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*The Daily Telegraph*

Left: *Learning to Love the Grey*, 2000 © Robert Workman  
 Below: *Starfish*, 2009 © Robert Workman



## Science and the Public

**Professor Lewis Wolpert**

Science provides the best way of understanding the world in a reliable, logical, quantitative, testable and elegant manner. It is, however, quite unnatural, and goes against common sense. Is it sensible to think of the earth moving round the sun; that force causes acceleration, not motion; or of the very idea of Darwinian evolution, that we humans came from random changes and selection?

Science is special and only one society discovered it - the ancient Greeks. They were the first to understand logic and contradiction and to stand back from the world in order to try and understand how things worked. Just consider my hero Archimedes, the greatest of all scientists, for he had few shoulders to stand on.

I am pretty sure that in physics at school, no one teaches his elegant proof of why, with a simple balance with one heavy weight on one side, and a light one on the other, the distances of the weights from the centre, the fulcrum, must be proportional to their weights. This, together with his discovery of specific gravity and why some bodies float, is

the beginning of real science.

There are many styles in science from theory makers to experimenters to close observers. The central feature is having an explanation that fits with the evidence and does not contradict either itself or other accepted scientific ideas. An essential feature is that the idea must be presented to the scientific community in the form of a paper published in a scientific journal which will undergo peer review. Science is a communal activity, and ultimately the individual scientist is irrelevant, for if X does not make the discovery Y will. Great scientists just speed things up. It is also the cleverest scientists who are the luckiest.

Yet 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'. Moreover the archangel Raphael advised Adam to be lowly wise when he tries to question him about the nature of the universe and to confine his attention to local events.

Indeed the whole of Western literature has not been kind to science or scientists and is filled with images of scientists meddling with nature with disastrous results. Just consider Mary Shelley's *Frankenstein*, Goethe's *Faust*, and Huxley's *Brave New World*.

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The media also must bear much of the responsibility for the misunderstanding of biology as biological pornography is, unfortunately, widespread - pictures and stories that titillate. A recently 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. Many of such negative images coexist with the hope, particularly in medicine, that science will provide cures to all major illnesses, like cancer, heart disease, and genetic disabilities like cystic fibrosis. Nevertheless, one will search with very little success for a novel in which scientists come out well. And where are well known films or plays relevant to science, or which provide reliable images of scientists and how they work, an exception being Michael Frayn's *Copenhagen*, which deals with physics and the atom bomb?

All the more reason for the great importance of Y

Touring putting on plays about science in schools, together with the special feature that the cast retain their identity so that there can be a debate about the issues raised by the play. Also of great importance is that in their plays the scientists are quite ordinary, if very intelligent, human beings who do not resemble Frankenstein. Also the plays raise scientific issues which are understandable.

15 years ago I saw Y Touring's *The Gift* by Nicola Baldwin and it was, and still is, particularly relevant, because the issues explored arose from our misunderstanding of genetics.

Like all science, genetics goes against common sense, and there is nothing in an individual's experience of the world that relates to the way genes influence cells and how we develop from the egg. For many, genes are as mystical as witches and possibly as potentially evil since they can cause so many diseases. The evidence about understanding of genetics by the public is disturbing when one notes that a European survey found that about half of those questioned thought that tomatoes did not have genes unless they were genetically modified.

All living organisms have genes, as they code for proteins which determine the behaviour of cells, the fundamental units of life. We are no more than a society of billions of cells. It is all too easy to be misled as to what genes actually do for us. There is no single gene, for example, for the eye; many hundreds, if not thousands, are involved, but a fault in just one can lead to major abnormalities. The language in which many of the effects of genes are described leads to confusion. No sensible person would say that the brakes of a car are for causing accidents. Yet, using a convenient way of speaking, there are numerous

From Left to Right:

*Cracked*, 2001  
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*The Gift*, 1995  
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references to, for example, the gene for homosexuality or the gene for criminality. When the brakes of the car, which are there for safe driving, fail then there is an accident. Similarly if criminality has some genetic basis then it is not because there is a gene for criminality but because of a fault in the genetic complement which has resulted in this particular undesirable effect. It could have affected how the brain developed – genes via the proteins they code for control development of every bit of our bodies, or could be due to malfunction of the cells of the adult nerve cells.

*The Gift* is about a young woman with a genetic disease, Friedreich's Ataxia, and raises issues about genetic choices. Should an embryo be destroyed if it has genes for a nasty disease, and should one choose embryos that contain genes that could give the child special skills?

The second Y Touring play I saw was *Cracked* again by Nicola Baldwin. There is a curious resistance by many to accept that genes can play a key role in mental illnesses. Consider, for example, depression or schizophrenia. Both have a strong genetic basis; in the case of schizophrenia about 80% of the cause is genetic. Many genes are involved and many of these act to determine the behaviour of the numerous neurones in the developing nervous system in the embryo. And then the interaction between the myriad nerve cells that result in schizophrenia needs to be understood. There is no simple route from the genes to the illness, and environmental influences are involved, and so it has an almost mystical character quite outside our normal experience of causal events. The result of complex pathways like this is that, for most people, genes can provide only a limited insight into how human nature is determined.

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Depression is unfortunately all too common an illness, and the stigma associated with it makes things worse. There are claims that it is over-diagnosed, that antidepressants are too widely prescribed, and that they are only effective for severe depression. Severe depression can result in the individual being unable to work and can even lead to suicide. For these reasons I believe it is essential that mental health be taught at school so that the young have some understanding of the illnesses. These are the illnesses that they are very likely to come in contact with. Understanding

more about the conditions could reduce stigma and also lead to those who have symptoms seeking help at an early stage. All the more reason that the play *Cracked*, about a teenager with depression, should be performed at schools, as there is evidence that it had a significant impact on the students' attitudes to mental health

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A serious problem in relation to public understanding is the conflation in the public's minds of science and technology. Science produces ideas about how the world works, whereas technology results in usable objects. Technology is much older than anything one could regard as science and unaided by any science, technology gave rise to the crafts, like agriculture and metalworking. Science made virtually no contribution to technology until the 19th century, even to the great triumphs of engineering like the steam engine. Renaissance cathedrals were built without virtually any impact of science. It was done by imaginative trial and error and they made use of the Five Minute Theorem. If, when the supports were removed, the building stood for five minutes, it was assumed that it would last forever.

Much modern technology is now founded on fundamental science. In contrast to technology, reliable scientific knowledge is value-free and has no moral or ethical value. Science tells us how the world is. That we are not at the centre of the universe is neither good nor bad, nor is the possibility that genes can influence our intelligence or our behaviour. Dangers and ethical issues only arise when science is applied through technology. However ethical issues can arise in actually doing the scientific research, such as doing experiments on animals. The play *Pig in the Middle* by Judy Upton is about two young students with kidney disease who are on dialysis. There is discussion about the possibility of genetically engineering pigs so that their kidneys could be used for transplantation into the patient, much against the views of those defending animal rights. And *Every Breath*, by Judith Johnson, explores the social, moral, scientific and political questions raised by the use of animals in medical research.

In Jonathan Hall's *Learning to Love the Grey Sarah* is writing a play about cloning to create stem cells. She's shocked to discover that

embryos and fetuses are used and dispersed as an integral part of the process. Set against the potentially huge benefits of stem cell therapy, does this matter?

Mary Shelley could be both proud and shocked. Her creation of a scientist, Frankenstein, creating and meddling with human life has become a potent symbol of modern science. But her brilliant fantasy has become so distorted we are shocked, and even those who are normally quite sensible lose all sense when the idea of cloning humans appears before them. The image of Frankenstein's monster has been turned by the media into genetic pornography whose real aim is to titillate, excite and frighten. Ironically, the real cloning of sheep has seen the media blindly and unthinkingly following each other - how embarrassed Dolly ought to be. *Learning to Love the Grey's* value is that it is a powerful way of engaging and at the same time challenging its audiences to balance the somewhat one sided debate

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Finally we come to *Starfish*. Clinical trials are crucial for getting evidence for the effectiveness of any treatment and for this reason homeopathy has not been shown to be effective. *Starfish* by Judith Johnson is a play which explores the issues raised by clinical trials. The project was funded by the Wellcome Trust. A *Daily Telegraph* article about *Starfish* commented, "The heartfelt

response to this tear-jerking story of love, romance and grief was all the more surprising given that the play was also an attempt to explore the issues surrounding clinical trials in medicine."

I cannot praise Y Touring enough for their science plays, of which I have only referred to a few, or the many organisations that have supported them. They are doing a wonderful job in getting across to students the nature and importance of science and technology in our everyday lives and in letting the students express what they feel. And many congratulations on your 21st anniversary.

From left to right:

*Cracked*, 1997  
© Wellcome Trust

*Pig In The Middle*,  
1998  
© Robert Workman

