

From Alchin, Nicholas. *Theory of Knowledge*. London: John Murray, 2004. Pp. 12-13.

On science and uncertainty

An essay from *Discover*, by Lewis Thomas.

SCIENCE and technology, hailed just a few years back as the sure solutions for all our increasingly complex societal problems, are both in trouble these days. Part of the difficulty is that the two enterprises, really quite separate, generally seem so tightly linked as to be one thing: the nuclear bomb and energy plants are scientific accomplishments; chemical waste products are the droppings of science; the increased levels of CO₂, in the Earth's atmosphere are pumped there by science; and now we have genetic engineering, computers playing high-class chess, satellites capable of photographing the tears on up-turned faces, overpopulation of the planet by older and older people blocking options for the young. Soon enough we will have to begin worrying about traffic accidents on Mars.

If you concentrate on technology, it can seem as though science has developed into the mightiest force in the affairs of mankind, and is getting out of hand and beyond control because of the overwhelming power of piledup mountains of new information. There are uncomfortable doubts in the public mind about the risks entailed by learning so much so fast. Soon there will be earnest proposals that science should be slowed down by law to regulate the enterprise more tightly, with agencies deciding in advance that there are some things that human beings are better off not knowing. There is concern that research, left to itself, driven by its implacable reductionism, will quickly penetrate all the great mysteries and we will be left with nothing to contemplate but the nasty little details of a monstrous machine. There is a genuine apprehension that science may be taking the meaning out of life.

But if you concentrate on science, it is in real life not like this at all. We are nowhere near comprehension. The greatest achievements in the science of this and the last century are themselves the sources of more puzzlement than human beings have ever experienced. Indeed, it is likely that these times will be looked back on as the time when science provided the first close glimpse of the profundity of human ignorance. We have not reached solutions; we have only begun to discover how to ask questions.

Science is founded on uncertainty. Each time we learn something new and surprising the astonishment comes with the realisation that we were wrong before. The body of science is not, as is sometimes thought, a huge coherent mass of facts, neatly arranged in sequence, each one attached to the next by a logical string. In truth, whenever we discover a new fact it involves the elimination of old ones. We are always, as it turns out, fundamentally in error.

I cannot think of a single field in biology or medicine in which we can claim genuine understanding, and it seems to me the more we learn about living creatures, especially ourselves, the stranger life becomes. I do not understand modern physics at all, but my colleagues who know a lot about the physics of very small things, like the Universe, seem to be running into one

queerness after another, from puzzle to puzzle.

The sense of strangeness and ambiguity is the best evidence that science is working. The world is not a simple place, nor are we simple instruments. We should have known this long ago, but we found it easier in earlier centuries to tell tales to each other, powerfully explanatory but based on pure guesswork, and generally mistaken. Now that we have made a beginning of sorts, it is becoming clear that nothing is clear. I believe that the exploration of nature, given the spectacular human gift of insatiable curiosity, will never be concluded. I cannot for the life of me imagine a time when all our questions will do more than raise new questions, with new astonishments for answers.

It is a risky business, science. Not only do you have to start your work by assuming the existence of wrongness, you must count on a very high probability of being wrong in your own experiments, running into dead ends, finishing the work with that greatest of scientific disasters, a 'trivial' observation. It takes the greatest skill, and a measure of courage, to turn your imagination completely loose and this is the mandatory first step. You make up a story to explain whatever it is that you are curious about and then you design an experiment to test the story, building in all the controls that you can think of in order to make sure that your wish to be right, just this once, will not influence the outcome. This, by the way, is where the greatest danger lies' you can wish too hard for it to be garden path and overlook the plainest evidence of a blind alley. I do not know of a chancier profession.

It is true that scientists have not done a very good job of explaining what they are up to, but this is not because of any reluctance to display their accomplishments; they tend to brag all over town, to anyone willing to listen. The real trouble is that the public knows too little, and is told by the scientists too little, about the ignorance of science itself.

This has nothing at all to do with the applications of science. The ignorance I have in mind is of another order, unrelated to usefulness, not connected with our capacity as a species to solve practical problems. There are questions of the agenda of modern science that need answering simply for better comprehension, and for the wisdom of a future society.

We know a lot about the structure and function of the cells and fibres of the human brain, but we haven't the ghost of an idea about how this extraordinary organ works to produce awareness; the nature of consciousness is a scientific problem, but still an unapproachable one. We can make good educated guesses about the origin of life on this planet; it must have started, we think, as single-celled creatures resembling today's bacteria, but we have no way of tracking back to the events preceding this first cell, nor can we lay out an orderly scheme for explaining the nearly four billion years of evolutionary process from such a cell to ourselves.

We do not know how the first cells of an embryo, starting from the fusion of an egg and a sperm, sort themselves out with infallible precision into the systems of differentiated cells of a baby, each cell in possession of all the information needed for a complete baby but with most of that information switched off so that it can only become, say, a skin cell or a brain cell. We do not know how normal cells are transformed into cancer cells; we know the names of some of the chemicals, and types of radiation that can launch this process, but the nature of the process itself eludes us.

Lewis Thomas: Essay from *Discover*

We know that songbirds have centres on the left sides of the brain for the generation of bird song, and we suspect that this may somehow be related to the lateralisation of speech centres in our own brains, but we do not understand language itself. Indeed, language is so incomprehensible a problem that the language we use for discussing the matter is itself becoming incomprehensible. We do not know what holds us together as a social species; it is a mystery that we are so dependent on each other, in search all our lives for affection, and yet so willing to destroy each other when assembled in larger groups; the failure of nations to conduct their affairs with anything resembling the humanity we expect from each other as individuals is, somehow, a biological problem still beyond our reach. We do not understand the process of dying, nor can we say anything clear, for sure, about what happens to human thought after death.

In short, we are an ignorant species, new to the Earth, still juvenile, still in the earliest stages of inquiry, bound by our very nature to discover more about ourselves and the life around us in which we are, like it or not, embedded. It is in our genes to understand the Universe if we can, to keep trying even if we cannot, and to be enchanted by the act of learning all the way.

But we have a long way to go.