The Experimental Philosophy

Francis Bacon (1561- 1626)

Novum Organon, 1620.
(new instrument of thought)

Bacon was not a scientist, but greatly esteemed by the new generation of scientists, the Royal Society. His impact on the world is illustrated by the fact that Kant (not a Baconian!) dedicated his Critique of Pure Reason (1781) to Bacon.

Bacon is known as the father of British Empiricism. Empiricism is a cluster of views, not a single view. But all forms of empiricism regard experience (through the 5 senses) as the main source of concepts and knowledge. Empiricists typically deny the existence of innate knowledge, e.g. cognitive structures that are genetically determined, and somewhat play down the role of reason in scientific enquiry.

Bacon believed in something that has been called “Immaculate Perception” –

‘all depends on keeping the eye steadily fixed upon the facts of nature and so receiving their images simply as they are.’

Such theory-free observation is the foundation of scientific work.

Just the facts

One method of delivery alone remains to us which is simply this: we must lead men to the particulars themselves, and their series and order; while men on their side must force themselves for a while to lay their notions by and begin to familiarize themselves with facts. [my emphasis]

“Idols”

Bacon lists some of the causes of faulty reasoning, referring to them as “idols” of the Tribe, the Cave, the Market Place, and the Theatre. Human understanding is “like a false mirror, which, receiving rays irregularly, distorts and discolours the nature of things by mingling its own nature with it”.

Ants, spiders and bees

For Bacon, science is far more than the mere gathering of data. First two kinds of scientists are described, the men of experiment and men of dogmas. The men of
experiment, like ants, “only collect and use”. The men of dogmas, or reasoners (resembling spiders) “make cobwebs out of their own substance”.

“But the bee takes a middle course: it gathers its material from the flowers of the garden and of the field, but transforms and digests it by a power of its own. Not unlike this is the true business of philosophy; for it neither relies solely or chiefly on the powers of the mind, nor does it take the matter which it gathers from natural history and mechanical experiments and lay it up in the memory whole, as it finds it, but lays it up in the understanding altered and digested. Therefore from a closer and purer league between these two faculties, the experimental and the rational (such as has never yet been made), much may be hoped.”

Thus the ideal scientist, for Bacon, does involve reasoning as well as observation. This doesn’t contradict his idea of “immaculate perception”, since presumably the reasoning doesn’t begin until the data are in, and so doesn’t infect the process of observation.

**Galileo** (1564-1642)

Observation vs. Experiment

Galileo challenged Aristotelian naturalism, which said science should study the *natural* motions of systems, so that systems should simply be observed while they act normally, unimpeded by human intervention.

In conducting an *experiment*, the scientist constructs an unnatural situation, interferes with the bodies’ natural motions, and then watches what happens. According to the Aristotelians, the results of such a contrived situation are uninteresting, and of no value to science. So free fall is ok, but pendulums and so on are not. (This makes more sense in biology than in physics. What do we learn about gorillas when we observe them in a cage?)

Aristotelians also criticized Galileo for his use of mathematical abstractions, such as perfect spheres and frictionless surfaces. He was not describing the real world, as we experience it. He did imaginary experiments.

**Christian Huygens** (1629 – 1695)

*Treatise on Light* (1678)

“One finds in this subject a kind of demonstration which does not carry with it so high a degree of certainty as that employed in geometry; and which differs distinctly from the method employed by geometers in that they prove their propositions by well-established and incontrovertible principles, while here *principles are tested by the inferences which are derivable from them*. The nature of the subject permits no other treatment. It is
possible, however, in this way to establish a probability which is little short of certainty. This is the case when the consequences of the assumed principles are in perfect accord with the observed phenomena, and especially when these verifications are very numerous; but above all when one employs the hypothesis to predict new phenomena and finds his expectations realized.”

This is one of the earliest and clearest statements of “hypothetical-deduction”, or “abduction”, or “inference to the best explanation”. The hypothesis is not derived from observational data. Rather, the hypothesis is put forward, and its observational consequences are inferred. Then these “predictions” are compared with the results of experiments.

Note that, for Huygens, the hypotheses of science are never more than probable, even if they agree with every experiment so far performed. There is no “scientific proof”. Thus Huygens was also a fallibilist.

Isaac Newton (1642 – 1727)

Principia (The Mathematical Principles of Natural Philosophy) 1687

RULES OF REASONING IN PHILOSOPHY

Rule I

*We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.* To this purpose the philosophers say that Nature does nothing in vain, and more is in vain when less will serve; for Nature is pleased with simplicity, and affects not the pomp of superfluous causes.

Rule II

*Therefore to the same natural effects we must, as far as possible, assign the same causes.* As to respiration in a man and in a beast; the descent of stones in Europe and in America; the light of our culinary fire and of the sun; the reflection of light in the earth, and in the planets.

Rule III

*The qualities of bodies, which admit neither intensification nor remission of degrees, and which are found to belong to all bodies within the reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever.* For since the qualities of bodies are only known to us by experiments, we are to hold for universal all such as universally agree with experiments; and such as are not liable to diminution can never be quite taken away...The extension, hardness, impenetrability, mobility, and inertia of the whole, result from the extension, hardness, impenetrability, mobility, and inertia of the parts; and hence we conclude the least particles of all bodies to be also extended, and hard and
impenetrable, and movable, and endowed with their proper inertia. And this is the foundation of all philosophy.

Rule IV

*In experimental philosophy we are to look upon propositions inferred by general induction from phenomena as accurately or very nearly true, notwithstanding any contrary hypotheses that may be imagined, till such time as other phenomena occur, by which they may either be made more accurate, or liable to exceptions.* This rule we must follow, that the argument of induction may not be evaded by hypotheses.

GENERAL SCHOLIUM

...But hitherto I have not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses; for whatever is not deduced from the phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy. In this philosophy particular propositions are inferred from the phenomena, and afterwards rendered general by induction.

*Opticks* (1704)

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...As in Mathematicks, so in Natural Philosophy, the Investigation of difficult Things by the Method of Analysis, ought ever to precede the Method of Composition. This Analysis consists in making Experiments and Observations, and in drawing general Conclusions from them by Induction, and admitting of no Objections against the Conclusions, but such as are taken from Experiments, or other certain Truths. For hypotheses are not to be regarded in Experimental Philosophy. And although the arguing from Experiments and Observations by Induction be no Demonstrition of general Conclusions; yet it is the best way of arguing which the Nature of Things admits of, and may be looked upon as so much the stronger, by how much the Induction is more general. And if no Exception occur from Phenomena, the Conclusion may be pronounced generally. But if at any time afterwards any Exception shall occur from Experiments, it may then begin to be pronounced with such Exceptions as occur. By this way of Analysis we may proceed from Compounds to Ingredients, and from Motions to the Forces producing them; and in general, from Effects to their Causes, and from particular Causes to more general ones, till the Argument ends in the most general. This is the Method of Analysis: And the Synthesis consists in assuming the Causes discover’d, and establish’d as Principles, and by them explaining the Phenomena proceeding from them, and proving the Explanations.