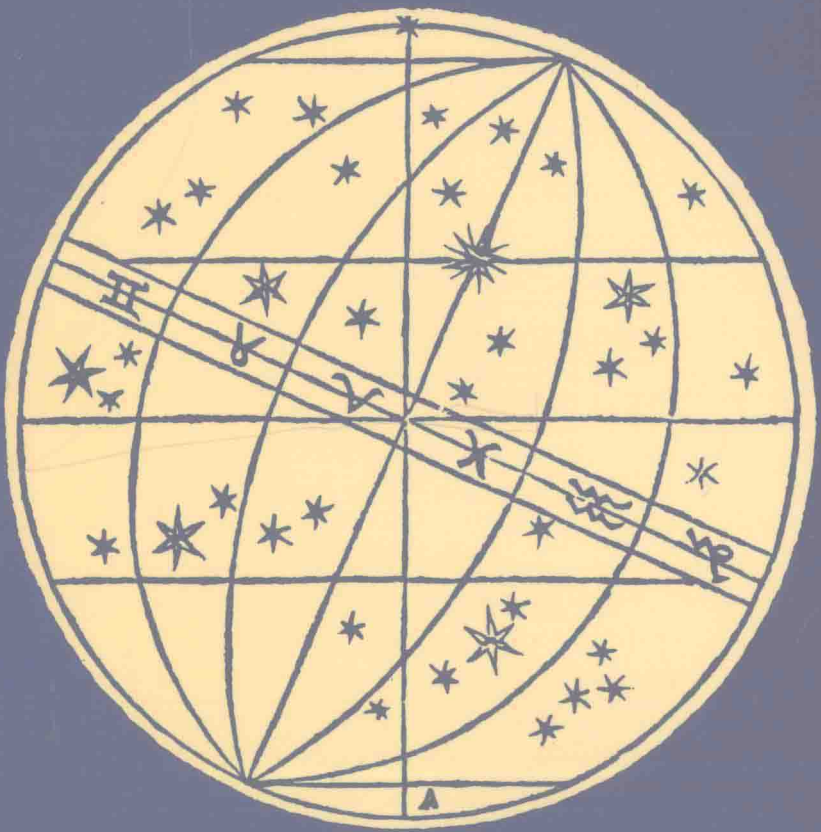
The Common Sense of Science

J. Bronowski



With a new preface by Sir Hermann Bondi

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by

J. BRONOWSKI

with a foreword by
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FOREWORD

This is a delightful book, at least as important now as when it first appeared. Dr. Bronowski squarely attacks the widespread attitude that science is different and separate from general culture, which he regards as totally mistaken, just as I do. Why, I wonder, is it that if you ask the man in the street whether he could learn, say, Albanian, he will respond that of course he could though it would be an effort, but if he is asked whether he could learn theoretical physics he will say "No, I have not got a mind like that". This distinction is unwarranted, false, and most damaging, and I thoroughly applaud Bronowski's efforts to demolish it.

What this book does so splendidly, and with a freshness which has grown rather than diminished with the years, is to analyse the evolution of scientific thinking in a language common to us all. Like any field of human endeavour, like any community, science and the scientific community are rooted in history and are shaped by, and partake in the shaping of, the common perceptions and predispositions of successive periods. Bronowski's talents combine in this book to describe the evolution of the climate of opinion in a most readable form. I am particularly glad that he has been able to put the role of causal connection in science into perspective, so that the philosophical worries about indeterminacy are shown not only

to be invalid but to refer to a much overemphasized aspect of the essence of science.

In the years since Bruno (to call him as all his friends always did) wrote this book, attitudes to science have changed. In 1950 the general public thought of science in this way:

> incomprehensible
> of immense power for good and perhaps also for evil
> if only it could be made to grow and spread more widely amongst countries, the world would be a happier place
> the chosen few who had the gifts and the opportunity to become scientists were very fortunate indeed and bound to lead a wonderful life; they should be venerated; and not only they themselves, but all their whims, should be supported by the public purse.

By 1970 this had changed to the following view of science:

> incomprehensible
> of great power for evil from which some good could occasionally come, but even what looked good at first was likely to have disastrous drawbacks
> its growth and spread needed curbing
> it offered a possible career for people who did not mind being shut away in a back room, doing rather dull work.

By 1978 we have moved some of the way back to the earlier, more optimistic, image, but these absurd oscillations of attitudes will continue while people regard not only the substance, but the outlook and methods, as incomprehensible. Until this notion is put right, the rest will hardly become sensible. Hence Bruno's book is still as essential and topical today as when it was first published.

Sir Hermann Bondi

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CHAPTER I

SCIENCE AND SENSIBILITY

(1)

I CAME to England when I was twelve, and when I landed I could speak, rather badly, two words of English which I had learnt on the channel boat. I did not read English at all easily for two or three years after. The first writers in whom I was able to distinguish what my patient schoolmasters called style were, I remember, Macaulay and Joseph Conrad. I do not remember now whether at that time I was also able to distinguish between their styles. I read greedily, with excitement, with affection, with a perpetual sense of discovering a new and, I slowly realised, a great literature. But I was handicapped then, and I have been ever since, by the disorderly way in which I fell upon my masterpieces: Dickens cheek by jowl with Aphra Behn and Bernard Shaw, and elsewhere leaving tracts of neglected literature by the century. To this day I have not read the Waverley novels, and in consequence I have remained rather insensitive to historical romance, particularly if much of the conversation is in dialect.

I make these confessions because they seem to me to bear on many stories besides my own. The difficulties which I had are not mine alone, and they are not in any special way literary difficulties. On the contrary, what now strikes me about them is their likeness to the trouble which other people have with science. At bottom my difficulties in facing a strange literature are precisely the difficulties which all intelligent people today have in

trying to make some order out of modern science.

We live surrounded by the apparatus of science: the Diesel engine and the experiment, the bottle of aspirins and the survey of opinion. We are hardly conscious of them; but behind them we are becoming conscious of a new importance in science. We are coming to understand that science is not a haphazard collection of manufacturing techniques carried out by a race of laboratory dwellers with acid-yellow fingers and steel-rimmed spectacles and no home life. Science, we are growing aware, is a method and a force of its own, which has its own meaning and style and its own sense of excitement. We are aware now that somewhere within the jungle of valves and formulae and shining glassware lies a content; lies, let us admit it, a new culture.

How are we to reach that culture, across its jargons, and translate it into a language which we know? The difficulties of the layman are my boyhood difficulties. He opens his newspaper and there stands a revelation in capitals: THE ELECTRONIC BRAIN, or SUPERSONIC FLIGHT, or *Is there life on Mars?* But capitals or italics, the revelation remains in code for him. The language is as strange to him as *The Anatomy of Melancholy* was to me at fifteen. He has only the smallest vocabulary: a smattering from other popular articles, schoolboy memories of the stinks lab, and a few names of scientists sprinkled at random across history. His history, which might have given an order to it all, is the most maddening of his uncertainties. I knew no English history, and therefore I could not make sense of literary development. How well I recall the helplessness with which I faced a list of names such as Marlowe and Coleridge and H. G. Wells. I could not make any historical order of them. It is hard to visualize my difficulty; yet just this is the difficulty which every reader meets when he sees the

names of Napier, Humphry Davy and Rutherford. These three scientists were contemporaries of the three writers, and they were by no means lesser men.

(2)

A knowledge of history of course, even the history of science, will not do duty for science. But it gives us the backbone in the growth of science, so that the morning headline suddenly takes its place in the development of our world. It throws a bridge into science from whatever humanist interest we happen to stand on. And it does so because it asserts the unity not merely of history but of knowledge. The layman's key to science is its unity with the arts. He will understand science as a culture when he tries to trace it in his own culture.

It has been one of the most destructive modern prejudices that art and science are different and somehow incompatible interests. We have fallen into the habit of opposing the artistic to the scientific temper; we even identify them with a creative and a critical approach. In a society like ours which practises the division of labour there are of course specialised functions, as matters of convenience. As a convenience, and only as a convenience, the scientific function is different from the artistic. In the same way the function of thought differs from, and complements, the function of feeling. But the human race is not divided into thinkers and feelers, and would not long survive the division.

Much of this quarrel between science and soul was trumped up by the religious apologists of Queen Victoria's day, who were anxious to find science materialistic and unspiritual. The sneer that science is only critical came from others. It was made by the timid and laboured

artists of the nineties in order that they might by comparison appear to be creative and intuitive. Yet this finesse could not hide their own knowledge that the best minds were already being drawn to the more adventurous practice of the new sciences: a movement which Peacock had foreseen seventy-five years before in *The Four Ages of Poetry*.

The arts and the sciences ever since have been in competition for the most lively young brains. This competition is itself the clearest evidence that good minds can fulfil themselves as well in one as in the other. Here in fact is one of the few psychological discoveries of our generation to which we can hold with a reasonable certainty: that the general configuration of intelligence factors which distinguish the bright from the dull is the same in one man as another, in the humanist as in the scientist. We are divided by schooling and experience; and we do differ, though we differ less, in our aptitudes; but below these, we share a deeper basis of common ability. This is why I write with confidence for laymen and scientists, because the reader who is interested in any activity which needs thought and judgment is almost certainly a person to whom science can be made to speak. It is not he who is deaf, but the specialists who have been dumb—the specialists in the arts as well as the sciences.

Many people persuade themselves that they cannot understand mechanical things, or that they have no head for figures. These convictions make them feel enclosed and safe, and of course save them a great deal of trouble. But the reader who has a head for anything at all is pretty sure to have a head for whatever he really wants to put his mind to. His interest, say in mathematics, has usually been killed by routine teaching, exactly as the literary interest of most scientists (and, for that

matter, of most non-scientists) has been killed by the set book and the Shakespeare play. Few people would argue that those whose taste for poetry has not survived the School Certificate are fundamentally insensitive to poetry. Yet they cheerfully write off the large intellectual pleasures of science as if they belonged only to minds of a special cast. Science is not a special sense. It is as wide as the literal meaning of its name: knowledge. The notion of the specialised mind is by comparison as modern as the specialised man, "the scientist," a word which is only a hundred years old.

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Therefore I have in mind as I write a reader who is less interested in the sciences than he is in science. There was in the last century a tradition of self-teaching in the Mechanics' Institutes which in its time was a just cause for pride. But the tradition is gone and its going now is not a loss, because the interest in science has widened. We are all aware of the widening. Those who hanker after a knowledge of science today are not looking for technical information. They are no longer unfortunates who would have liked to work in a laboratory too, if fate had not sent them into a mill at twelve. I take it for granted that those who take up this book are well content with what they know and do, and are not thinking of themselves vicariously as the white-coated hero of a second feature about the discovery of Compound E. And I do not assume that they must necessarily be fascinated by the marvels of the electron microscope or of radio-active iodine. I think of them as people aware that the world into which they were born is changing during their lifetime, and who have about

this change the same curiosity which they have about what is new in their closer neighbourhood—in literature or the arts or local politics or the business of the tennis club.

Few people today are really in doubt about the scale and the lasting importance of this change. But many people push it to the back of their minds, resolutely or in embarrassment. And much of the time they fear to face it, because they are afraid to acknowledge that this movement is changing their lives, is washing away the landmarks of their familiar world, rising round their values and in the end drowning the selves which must last them their lifetime. Yet these fears are less fears of the social change which science is working than simple personal fears. They are afraid, we are all afraid of being left out. We are afraid that something is happening which we shall not be able to understand and which will shut us out from the fellowship of the brighter and younger people.

These fears I believe are groundless. I believe that it is easy for a man who likes conversation and to read the second leader now and again to be comfortable with the large ideas of science: as easy as it is for a scientist to have a fancy for biography. The difficulties are those of language and the personal fear of what is unfamiliar. These are merely fed by those enthusiastic scientists who write as if the layman were to be pitied, and treat him as an erring would-be scientist who ought to be converted to an interest in the nucleus. I have no such reader in mind. I think of my readers, scientists as well as laymen, as balanced people who see about them the world in movement, and who want to know enough about the forces of science outside their own neighbourhood to assess their part in that profound and total movement of history.

(4)

Many people affect to believe that science has progressively strangled the arts, or distorted them into some unpleasant "modern" form; and therefore that the arts can be revived only by throwing over science. Often of course this is merely an elderly sentiment in favour of the art of our younger days, and the real scapegoat is not science but change. But even where the sentiment is less partial, it springs from a misunderstanding of progress in art and science. Science today is plainly more powerful than, let us say, in the time of Isaac Newton. Against this, the arts today seldom reach the height of, say, his contemporary John Dryden. It is therefore tempting to conclude that science continually outgrows its older ideas, while great literature remains permanent. But this is a hopeless muddle of concepts. Newtons are no more plentiful today than Drydens; and the work of Newton continues to stand to modern science in precisely the relation that the prose of Dryden stands to modern prose. Dryden and Newton each revealed a wholly new set of possibilities in their forms of knowledge. Both are classics in this sense, that they were at once pioneers and men of great achievement. And neither is a classic in any other sense.

The belief that science destroys culture is sometimes supported by historical statements that the arts have flourished only when the sciences have been neglected. This thesis is so directly contrary to history that I find it difficult to begin to debate it. What is this golden age of art untarnished by the breath of rude mechanics? Where did it exist? In the East? The civilisations of Egypt, of India, and of the Arabs belie it. The only

oriental poet at all well known in England, Omar Khayyam, was a Persian astronomer. In the West? The culture of the West begins in Greece; and in the great age of Greece, art and science penetrate one another more closely than in any modern age. Pythagoras lived before Aeschylus had created Greek drama. Socrates taught when that drama was at its greatest; and is Socrates to be claimed by art or science? And Plato, who did not tolerate poets in his ideal state, was a scholar when Aristophanes closed the eyes of Greek drama. The example of these men in science as much as in art set the modern world afire in the Renaissance. And the type and symbol of Renaissance man was from the beginning and remains Leonardo da Vinci, painter, sculptor, mathematician, and engineer. No man has shown more strikingly the universality and the unity of the intellect.

In England we put the golden age into the reign of Queen Elizabeth; and that characteristically was an age of commercial and industrial as well as of literary invention. Voyagers and adventurers like Sir Walter Ralegh were the Leonardos of that age; and Ralegh's own circle, which turned Christopher Marlowe into a rationalist, was dominated by a mathematician and an astronomer. For navigation is dependent on astronomy; it went hand in hand with the new speculations about the world and the solar system; and in turn, the voyages of the great navigators inspired the literature of Elizabethan England. The worlds of art and of science and the physical world unfolded then together. It was not by accident that the first table of logarithms was published within a few years of the First Folio.

Sixty years after the death of Elizabeth, another great age ripened in England, the age of Restoration literature. I shall have a great deal to say about that in this book,

because one symbol of the age is the founding of what has remained the most important scientific society in the world. The meeting which founded it opened with a lecture on astronomy, and the lecture was given by Christopher Wren the architect. The society was given its name, the Royal Society, and its motto by the most enthusiastic of its founders. He was John Evelyn the diarist. When the society wanted to encourage the use of simple and lucid prose, it appointed a committee which included a fellow of the society with a special gift for such writing. He was the poet John Dryden.

(5)

The golden ages of literature were in fact times of greatness when science and the arts went forward hand in hand. Has all this come to an end? Literary critics say Yes, it ended in England at the Industrial Revolution, somewhere between 1760 and 1800. Yet these critics date the Romantic Revival from some point between the death of Collins in 1759, which meant so much to Wordsworth, and the publication of the *Lyrical Ballads* in 1798. These two sets of dates are almost identical, and can it be reasonable to keep them in separate compartments of the mind? Is it really tenable to think of the Industrial Revolution as a kind of death? It gave our world its structure. It turned science from astronomy to what are essentially its modern interests, which hinge on the use of mechanical power. And it created in the romantic poets and the reformers what has remained our sensibility.

I say created our sensibility, although of course I have pointed only to the coincidence of dates: that Blake and Coleridge and Wilberforce were after all contemporaries

of Arkwright and James Watt. Against this, those who hold the illusion that pre-industrial England was more sensitive and cultured, point to the misery of the manufacturing age: women in mines, children in factories, the disasters of enclosure, famine, the Napoleonic wars, and political reaction. These were very terrible evils, but they are evils far older than 1800 and the machines. The labour of women and children for endless hours in their own homes is a commonplace in Defoe's journals in 1725. Yet the Augustan optimists of his day did not see it as matter for protest. But in the factory these evils became naked and public; and the driving force for reform came from the men of the mill, from Robert Owen and the elder Peel. We today are scandalized that boys went on climbing in chimneys for nearly eighty years after the heart-rending poems which Blake wrote about them around 1790; the last of the climbing boys, Joseph Lawrence, is still alive as I write. But the boys had been climbing for a hundred years before Blake without a line of protest from Addison or Gay or Dr. Johnson. In their broad Augustan day, Scottish miners were legally still serfs, just as the miners of Greece had always been slaves; and neither civilisation thought anything amiss. So today in China and India and other countries with few machines, life is brutal and laborious, and sensibility is unknown; I have seen it so myself, under the rusty thin surface of mechanisation in Japan, for women and animals alike. It was the engine, it was the horsepower which created consideration for the horse; and the Industrial Revolution which created our sensibility.

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Science changes our values in two ways. It injects new ideas into the familiar culture. And it subjects it to the pressure of technical change, in the way I have just been describing, until the whole basis of our culture has imperceptibly been remade. The invention of printing does not seem to bear very directly on the content of poetry. But when a poem can be read and read again, it is natural that the interest shifts from the rhythm to the meaning and the allusion. So the invention of photography has made the painter and the patron lose interest in the likeness and transfer it to some more formal pattern. Our whole sensibility has been re-created by such subtle shifts.

Science and the arts today are not as discordant as many people think. The difficulties which we all have as intelligent amateurs in following modern literature and music and painting are not unimportant. They are one sign of the lack of a broad and general language in our culture. The difficulties which we have in understanding the basic ideas of modern science are signs of the same lack. Science and the arts shared the same language at the Restoration. They no longer seem to do so today. But the reason is that they share the same silence: they lack the same language. And it is the business of each of us to try to remake that one universal language which alone can unite art and science, and layman and scientist, in a common understanding.