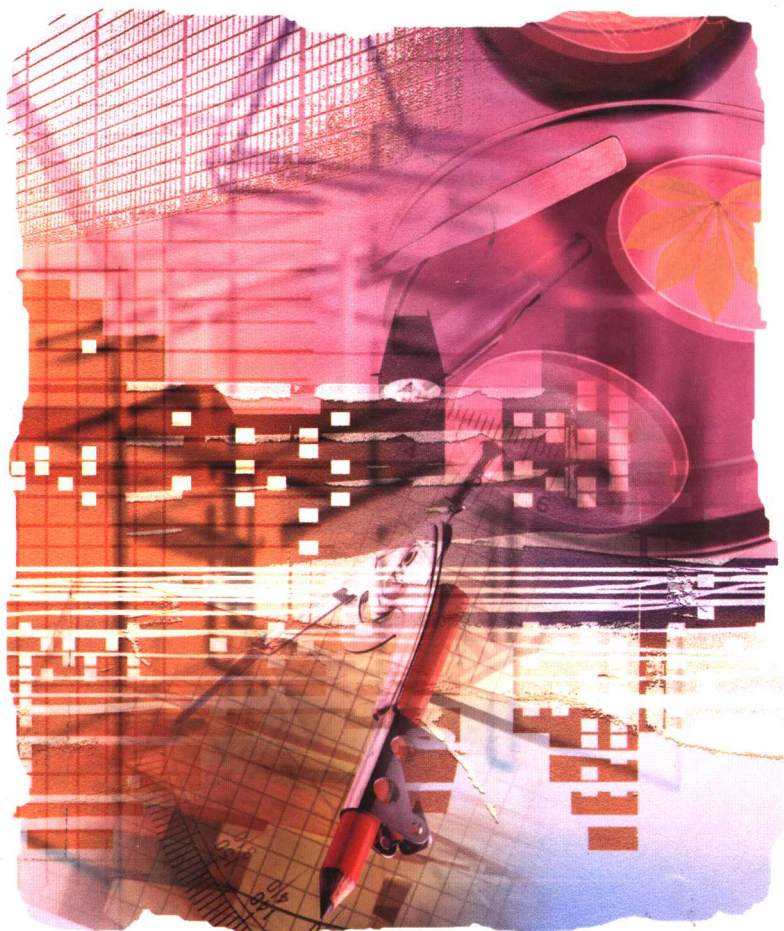


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Science and the Modern World

科学与近代世界



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Science and the Modern World

科学与近代世界

Alfred North Whitehead 著

廖英 注释

上海外语教育出版社

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二〇〇〇年一月

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1

The Origins of Modern Science

The Progress of Civilisation is not wholly a uniform drift towards better things. It may perhaps wear this aspect if we map it on a scale which is large enough. But such broad views obscure the details on which rests our whole understanding of the process. New epochs emerge with comparative suddenness, if we have regard to the scores of thousands of years throughout which the complete history extends. Secluded^{〔1〕} races suddenly take their places in the main stream of events; technological discoveries transform the mechanism of human life; a primitive art quickly flowers into full satisfaction of some aesthetic craving^{〔2〕}; great religions in their crusading youth^{〔3〕} spread through the nations the peace of Heaven and the sword of the Lord.

The sixteenth century of our era saw the disruption of Western

〔1〕 seclude *v.* 使隔离。

〔2〕 a primitive ... craving. 原始的艺术可以很快地开出花朵以满足某种审美的热情。

〔3〕 crusading youth 披荆斩棘的时代(此处的 *crusade* 是一个比喻,原指参加十字军或改革运动)。

2 Science and the Modern World

Christianity and the rise of modern science. It was an age of ferment^[1]. Nothing was settled, though much was opened — new worlds and new ideas. In science, Copernicus^[2] and Vesalius^[3] may be chosen as representative figures: they typify the new cosmology and the scientific emphasis on direct observation. Giordano Bruno^[4] was the martyr^[5], though the cause for which he suffered was not that of science, but that of free imaginative speculation^[6]. His death in the year 1600 ushered in the first century of modern science in the strict sense of the term. In his execution there was an unconscious symbolism; for the subsequent tone of scientific thought has contained distrust of his type of general speculativeness. The Reformation^[7], for all its importance, may be considered as a domestic affair of the European races. Even the Christianity of the East viewed it with profound disengagement^[8]. Furthermore, such disruptions are no new phenomena in the history of Christianity or of other religions. When we project this great revolution upon the whole history of the Christian Church, we cannot look upon it as introducing a new principle into human life. For good or for evil, it was a great transformation of religion; but it was not the coming of religion. It did not itself claim to be so. Reformers maintained that they were only restoring what had been forgotten.

It is quite otherwise with the rise of modern science. In every way it contrasts with the contemporary religious movement. The Reformation was a popular uprising, and for a century and a half

[1] ferment *n.* 动乱。

[2] Copernicus 哥白尼(1473—1543),波兰天文学家。

[3] Vesalius 维萨留斯(1514—1564),比利时医生,解剖学的奠基人。

[4] Giordano Bruno 乔尔丹诺·布鲁诺(1548—1600),意大利哲学家、天文学家。

[5] martyr *n.* 殉道者。

[6] speculation *n.* 沉思。

[7] Reformation *n.* 宗教改革(十六世纪欧洲改革天主教的运动)。

[8] disengagement *n.* 解脱。

drenched^{〔1〕} Europe in blood. The beginnings of the scientific movement were confined to a minority among the intellectual élite. In a generation which saw the Thirty Years' War and remembered Alva in the Netherlands^{〔2〕}, the worst that happened to men of science was that Galileo^{〔3〕} suffered an honourable detention^{〔4〕} and a mild reproof^{〔5〕}, before dying peacefully in his bed. The way in which the persecution of Galileo has been remembered is a tribute to the quiet commencement of the most intimate change in outlook which the human race had yet encountered^{〔6〕}. Since a babe was born in a manger, it may be doubted whether so great a thing has happened with so little stir.

The thesis which these lectures will illustrate is that this quiet growth of science has practically recoloured our mentality so that modes of thought which in former times were exceptional are now broadly spread through the educated world. This new colouring of ways of thought had been proceeding slowly for many ages in the European peoples. At last it issued in the rapid development of science; and has thereby strengthened itself by its most obvious application. The new mentality is more important even than the new science and the new technology. It has altered the metaphysical presuppositions^{〔7〕} and the imaginative contents of our minds; so that now the old stimuli provoke a new response. Perhaps my metaphor of a new colour is too strong. What I mean is just that slightest change of tone which yet makes all the difference. This is exactly illustrated by a sentence from a published letter of that adorable

〔1〕 drench *v.* 使湿透。

〔2〕 Alva in the Netherlands 荷兰的亚尔伐事件(西班牙将军亚尔伐征服荷兰时曾大肆屠杀)。

〔3〕 Galileo 伽利略(1564—1642),意大利数学家、天文学家和物理学家。

〔4〕 detention *n.* 拘禁。

〔5〕 reproof *n.* 谴责。

〔6〕 encounter *v.* 遇见。

〔7〕 metaphysical presupposition *n.* 形而上学前提。

4 Science and the Modern World

genius, William James^{〔1〕}. When he was finishing his great treatise on the *Principles of Psychology*, he wrote to his brother Henry James, "I have to forge every sentence in the teeth of irreducible and stubborn facts"^{〔2〕}.

This new tinge to modern minds is a vehement^{〔3〕} and passionate interest in the relation of general principles to irreducible and stubborn facts. All the world over and at all times there have been practical men, absorbed in "irreducible and stubborn facts": all the world over and at all times there have been men of philosophic temperament who have been absorbed in the weaving of general principles. It is this union of passionate interest in the detailed facts with equal devotion to abstract generalisation which forms the novelty in our present society.^{〔4〕} Previously it had appeared sporadically^{〔5〕} and as if by chance. This balance of mind has now become part of the tradition which infects cultivated thought. It is the salt which keeps life sweet. The main business of universities is to transmit this tradition as a widespread inheritance from generation to generation.

Another contrast which singles out science from among the European movements of the sixteenth and seventeenth centuries is its universality. Modern science was born in Europe, but its home is the whole world. In the last two centuries there has been a long and confused impact of western modes upon the civilisation of Asia. The wise men of the East have been puzzling, and are puzzling, as to what may be the regulative secret of life which can be passed from West to East without the wanton destruction of their own in-

〔1〕 William James 威廉·詹姆士(1842—1910),美国哲学家和心理学家。

〔2〕 I have ... stubborn facts. 我必须面对着无情而不以人为转移的事实锤炼每一个句子。in the teeth of 直面。

〔3〕 vehement *adj.* 激烈的。

〔4〕 It is ... present society. (强调句)正是对详细事实的这种热烈兴趣以及对抽象结论的同样倾心构成了现代世界的新奇观。union of ... with ... ……与……的结合。

〔5〕 sporadically *adv.* 零星地。

heritance which they so rightly prize.^{〔1〕} More and more it is becoming evident that what the West can most readily give to the East is its science and its scientific outlook. This is transferable from country to country, and from race to race, wherever there is a rational society.

In this course of lectures I shall not discuss the details of scientific discovery. My theme is the energising^{〔2〕} of a state of mind in the modern world, its broad generalisation, and its impact upon other spiritual forces. There are two ways of reading history, forwards and backwards. In the history of thought, we require both methods. A climate of opinion — to use the happy phrase of a seventeenth century writer — requires for its understanding the consideration of its antecedents and its issues. Accordingly in this lecture I shall consider some of the antecedents of our modern approach to the investigation of nature.

In the first place, there can be no living science unless there is a widespread instinctive conviction in the existence of an *Order of Things*, and, in particular, of an *Order of Nature*. I have used the word *instinctive* advisedly. It does not matter what men say in words, so long as their activities are controlled by settled instincts. The words may ultimately destroy the instincts. But until this has occurred words do not count. This remark is important in respect to^{〔3〕} the history of scientific thought. For we shall find that since the time of Hume^{〔4〕}, the fashionable scientific philosophy has been such as to deny the rationality of science. This conclusion lies upon the surface of Hume's philosophy. Take for example, the following passage from Section IV of his *Inquiry Concerning Human Understanding*:

〔1〕 The wise ... rightly prize. 在过去和现在,东方的圣贤都一直百思莫解,不知道哪种控制生命的秘密可以从西方传播到东方,而不会胡乱破坏他们自己非常应该加以珍视的遗产。

〔2〕 energising *n.* 激发。

〔3〕 in respect to 关于,在……方面。

〔4〕 Hume 休谟(1711-1776),英国哲学家。

"In a word, then, every effect is a distinct event from its cause. It could not, therefore, be discovered in the cause; and the first invention or conception of it, *a priori* [1], must be entirely arbitrary." If the cause in itself discloses no information as to the effect, so that the first invention of it must be *entirely* arbitrary, it follows at once that science is impossible, except in the sense of establishing *entirely arbitrary* connections which are not warranted by anything intrinsic to the natures either of causes or effects. [2] Some variant of Hume's philosophy has generally prevailed among men of science. But scientific faith has risen to the occasion, and has tacitly [3] removed the philosophic mountain.

In view of this strange contradiction in scientific thought, it is of the first importance to consider the antecedents of a faith which is impervious to [4] the demand for a consistent rationality. We have therefore to trace the rise of the instinctive faith that there is an Order of Nature which can be traced in every detailed occurrence.

Of course we all share in this faith, and we therefore believe that the reason for the faith is our apprehension of its truth. But the formation of a general idea — such as the idea of the Order of Nature — and the grasp of its importance, and the observation of its exemplification in a variety of occasions are by no means the necessary consequences of the truth of the idea in question. Familiar things happen, and mankind does not bother about them. It requires a very unusual mind to undertake the analysis of the obvious. Accordingly I wish to consider the stages in which this analysis became explicit, and finally became unalterably impressed upon the

[1] *a priori* 先验地,由因到果地看。

[2] If the ... or effects. 如果原因本身不能提供关于结果的任何消息,致使这一概念的产生过程完全变成武断的,那么我们马上可以得出一个结论说:除非科学可以建立完全武断的关联,而这种关联也完全得不到原因或结果的固有本质的证实,否则科学不可能存在。in the sense of 在……的意义上。

[3] *tacitly adv.* 悄悄地。

[4] *be impervious to* 与……格格不入。

educated minds of Western Europe.

Obviously, the main recurrences^{〔1〕} of life are too insistent to escape the notice of the least rational of humans; and even before the dawn of rationality, they have impressed themselves upon the instincts of animals. It is unnecessary to labour the point, that in broad outline certain general states of nature recur, and that our very natures have adapted themselves to such repetitions.

But there is a complementary fact which is equally true and equally obvious; — nothing ever really recurs in exact detail. No two days are identical, no two winters. What has gone, has gone forever. Accordingly the practical philosophy of mankind has been to expect the broad recurrences, and to accept the details as emanating from the inscrutable womb of things beyond the ken of rationality.^{〔2〕} Men expected the sun to rise, but the wind bloweth where it listeth^{〔3〕}.

Certainly from the classical Greek civilisation onwards there have been men, and indeed groups of men, who have placed themselves beyond this acceptance of an ultimate irrationality. Such men have endeavoured to explain all phenomena as the outcome of an order of things which extends to every detail. Geniuses such as Aristotle, or Archimedes, or Roger Bacon, must have been endowed with the full scientific mentality, which instinctively holds that all things great and small are conceivable as exemplifications of general principles which reign throughout the natural order.^{〔4〕}

But until the close of the Middle Ages the general educated

〔1〕 recurrence *n.* 再现。

〔2〕 Accordingly ... rationality. 因此,人类的实用哲学只是预见广泛的重复出现的现象,而把那些细节看成是超越了理性范围的神秘莫测的事物深处发出来的。inscrutable 不可理解的,不可测知的。

〔3〕 but the ... it listeth. 风向着它想吹的方向吹。listeth 古英语词,意愿,想。

〔4〕 Geniuses such ... natural order. 像亚里士多德、阿基米德、罗吉尔·培根等天才人物必然都具有完全的科学头脑,他们本能地认为事无大小,全都可以看作是支配全部自然秩序的普遍原则的体现。亚里士多德,古希腊哲学家;阿基米德,古希腊数学家和物理学家;罗吉尔·培根,中世纪哲学家。

public did not feel that intimate conviction, and that detailed interest, in such an idea, so as to lead to an unceasing supply of men, with ability and opportunity adequate to maintain a coordinated search for the discovery of these hypothetical principles.^[1] Either people were doubtful about the existence of such principles, or were doubtful about any success in finding them, or took no interest in thinking about them, or were oblivious to their practical importance when found. For whatever reason, search was languid^[2], if we have regard to the opportunities of a high civilisation and the length of time concerned. Why did the pace suddenly quicken in the sixteenth and seventeenth centuries? At the close of the Middle Ages a new mentality discloses itself. Invention stimulated thought, thought quickened physical speculation, Greek manuscripts disclosed what the ancients had discovered. Finally although in the year 1500 Europe knew less than Archimedes who died in the year 212 B. C. , yet in the year 1700, Newton's *Principia*^[3] had been written and the world was well started on the modern epoch.

There have been great civilisations in which the peculiar balance of mind required for science has only fitfully appeared and has produced the feeblest result. For example, the more we know of Chinese art, of Chinese literature, and of the Chinese philosophy of life, the more we admire the heights to which that civilisation attained. For thousands of years, there have been in China acute and learned men patiently devoting their lives to study. Having regard to the span of time, and to the population concerned, China forms the largest volume of civilisation which the world has seen. There is no reason to doubt the intrinsic capacity of individual Chinamen for

[1] But until ... hypothetical principles. 但直到中世纪结束以前,一般知识界人物对这种观念还没有十分确切的认识和不厌其烦的兴趣,以便不断使人们有足够的能力和机会来共同致力于发现这种假说的原则。lead to 导致。supply ... with 为……提供……。search for 追求。

[2] languid *adj.* 无力的。

[3] Newton's *Principia* 牛顿的《自然哲学的数学原理》。

the pursuit of science. And yet Chinese science is practically negligible. There is no reason to believe that China if left to itself would have ever produced any progress in science. The same may be said of India. Furthermore, if the Persians^[1] had enslaved the Greeks, there is no definite ground for belief that science would have flourished in Europe. The Romans showed no particular originality in that line. Even as it was, the Greeks, though they founded the movement, did not sustain it with the concentrated interest which modern Europe has shown. I am not alluding to the last few generations of the European peoples on both sides of the ocean; I mean the smaller Europe of the Reformation period, distracted as it was with wars and religious disputes^[2]. Consider the world of the eastern Mediterranean^[3], from Sicily^[4] to western Asia, during the period of about 1400 years from the death of Archimedes [in 212 B. C.] to the irruption of the Tartars^[5]. There were wars and revolutions and large changes of religion; but nothing much worse than the wars of the sixteenth and seventeenth centuries throughout Europe. There was a great and wealthy civilisation, Pagan^[6], Christian, Mahometan^[7]. In that period a great deal was added to science. But on the whole the progress was slow and wavering; and, except in mathematics, the men of the Renaissance practically started from the position which Archimedes had reached. There had been some progress in medicine and some progress in astronomy. But the total advance was very little compared to the marvellous success of the seventeenth century. For example, compare the pro-

[1] Persian *n.* 波斯人。

[2] distracted as ... religious disputes (让步状语从句) 它尽管因战争和宗教争端而迷狂。

[3] Mediterranean 地中海。

[4] Sicily 西西里岛, 在今天的意大利南部。

[5] Tartars 鞑靼。

[6] Pagan *adj.* 异教的。

[7] Mahometan *adj.* 伊斯兰教的, 穆罕默德的。

gress of scientific knowledge from the year 1560, just before the births of Galileo and of Kepler^[1], up to the year 1700, when Newton was in the height of his fame, with the progress in the ancient period, already mentioned, exactly ten times as long.

Nevertheless, Greece was the mother of Europe; and it is to Greece that we must look in order to find the origin of our modern ideas. We all know that on the eastern shores of the Mediterranean there was a very flourishing school of Ionian^[2] philosophers, deeply interested in theories concerning nature. Their ideas have been transmitted to us, enriched by the genius of Plato^[3] and Aristotle. But, with the exception of Aristotle, and it is a large exception, this school of thought had not attained to the complete scientific mentality. In some ways, it was better. The Greek genius was philosophical, lucid and logical. The men of this group were primarily asking philosophical questions. What is the substratum of nature? Is it fire, or earth, or water, or some combination of any two, or of all three? Or is it a mere flux, not reducible to some static material? Mathematics interested them mightily. They invented its generality, analysed its premises, and made notable discoveries of theorems by a rigid adherence to deductive reasoning. Their minds were infected with an eager generality. They demanded clear, bold ideas, and strict reasoning from them. All this was excellent; it was genius; it was ideal preparatory work. But it was not science as we understand it. The patience of minute observation was not nearly so prominent. Their genius was not so apt for the state of imaginative muddled suspense which precedes successful inductive generalisation^[4]. They were lucid thinkers and bold reasoners.

[1] Kepler 开普勒(1571—1630),德国天文学家。

[2] Ionian *adj.* 爱奥尼亚的, Ionia 为古希腊的一个地区。

[3] Plato 柏拉图(前 427 年—前 347 年),古希腊哲学家。

[4] generalisation *n.* 普遍化。

Of course there were exceptions, and at the very top: for example, Aristotle and Archimedes. Also for patient observation, there were the astronomers. There was a mathematical lucidity about the stars, and a fascination about the small numerable band of run-a-way planets^[1].

Every philosophy is tinged with the colouring of some secret imaginative background, which never emerges explicitly into its trains of reasoning. The Greek view of nature, at least that cosmology transmitted from them to later ages, was essentially dramatic. It is not necessarily wrong for this reason; but it was overwhelmingly dramatic. It thus conceived nature as articulated in the way of a work of dramatic art, for the exemplification of general ideas converging to^[2] an end. Nature was differentiated so as to provide its proper end for each thing. There was the centre of the universe as the end of motion for those things which are heavy, and the celestial^[3] spheres as the end of motion for those things whose natures lead them upwards. The celestial spheres were for things which are impassible^[4] and ingenerable^[5], the lower regions for things possible and generable. Nature was a drama in which each thing played its part.

I do not say that this is a view to which Aristotle would have subscribed without severe reservations, in fact without the sort of reservations which we ourselves would make. But it was the view which subsequent Greek thought extracted from Aristotle and passed on to the Middle Ages. The effect of such an imaginative setting for nature was to damp down the historical spirit^[6]. For it was the

[1] the small numerable band of run-a-way planets 一小群逃逸了的可以计数的行星。

[2] converge to 归结到。

[3] celestial *adj.* 天空的。

[4] impassible *adj.* 无感情的。

[5] ingenerable *adj.* 不能繁殖的。

[6] damp down the historical spirit 把历史精神窒息了。

end which seemed illuminating, so why bother about the beginning? The Reformation and the scientific movement were two aspects of the revolt which was the dominant intellectual movement of the later Renaissance. The appeal to the origins of Christianity, and Francis Bacon's^[1] appeal to efficient causes as against final causes, were two sides of one movement of thought. Also for this reason Galileo and his adversaries were at hopeless cross purposes, as can be seen from his *Dialogues on the Two Systems of the World*.

Galileo keeps harping on how things happen, whereas his adversaries had a complete theory as to why things happen. Unfortunately the two theories did not bring out the same results. Galileo insists upon "irreducible and stubborn facts," and Simplicius^[2], his opponent, brings forward reasons, completely satisfactory, at least to himself. It is a great mistake to conceive this historical revolt as an appeal to reason. On the contrary, it was through and through an anti-intellectualist^[3] movement. It was the return to the contemplation of brute fact; and it was based on a recoil^[4] from the inflexible rationality of medieval thought. In making this statement I am merely summarising what at the time the adherents of the old régime themselves asserted. For example, in the fourth book of Father Paul Sarpi's *History of the Council of Trent*^[5], you will find that in the year 1551 the Papal Legates^[6] who presided over the Council ordered: "That the Divines ought to confirm their opinions with the holy Scripture^[7], Traditions of the Apostles^[8], sacred

[1] Francis Bacon 弗兰西斯·培根(1561-1626),近代英国著名哲学家。

[2] Simplicius 辛普里修斯,意大利籍教皇,468—483在位。

[3] anti-intellectualist *adj.* 反理智主义的。

[4] recoil *n.* 反退,反弹。

[5] *History of the Council of Trent* 《特里腾宗教会议史》。

[6] Papal Legates 教皇特使。

[7] the holy Scripture 《圣经》。

[8] Apostles 使徒。