I can think of no better way to start a talk to a mainly scientific audience than with a slide in ancient Greek:

Slide 1

ιδιώτης

_Idiotes_: the origin of the word idiot

In the ancient citizens’ democracy of Athens it meant someone who took no part in public affairs. One of the aims of Sense About Science when it was launched 10 years ago was to stop scientists being idiots, at least etymologically. At the time most scientists were reluctant to take part in public discussion, let alone political debate. The meaning of the word has of course changed. Otherwise politicians cannot be idiots, which runs counter to experience. But I think Sense About Science, and the Science Media Centre, have succeeded in substantially reducing the number of scientific _idiotai_. We now have a list of over 5,000 scientists who are willing, often eager, to take part in public discussion and debate.

Pericles, the great Athenian statesman, said that Athens differed from other states in regarding the man who holds aloof from public life as useless. I would not go as far as that. But a decline in civic participation, and indeed a decline in concern about politics, is a slippery and dangerous slope that weakens democracy. If we are in no way involved in the management of our collective affairs, we should not be surprised if no one is listening to us. So I do believe it is an important achievement that there has been a significant increased participation in public discussion by scientists. On the other side of the coin, I regret that the number of my fellow _politicians_ who know or really care about science has not notably increased.

When politicians say: “I know nothing about science” it is often a boast rather than an admission. They’re all for science in principle - because it helps economic growth and provides new drugs to cure disease, because it helps to make us wealthier and healthier. But generally they have little clue how science works and aren’t that interested in finding out. The same is true of the public generally, and much of the civil service and the media. A poll taken a few years ago showed that overwhelmingly people think science is a good thing. But the same poll showed that an overwhelming majority also believe no new product should be allowed to be marketed unless science has first proved it absolutely safe. So much for their understanding of scientific method. Again, the popularity of alternative medicine hardly demonstrates public dedication to the evidence-based approach. And as for understanding risk, just look at the success of the lottery.
Well, what has science ever done for us? OK it has made us more prosperous. OK it has made us healthier and we now live longer. But what has science done for us apart from promoting wealth and health? My theme today is that it has made us more democratic, more tolerant and more compassionate. When I started Sense About Science my aim was not only to expose bogus science but increase public awareness of the role of science in making us more civilised.

The Enlightenment was in my view one of the most glorious events in the history of mankind. It saw the birth of modern science. I don’t deny the contribution of medieval Islam, or the technological achievements of Chinese civilisation, or especially the astonishing insights of the ancient Greeks. In a fragment of one of the first books ever written, about nature, the Greek philosopher Xenophanes, who lived in the late 6th and early fifth century BC, even wrote about the impossibility of absolute certainty:

Slide 2
The gods did not reveal, from the beginning
All things to us, but in the course of time,
Through seeking we may learn, and know things better...
But as for certain truth, no man has known it...
For all is but a woven web of guesses.
Xenophanes

That period saw not only the first stirrings of the search for scientific explanations of the world about us, but also of democracy. Even then the two were linked.

But consider what the Enlightenment in Europe achieved in the late 17th and 18th century

Slide 3
The Enlightenment
• Challenged authority as the arbiter of truth
• Dethroned theocracy
• Overturned years of sterile metaphysics
• Challenged superstition
• Put reason and science at the centre of the explanation of the world

Look what it achieved in Britain.

Slide 4
In Britain
• The witchcraft statutes were repealed
• Smallpox vaccination was introduced
• Madness ceased to be regarded as a supernatural occurrence
• The Divine Right of Kings was abolished
• The Royal Society was founded (1662)
• Liberal democracy was born

Not a bad record.
Voltaire declared that the three key figures of the Enlightenment were Bacon, Newton and Locke. Bacon was the prophet of modern science, Newton revealed the laws of the universe and Locke demolished Descartes and rebuilt philosophy on the bedrock of experience. Thomas Jefferson said Bacon, Newton and Locke were the three greatest men that ever lived. They were certainly an extraordinary trio. But how were they responsible for linking modern science and liberal democracy?

First, and crucially, they challenged dogma.

Bacon was the great empiricist. He championed reasoning by induction, proceeding from observation and experiment to ever-broader conclusions. I’m a Karl Popper fan and Popper pointed out, as did Medawar, that Bacon was wrong, because the first step, observation, does not involve looking at things in an open-minded but empty-headed sort of way. How do you know what you are looking for? What question do you have in mind? Instead you start with an idea, a possible explanation of the facts in which you are interested. Instead of observation leading to theory, theory comes first. Then, Popper argued, to support the hypothesis, the good scientist will look for facts that falsify it. If you claim that all swans are white, you don’t keep looking for more white swans to confirm your claim, but see if you can find a black one. And if you look in St James’s Park you may find one.

Whatever the flaws in Bacon’s approach - and some of Popper’s followers also admit that he understated the complexities of his falsification principle - Bacon’s message was a practical one: to observe and study the real world and base conclusions on these observations and studies. That is how our knowledge of the world improves. Knowledge gives power over nature, and this leads to real benefits. But greater knowledge depends on constant criticism and constant criticism means rejection of dogma. It follows that science does not do certainty. Some new hypothesis may always provide a better explanation of the facts.

As for Newton, Popper said his *Principia* marked the greatest intellectual revolution in the history of mankind. I find its impact mind-boggling. It was written in Latin. It was crammed with mathematics, largely unintelligible to all but dedicated mathematicians - Newton was not exactly the Brian Cox of his day. I have not actually read it. Perhaps members of this audience have. I gather it not only demonstrates that the solar system works according to mathematically precise rules, which apply on earth as in the heavens, but provided a handbook that could be used for calculating a million practical matters, such as the strength of bridge girders, and even, so I am told, the amount of rocket fuel needed to dispatch astronauts to the moon. Newton, more than anyone else showed that reason, not superstition, could explain the world.

Incidentally, it is extraordinary how some of the books that changed the world are indigestible. *Principia* was one. Another was Keynes’ General Theory of Employment, Interest and Money - very hard going for non-economists, although generally Keynes wrote beautifully. Then there was Das Kapital, a deadly volume, although Marx like Keynes coined some memorable phrases. The Communist manifesto ended with a stirring battle cry: “Workers of the World Unite. You have nothing to lose but your chains”. Scientists have no rival battle cry, except maybe Adlai Stevenson’s injunction: “Egg-heads of the world unite. You have nothing to lose but your brains”. Stevenson, of course, lost two Presidential elections to Eisenhower, who is reputed to have said he was appalled to learn that half the population of America had a below-average level of intelligence.
Of the glorious triumvirate, my favourite is John Locke who based his political philosophy on Bacon’s practical, empirical approach and his friend, Newton’s reason.

**Slide 5**

“In an age which produces such masters as the incomparable Mr Newton, it is ambition enough to be employed as an under-labourer in clearing the ground a little and removing some of the rubbish that lies in the way to knowledge.”

*John Locke*

Inspired by science, his approach to public affairs was tentative, anti-dogmatic, and therefore anti-authoritarian, and profoundly tolerant of dissent.

**Slide 6**

“Where is the man that has incontestable evidence of the truth of all that he holds, or of the falsehood of all he condemns, or can say that he has examined to the bottom all his own or other men’s opinions?”

*John Locke*

Locke argued that sovereignty must reside in the people. From his rejection of dogma and certainties, it followed that respect for the wishes of the majority must be tempered by checks and balances, by respect for the rights of minorities, for the rule of law and for human rights, essential parts of Parliamentary democracy.

It should be clear to everyone that democracy, like science, depends on the right to criticise. However inefficient the political process may be, if you can’t openly challenge what has gone wrong, the odds are against progress. But in politics today you must never say you have changed your mind or that you were wrong. Jeremy Paxman on Newsnight spends his time trying to get politicians to admit they have changed their minds - which they in turn vigorously deny. They should glory in it. As Oscar Wilde said: “Experience is the name everyone gives to their mistakes.” And the eminent physicist John Archibald Wheeler said: “Our whole problem is to make the mistakes as fast as possible”. (Now wouldn’t that make a really appealing election promise: “We will make mistakes as fast as possible”)

But Parliamentary democracies make progress, because in the end politicians have to abandon policies that don’t work and must change their minds. Democracies are the best system for coping with mistakes and learning from them. In a sway it proceeds by trial and error. And if you are not prepared to make mistakes you will not take risks. And if you are not prepared to take risks, you will have no innovation. That is why democracies have proved more prosperous than autocracies.

Incidentally, there was once a politician who would have dealt with Paxman. He was that mercurial figure, George Brown, who was Foreign Secretary from 1966 to 1968 in the first Wilson government - not to be confused with Gordon Brown. When he was challenged with having changed his position, his answer was simple: “Yes I have. I was wrong”. His challenger came back; “How do we know you won’t be wrong again?” George replied: “ I will be wrong again, but at least I’ll admit it”.

George Brown was unorthodox in other ways. At times a brilliant Foreign Secretary he would also get embarrassingly drunk and was not always diplomacy personified. The august,
towering, figure of President De Gaulle once said of him: “I rather like that little Brown. But I wish he wouldn’t keep calling me Charlie”. When Gaitskell died in 1963, George Brown stood against Harold Wilson for the leadership of the Labour party and came quite close to winning. Most of the Gaitskellites voted for him, though they knew about his weaknesses. As one of them said afterwards, their view was: “Better George drunk than Harold sober”.

As for de Gaulle, he was aloofness personified. If some one said to him: “A fine day Monsieur le President” he would reply: “Thank you”

But I digress. Back to my theme. Locke’s antithesis at the time of the Enlightenment was Rousseau, the great romanticist. You know, Rousseau actually wrote that science and technology were ignoble. He was the guru of anti-science. “Let us begin” he wrote, “by laying facts aside”. He admitted that his Noble Savage might never have existed, but that did not stop him describing how this primitive saint lived his Arcadian existence in harmony with nature:

Slide 7
“...I see him satisfying his hunger at the first oak, and slaking his thirst at the first brook; finding his bed at the foot of the tree which afforded him a meal and with that, all his wants are supplied.”

J.J. Rousseau

Doesn’t that remind you of someone who frequently expresses a nostalgic longing for a pre-scientific agrarian paradise, urges us to favour “complementary” rather than evidence-based medicine, and complains that scientists try to play God by interfering with the genes of plants?

There are rumours that the Queen is not immortal. I hope to God they are wrong.

Rousseau also preached that the will of the majority must always prevail and his influence on the French Revolution was profound. It started stirringly with the declaration of Rights of Man by Thomas Paine, so that Wordsworth could exclaim

“Bliss was it that dawn to be alive,
But to be young was very heaven”

But gradually it succumbed to mob rule, and Paine’s Rights of Man were overwhelmed by Rousseau’s Will of the People. In the history of politics after the Enlightenment, there was a split between followers of Rousseau, the champion of unreason and the Will of the Majority, and those of Locke, the champion of science and Parliamentary Government. One led to tyranny; the other promoted democracy.

Now when I argue that democracy and science are linked, I am sometimes asked: Didn’t Communism claim to be scientific and didn’t the Nazis use technology effectively in the Second World War? And how about China today?

In fact Communism denied the basic principles of science. Though denouncing religion, it said: “There is no God and Karl Marx is his prophet.” Soviet rulers claimed that Marxism applied the laws of nature to history and society, but there was no question of testing Marxist theory to see if it was contradicted by facts, as it was. Doubt was not allowed and dogma ruled. Any scientists who questioned Lysenko’s doctrines of Lamarckism and
“vernalisation” disappeared into the gulags, or were shot or forced to recant - just like Galileo. Bourgeois, class-ridden genetics were banished. A new “creative” Darwinism had to be adopted, based on dialectical materialism.

The only scientists allowed any freedom were those useful to the state, for example some distinguished physicists who worked on the atom bomb. When a meeting was called to denounce them for their bourgeois approach, Stalin cancelled it and said to Beria: “Let them get on with their work. We can always shoot them afterwards.” Even today, when autocracy is no longer absolute, as a recent comment in Nature pointed out, favouritism and corruption pervade science and a stifling bureaucracy and perplexing jungle of regulations and restrictions are the despair of aspiring Russian scientists.

Science did not flourish under Communism and Communism certainly did not lead to prosperity. As Khruschev once said: “We have nothing to hide. We have nothing. And we hide it.”

By the way, the Russians did make good political jokes. My favourite was made by Gorbachov when he met Ronald Reagan. They got on very well, as Gorbachov did with all Western leaders, but at some point Reagan said to him: “You know, there is one fundamental difference between America and the Soviet Union. Anyone can come into my office and say: ‘I don’t like the way Reagan is running the government of America’”. “Nonsense,” said Gorbachov, “There is no such difference. Anyone can come into my office in the Kremlin and say: ‘I don’t like the way Reagan is running the government of America’”. I can’t resist one other cold war joke, this time by Kissinger. When asked what would have happened if Khruschev had been shot instead of Kennedy. He said: “I don’t think Onassis would have married Mrs Khruschev.”

Let me briefly mention Nazi Germany, which appeared to combine dictatorship with scientific development particularly for military purposes. In fact they made little pretence to be pro-science, most of which was dismissed as Jewish science. Hitler declared the end of the Age of Reason. They championed alternative medicine, especially homeopathy, which was invented by a German, Hahnemann, and favoured organic farming, which was founded by Nazi party members and fitted neatly with the doctrine of Blood and Soil. In some ways, they were pretty green. As for technology, except for rocketry this was a field in which Britain was generally superior. The great strength of the Germans in the Second World war was the quality of their army. It has taken German science a long time to recover from the Nazis.

But what about China today? Will it disprove the thesis that science is linked with democracy. It has given scientists a degree of freedom that Soviet and Nazi scientists never had. Their best students are encouraged to go to the top universities abroad and their rulers don’t seem to worry that they will be corrupted by foreign democratic influences. China invests hugely in science. Yet it is still an autocracy that puts dissidents in prison.

Well, reports in Nature suggest that Chinese science has its weaknesses. It is not strong in basic science, has produced little innovation and good connections often trump academic expertise. There also seems little doubt that their political system is under great stress. I believe it is too early to say whether in China science and autocracy will co-exist.

Let me turn to my other claims for science, that it has made society not only more democratic but more tolerant and more compassionate.
Throughout history dogma, superstition, prejudice, and hysterical fears based on ignorance have been responsible for the denial of human rights and for any number of atrocities. Reason and civilisation go hand in hand. As Voltaire said: “Those who can make you believe absurdities can make you commit atrocities”.

Dogma, often based on passionately held ideology, has been responsible for many of the worst things that people have done to each other. Stephen Pinker in his book, *The Better Angels of our Nature* lists the Crusades, the European Wars of Religion, the French and Napoleonic Revolutionary Wars, the Russian and Chinese Revolutionary Wars, the Second World War, the holocaust and the genocides of Stalin, Mao and Pol Pot and could have added many other examples.

Pinker could also have added that millions of lives have been lost through bad science. One of my heroines was Rachel Carson when I read Silent Spring. Later I learnt that her unfounded claims that DDT caused cancer led to a ban on what had been the most successful agent there has ever been for saving lives, preventing some hundreds of millions of people dying from malaria. Again consider the deaths from the denial by the government of South Africa of a link between HIV and AIDS.

But quite apart from horrors inflicted by dogma, sheer ignorance has played a major part in the denial of human rights. We rightly associate progress on human rights with people such as Wilberforce who championed slaves, Mary Wollstonecraft who championed women’s rights, Martin Luther King who fought for the rights of black people, and so on. But why were these rights denied in the first place?

Because of prejudice based on ignorance and superstition. It was believed that women had smaller and therefore inferior brains and black people belonged to an inferior species. These prejudices still of course persist. But they are nowhere near as widespread as they used to be. Science has eroded the denial of human rights since the Enlightenment by its exposure of superstition and ignorance, as well as by its repugnance to dogma.

Tribalism and nationalism are two other causes of wars and intolerance. Certainly, many individual scientists have been nationalists, indeed chauvinists, but science itself is international, indeed anti-nationalist and anti-tribalist. Its conferences are international. Its findings are shared internationally. As Chekhov observed: “There is no national science, just as there is no national multiplication table.” The nationality of a scientist is totally irrelevant. The same, of course, is true of art.

Pinker argues that mankind has made progress over the centuries and that we have gradually become more civilised. He does not claim that we are bound to become more civilised by some iron law of history, or that progress is irreversible, or proceeds by a steady upward graph, There are many blips and temporary reverses. But the trend, he argues, is upwards.

Of course it is easy to depict those who believe in progress as Pollyannas. Look at the reasons for gloom at the present time:

**Should we be worried?**
• Global warming
• Nuclear weapons in Iran and deadlock in the Middle East
• Potential break-up of the European Union
• The US Republican Presidential candidates, many of whom deny evolution and support the teaching of creationism. Some even oppose contraception.
• Young people nowadays...

To be an optimist, especially to claim to be a rational optimist like Matt Ridley, seems the apogee of naivete. Pessimists seem to be the realists. Gloomsters convey a spurious aura of intellectual depth.

Well, Pinker produces strong evidence in favour of his claim.

Murder rates per head of population, for example, have steadily and dramatically declined. In the 14th century they were 110 times higher in England than they were at the end of the 20th century. Similar declines are recorded for Italy and the Netherlands. The twentieth century was not the bloodiest in history, though there were certainly some very big blips.

Consider what used to be regarded as public entertainment. What did the Romans ever do for us? Well of course, bread and circuses, which meant seeing people torn apart by wild beasts. Oh, and of course crucifixion, a standard method of carrying out the death penalty - automatic for escaping slaves. In England public executions were public spectacles, to which parents took their children, even to see someone hung, drawn and quartered. Even as late as the 17th century, in Paris live cats were roasted for entertainment and people squealed with delight as the cats squealed in agony.

We now value human life to the extent that we spare murderers. Capital punishment has been abolished in all member states of the EU and even in fourteen states of the USA. In fact no country will now be accepted as an EU member if they retain the death penalty - which for some is an additional reason for getting out.

Pinker, in my view, makes an overwhelmingly convincing case.

It is sometimes argued in contrast to my thesis, that science does not influence the nature of society, but social changes influence science. We even have a report on Science and Society in 2000 from a House of Lords Select Committee - and what could possibly be a more authoritative body? - that stated:

Slide 9
“Scientists must have morality and values, and must be allowed and indeed expected to apply them to their work and its applications. By declaring openly the values that underpin their work, and by engaging with the values and attitudes of the public, they are far more likely to command public support.”

House of Lords Select Committee on Science & Society 2000

Scientists and researchers should certainly declare any conflicting interests. But their values? Should scientists who find that the impact of pollen from Bt corn on Monarch butterflies in
the field is negligible declare that they have been lifelong Democrats or Republicans, or Seventh Day Adventists, or that they are against abortion? Would the public really trust a scientist more if it knew that he or she hates capitalism, or is an Arsenal supporter?

Indeed, one irrefutable answer to the supposed relevance of a scientist’s background is to ask the question posed by Professor Robin Fox of Rutgers University: What did it matter whether Gregor Mendel was a male, white, European, monk? His findings about the heritable characteristics of peas would have been no less valid if he had been a female plant geneticist from Africa. (I have slightly adapted his answer)

With the greatest respect, the House of Lords Committee was confusing the values of scientists with the values of science. Of course scientists have moral and social values, but science does not, so that ultimately the motives of researchers are unimportant. Scientists may embark on a particular research project because they hope it will help mankind, or make them famous, or will confirm their prejudices, or they may select it because they can get it funded. If they work for a company, no doubt they hope it will help the company make higher profits.

Whatever their motives or their values, in the end the results of their research will be subjected to objective scrutiny. Do the findings stand up to the critical analysis of peer review? Are they reproducible? Can they be verified or falsified? If they stand up, it does not matter whether a scientist works for Greenpeace or Monsanto. If the results are obviously biased by the researcher’s prejudices or vested interests, they will be worthless and his or her reputation will suffer. Scientists have a strong incentive not to let their prejudices interfere with their work. Their reputation depends on getting things right. But of course they are human and sometimes hopes will cloud judgment.

In conclusion, let me turn to the present. Since the Enlightenment, progress in our understanding of the world around us has been astonishing. But where do we stand today?

I founded Sense About Science in 2002 out of frustration with the misinformation, misrepresentation and basic lack of understanding of science that pervaded politics, much of the media, and public opinion. There seemed to be a dimming of the Enlightenment

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**Slide 10**

**The Dimming of the Enlightenment**

**Widespread hostility to GM crops**
- Every trial in the UK and Europe had been trashed

**Exaggerated fears of radiation**
- Fear of nuclear power stations
- Fear of phone masts. “Mobile phones fry your brain”

**Popularity of alternative medicine**
- BSc degrees in Ayurveda, reflexology, chiropractics
- NHS funding for homeopathy

**A general assumption that organic food is better for health**

**Reaction against the MMR vaccine**
Creationism beginning to be taught in schools

TV programmes on how to cleanse your body of all chemicals

There was even one echo of the confrontation between Galileo and the Pope. When the Director of Greenpeace was asked by a House of Lords Select Committee about his opposition to GM crops: was it absolute and definite or could it be affected by future research?, he replied: No, it was “permanent and definite and complete”. It was the answer which the Pope’s representative gave when Galileo asked him to look through his telescope at the newly discovered moons of Jupiter. “I refuse to look at something which my religion tells me cannot exist.”

Today, Greenpeace and Friends of the Earth still passionately reject the unanimous finding by every scientific body in the world that no harm has been caused by GM crops to human health or to the environment. As HL Mencken observed, “Most common of all fallacies is to believe passionately in the untrue.”

But there has been substantial progress.

I believe we are at a turning point in public attitudes to transgenic crops, not only in this country, but importantly in Africa. This government has firmly declared its support. And at some stage the inexorable and dramatic growth in cultivation of GM crops in the rest of the world, especially the emerging world, will force the rest of Europe to face reality.

It is overwhelmingly clear that they will be essential in dealing with the effects of global warming, feeding the hungry, dealing with drought and water shortage and the loss of good farming land, and indeed in conserving biodiversity. We should applaud those once passionate opponents like Mark Lynas, who have now publicly declared how wrong they were.

In Britain most people now accept the need for nuclear power. There has been no hysterical reaction to Fukushima, as there has been elsewhere.

The NHS has largely ceased funding homeopathy, which is increasingly becoming a joke, to judge by comedians on television. Look at this

Slide 11
The cumulative onslaught on pseudo-science by Edzard Ernst, Simon Singh, Ben Goldacre, Evan Harris, Francis Wheen and many others, has had its effect. The New Year pillorying of celebrity follies by Sense about Science attracts splendid publicity. Long live Gwynneth Paltrow and Madonna. Long may they delight us with their absurdities.

David Colquhoun has almost single-handedly shamed several Universities into withdrawing degree courses in Mumbo-Jumbo.

The government has appointed chief scientists to all its departments.

Schools have been stopped from teaching creationism

The sales of organic food are in decline, though cost has a lot to do with that. But it is no longer almost universally assumed that organic food is good for you. Alan Dangour’s meticulous analysis for the FSA has finally exploded the myth of its nutritious benefits.

Especially important is the review carried out for the BBC Trust by Steve Jones on the impartiality and accuracy of the BBC coverage of science. Polls show that 84 per cent of the public gets its information about science from television. Now the BBC has agreed to appoint a Science editor for BBC News; and there are new guidelines on “due weight” in observing impartiality in its treatment of science issues. There is to be training for journalists. It seems likely that “balance” will no longer mean equal time for sense and nonsense.

So Mumbo Jumbo may not conquer the world. But will these efforts actually increase public understanding of science? How can we best communicate the way science works? One can’t really organise demos with banners “Long live the scientific method.”

But every time bogus science is pulled apart, it reveals how good science works. The SAS leaflet “I Don’t Know What to Believe” explained the importance of peer review. It has had a big impact, with over half a million downloads and wide distribution in schools. Our campaign “Ask for the Evidence” is growing in momentum and goes to the root of the
scientific way of thinking. As for public interest, there are few more effective communicators
to inspire future scientists than David Attenborough and Brian Cox. The Voice of Young
Science, a movement of young research workers developed by our young staff, has
stimulated other young scientists to promote good science. It has spread like wildfire and is
now being copied in several other countries. It has been one of our most unexpected
successes.

I believe Sense about Science is a great organisation, and for this credit is due above all to its
Director, Tracey Brown, who combines a unique drive, imagination, a great sense of strategy
- and is also incorrigibly argumentative.

Personally I have found working with our staff one of the most enjoyable episodes in my
career - so far. It has been for a cause that Popper and Medawar have both, I think rightly,
described as “the greatest adventure of mankind”.