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## The Scientific Revolution and the Enlightenment: New Intellectual Standards in the West

From the fifteenth through the eighteenth centuries, intellectual life in the West went through a dizzying series of changes, some contradictory. Renaissance thinkers and artists challenged medieval styles and standards, urging a greater focus on humanity and things of this world. The Reformation, shortly on the heels of the Renaissance, argued for a return to religious authority but also shattered the unity of Western Christendom. Ultimately—as became clear by the later seventeenth century—the cutting edge of Western intellectual life was redefined away from religion and toward the growing authority of science. By science, in turn, Western intellectuals meant a set of rational operations, including both deductive reasoning and experiment, by which scientists could discover the clear-cut laws of nature. Religious authority was not directly attacked, but it was sidestepped in favor of a belief that humans could know what they needed to know by unaided reason. Knowledge itself could progress, rather than referring constantly to faith or tradition.

The following selections, written by leading figures in the Scientific Revolution in the seventeenth century and its aftermath, the eighteenth-century Enlightenment, describe the new intellectual framework. Isaac Newton, whose great discoveries in physics and mathematics brought together more than a century of work on planetary motion and the laws of gravity, shows how science and religion could be combined—but obviously on the terms of science. John Locke, also a seventeenth-century Englishman, sketches new principles of knowledge wherein reason has the crucial role.

Locke and Enlightenment figures after him intended to apply rational principles and the idea of a harmonious, knowable nature to human society. Obviously, education had to change in order to develop the rational spark inherent in each child. Human institutions, such as criminal punishments, long based on outmoded religion and tradition, could

Selection I from Sir Isaac Newton, *Optics, or A Treatise of the Reflections, Refractions, Inflections and Colours of Light*, 4th ed. (London: 1730), p. 18. Selection II from John Locke, *An Essay Concerning Human Understanding* (Oxford: 1894), pp. 28, 37–38, 121–122, 387, 412–416, 420–421, 425–426. Selection III reprinted with permission of Macmillan Publishing Company. From Cesare Beccaria, *On Crimes and Punishments*, translated by Henry Paolucci, p. 67. Copyright © 1963 by Macmillan Publishing Company. Reprinted by permission of Prentice Hall/Pearson Education.

be rethought, again to make the best of the fundamental reason and goodness in each person. Cesare Beccaria, an Italian Enlightenment writer, took the lead here.

Science and the Enlightenment were not unchallenged in the Western world, but they did reshape previously dominant belief. Western intellectual life came to rest on assumptions radically different from those of a few centuries before. And there was more. The intellectual revolution reverberated in the wider culture of the West, as ordinary people picked up some of the same assumptions and began to challenge many traditions of popular culture. Finally, as the West spread its influence in the wider world, the baggage of the Age of Reason accompanied its journeys, challenging traditional cultures in Asia and Africa. Here, too, the intellectual revolution that started in the West is still working in the world, though with varied results.

## FROM THE SCIENTIFIC REVOLUTION AND THE ENLIGHTENMENT

### I. NEWTON'S VIEW OF THE WORLD (1704)

All these things considered, it seems probable to me, that God in the beginning formed matter in solid, massy, hard, impenetrable, moveable particles [atoms], of such sizes and figures, and with such other properties, and in such proportion to space, as most conduced to the end for which he formed them; and that these primitive particles, being solids, are incomparably harder than any porous bodies compounded of them; even so very hard, as never to wear or break in pieces; no ordinary power being able to divide what God himself made one in the first creation. . . .

Now by the help of these principles, all material things seem to have been composed of the hard and solid particles above-mentioned, variously associated in the first creation by the counsel of an intelligent agent. For it became him who created them to set them in order. And if he did so, it's unphilosophical to seek for any other origin of the world or to pretend that it might arise out of a chaos by the mere laws of nature; though being once formed, it may continue by those laws for many ages.

### II. JOHN LOCKE ON THE POWER OF REASON (1690)

#### I

It is an established opinion amongst some men, that there are in the understanding certain *innate principles*; some primary notions, characters, as it were stamped upon the mind of man; which the soul receives in its very first being, and brings into the world with it. It would be sufficient to convince unprejudiced readers of the falseness of this supposition, if I should only show (as I hope I shall in the following parts of this Discourse) how men, barely by the use of their natural faculties, may attain to all the knowledge they have, without the help of any innate impressions; and may arrive at certainty, without any such original notions or principles. . . .

Let us then suppose the mind to be, as we say, white paper, void of all characters, without any ideas:—How comes it to be furnished? Whence comes it by that

vast store which the busy and foundless fancy of man has painted on it with an almost endless variety? Whence has it all the *materials* of reason and knowledge? To this I answer, in one word, from EXPERIENCE. In that all our knowledge is founded; and from that it ultimately derives itself. Our observation employed either about external sensible objects, or about the internal operations of our minds perceived and reflected on by ourselves, is that which supplies our understandings with all the *materials* of thinking. These two are the fountains of knowledge, from whence all the ideas we have, or can naturally have, do spring. . . .

Sense and intuition reach but a very little way. The greatest part of our knowledge depends upon deductions and intermediate ideas: and in those cases where we are fain to substitute assent instead of knowledge, and take propositions for true, without being certain they are so, we have need to find out, examine, and compare the grounds of their probability. In both these cases, the faculty which finds out the means, and rightly applies them, to discover certainty in the one, and probability in the other, is that which we call reason. . . .

## II

*Assent to supposed innate truths depends on having clear and distinct ideas of what their terms mean, and not on their innateness.* A child knows not that three and four are equal to seven, till he comes to be able to count seven, and has got the name and idea of equality; and then, upon explaining those words, he presently assents to, or rather perceives the truth of that proposition. But neither does he then readily assent because it is an innate truth, nor was his assent wanting till then because he wanted the use of reason; but the truth of it appears to him as soon as he has settled in his mind the clear and distinct ideas that these names stand for.

## III

### Faith and Reason

By what has been said of reason, we may be able to make some guess at the distinction of things, into those that are according to, above, and contrary to reason. 1. *According to reason* are such propositions whose truth we can discover by examining and tracing those ideas we have from sensation and reflection; and by natural deduction find to be true or probable. 2. *Above reason* are such propositions whose truth or probability we cannot by reason derive from those principles. 3. *Contrary to reason* are such propositions as are inconsistent with or irreconcilable to our clear and distinct ideas. Thus the existence of one God is according to reason; the existence of more than one God, contrary to reason; the resurrection of the dead, above reason. . . .

From these things thus premised, I think we may come to lay down *the measures and boundaries between faith and reason*: the want whereof may possibly have been the cause, if not of great disorders, yet at least of great disputes, and perhaps mistakes in the world. For till it be resolved how far we are to be guided by reason, and how far by faith, we shall in vain dispute, and endeavour to convince one another in matters of religion. . . .

*Reason*, therefore, here, as contradistinguished to *faith*, I take to be the discovery of the certainty or probability of such propositions or truths, which the mind arrives at

by deduction made from such ideas, which it has got by the use of its natural faculties: viz. by sensation or reflection.

*Faith*, on the other side, is the assent to any proposition, not thus made out by the deductions of reason, but upon the credit of the proposer, as coming from God, in some extraordinary way of communication. This way of discovering truths to men, we call *revelation*. . . .

But yet nothing, I think, can, under that title [revelation] shake or overrule plain knowledge; or rationally prevail with any man to admit it for true, in a direct contradiction to the clear evidence of his own understanding. . . . And therefore *no proposition can be received as divine revelation. . . . if it be contradictory to our clear intuitive knowledge*. Because this would be to subvert the principles and foundations of all knowledge, evidence, and assent whatsoever: and there would be left no difference between truth and falsehood, no measures of credible and incredible in the world, if doubtful propositions shall take place before self-evident; and what we certainly know give way to what we may possibly be mistaken in. In propositions therefore contrary to the clear perception of the agreement or disagreement of any of our ideas, it will be in vain to urge them as matters of faith. They cannot move our assent under that or any other title whatsoever. For faith can never convince us of anything that contradicts our knowledge. . . .

Thus far the dominion of faith reaches, and that without any violence or hindrance to reason; which is not injured or disturbed, but assisted and improved by new discoveries of truth, coming from the eternal fountain of all knowledge. Whatever God hath revealed is certainly true; no doubt can be made of it. This is the proper object of faith: but whether it be a *divine* revelation or no, reason must judge; which can never permit the mind to reject a greater evidence to embrace what is less evident, nor allow it to entertain probability in opposition to knowledge and certainty. There can be no evidence that any traditional revelation is of divine origin, in the words we receive it, and in the sense we understand it, so clear and so certain as that of the principles of reason: and therefore *Nothing that is contrary to, and inconsistent with, the clear and self-evident dictates of reason, has a right to be urged or assented to as a matter of faith, wherein reason hath nothing to do*.

### III. BECCARIA APPLIES RATIONALISM TO PUNISHMENT (1764)

#### A. *Crimes and Punishments*

To examine and distinguish all the different sorts of crimes and the manner of punishing them would not be our natural task, were it not that their nature, which varies with the different circumstances of times and places, would compel us to enter upon too vast and wearisome a mass of detail. But it will suffice to indicate the most general principles and the most pernicious and common errors, in order to undeceive no less those who, from a mistaken love of liberty, would introduce anarchy, than those who would be glad to reduce their fellow men to the uniform regularity of a convent.

What will be the penalty suitable for such and such crimes?

Is death a penalty really *useful and necessary* for the security and good order of society?

Are torture and torments *just*, and do they attain the *end* which the law aims at?

What is the best way of preventing crimes?

Are the same penalties equally useful in all times?  
What influence have they on customs?

These problems deserve to be solved with such geometrical precision as shall suffice to prevail over the clouds of sophistication, over seductive eloquence, or timid doubt. Had I no other merit than that of having been the first to make clearer to Italy that which other nations have dared to write and are beginning to practise, I should deem myself fortunate; but if, in maintaining the rights of men and of invincible truth, I should contribute to rescue from the spasms and agonies of death any unfortunate victim of tyranny or ignorance, both so equally fatal, the blessings and tears of single innocent man in the transports of his joy would console me for the contempt of mankind. . . .

### *B. Torture*

The torture of a criminal during the course of his trial is a cruelty consecrated by custom in most nations. It is used with an intent either to make him confess his crime, or to explain some contradictions into which he had been led during his examination, or discover his accomplices, or for some kind of metaphysical and incomprehensible purgation of infamy, or, finally, in order to discover other crimes of which he is not accused, but of which he may be guilty.

No man can be judged a criminal until he be found guilty; nor can society take from him the public protection until it has been proved that he has violated the conditions on which it was granted. What right, then, but that of power, can authorize the punishment of a citizen so long as there remains any doubt of his guilt? This dilemma is frequent. Either he is guilty, or not guilty. If guilty, he should only suffer the punishment ordained by the laws, and torture becomes useless, as his confession is unnecessary. If he be innocent his crime has not been proved. Besides, it is confounding all relations to expect a man should be both the accuser and accused; and that pain should be the test of truth, as if truth resided in the muscles and fibres of a wretch in torture. By this method the robust will escape, and the feeble be condemned.

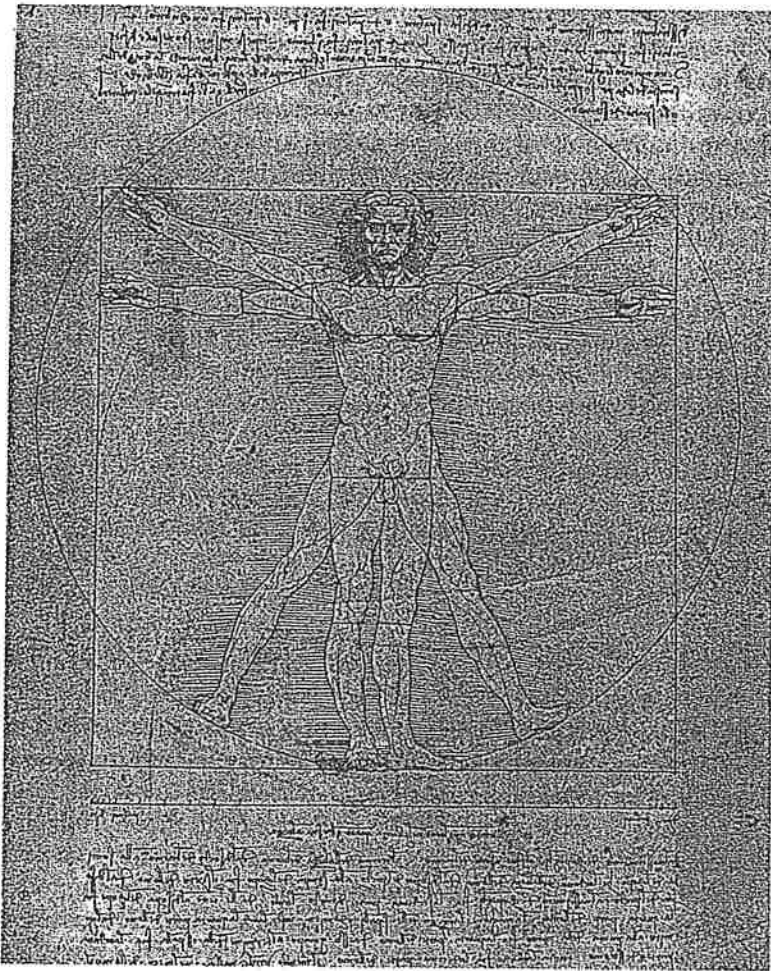
### **STUDY QUESTIONS**

1. How did Newton seek to reconcile the idea of a scientifically discoverable nature with Christianity? What was new about his approach?
2. How did Locke alter common Christian thinking about human nature? How would his ideas lead to growing emphasis on the importance of education?
3. Would Locke and Newton have agreed about the importance of religion?
4. How did Beccaria suggest a new approach to the punishment of criminals? Did his approach suggest the scientific and philosophical ideas pioneered earlier by people like Newton and Locke?
5. Were the Scientific Revolution and Enlightenment, in fact, revolutionary compared with earlier Western culture? Would their implications be radical in the context of most other major cultures in the early modern world?

## VISUAL SOURCE

The Italian artist Leonardo da Vinci (1452–1519), known for Renaissance classics such as the *Last Supper* and the *Mona Lisa*, also did a series of technological and scientific sketches. This one represents one of his anatomical sketches.

Obviously, Leonardo worked well before the Scientific Revolution. Obviously also, the Renaissance is not usually known for its strong interest in science. Issues of literary and artistic style, manners, and other preoccupations were more typical—as in the writings of Petrarch (see Chapter 1). But da Vinci's work shows how Renaissance concerns could also relate to science. His anatomical sketches resulted from his observations in medical school classrooms, and in turn furthered an interest in scientific as well as artistic inquiries about



**Renaissance Art Often Prefigured the Scientific Revolution.**  
Anatomical sketches by Leonardo da Vinci. (Alinari/Art Resource, NY)

the human body. Da Vinci was also a literal Renaissance man, in terms of the range of his interests, and this too helps explain connections with later scientific activity.

### STUDY QUESTIONS

1. In what ways does this sketch reflect characteristic Renaissance interests? Can you see connections to the interests of Petrarch? Why would a Renaissance painter be drawn to this kind of representation (and why would earlier painters during the Middle Ages in Western Europe not have been so interested)?
2. In what ways does this sketch prefigure aspects of the Scientific Revolution?
3. Does this sketch suggest an important connection between the Renaissance and the Scientific Revolution, or does it simply reflect the distinctive genius of da Vinci? What other evidence would help you to answer this question?
4. How did work on anatomy and other aspects of human physiology relate to other aspects of the Scientific Revolution, such as physics?

