from the literary establishment cannot be put down to inadequate numbers of artefacts, how may it be explained? To some degree, scientific autobiographies belong to a rather awkward literary genre, offering the account of a career rather than a life. In a review of James D. Watson's The Double Helix, Erwin Chargaff noted this, and added that as such scientific autobiographies lacked general interest. Contrasting the situation in the arts and the sciences, Chargaff added, "it is not the men that make science; it is science that makes the men." Even once we take into account the strong dislike Chargaff is known to have had for Watson, we cannot ignore what he says about the lack of personality in scientific autobiography, because there seems to be broad, though indirect, support for his views in the work of some active science watchers. In a review of recent work on the psychology and style of science, Gerald Holton draws together what he call "the main features that define scientific style as commonly understood at present." There are five of these:

- (1) In written work "the individual traces of the personal self [should] be attenuated as far as that can be done."
- (2) Scientist should "be logical, not emotional ... Mere opinions, preferences, emotions, and instincts must be repressed."
- (3) "Errors or unlikely hypotheses are to be avoided at all cost."
- (4) "The desired outcome is the simple, not the complex."
- (5) "As with the content of science itself, the setting in which one does one's science is ideally as removed from interpersonal disputes as possible."

The five points of Holton's consensus strongly suggest that science on the whole is an activity hostile to the possession, or the discovery, of a personal self. If the style of science is echoed in the scientist as a person, that by itself would be enough to account for Chargaff's complaint.

But to what extent does Holton's characterization of science apply to scientists as they appear in their autobiographies? Nietzsche felt that most Europeans, in their later years, "confused themselves with their [professional] roles." Does this happen in scientific autobiography? What is the relation between science and self in these works? Do writers see personality as interwoven with the choice and practice of a career, as irrelevant to it, or as ending with it, as if personality were a mere stage of life? Holton's summary suggests that we should not expect to find full-blown literary or confessional selves in most of these works, because that would go so squarely against a professional code that seems strong enough to reach beyond the laboratory to affect scientists as persons. If we do not find such selves, what do we find? Are there any constructions we might want to call "scientific selves"?

It is time to say what I mean by "self" - and I want to at least begin what I hope will be fruitful discussions at the ICUS in a simple way. I mean a sense of the writer's essential individual or "transpersonal" identity. Roy Pascal finds that the most interesting autobiographies "are written from an inner necessity", and that their essential content is "the evolution of [the author's] mode of vision in terms of his successive engagement with the world". James Olney makes a broad distinction between "simple" and "duplex" autobiography. In simplex autobiography the author sees his or her personality as one-dimensional, as unchanging, or as beside the point. For the duplex autobiographer, on the other hand, the individual self, the idea that life has a subjective basis, that one's potential and one's limits both derive from a unique and evolving personality, is the whole point. Olney sees Darwin as simplex, for example, and Jung as duplex. Inner necessity, evolving vision, and acknowledged subjectivity are all aspects of what I have loosely called the self, and should be part of any extended search. I hope we should have the opportunity to discern yet further features of the scientific self in our discussions, for this is surely a key determinant in constructive engagements with the possibility of "one culture".

How do we know the self when we encounter it? Sometimes it is easy, as when the author tells us something personal that we feel is both important and accurate. Often, of course, we get our cues from what we feel are omissions, or when we and the author seem to feel differently about something that is there. We respond ironically to excess, reticence, and inconsistency, just as we do in certain works of fiction - with the difference that in fiction the writer has created them for us whereas in autobiography they are mostly unintended. As with fiction, we take our cues from many places, looking for a theory of the whole that does justice to our sense of the narrator and also to our sense of the world which that narrator has arranged by way of self-explanation.

Now, if one accepts the meaning of "self" presented by critics who have examined the autobiographical genre, it appears that the scientific autobiography not only fails to present this literary "self" but even breaks the cardinal rule of all autobiography: that it should focus attention onto self, onto any self. After all, it is widely accepted that the autobiography by its very nature should describe a subject trying to get into his or her own skin, that it should be a personal, subjective outpouring; a quest dealing with the author's experiences, in a rather confessional mode. So keen are some commentators on this definition of an autobiography that they promptly relabel all scientific autobiography as "memoir" and thereafter dispense with it entirely.

This is an unfortunate response in that it tends to define scientific autobiography according to preset requirements only to detect in it an absence. This absence is then taken to be a lack. I hope to show that whilst the bulk of scientific autobiographies have indeed sought to efface self, to deaden the subjective impulse, this is the result of a particular historical conjuncture now, thankfully, past. Since the conditions which led to the production of self-destructive autobiography have disappeared the opportunity now arises for scientists to begin writing reflectively, or reminiscing critically, on their role as individual scientists. They may now restore the "I" in science. Thus far, it appears that this opportunity has only been taken up by the authors I have described as instituting a new form of science writing, though it might be claimed that the physicist Richard P. Feynman's autobiography breaks new ground in this respect. Before I turn to that idiosyncratic production, I would like to consider the particular historical circumstances which seemed to have called forth that apparently impossible text - the anti-autobiographical autobiography.

The first indication one has that the scientific autobiography may be a reflection of certain determining scientific-historical circumstances is that the genre only arises in the late nineteenth century. The second is that only a certain kind of scientist typically left an "autobiographical trace". Such a scientist had been marginalized by the scientific establishment, because of geographical location (e.g in the provinces), class, training (or rather lack of it), or subject specialism. As a result, scientific autobiographies have served first and foremost to defend or articulate a series of territorial, individual or scientific claims. Most often, they have been written to show that scientific culture "beyond the cities" could nurture valuable results or that non-physical sciences could produce valid knowledge.

That scientific autobiographies were prepared as promotional exercise becomes easier to appreciate from the shape and structure of the early nineteenth-century scientific establishment (the establishment which was active when later nineteenth-century autobiographers began their reminiscences). We probably have an image of today's scientific establishment as a powerful, well-entrenched, well-policed social force. It speaks, for the most part, with a unitary voice:

whether you are a scientist in Oxford, New York or Tokyo, whether you study bones, bats or bacteria there is one scientific method, there are a number of accepted scientific laws, and there are rigorous procedures for collecting and marshalling evidence. There exists, in short, a pervasive and potent scientific ideology which binds scientists together into a community. But things were not always as secure as this. The authority, power and hegemony which science now wields has been fought for hard and only quite recently acquired.

For much of the last century, certainly, and in some respects well into our own, the "scientific community" has been fissured into warring factions, across subject, class and regional divides. Some factions retained their own research agendas, leadership, journals and debates, provoking disputes about the methods, laws, procedures and evidence of various scientific disciplines and specialisms. As the nineteenth century wore on, such disputes came to centre increasingly on claims to scientific objectivity. So far as the physical scientist trained in a recognized university was concerned, scientific objectivity was an early acquisition of the trade: he could claim that in researching "dead matter" his subjective interpretations and prejudices did not come into play to inform, or misinform, his findings. Moreover, he could assert as a failsafe that a training at university ensured that he had mastered the appropriate techniques of observation, theorizing, and just reasoning.

However, on both these counts, the bulk of nineteenth century scientific autobiographers faced a problem. For one thing they did not study dead matter, but living forms. For another, they had not for the most part been through the conventional academic mill or metropolitan apprenticeship. The pressure imposed on these "marginal" scientists to justify their labours was intense: so much so that when they came to look back on their scientific careers, they felt impelled once again to emphasize their just title to the mantle of "objective scientist". This they did in a number of ways, each of which throws considerable light on the nature of "self" in science and the imperatives of scientific conformism.

The simplest means was for the scientific autobiographer to boast continuously of his honesty and modesty. He does not lie and has no reason not to tell the truth. T.H. Huxley reiterates the point throughout his little memoir, and already sets the scientific autobiography apart on this basis: literary autobiographies are works of fiction, his a work of fact, without - as he puts it - "cant, humbug or self-seeking". But, despite Huxley's neat rhetorical move, the self attribution of honesty is rather typical of autobiographies in general. Though some autobiographers are liars and many misinterpret themselves, it is almost in their nature to claim to tell the truth. Nevertheless, scientific autobiographers do this more consistently, I think, and I am sure more often, than other memoir writers. But more crucially, I sense that they do so for slightly different reasons. Rousseau, for example, promises to tell us the "naked unblushing truth" but does

so, it is clear, to raise his own status and our respect for him; when Huxley does the same it is not that we may be assured of his sincerity but that we may think his science valid and correct.

This brings us to a second procedure much deployed in laying claim to objectivity. This is to erase from the scientific autobiography all literary conceits, so that the work seems quite without art or artifice. Now I do not wish to say that we have to take scientific autobiographers at their word. After all the claim that literariness can be dispensed with is literary through and through, just as a political credo lies behind the claim to be "above" or "beyond" politics. Nevertheless, it is obviously significant that an autobiographer like Herbert Spencer should reiterate time and again how "plain", hence "natural" is his Autobiography, and how little his life has been touched by the reading of novels. Spencer wishes to invent nothing. Better still, he wishes us to believe he invents nothing, but simply conveys clear recollection, unadorned facts and figures, and a ceaseless striving for objective statement.

These two methods function most effectively in the scientific autobiography to distinguish it from other variants of memoir writing. Yet it is a third procedure which answers most drastically to the needs of objectivity and which ensures a breach between this and other forms of literature. This is for the scientific autobiographer to distance himself, as a subject, so fully from his objects of study as to destroy or efface himself totally. Leaving aside, for one moment, the reasons why he might wish to do this, let me turn first to the question of how he does so. The first procedure is to disassociate the subject from the process of scientific investigation. Given the criticism that in examining living beings is naturally tempted to bring values, preconceptions and prejudices to his examination, the scientist responds by denying his very role in scientific investigation. And by this denial, the second criticism - that the scientist may lack the training to make him recognize laws, hypotheses and the true scientific method - is also neatly deflected. So we are faced with the peculiar situation in which even eminent nineteenth-century scientists of the living world seem to be denying the very contributions they, as individuals, made - the contributions which have elevated them to the position of autobiographer in the first place! There are many examples of this, but I shall take mine from the Autobiography of Charles Darwin, the most renowned biologist of the time. Here is a figure, one might think, with little to fear for his science. With honours heaped upon honours, with a worldwide reputation, with respect coming from all quarters, it seems incredible that Darwin would at the end of his life have written an Autobiography which so clearly set out to diminish his contribution, as an individual, to the process and progress of science.

Many impulses feed this self-negation. Darwin tells us, for one thing, that he was never very intelligent or far-seeing: he was mediocre at school and university, generally slightly dull. This is something other scientific autobiographers often mimic, even when it is patently untrue; Francis Galton, for example, repeats the affectation even though he did spectacularly well in his early

education and at Cambridge. So, to begin with, we are told that the subject has not introduced much intelligence into scientific work. Then we are told that he has not introduced into it much imagination either. Darwin tells us how he gradually lost all aesthetic sense, all enjoyment of poetry and literature, how he became - as he says - "like a man who is colour blind". In fact - and this is the crucial organizing device running through his Autobiography - Darwin is a humble, avid, greedy collector of facts. Here is the key, it seems to me, both for how the book is set up and for the purpose it serves. To make his pitch for scientific objectivity, particularly when the theory of evolution had been decried as a law of higgledy-piggledy, as a vague hypothesis who lacks evidential basis, Darwin wants to confront us with a world of nature which teems with life, with an animated, jumbled confusion of different varieties, species, beasts and plants. Faced with this panorama, Darwin approaches it with the emotional emptiness of the collector of evidence without prior expectation, knowledge or subjectivity. Working, he says, on pure Baconian principles, "I collected facts without theory on a wholesale scale"; and again, later "my mind has become a kind of machine for grinding general laws out of a large collection of facts". The point is then that his mind simply exists as a device to crank up theory from fact, without any input of intelligence and imagination, bias or prejudice. He wishes simply to mirror what he has seen. That is the pose Darwin the scientist wants to strike; it is the pose he has to strike in his Autobiography to counter various possible criticisms of a lack of objectivity.

I want to make it clear that I am not delving back simply to recuperate Darwin's intentions. The very texture and structure of the book reveals the same message. For what Darwin does is to assume the final defence against charges of authorial subjectivity by adopting what might be termed the defence ex morte. Having cast self from science, he casts it from his autobiography: "I have attempted", Darwin begins, "to write the following account of myself as if I were a dead man in another world looking back at my own life". That I claim is not a morbid impulse, but a scientific one. My point is that the particular historical circumstances in which non-physical scientists wrote their autobiographies in the nineteenth century led them instead to write, if I may be permitted this excess, their own obituaries. This is the sense in which the great bulk of scientific autobiographies form part of a self-destructive genre.

After this historical section, it is time to return to the theme with which I opened this essay. I hope the reader will have gathered the direction in which my thoughts are travelling. It is a familiar observation that scientific articles and textbooks dispense so far as is possible with the first person mode of expression; the scientific establishment looks with displeasure at the "I" in "science" being drawn out and stressed. The discussion above has aimed to show that even in the form of literature to which scientists have conventionally turned, if they have turned to literary expression at all, the "I" has been wholly effaced. In the very remembrance of their role as innovators, as creators, as scientists who would write about themselves at all, autobiographers have

denied that role. They have not created science: science has created them. They have been the humble vehicles - or as Darwin has it, "machines" - through which chaotic nature is distilled into organized natural laws. Scientists are absent victims in a scientific knowledge process without a knowing subject.

Bleak though this may seem, one can at least see the historical conjuncture which led scientists such as Darwin to adopt this pose. On the other hand, ever since the fledgling scientific community has become a scientific establishment with its well-known powers, laws and orthodoxies, the pose has been quaint and outmoded. Yet it has persisted, perhaps by convention or by some misconstrued loyalty to the progress of science which, it is felt, needs to be presented to the wider public as the result of disinterested, disembodied, objective research. More recent autobiographies find scientists effecting the same pose. Einstein, for example, perhaps this century's most cultured and literate scientist falls into line to present, in his autobiography, a thin, dessicated performance, a reminiscence offered as "an obituary".

If the scientific autobiography is the highest form of literature produced by scientists, one can begin to see why figures from the arts would hold it, and by extension scientists, in such low regard. How could an artist who places so much value on inspiration and imagination think well of a form of inquiry which, apparently, finds no place for either in its development? How could a literary critic, so attuned to the presentation of self and the display of the full range of human sensibility in literature, have sympathy with a discourse which erases self and denies the emotional input in scientific research? Dr Goldsmith opens his discussion paper with the remark that "scientific knowledge alone is not sufficient". I agree. But the non-scientist listening to the scientist reflecting autobiographically upon his life on the one occasion when he speaks directly to the public is likely to find here a picture of scientific knowledge which is woefully insufficient, not to say inadequate.

In opening this contribution, I mentioned a "new science writing" which seemed to offer the potential for a genuinely viable communication between scientist and non-scientist. This science writing has managed to fill the gap which should have been filled by the genuinely autobiographical scientific memoir. It is a form of writing which centres "self", which replaces creativity, intuition, and imagination at the heart of the scientific endeavour, which, in a word, restores life to science. It is tempting, indeed, to conjecture that it restores literariness to science as well, though this would be to succumb to that hoary scientific myth that the narrative of science possesses no literary qualities. Recent critical studies of the writing of scientists have shown beyond doubt that even the most apparently "transparent" and "realist" reportage, cast on to the pages of Nature or Science apparently without any consideration beyond accuracy and succinctness, is deeply moulded by literary conventions and codes.

To acknowledge this fully, as the new science writing has done, permits more than the freedom of expression. It allows, and to some degree encourages, the freedom of self-criticism and reflection: just that freedom offered by, but so rarely accepted within, the autobiographical format. The need for such criticism and reflection is pressing, particularly so when we recall that whereas we are surrounded today by political critics, art critics, literary critics, even television critics, we may look in vain for more than a handful of figures who could be judged "science critics". We have critics of science aplenty, but these hardly meet the requirements. A critic of politics is hardly a political critic. We have science journalists too, though judging from the column inches devoted to science issues in the daily press, they have little weight or influence in the editorial offices. Even so, it has to be said that the science critics would not have the same role to play as their journalist counterparts. Journalists fall prey to just those pressures and constraints which the critic must resist: the demand to simplify and disfigure issues in the interests of "good copy". Even the most resolute science journalist is likely to conceive his or her role being a didactic and explanatory one: science is complex and must be made easier to grasp. This actually makes science journalism comparatively straightforward. But the necessity for science critics arises in part from the recognition that one of the central defining features of science is not its complexity but the uncertainties with which it is associated.

Science presents a series of uncertainties for many reasons. Scientists, of course, continually debate and disagree with one another, to the great consternation of those who turn to them for authoritative "expert" counsel. The history of science reveals these debates as a series of sudden breaks or ruptures, albeit overlaid onto an apparently measured scale of progress. Another reason for uncertainty comes from the contract science has with the social world - the moment scientists escape the very narrow range of enquiry which normally holds their attention, they encounter problems which demand evaluation, decision and choice. What may have been neat and tidy (but in fact seldom is) becomes blurred and problematic once the findings of science end their laboratory lives.

This said, something of the tasks of the science critic becomes apparent. One aspect of science which has appeared from many previous studies is what one might call science's "dual image". Large majorities of the public have expressed the view that science is important, beneficial, and interesting and declared that they think it potentially dangerous, oversecretive and esoteric. It intrudes on their daily lives but remains somehow distant. People are affected by science but cannot themselves see the means to affect science in turn. In the classical sense of the word, one might say that the public has become "alienated" from science.

This alienation is a very complex and ambivalent feature of the relationship between science and its "audience". It will not be dispelled, as some scientists believe, simply by injecting more funds

into popularising science. Nor will the distance which now separates science from the public be contracted by merely presenting more science in the public's daily media diet. The problem demands a qualitatively new approach not a quantitative solution. The ambivalence reported in surveys of public attitudes to science is an important starting point for anyone who would wish to consider the relations between "science" and "literature". For those who might need to work at the interface between science and literature or science and the public, the first task must be to accept (or at least, investigate) the uncertainties which exist within science and the ambivalences which exist within the public. That task falls, in part, onto the shoulders of the science critic, which is why I have suggested that the raw materials of that critic must include "the uncertainties associated with science".

What is abundantly clear from a reading of the work of the new science writers - Oliver Sacks' Awakenings and The Man who Mistook his Wife for a Hat; Stephen Jay Gould's Ever Since Darwin, Hen's Teeth and Horse's Toes, and The Panda's Thumb; Lewis Thomas' The Youngest Science, The Lives of a Cell, and The Medusa and the Snail (to name but a selection) - is the centrality they give to those uncertainties. What is presented is a model of scientific discovery and invention which has none of the clean lines of the textbook account. There are no continuous ascents up the high peaks of knowledge, but hard climbing, with many false trails and blind alleys along the way.

I said a little earlier that this writing replaces "self" to a core position in the scientific endeavour. This strikes me as a crucial innovative feature of this form of science criticism and as a potentially fruitful basis for a viable rapprochement between scientific and literary discourses. To an extent which it would be well worth investigating, the autobiography, the narrative fiction and this new science writing all present to the reader similarly structured "stories". These have a number of clearly defined features: firstly, and most obviously, they have a beginning, a middle and an end - in that order, not as science articles often present their materials, with the conclusion laid out first of all. Next, they have characters - the authorial subject or some other familiar trope - with which the reader can make ready and easy identification. And lastly, they play with tension - the tension of discovery, development, and incident.

Taken together, this suggests not only some common themes across the divide which has long been assumed to separate science from the arts but also some of the ways in which the human qualities of those two realms may be preserved and assimilated. It may perhaps be said that the new science writing is a public relations exercise, a means merely to present the old science with a human face. I do not accept this, believing instead that the new writing offers genuine opportunities for broad public engagement with scientific research which a mere promotion exercise would not legitimate. But the development of the personal mode by scientists needs to be extended as well as encouraged. There is some scattered evidence that this extension is now taking place. The appearance of the

physicist Richard P. Feynman's autobiography may herald the introduction into the public domain of a genuinely personal scientific autobiography. This work - suggestively titled "You Must be Joking, Mr Feynman" - offers an excellent counterblast to those who have judged scientists incapable of self-criticism, wit, individualism and I-centredness. One is tempted to ask: does Professor Feynman's ludic production create what Dr Goldsmith has termed a "cultural earthquake", or does it instead result from a seismic shift originating elsewhere?

That is a question which it might be over-ambitious to pose at this early stage in discussions of the actual and possible relations between science and the arts. When an innovative form of "science literature" appears on the scene, it is best to hold it aloft for a while, to inspect it from many different angles, before finding it a neat fit in any predetermined category. The question whether the new scientific autobiography and science writing are forms of "science" or "literature" strikes me as premature, if not ill-judged. Far better to view these innovative productions against a broad historical background and then consider the bearing they might have on cultural transformation. The first task I have tried to begin to do in this contribution; the second will, I hope, attract the attentions of Committee IV of ICUS XV.