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Session 1 – Origins of Reason, Methodology and the Rise of Irrationality

The Unnatural Nature of Science

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Science provides the best way of understanding the world. Public understanding of science is limited: science goes against common sense, the earth moves round the sun. Paranormal beliefs are all too common and they go completely against science, there is a mystical element in our brains. Unlike religion, science is universal and is almost entirely independent of the particular culture in which it is performed. It had is origin in ancient Greece. Whenever a new technology is introduced it is not for the scientists to take an ethical decision about how it should be used, but they must make public the implications.

Science is very beautiful. It provides us with wonderful explanations of how the world works and underpins most of our marvellous modern technology. Yet public attitudes to science seem to be rather confused and contradictory. There is, on the one hand, the hope that science will provide the solutions to our ills, particularly medical ones. But on the other hand there is the fear that meddling with 'nature' – genetic engineering and atomic energy for example – will lead to disaster.

The idea that scientific knowledge is dangerous is deeply embedded in our culture. Adam and Eve were forbidden to eat from the Tree of Knowledge, and in Milton's *Paradise Lost* the serpent addresses the Tree as the 'Mother of Science'. Prometheus had a terrible time of it after letting slip some of nature's secrets to humanity.

Moreover, the archangel Raphael advised Adam to be 'lowly wise' when Adam tried to question him about the nature of the universe, putting a Celestial brake on Adam's natural and, perversely, God-given 'thirst for knowledge'. Western literature has not been kind to science or scientists and is filled with images of them meddling with nature with disastrous results.

Just consider Mary Shelley's *Frankenstein*, Goethe's Faust, and Huxley's *Brave New World*. One will search with very little success for a novel in which scientists come out well; the persistent image is that of scientists as a soulless group unconcerned with ethical issues. And has there been a Hollywood film sympathetic to science? The media must bear much

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of the responsibility for the misunderstanding of genetics, as genetic pornography is, unfortunately, widespread – pictures and stories that titillate. A widely publicised picture of a human ear on the back of a mouse is a nice, or rather a nasty, example. This was just ear shaped cartilage stuck under the skin for no obvious scientific reason – not an ear at all.

Yet science provides the best way of understanding the world in a reliable, logical, quantitative, testable and elegant manner. There are many styles of doing science, from theory, to experiment, to careful observation. There is one scientific method – to be internally consistent and to have explanations that fit with the real world, as determined by observation and experiment. In science, for any set of observations, there is only one, correct, causal explanation.

In this, science stands apart from the intellectual discipline from which so many of its tenets originally sprang forth. The sad truth is that since the advent of proper science, philosophy has made no useful contribution to its understanding. For a start, reliable scientific beliefs have no intrinsic ethical or moral content – they refer to how the world is. Does science provide beliefs that are fundamentally true? In general, the answer is yes, but it is important to realise that new evidence can always make scientific 'truths' subject to change.

It is this willingness to change ideas to accommodate new data that distinguishes science from religion. Unlike religion, contemporary science is almost entirely independent of the particular culture in which it is done – science is universal, and there is no Western or Eastern science. If the history of science were to be rerun, its history would be different, but the conclusions would be the same. The individual scientist, unlike the artist in the arts, is ultimately irrelevant, and the scientific genius merely speeds up progress. Science is, with rare exceptions, independent of cultural beliefs.

For many people, science is something rather remote and often difficult. Part of the problem is that almost all scientific explanations go against common sense, because our natural expectations, for the world is just not built on a common sense basis.[1] Science appears to be unnatural because the world just happens to be built in a way that does not fit our everyday expectations.

In fact, I would go so far as to say that if an idea fits with common sense then scientifically it will almost certainly be wrong. If you stand on the ground and look up at the sky it is clear that the sun goes round the earth and the only reason that most of us accept that it is the other way round comes from the canon of knowledge that we are taught at school rather than from a proper understanding.

Again, we all believe that the moon causes the tides but the correct explanation is rather complex. Despite our experience of moving objects since birth and Newton's discovery of the laws of motion several hundred years ago, namely that force causes acceleration, not motion, it is hard to accept that when we are in a plane travelling in level flight at 500 mph the forces acting upon it are in balance. In an ingenious experiment conducted some years ago, a group of volunteers were asked to make a billiard ball travel round a curved path marked out on a billiard table. Nearly everyone made their hands move in a curved motion before releasing the ball, which of course travelled off in a straight line. The volunteers included several physics graduates.

Or imagine that you are in a flat field with a gun and two bullets. If one bullet is fired horizontally at exactly the same time that the other is simply dropped, which bullet

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hits the ground first? It surprises many that they both hit the ground at the same time. No matter where one looks in science its ideas confound common sense. It is not even easy to think of how ice cools one's drink in the correct way – 'cold' does not flow from the ice to the liquid but heat from the liquid to the ice.

The very idea of Darwinian evolution that we humans came from random changes and selection is unnatural. And things get much worse when one enters into the world of subatomic particles, quantum mechanics, black holes and big bang, everyday analogies completely break down. Scientific thinking is not – usually – a natural mode of thought.

It is important to be clear about the relation between science and its applications. Science is not the same as technology. While much of modern technology is based on science, this link is of recent origin since science had virtually no impact on technology until the nineteenth century. Agriculture was already established in 7000 BC and relied on causal beliefs and not on any understanding, rather as it does in some remote areas today. The great cathedrals were built by engineers who based their construction on, effectively, trial and error. They may well have made use of the five-minute theorem – when a structure was built and the supports removed, if it remained standing for 5 minutes then it was assumed that it would stand forever. The steam engine owed almost nothing to science – it probably could have been built by the Greeks And the science of aerodynamics largely followed the technology of aeronautics rather than the other way round.

Although they were ignorant of the principles of thermodynamics, it is to those Greeks that we must offer our gratitude for the invention of science. It is part of the special nature of science that, unlike either technology or religion, it had a single origin. All science as we know it had its beginnings in Greece. No other society independently developed a scientific mode of thought. The honour of being the first scientist goes to Thales of Miletos, who in about 600 BC took for the first time a detached view of the world and tried to understand it. He wondered what the world might be made of. His answer, which went against common sense (and which turned out not to be true), was that it was made of water in various forms. But this was the first time that a curiosity about nature came about that was not linked to human needs. This was an attempt to find a unifying principle in nature that could be subject to critical discussion.

Aristotle was the dominant influence in the early days of science but because he often based his ideas on a common sense view of the world, his science was almost always wrong. But his promotion of logic lead to the achievements of both Euclid in geometry and of Archimedes in mechanics.

Archimedes was the first applied mathematician and he laid the foundations of physics. He had a major influence on Galileo. How right he was to leap naked from the bath shouting Eureka! when he discovered specific gravity. It remains a puzzle as to why Archimedes approach took so long to become generally adopted.

The Chinese, while brilliant engineers, made a minimal contribution to science. Albert Einstein, on receiving a letter from a correspondent asking why it was that science only arose once and in Greece, and then only persisted in the West, replied:

> Dear Sir, The development of Western science has been based on two great achievements, the invention of the formal logical system (in Euclidean geometry) by the Greek philosophers, and the discovery of the possibility of finding out causal relationships by

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> systematic experiment (at the Renaissance). In my opinion one need not be astonished that the Chinese sages did not make these steps. The astonishing thing is that these discoveries were made at all.

Science, I suggest, is very special and provides the best way to understand the world. This imposes on scientists a special social responsibility. Because they have access to specialised knowledge whose applications can have an important effect on our lives, they have the obligation to make public both the implications of their work and its reliability. In the case of the atom bomb, I believe they fulfilled these obligations. During the war, the scientists advised the British and American governments that it was possible to construct a nuclear weapon. The political, military and strategic decision to actually build the Bomb was taken by the American government and was an enormous engineering enterprise. It was the application of science.

As Robert Oppenheimer, who was in charge of building the bomb made very clear, the scientist is not responsible for the laws of nature but it is the scientists' job to find out how these laws operate. It is not the scientists' role to determine how this information should be used. This is not a cop-out for it is very important that moral and ethical decisions are not left to the scientists. That would be most unwise. It would give them far too much power. It is essential that the public be fully involved in all such decisions. The poet Paul Valery's remark that 'We enter the future backwards' is very apposite in relation to science and technology. Scientists cannot easily if at all predict the technological implications of their work nor its impact on society, although of course their opinions are as valid as anybody's.

Whenever a new technology is introduced it is not for the scientists or doctors to take an ethical decision about how or if it should be used. Sometimes questions arise that are not wholly scientific but social or political, such as the decision to favour a particular kind of electricity generation, which may be influenced by political and economic factors as much as scientific or engineering logic.

For their part, the scientists must take great care that they do not allow themselves to become the unquestioning tools of either industry or government. For all of us, with knowledge comes responsibility.

For many people, beliefs are like possessions and are rarely given up.[2] We cannot tolerate not knowing the cause of important events such as illness and death. As Peter Medawar pointed out 'If a person is poorly, receives treatment to make him better, and then gets better, then no power of reasoning known to medical science can convince him that it may not have been the treatment that restored his health'.

A large majority of the public believe that they are more intelligent, fair-minded, better describers and less prejudiced than the average person. Paranormal beliefs are all too common and they go completely against science – these beliefs, which persist into the twenty-first Century a full 300 years after the supposed Enlightenment, include a widespread acceptance of homeopathy, a belief in ghosts, horoscopes, telepathy, contact with the dead, superstitions, mind reading, and levitation. Most mental illnesses such as confabulation, depression, and schizophrenia involve false beliefs.

There is also the view that we have mysticism in all our minds. Causal beliefs about the physical world are a major characteristic of humans compared with other animals, are

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very most important and can determine what we believe and how we behave. They came from the evolution of tool use that drove human evolution, as this requires causal understanding of physical interactions. This then gave rise to religion, which provided causal understanding of almost anything. Humans were the most obvious causal agents and so gods are human-like.

It was a selective advantage to have religious belief, as it removed uncertainty. Such beliefs may have become genetically programmed and there are claims that there is a mystical mentality present in every human mind. Timothy Leary after LSD said 'I discovered that beauty, revelation, sensuality, the cellular history of the past, God, the Devil – all lie inside my body, outside my mind'. LSD is a simple drug and it caused the 'mystical circuits' in his brain to become activated. It is this mysticism in our brains that may account for many paranormal beliefs.

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About the Author

Lewis Wolpert's research interests are in the mechanisms involved in the development of the embryo, particularly pattern formation. He originally trained as a civil engineer in South Africa and then changed from soil mechanics to cell mechanics. He was made a Fellow of the Royal Society in 1980. He has been involved in the public understanding of science. His books include *Malignant Sadness – the Anatomy of Depression and Principles of Development*. He is an editor of the *Journal of Theoretical Biology.*

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