

An Introduction to the Grammar of Science

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I wouldn't be surprised if a good few people looking at my title were reluctant to read much further. As a schoolboy, some of my least favourite textbooks had the word 'grammar' in the title. I've somewhat astonished myself years later by using the 'g' word myself. It seems to hit the spot. Karl Pearson, a statistician and philosopher of science, used the same phrase over a century ago as his title for a well-known book that is still in print, if little read. It's a product of its time (the 1890s) and mainly addresses different issues from the ones discussed here.

The deepest insight I've got out of science is an understanding of how nature works, at least as much of it as I've had time to learn about. Underneath the constantly novel experiences of daily life we find laws and regularity. In almost every scientific discipline – just think astronomy, mechanics, chemistry, biology, geology and medicine as examples – what's governing the natural world are not the laws that our distant ancestors thought were at work. The natural world is more subtle, as we've discovered. This piece isn't about the laws of nature as such but about how the subtle factors governing natural behaviour have been discovered through science. One of the consequences of thinking scientifically is that the methods of science also turn out to be very useful in running our daily lives, deciding what to buy and what not to buy, what to believe and what not to believe, what ideas to pursue and which ones not to. Some would go further and argue that the methods of science are not just a luxury that makes life better but are essential for our future survival. They may be right. Time will tell.

There's a view among some 'arty' people that finding out how something works takes away from the wonder of the phenomenon. I suspect this is just an excuse of the intellectually lazy. If you want to study music, you spend years at a *Conservatoire* or equivalent finding out how classical music is constructed, jazz is improvised and so on. Likewise if you want to become a painter, you study the aesthetics of painting as well as the techniques of the brush; writers study what makes a successful story, novel or poem; and so on. In some arts, the university of life and a generous gift of natural talent may be enough but years of practice and study are sure to be behind a successful artist in almost any medium. An understanding of the subject never detracted from an appreciation of creativity. Likewise an understanding of how science works and what science has told us generally enhances our appreciation of nature. Moreover, as the world increasingly becomes more science oriented, then understanding the methods of science is almost essential for keeping afloat in society, choosing the informed opinion and actions from the misguided, the mistaken and the deluded. It is in fact just the methods of science that make scientific knowledge more trustworthy than assertions passed down as 'received wisdom' with more or less force of assertion depending on the source. At least even the quacks imply that genuine scientific knowledge has validity for you haven't got to look far these days, particularly on the web, to find people using scientific jargon in completely bogus ways, misusing the language of science trying to sell you something that isn't fit for purpose and certainly isn't based on the real concepts behind the descriptive words. Distinguishing the real from the bogus is part of the intent of the grammar of science.

This piece began as a postscript to a fragment I wrote on science and religion. On reflection, I thought it was worth a life of its own rather than sitting in the shadow of a larger and more controversial subject. However, if you've read the other piece then you'll have read some of what I'm about to put here.

My thesis is that the 'grammar of science' is essential both to understanding how science works and for making sense of life. Curiously enough, this 'grammar' is seldom taught explicitly. One is supposed to pick up the details by exposure to the results of scientific enquiry, somewhat as a language student is expected to pick up the finer points of a language by listening to its use. The grammar of science is very powerful. Disparate people and societies around the globe with strong and diverse cultures who are not in the habit of agreeing much with each other all concur with much of the body of knowledge that falls under the heading 'science'. Why? The answer is that science has developed techniques for sifting vast amounts of experience about how nature works, selecting appropriate concepts from the myriad of suggestions, finding regularities of mathematical precision in many aspects of nature's workings and testing ideas against reality, rejecting concepts that lead to false conclusions. Science isn't just about appropriate descriptions; science does something no other discipline does. It makes accurate calculations of how nature works, often to accuracies of better than one in a million. You don't sit comfortably in your cabin seat on an airplane, reading your novel or magazine with less than half an ear on the safety briefing because some people have watched birds flying, marvelled at the beauty and elegance of flight and had the notion that they could make a bird-shaped thingy with wings that could fly too. You sit relaxed because you know that the calculations have been accurate for the power needed to take off and fly, the control needed to land, the strength of materials adequate to resist the buffeting of clear-air turbulence, in-cloud convection or even lightning strikes, and the navigation aids will steer the plane through clouds exactly to the destination runway. You sit comfortably because science works. Science works because the methods of science work. What have we learnt from the methods of science that is relevant to everyday life?

We've learnt that common decision making processes that served our ancestors well enough, so much so that we use them intuitively, can be flawed when it comes to finding truths that will stand up to multi-cultural scrutiny. I'll give some specific examples. Science gains respect when it gets things right but it really advances when it sees it has got things wrong. Just think of the advances in astronomy when the predictions of the old Earth-centred model of the cosmos (upon which most biblical imagery of the heavens is based) were proved wrong by the telescopic observations of the phases of Venus, or how experiment proved that the Lammarkian concept of the inheritance of acquired characteristics (that underpinned Soviet agricultural policy for decades) was wrong, or Einstein's General Theory of Relativity demonstrated that Newtonian gravitational concepts were just a useful simplification of a much more complex phenomenon, and so on. These are not examples of minor issues but changes in core perceptions. Science becomes stronger and its insights more penetrating when new, tested, ideas replace old ones. Science textbooks of today are hugely different from those of even a century ago; so too for that matter are works of literature, music, sculpture, painting and any of the creative arts. Many people have been taught that the most profound knowledge is that passed down through the generations from our ancestors. Of course we learn a lot from those who have lived before us and passing down mantras through the generations has advantages in small societies, where the opportunity to test beliefs is limited, but it is not a satisfactory way for mankind to acquire globally valid knowledge, when testing the validity of knowledge is not subject to limited opportunity.

Another example of intuition misleading us is our propensity to accept assertions without critical appraisal. This not only provides a channel for propagating false beliefs but it's a dangerous tendency that gives a ready-made opening to snake-oil salesmen, purveyors of bogus therapies such as pixie dust, the swinging crystal pendulum and medicines with no active ingredient at all, sellers of get-rich quick schemes and other dreams of health and wealth that will never be fulfilled, except by chance. The fact is that we don't critically assess

everything we are told but are biased by our existing beliefs. It's all the more important then that those beliefs should be well grounded. In daily life we intuitively value evidence that favours our existing beliefs and downplay contrary evidence. The emphasis that we place on existing beliefs leads to socially reinforced conformity. We seek out others with the same beliefs, gather in designated meeting places and repeat the beliefs in unison, in words or song. It's a well-tested and successful means of passing doctrine down through the ages regardless of the value or truth of what is being passed down. Science, I'd put it to you, is always looking to test its basic knowledge, find contrary evidence, predictions that are poor and explanations that can be disputed. It is this process that has made science revise many of its core doctrines in centuries past and made its present knowledge all the more believable.

Many people find belief systems that have an answer for every contingency very attractive. I suspect we have all met the politically motivated person who has an answer within his politics for every circumstance, real or imagined; or, indeed, the religious adherent who always has a belief to fall back on. In every field that can be called 'scientific' there are many questions without answers, at least answers that are known within the current state of knowledge. There is no stigma to admitting ignorance, in fact ignorance is one of the fundamental necessities to making progress and helps one decide where to put ones energy and resources.

If you want just one definite example of where the scientific method has made an enormous difference to everyday life just think of the advances in medicine over the past two centuries. Modern medicine, based on evidence-led practices in general and scientific methods in particular, doesn't claim effective cures for all ailments by any means but it is hugely more effective than the combination of folk-practice, prayer and quackery that was prevalent a few centuries ago. The biggest complaint of many people today is that they can't get an appointment quickly enough with a medical practitioner and the appointment often doesn't last long enough. I, for one, would only see a doctor as a very last resort if the knowledge he or she had was that professed by a qualified medical man two-and-a-half centuries ago.

There seems to be a view among those who have never participated in scientific enquiry that science is impersonal. Perhaps it's arisen because of the convention of writing science papers in the third person. Whatever the cause, little is further from the truth. Science is driven by those distinctly human characteristics we all share: inquisitiveness, resourcefulness, adaptability, ingenuity and a need to understand. So is 'Art' in its broadest sweep, which is perhaps why both continuously evolve.

A final lesson from science that I'll quote is that intuition can easily fool us into seeing relationships that aren't really there. Superstitions about bad luck brought by black cats, broken mirrors, decisions made on Friday the 13th and a host of almost random events are minor examples of reading too much into disconnected circumstances. I say 'minor examples' but superstition ruled people's lives in the past, I would say to the detriment of many a healthy and rational life. Superstition is by no means dead. Otherwise intelligent people will readily develop 'good luck' habits from the simple wearing of a 'lucky charm' or carrying around a favourite doll, to acquiring repetitive behavioural characteristics in sport that don't of themselves improve performance. Think of the batsman who always touches the left side of his cap before he faces the bowler or pitcher, the tennis player who ritually adjusts his clothing before serving, the sprinter who performs the same elaborate pantomime before settling in the blocks. All probably started because on a few earlier occasions similar actions preceding winning performances. A relationship between action and result is invented that doesn't really exist but has become so embedded in the mind of the sportsman that if he gave it up he would be genuinely unhappy and perform poorly. The ritual creates the illusion of being in control.

The grammar of science includes good methods for testing whether apparent patterns of events reflect an underlying randomness or are causally connected, whether co-incidental events are random occurrences taking place at the same time or are truly correlated. Recognising randomness is not easy; it is far easier to invent specious relationships. Illnesses treated as a punishment from God for alleged transgressions of the moral code are one religious example of this phenomenon.

I should add that it's not stupidity that's responsible for us jumping to conclusions without good grounds. The tendency clearly had evolutionary advantages when most of mankind lived in the wild and survived on their wits. If one heard a distinct rustle not far away, better to assume it was a hungry predator or members of a neighbouring tribe trying to sneak up than wait to find out what it really was. A noise in the night might just be caused by a falling stone or rock cooling down but better to act as if it were a prowling bear; it just might be. There are evolutionary advantages in appearing to see threats that often weren't there but sometimes could be. We are a product of our evolutionary history. The fact is, though, that times change faster than our instincts and the driver for evolution is survival, not the quest for discovering reality.

In summary, the assertion that "if common-sense was good enough for our ancestors it is good enough for us" is misleading on two counts. First, many aspects of daily life and practice in the past were not simply applications of common sense but were based on false ideas that were asserted without proof by the shapers of society. Secondly, we have moved on from simply interpreting nature through 'common-sense' to finding that one needs to interpret nature through 'uncommon-sense' to find out what is really happening. Modern science such as quantum mechanics, relativity, genetics, continental drift, the Big Bang and many other 20th century discoveries are the result.

I plead guilty to the charge of being discursive. Having made some general statements I'll now be more specific on how science goes about its business. The operational rules governing the workings of science are what I have chosen to call the grammar of science. Here are some of the key points. The subject merits a book: I have bullet-pointed headings covering two pages. The science graduate will recognise that behind each point there is a wealth of technique and experience. For example, how is a phenomenon of interest isolated for study? How are complex circumstances simplified sufficiently to make analysis possible? How does one isolate the cause of a particular event when there are a large number of factors contributing to the general situation? How is information extracted from data which at some level contains random effects? When is it appropriate to argue by analogy, or with models, or use mathematics? There's a good reason why it takes 3 or 4 years to obtain one's first science degree. Just as a grammar book in a foreign language doesn't tell us how to converse in that language on a given subject, so these headings on their own won't enable anyone to set to and undertake some science.

- *Science is based on observation and the interpretation of what is seen or experienced using reason and logic.* Thus, science is evidence-based, not authority-based. Anyone who has been brought up in a strict authoritarian environment, political, military, religious or of some other flavour, will scarcely believe that such a system can work. It does. The collective judgement of those who have looked at the evidence provides the reputation of a body of scientific knowledge.

- Mathematics is the formal development of logic when numbers and quantities with properties like those of numbers are involved and hence mathematics is the natural language of all quantitative science.
- Science is about what happens in the real world, not about the development of imaginary places and beings. This may sound a clear distinction but not everyone agrees where the boundary lies.
- *An essential element of science is testing the predictions of ideas against reality.* Einstein expressed it as ‘Truth is what stands the test of experience’. Arthur Eddington put it that observation was the supreme court of appeal. In other words, there is no book of science whose words are the final authority, no scientist however famous whose pronouncements must be true. If you want to know whether the predictions of a theory or an idea are right then ask nature herself.
 - *Scepticism* is an important part of scientific culture. Assertions in science need to be supported by evidence drawn from natural behaviour. One can probably go further and say that as a piece of science an assertion is only as good as the evidence for it. Climate change naysayers have given scepticism a bad name by continuing to deny what is supported by evidence, but the application of scepticism is fully consistent with scientific methods. The judgement required is to know when to stop.
 - *Scientific knowledge must be predictive.* It is implicit in the previous paragraphs that there must be **testable** predictions. This is to some extent a self-imposed restriction on what is science but it provides a useful dividing line between what is science and what isn’t. Science isn’t just about collecting observations, however useful this can be, but about interpreting them in a self-consistent framework of ideas. Useful concepts enable predictions to be made that can be tested against actual behaviour. If your idea can’t predict anything testable about the natural world it doesn’t provide useful scientific understanding.
- *Experiment is refined observation.* If the phenomenon of interest isn’t happening naturally in front of you or your senses can’t detect it, then make it so. Experiments can be very simple or hugely complicated and expensive, like the large particle accelerators in dedicated laboratories such as Fermilab or CERN. Nonetheless, the philosophy behind them all is the same, namely observation. In fact our huge gain in understanding nature that has come about in the past few centuries would not have happened without the development of sophisticated equipment, increasingly very sophisticated equipment, and methods of designing experiments that allow valid conclusions to be drawn.
 - The techniques of experimental design and rigorous data analysis are a major part of modern science and are key aspects of why scientific results are now more penetrating and more secure than ever.
 - I could have said earlier that in scientific writing, the sources of data, experimental results, interpreted knowledge, specialised methodology and other external contributions to the discussion and conclusions are usually explicitly referenced. This allows the evolution and development of knowledge to be traceable and helps readers assess the validity of what is presented.
- *One can disprove a generalisation but never completely prove it.* The philosopher Karl Popper is credited with pointing this out. Generalisations are based on observing many instances, and different words are used to describe how certain we are about their validity. ‘Principles’ are often fundamental assumptions; ‘laws’ are seen as universally applicable generalisations within a specified context; ‘hypotheses’ and ‘postulates’ are working assumptions awaiting further evidence, or disproof, and so on right down to hunches. Many instances can support a generalisation but never prove it; one counter example

disproves a sweeping generality. It takes a lot of conceptual effort and evidence before one can come up with a ‘law’ of science. Some practitioners of subjects that aspire to be sciences are not above claiming relationships are true without troubling to go to the labour and expense of finding evidence that they work. This isn’t science.

- *The scientific method includes the correction of false ideas.* Because ideas can be falsified, generalisations that are found untrue in some circumstances or concepts that turn out to be invalid (in the light of evidence against them or reasoned criticism) are replaced or refined. Scientific knowledge is therefore an intrinsically evolving body of knowledge. Of course it also evolves because the range of phenomenon studied increases as new techniques enable the next generation to do what previous generations couldn’t.
 - *Ideas that have been disproved are thrown away.* The history of ideas is full of concepts that were accepted in the past but evidence or reason has since discredited them. A few examples are the Aristotelian 4 elements of nature (5 if you include quintessence), astrology, alchemy, the creation of the Earth some 6000 years ago. You won’t have to look far to find someone who can’t ditch one of these ideas inspite of all the evidence that it’s wrong. Science has a wastepaper basket for disproved concepts. Indeed, every culture includes a skip full of ideas that people at one time thought described reality but which modern knowledge says should be re-classified as the creative fiction of our ancestors – part of our heritage but not part of modern scientific understanding.
- *Scientific knowledge is taken as universal.* This is so much embedded in science culture that it is often left unarticulated. There may be national interests in science but there is no national science. It has been so for centuries. When Isaac Newton was putting down on paper his own ‘rules of reasoning’ he said ‘*to the same natural effects we must, as far as possible, assign the same natural causes*’. Thus he cited that one should look for the same cause of the descent of stones in Europe as in America. People breathe in Asia for the same reason they breathe in Europe. Animals breathe for the same reason people do. Extending ideas outwards to the universe at large, the cause of the orbital motion of planets in other systems around their local star, no matter how far away, is expected to be the same as the cause of the rotation of our planets around the Sun. In short, science aims for universally applicable understanding.
- *The aim of science is to provide deep, long-term understanding.* This may sound inconsistent with the progressive evolution of ideas that actually takes place but newer ideas aim to be more robust concepts with greater validity and a longer life. My first bullet point implies that it’s up to the next generation to assess whether newer ideas do stand up to long-term scrutiny. In any case, science is not in the business of generating short-term fashion statements with commercial motivation.
- *Science acknowledges ignorance.* It is perfectly valid within a scientific discipline to acknowledge that there are questions that have no answers, yet. Indeed it’s a common result of an experiment or piece of exploration to say “that raises more questions than it answers”. The investigation may have been very successful in answering what it set out to but in so doing it may well widen the field of enquiry. Claiming that all issues in a subject have answers is not science.
- *Involvement of the public domain is an essential part of science.* The publication of results, the duplication of experiments by others, the public scrutiny of one’s work are essential ingredients in science. It’s true that good investigative work can be done behind the screens of commercial or military secrecy but if that work is to contribute to the body of knowledge treated as science it should eventually emerge in the public domain. Implicit in this public involvement is that the language used must be clearly defined and the meaning of words universally agreed. This aids clarity of expression and has contributed

to the use of a dominant language of science throughout the world. Fortunately for me it is English. The importance of scientific publication is implicit in no less than the Universal Declaration of Human Rights, ratified by the United Nations General Assembly in 1948, which contains the section '*Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits*'. Without science being made public, humanity cannot share in its advancement.

[I'm tempted to add another paragraph on making scientific knowledge public. It's quite clear that simply publishing scientific results isn't enough. It's true there is a certain obligation on society to learn some of the basic vocabulary of science but in almost all areas science has become a highly technical subject that needs clear explanation to make it intelligible. We have all experienced how specialist language is good for dealing with technicalities but poor for propagating ideas. Ask a politician a simple question and you'll likely get back an answer in political speak; listen to the explanations given by management consultants and they come in management speak; religious dogma is propagate in religious speak. My will is written in legalise that is almost incomprehensible to those who will benefit, without a legal interpreter on hand. I recently asked some simple questions of our local planning authority about a multi-million pound by-pass project that is near to starting in my area and received 2 pages of answer in planning speak that didn't clearly answer the points. Everyone is at it. Science needs to recognise the need for public interpreters that know what they are talking about in depth but can genuinely bring scientific knowledge out of the laboratory to the public at large. The track record of the media in presenting science has been, on the whole, rather poor to date.]

All the main points above have one thing in common: they involve people thinking logically and creatively. Just because measurements are made using instruments doesn't mean that science is impersonal. Practising science involves creating what doesn't exist; perhaps new equipment to measure what hasn't been measured before, new experiments to observe what hasn't been observed before, new concepts that hadn't occurred to anyone before in quite that way, new links between existing ideas, the application of the logic of mathematics to demonstrate conclusions not reached before, the creation of computer programs that calculate or display what hadn't been done before, or putting explanations in the public domain that weren't there before. Involving the public is an integral part of scientific practice. A life in science is a continuously creative experience. It also involves reflection and understanding. Not surprisingly, perhaps, science attracts a good many of the most talented people of every generation. Talented people can make advances by breaking the rules, just as talented writers and orators sometimes break the rules of the grammar of language. Science is flexible enough to gloss over how some people arrive at their conclusions but no science is immune from the test of comparing its predictions with the behaviour of the natural world in its broadest sweep.

Contrary to some opinion at the moment, it seems likely to me that the influence of scientific knowledge and methods will gain ground in the coming decades. Karl Pearson in his 'Grammar of Science' refers to the 'war between science and dogma' that was very much apparent at the beginning of the twentieth century. It is still very much apparent today but my take is that the humanity behind science is becoming increasingly recognised, the methods of science more widely appreciated and the conclusions of science, once understood, increasingly accepted.

I seem to have missed saying explicitly that the goal of science is none other than to understand the universe and everything in it, for real this time, not to spin yet another yarn to add to the many our ancestors produced. It's an ambitious, even breath-taking, mission – a mission for

mankind as a whole. A single discipline such as Physics covers a huge range of nature, from astrophysics and the universe at large, through subjects experienced in our daily lives such as mechanics, dynamics, fluid flow, the properties of matter and so on down to the micro-scale entities of nuclei, electron orbitals and the complex of 'elementary particles' that appear when matter is taken apart. Likewise the sciences of modern chemistry, botany, zoology, geology and other disciplines cover a huge range of natural behaviour. I find it very convincing that there are no special rules for each subject. The Grammar of Science works across the board, embodying a very powerful method for extracting real knowledge.

I believe that science has a lot to tell us, not only about knowledge but about how to acquire knowledge. The ancient Greeks showed that good rhetoric and clear argument followed rules that could be taught, to the benefit of both performance and appreciation. Modern science has added to those tools a whole lot more that allow us to understand nature, not only in the laboratory but also in many aspects of daily life. These tools allow us to judge such varied everyday aspects as which treatments for ill health are based on genuine knowledge of disease, which products are likely to perform properly what they claim to for a reasonable length of time, which aspects of daily life is society likely to be able to sustain in the coming centuries, what aspirations is it sensible to plan for, and other apparently non-scientific issues. I've probably left you with the impression that I think scientific knowledge and method is the answer to everything. It's not. There are plenty of areas of experience where science provides little in the way of explanation and concepts that don't come from science are necessary to make decisions. But we all need tools for sifting the believable from the unbelievable and for those who choose to use them there are a lot more tools now available than there used to be.

JSR

Afterward

I used the word 'real' twice a few paragraphs back, a word that seems dangerously close to the contentious word 'truth'. This is an aside from 'the grammar of science' but does impinge on what science is. On the whole, scientists don't agonise about 'reality'. It is the world outside that can be touched, perceived and used by all who have the senses to do so. Not only do I see the tree in the park but clearly everyone else nearby does too. Prams change direction on the grass to avoid it, the Council has put up a sign 'quercus quercus' to identify it and the bird on the branch perceives it as clearly as I do. The tree is real, let's get on with life. Of course, there are less clear cut examples. Your ghost may be real to you but a delusion as far as I'm concerned. What about truth? Is it like the tree, or like the ghost?

The mathematicians have rather shown us the way to go in assessing whether something is true. They start with a set of ideas - they usually call them axioms - that appear not to conflict with each other and then use logic to demonstrate statements that must be true, given the axioms. The difference between science and mathematics is that in science the basic principles and concepts are not given in advance - we have to deduce them from natural behaviour. We then use logic and such other input as is necessary to make statements that will stand up as scientific truth. Scientific truth, then, is based on the accuracy of concepts and knowledge we have deduced from our perceptions of reality and our deductive powers. My working assessment is that truth is as good as our underlying principles and the deductive processes that are built upon them. Recognising that scientific knowledge is provisional, some people like to think that all scientific statement are true with a certain probability. The widely accepted principles are true with probabilities very close to certainty; working conjectures may be true with a very modest probability. The intent of scientific enquiry is to continuously refine

knowledge so that the new statements are true with increased probability. Therefore, the view of nature mankind will have in the far distant future will be nearer the truth than our view is, though we clearly can't perform the comparison test.

Truth is a slippery customer if one probes deeply but I'd say that the biggest mistake one can make is to think that there is only one true viewpoint – *'The Truth'*. In Physics alone there are plenty of examples where two different descriptions make the same predictions and hence can be regarded equally as 'true'. Think of Huygens' Principle in Optics and Fermat's Principle, both fundamental ideas from which the basic behaviour of light such as straight-line propagation, reflection and refraction can be deduced, yet they are two radically different descriptions of the way light 'works'. Think of Schrödinger's wave mechanics and Heisenberg's matrix mechanics, again radically different approaches to quantum mechanics. Thus science deals in truths, not 'The Truth'.

In some areas I believe our view of reality has come from being very wide of the mark to close to a truth. For example the view of our Earth being a planet that is part of the Sun-centred solar system that is itself part of the Milky Way galaxy and in orbit around the galactic centre, etc. is a 20th century view of our locality in the universe that I feel sure is not going to be overturned, though very different views preceded it. In another area, there were arguments for over a century about whether the concepts of atoms and molecules referred to reality or were just useful mental aids to understanding. The argument is settled that atoms and molecules exist in nature. In some areas our view has gone from fuzzy to more clear but there is still a long way to go. The 4-base-pair genetic code in DNA discovered by Crick and Watson that controls life is reality but we are still a very long way from having sufficient understanding of genes to predict the kind of organism that a set of genes of known sequence will generate. Because cultures of the past have conceived such a wide range of disparate pictures of what nature 'really is', plenty of people have been seduced into believing that all understanding is illusory. It's not a view I hold. Discussion of this takes us away from the grammar of science into the nature of science itself. Most scientists I have met aren't steeped in the philosophy of science. Indeed I suspect they have a sneaking regard for a view that I think was articulated by Leibniz, that Philosophy is a discipline where the practitioners kick up a lot of dust and then complain they can't see clearly. Nevertheless, one needs to believe that science is a worthwhile pursuit before expending effort on its grammar.

JSR