

From Bacon, Roger. *Opus Majus, Vol. I.* Ed. & Trans. By Richard McKeon. *From Roger Bacon to William of Ockham: Selections from Medieval Philosophers.* Ed. The Modern Student's Library. Charles Scribner's & Sons: New York, 1930. 8-10.  
<<http://www.archive.org/details/selectionsfromme002063mbp>>

## Chapter I

There are, indeed, four chief hindrances to the understanding of truth, which stand in the way of every man, however wise, and permit hardly any to arrive at the true title of wisdom; to wit, (1) the example of frail and unsuited authority, (2) the long duration of custom, (3) the opinion of the unlearned crowd, and (4) the concealment of one's own ignorance in the display of apparent wisdom. Every man is involved in these difficulties, every condition of man is held by them. For every one in all the acts of life and study and every occupation uses three of the worst arguments to the same conclusion; namely, (1) this has been exemplified by our ancestors, (2) this is the custom, (3) this is the common belief: therefore, it must be held. But the opposite to the conclusion follows far better from the premises, as I shall prove in many instances by authority and experience and reason. But if these three arguments are sometimes refuted by the splendid power of reason, the fourth is always before the eyes or on the lips of every one to excuse his own ignorance; and although he knows nothing worth knowing, nevertheless, what he knows he magnifies, shamelessly so that he overwhelms and shatters the truth in the consolation of his unhappy stupidity. Moreover, all the evils of the human race come from these deadly plagues; for the most useful and the greatest and most beautiful instances of wisdom and the secrets of all the sciences and arts are ignored; but what is

even worse, men blinded by the mist of these four arguments do not perceive their own ignorance, but cover and conceal it with all caution so that they find no remedy for it; and finally, what is worst of all, they think they are in the full light of truth when they are in the densest shadows of error; because of this they hold the most true to be in the bounds of falsity, the best to be of no value, the greatest to possess neither weight nor worth; and on the contrary they honor the most false, praise the worst, extol the most vile, blind to the truth that all the brightness of wisdom is other than these, disdainful of what they can attain with great ease; and because of the greatness of their stupidity they spend most considerable labors, consume much time, pour out vast expenditures on things which are of no utility or little and of no merit in the judgment of the wise man. Hence it is necessary that the violence and harm of these four causes of all evils be known in the beginning and be condemned and put off far from the consideration of wisdom. For where the first three of these causes dominate, no reason moves; no right judges; no law binds; the injunctions of religion have no place; the dictates of nature perish; the face of things is changed; order is confounded; vice prevails; virtue is extinguished; falsity reigns; truth is puffed away. And therefore nothing is more necessary to this consideration than the sure condemnation of these four causes of error by chosen arguments of wise men

which shall not possibly be contradicted.

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From Bacon, Roger. *The Opus Majus of Roger Bacon*, Vol. II. Trans. by R.B. Burke. New York: Russell & Ruskin, Inc., 1928. 582-87.  
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*Part Six of This Plea*

CHAPTER I

HAVING laid down fundamental principles of the wisdom of the Latins so far as they are found in language, mathematics, and optics, I now wish to unfold the principles of experimental science, since without experience nothing can be sufficiently known. For there are two modes of acquiring knowledge, namely, by reasoning and experience. Reasoning draws a conclusion and makes us grant the conclusion, but does not make the conclusion certain, nor does it remove doubt so that the mind may rest on the intuition of truth, unless the mind discovers it by the path of experience; since many have the arguments relating to what can be known, but because they lack experience they neglect the arguments, and neither avoid what is harmful nor follow what is good. For if a man who has never seen fire should prove by adequate reasoning that fire burns and injures things and destroys them, his mind would not be satisfied thereby, nor would he avoid fire, until he placed his hand or some combustibile substance in the fire, so that he might prove by experience that which reasoning taught. But when he has had actual experience of combustion his mind is made certain and rests in the full light of

truth. Therefore reasoning does not suffice, but experience does.

This is also evident in mathematics, where proof is most convincing. But the mind of one who has the most convincing proof in regard to the equilateral triangle will never cleave to the conclusion without experience, nor will he heed it, but will disregard it until experience is offered him by the intersection of two circles, from either intersection of which two lines may be drawn to the extremities of the given line; but then the man accepts the conclusion without any question. Aristotle's statement, then, that proof is reasoning that causes us to know is to be understood with the proviso that the proof is accompanied by its appropriate experience, and is not to be understood of the bare proof. His statement also in the first book of the *Metaphysics* that those who understand the reason and the cause are wiser than those who have empiric knowledge of a fact, is spoken of such as know only the bare truth without the cause. But I am here speaking of the man who knows the reason and the cause through experience. These men are perfect in their wisdom, as Aristotle maintains in the sixth book of the *Ethics*, whose simple statements must be accepted as if they offered proof, as he states in the same place.

He therefore who wishes to rejoice without doubt in regard to the truths underlying phenomena must know how to devote himself to experiment. For authors write many statements, and people believe them through reasoning which they formulate without experience. Their reasoning is wholly false. For it is generally believed that the diamond cannot be broken except by goat's blood, and

philosophers and theologians misuse this idea. But fracture by means of blood of this kind has never been verified, although the effort has been made; and without that blood it can be broken easily. For I have seen this with my own eyes, and this is necessary, because gems cannot be carved except by fragments of this stone. Similarly it is generally believed that the castors employed by physicians are the testicles of the male animal. But this is not true, because the beaver has these under its breast, and both the male and female produce testicles of this kind. Besides these castors the male beaver has its testicles in their natural place; and therefore what is subjoined is a dreadful lie, namely, that when the hunters pursue the beaver, he himself knowing what they are seeking cuts out with his teeth these glands. Moreover, it is generally believed that hot water freezes more quickly than cold water in vessels, and the argument in support of this is advanced that contrary is excited by contrary, just like enemies meeting each other. But it is certain that cold water freezes more quickly for any one who makes the experiment. People attribute this to Aristotle in the second book of the *Meteorologies*; but he certainly does not make this statement, but he does make one like it, by which they have been deceived, namely, that if cold water and hot water are poured on a cold place, as upon ice, the hot water freezes more quickly, and this is true. But if hot water and cold are placed in two vessels, the cold will freeze more quickly. Therefore all things must be verified by experience.

But experience is of two kinds; one is gained through our external senses, and in this way

we gain our experience of those things that are in the heavens by instruments made for this purpose, and of those things here below by means attested by our vision. Things that do not belong in our part of the world we know through other scientists who have had experience of them. As, for example, Aristotle on the authority of Alexander sent two thousand men through different parts of the world to gain experimental knowledge of all things that are on the surface of the earth, as Pliny bears witness in his *Natural History*. This experience is both human and philosophical, as far as man can act in accordance with the grace given him; but this experience does not suffice him, because it does not give full attestation in regard to things corporeal owing to its difficulty, and does not touch at all on things spiritual. It is necessary, therefore, that the intellect of man should be otherwise aided, and for this reason the holy patriarchs and prophets, who first gave sciences to the world, received illumination within and were not dependent on sense alone. The same is true of many believers since the time of Christ. For the grace of faith illuminates greatly, as also do divine inspirations, not only in things spiritual, but in things corporeal and in the sciences of philosophy; as Ptolemy states in the *Centilogium*, namely, that there are two roads by which we arrive at the knowledge of facts, one through the experience of philosophy, the other through divine inspiration, which is far the better way, as he says.

Moreover, there are seven stages of this internal knowledge, the first of which is reached through illuminations relating purely to the sciences. The second consists in the

virtues, for the evil man is ignorant, as Aristotle says in the second book of the *Ethics*. Moreover, Algazel says in his Logic that the soul disfigured by sins is like a rusty mirror, in which the species of objects cannot be seen clearly; but the soul adorned with virtues is like a well-polished mirror, in which the forms of objects are clearly seen. For this reason true philosophers have labored more in morals for the honor of virtue, concluding in their own case that they cannot perceive the causes of things unless they have souls free from sins. Such is the statement of Augustine in regard to Socrates in the eighth book of the *City of God*, Chapter III. Wherefore the Scripture says, "In a malevolent soul," etc., for it is not possible that the soul should rest in the light of truth while it is stained with sins, but like a parrot or magpie it will repeat the words of another which it has learned by long practice. The proof of this is that the beauty of truth known in its splendor attracts men to the love of it, but the proof of love is the display of a work of love. Therefore, he who acts contrary to the truth must necessarily be ignorant of it, although he may know how to compose very elegant phrases, and quote the opinions of other people, like an animal that imitates the words of human beings, and like an ape that relies on the aid of men to perform its part, although it does not understand their reason. Virtue, therefore, clarifies the mind, so that a man comprehends more easily not only moral but scientific truths. I have proved this carefully in the case of many pure young men, who because of innocence of soul have attained greater proficiency than can be stated, when they have had sane

advice in regard to their study. Of this number is the bearer of this present treatise, whose fundamental knowledge very few of the Latins have acquired. For since he is quite young, about twenty years of age, and very poor, nor has he been able to have teachers, nor has he spent one year in learning his great store of knowledge, nor is he a man of great genius nor of a very retentive memory, there can be no other cause except the grace of God, which owing to the purity of his soul has granted to him those things that it has as a rule refused to show to all other students. For as a spotless virgin he has departed from me, nor have I found in him any kind of mortal sin, although I have examined him carefully, and he has, therefore, a soul so bright and clear that with very little instruction he has learned more than can be estimated. And I have striven to aid in bringing it about that these two young men should be useful vessels in God's Church, to the end that they may reform by the grace of God the whole course of study of the Latins.

The third stage consists in the seven gifts of the Holy Spirit, which Isaiah enumerates. The fourth consists in the beatitudes, which the Lord defines in the Gospels. The fifth consists in the spiritual senses. The sixth consists in fruits, of which is the peace of God which passes all understanding. The seventh consists in raptures and their states according to the different ways in which people are caught up to see many things of which it is not lawful for a man to speak. And he who has had diligent training in these experiences or in several of them is able to assure himself and others not only in regard to things spiritual, but also in

regard to all human sciences. Therefore, since all the divisions of speculative philosophy proceed by arguments, which are either based on a point from authority or on the other points of argumentation except this division which I am now examining, we find necessary the science that is called experimental. I wish to explain it, as it is useful not only to philosophy, but to the knowledge of God, and for the direction of the whole world; just as in the preceding divisions I showed the relationship of the languages and sciences to their end, which is the divine wisdom by which all things are disposed.

## CHAPTER II

SINCE this Experimental Science is wholly unknown to the rank and file of students, I am, therefore, unable to convince people of its utility unless at the same time I disclose its excellence and its proper signification. This science alone, therefore, knows how to test perfectly what can be done by nature, what by the effort of art, what by trickery, what the incantations, conjurations, invocations, deprecations, sacrifices, that belong to magic, men dream of, and what is in them, so that all falsity may be removed and the truth alone of art and nature may be retained. This science alone teaches us how to view the mad acts of magicians, that they may be not ratified but shunned, just as logic considers sophistical reasoning.

This science has three leading characteristics with respect to other sciences. The first is that it investigates by experiment the notable conclusions of all those sciences. For the other sciences know how to discover their principles by experiments, but

their conclusions are reached by reasoning drawn from the principles discovered. But if they should have a particular and complete experience of their own conclusions, they must have it with the aid of this noble science. For it is true that mathematics has general experiments as regards its conclusions in its figures and calculations, which also are applied to all sciences and to this kind of experiment, because no science can be known without mathematics. But if we give our attention to particular and complete experiments and such as are attested wholly by the proper method, we must employ the principles of this science which is called experimental. I give as an example the rainbow and phenomena connected with it, of which nature are the circle around the sun and the stars, the streak virid *also* lying at the side of the sun or of a star, which is apparent to the eye in a straight line, and is called by Aristotle in the third book of the *Meteorologies* a perpendicular, but by Seneca a streak, and the circle is called a corona, phenomena which frequently have the colors of the rainbow. The natural philosopher discusses these phenomena, and the writer on Perspective has much to add pertaining to the mode of vision that is necessary in this case. But neither Aristotle nor Avicenna in their *Natural Histories* has given us a knowledge of phenomena of this kind, nor has Seneca, who composed a special book on them. But Experimental Science attests them.

Let the experimenter first, then, examine visible objects, in order that he may find colors arranged as in the phenomena mentioned above and also the same figure. For let him take hexagonal stones from

Ireland or from India, which are called rainbows in Solinus on the Wonders of the World, and let him hold these in a solar ray falling through the window, so that he may find all the colors of the rainbow, arranged as in it, in the shadow near the ray. And further let the same experimenter turn to a somewhat dark place and apply the stone to one of his eyes which is almost closed, and he will see the colors of the rainbow clearly arranged just as in the bow. And since many employing these stones think that the phenomenon is due to the special virtue of those stones and to their hexagonal shape, therefore, let the experimenter proceed further, and he will find this same peculiarity in crystalline stones correctly shaped, and in other transparent stones. Moreover, he will find this not only in white stones like the Irish crystals, but also in black ones, as is evident in the dark crystal and in all stones of similar transparency. He will find it besides in crystals of a shape differing from the hexagonal, provided they have a roughened surface, like the Irish crystals, neither altogether smooth, nor rougher than they are. Nature produces some that have surfaces like the Irish crystals. For a difference in the corrugations causes a difference in the colors. And further let him observe rowers, and in the drops falling from the raised oars he finds the same colors when the solar rays penetrate drops of this kind. The same phenomenon is seen in water falling from the wheels of a mill; and likewise when one sees on a summer's morning the drops of dew on the grass in meadow or field, he will observe the colors. Likewise when it is raining, if he stands in a dark place and the rays beyond it

pass through the falling rain, the colors will appear in the shadow near by; and frequently at night colors appear around a candle. Moreover, if a man in summer, when he rises from sleep and has his eyes only partly open, suddenly looks at a hole through which a ray of the sun enters, he will see colors. Moreover, if seated beyond the sun he draws his cap beyond his eyes, he will see colors; and similarly if he closes an eye the same thing happens under the shade of the eyebrows; and again the same phenomenon appears through a glass vessel filled with water and placed in the sun's rays. Or similarly if one, having water in his mouth, sprinkles it vigorously into the rays and stands at the side of the rays. So, too, if rays in the required position pass through an oil lamp hanging in the air so that the light falls on the surface of the oil, colors will be produced. Thus in an infinite number of ways colors of this kind appear, which the diligent experimenter knows how to discover.

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