# HOW WE THINK

A RESTATEMENT OF THE RELATION
OF REFLECTIVE THINKING TO
THE EDUCATIVE PROCESS

BY

JOHN DEWEY

PROFESSOR EMERITUS OF PHILOSOPHY
COLUMBIA UNIVERSITY


D. C. HEATH AND COMPANY
BOSTON NEW YORK CHICAGO ATLANTA
DALLAS SAN FRANCISCO LONDON

CHAPTER THIRTEEN

# EMPIRICAL AND SCIENTIFIC THOUGHT

## I. What Is Meant by Empirical

Many of our ordinary inferences, in fact all of them that have not been regulated by scientific method, are empirical in character; that is to say, they are in effect habits of expectation based upon some regular conjunction or coincidence in the experience of the past. Whenever two things are associated together, like, say, thunder and lightning, there is a tendency on the part of the mind to expect that, when one occurs, the other will happen too. When the conjunction is frequently repeated, the tendency to expect becomes a positive belief that the things are so connected that it is safe to reason that when one happens, the other is sure, or almost sure, to accompany it.

For example, A says, "It will probably rain to-morrow." B asks, "Why do you think so?" and A replies, "Because the sky was lowering at sunset." When B asks, "What has that to do with it?" A responds, "I don't know, but it generally does rain after such a sunset." He does not know of any objective *connection* between the appearance of the sky and coming rain; he is not aware of any continuity in the facts themselves — any law or principle, as we usually say. From frequently recurring conjunctions of the two events, he has associated them so that, when he sees one, he thinks of the other. One *suggests* the other or is *associated* with it. A man may believe it will rain to-morrow



because he has consulted the barometer; but if he has no conception how the height of the mercury column (or the position of an index moved by its rise and fall) is connected with variations of atmospheric pressure, and how these in turn are connected with a tendency toward precipitation, his belief in the likelihood of rain is purely empirical. When men lived in the open and got their living by hunting, fishing, or pasturing flocks, the detection of the signs and indications of weather changes was a matter of great importance. A body of proverbs and maxims, forming an extensive section of traditionary folklore, was developed. But as long as there was no understanding *why* or *how* certain events were signs, as long as foresight and weather shrewdness rested simply upon repeated conjunction among facts, beliefs about the weather were thoroughly empirical.

### Empirical Thinking Is Useful in Some Matters

In similar fashion wise men in the Orient learned to predict, with considerable accuracy, the recurrent positions of the planets, the sun, and the moon, and to foretell the time of eclipses, without understanding in any degree the laws of the movements of heavenly bodies — that is, without having a notion of the continuities existing among the facts themselves. They had learned from repeated observations that things happened in about such and such a fashion. Till a comparatively recent time, the truths of medicine were mainly in the same condition. Experience had shown that 'upon the whole,' 'as a rule,' 'generally or usually speaking,' certain results followed certain remedies, when certain symptoms were given. Most of our beliefs about human nature in individuals (psychology) and in masses (sociology) are still of a largely empirical sort. Even the science of geometry, now frequently reckoned a typical rational science, began, among the Egyptians, as an accumulation of

recorded observations about methods of approximate mensuration of land surfaces and only gradually assumed, among the Greeks, scientific form.

### It Has Three Obvious Disadvantages

The *disadvantages* of purely empirical thinking are obvious. Attention may be called to three of them: (1) its tendency to lead to false beliefs, (2) its inability to cope with the novel, and (3) its tendency to engender mental inertia and dogmatism.

*False Beliefs.* First, while many empirical conclusions are, roughly speaking, correct; while they are exact enough to be of great help in practical life; while the presages of a weatherwise sailor or hunter may be more accurate, within a certain restricted range, than those of a scientist who relies wholly upon scientific observations and tests; while, indeed, empirical observations and records furnish the raw or crude material of scientific knowledge, yet the empirical method affords no way of discriminating between right and wrong conclusions. Hence it is responsible for a multitude of *false* beliefs. The technical designation for one of the commonest fallacies is *post hoc, ergo propter hoc;* the belief that because one thing comes *after* another, it comes *because* of the other. Now this weakness in method is the animating principle of empirical conclusions, even when they are correct — the correctness being almost as much a matter of luck as of method. That potatoes should be planted only during the crescent moon, that near the sea people are born at high tide and die at low tide, that a comet is an omen of danger, that bad luck follows the cracking of a mirror, that a patent medicine cures a disease — these and a thousand like notions are asseverated on the basis of empirical coincidence and conjunction.

The more numerous the experienced instances and the



closer the watch kept upon them, the greater is the trustworthiness of constant conjunction as evidence of connection among the things themselves. Many of our most important beliefs still have only this sort of warrant. No one can yet tell, with certainty, the necessary cause of old age or of death, which are empirically the most certain of all expectations.

*Confronting the Novel.* Second, even the most reliable beliefs of this type fail when they confront the *novel.* Since they rest upon past uniformities, they are useless when further experience departs in any considerable measure from ancient incident and wonted precedent. Empirical inference follows the grooves and ruts that custom wears and has no track to follow when the groove disappears. So important is this aspect of the matter that Clifford found the difference between ordinary skill and scientific thought right here. "Skill enables a man to deal with the same circumstances that he has met before, scientific thought enables him to deal with different circumstances that he has never met before." And he goes so far as to define scientific thinking as "the application of old experience to new circumstances."

*Mental Inertia and Dogmatism.* Third, we have not yet made the acquaintance of the most harmful feature of the empirical method. Mental inertia, laziness, unjustifiable conservatism, are its probable accompaniments. Its general effect upon mental attitude is more serious than even the specific wrong conclusions in which it has landed. Wherever the chief dependence in forming inferences is upon the conjunctions observed in past experience, failures to agree with the usual order are slurred over, cases of successful confirmation are exaggerated. Since the mind naturally demands some principle of continuity, some connecting link between separate facts and causes, forces are arbitrarily invented for that purpose. Fantastic and mythological explanations are

resorted to in order to supply missing links. The pump brings water because nature abhors a vacuum; opium makes men sleep because it has a dormitive potency; we recollect a past event because we have a faculty of memory. In the history of the progress of human knowledge, out-and-out myths accompany the first stage of empiricism, while hidden 'essences' and occult 'forces' mark its second stage. By their very nature these 'causes' escape observation, so that their explanatory value can be neither confirmed nor refuted by further observation or experience. Hence belief in them becomes purely traditionary. They give rise to doctrines that, inculcated and handed down, become dogmas; subsequent inquiry and reflection are actually stifled.[1]

Certain men or classes of men come to be the accepted guardians and transmitters — instructors — of established doctrines. To question the beliefs is to question their authority; to accept the beliefs is evidence of loyalty to the powers that be, a proof of good citizenship. Passivity, docility, acquiescence, come to be primal intellectual virtues. Facts and events presenting novelty and variety are slighted or are sheared down till they fit into the Procrustean bed of habitual belief. Inquiry and doubt are silenced by citation of ancient laws or a multitude of miscellaneous and unsifted cases. This attitude of mind generates dislike of change, and the resulting aversion to novelty is fatal to progress. What will not fit into the established canons is outlawed; men who make new discoveries are objects of suspicion and even of persecution. Beliefs that perhaps originally were the products of fairly extensive and careful observation are stereotyped into fixed traditions and semi-sacred dogmas, accepted simply upon authority, and are mixed with fantastic conceptions that happen to have won the acceptance of authorities.

[1] See page 27.



## II. Scientific Method

### Scientific Method Employs Analysis

In contrast with the empirical method stands the scientific. Scientific method replaces the repeated conjunction or coincidence of separate facts by discovery of a single comprehensive fact, effecting this replacement by *breaking up the coarse or gross facts of observation into a number of minuter processes not directly accessible to perception.*

If a layman were asked why water rises from the cistern when an ordinary pump is worked, he would doubtless answer, "By suction." Suction is regarded as a force like heat or pressure. If such a person is confronted by the fact that water rises with a suction pump only about thirty-three feet, he easily disposes of the difficulty on the ground that all forces vary in their intensities and finally reach a limit at which they cease to operate. The variation with elevation above the sea level of the height to which water can be pumped is either unnoticed, or, if noted, is dismissed as one of the curious anomalies in which nature abounds.

Now the scientist advances by assuming that what seems to observation to be a single total fact is in truth complex. He attempts, therefore, to break up the single fact of water-rising-in-the-pipe into a number of lesser facts, in short, into data.[2] His method of proceeding is by *varying conditions one by one* so far as possible, and noting just what happens when each given condition is eliminated. In this way a fact too coarse and too extensive to be explained as a whole is resolved into a set of minor facts. Each minor fact is understood because it states a connection of cause and effect.

[2] See page 104.

### Two Methods of Varying Conditions

There are two methods of varying conditions.[3] The first is an extension of the empirical method of observation. It consists in comparing very carefully the results of a great number of observations that have occurred accidentally under *different* conditions. The difference in the rise of the water at different heights above the sea level and its total cessation when the distance to be lifted is, even at sea level, more than thirty-three feet, are emphasized, instead of being slurred over. The purpose is to find out what *special conditions* are present when the effect occurs and are absent when it fails to occur. These special conditions are then substituted for the gross fact. Some of these more definite and exact data will give the key to understanding the event.

The method of analysis by comparing cases is, however, badly handicapped; it can do nothing until a certain number of diversified cases happen to present themselves. And even when such cases are at hand, it will be questionable whether they vary in just these respects in which it is important that they should vary in order to throw light upon the question at issue. The method is passive and dependent upon external accidents. Hence the superiority of the active, or experimental, method. Even a small number of observations may suggest an explanation — a hypothesis, or theory. Working upon this suggestion, the scientist then *intentionally* varies conditions and notes what happens. If the empirical observations have suggested to him the possibility of a connection between air pressure on the water and the rising of the water in the tube where air pressure is absent, he deliberately empties the air out of the vessel in which the water

[3] The next two paragraphs repeat, for purposes of the present discussion, what we have already noted in a different context. See page 176.



is contained and notes that ' suction ' no longer works, or he intentionally increases atmospheric pressure on the water and notes the result. He institutes experiments to calculate the weight of air at the sea level and at various levels above and compares the results of reasoning based upon the pressure of air of these various weights upon a certain volume of water with the results actually obtained by observation. *Observations formed by variation of conditions on the basis of some idea or theory constitute experiment.* Experiment is the chief resource in scientific reasoning because it facilitates the picking out of significant elements in a gross, vague whole.

### Experiment Involves both Analysis and Synthesis

Experimental thinking, or scientific reasoning, is thus a conjoint process of *analysis and synthesis,* or, in less technical language, of discrimination and identification. The gross fact of water rising when the suction valve is worked is resolved or discriminated into a number of independent variables, some of which had never before been observed or even thought of in connection with the fact. One of these facts, the weight of the atmosphere, is then selectively seized upon as the key to the entire phenomenon. This disentangling constitutes *analysis.* But atmosphere and its pressure or weight is a fact not confined to this single instance. It is a fact familiar, or at least discoverable as operative, in a great number of other events. In fixing upon this imperceptible and minute fact as the essence or key to the elevation of water by the pump, the pump-fact has thus been assimilated to a whole group of ordinary facts from which it was previously isolated. This assimilation constitutes *synthesis.* Moreover, the fact of atmospheric pressure is itself a case of one of the commonest of all facts — weight, or gravitational force. Conclusions that apply to the common fact of

weight are thus transferable to the consideration and interpretation of the *relatively* rare and exceptional case of the suction of water. The suction pump is seen to be a case of the same kind or sort as the siphon, the barometer, the rising of the balloon, and a multitude of other things with which at first sight it has no connection at all. This is another instance of the synthetic, or integrative, function of thinking.

If we revert to the advantages of scientific over empirical thinking, we find that we now have the clue to them.

*Lessened Liability to Error.* The increased security, the added factor of certainty or proof, is due to the substitution of the *detailed and specific fact* of atmospheric pressure for the gross and total and relatively miscellaneous fact of suction. The latter is complex, and its complexity is due to many unknown and unspecified factors; hence, any statement about it is more or less random and likely to be defeated by any unforeseen variation of circumstances. *Comparatively,* at least, the minute and detailed fact of air pressure is a measurable and definite fact — one that can be picked out and managed with assurance.

*Ability to Manage the New.* As analysis accounts for the added certainty, so synthesis accounts for ability to cope with the novel and variable. Weight is a much commoner fact than atmospheric weight, and this in turn is a much commoner fact than the workings of the suction pump. To be able to substitute the common and frequent fact for that which is relatively rare and peculiar is to reduce the seemingly novel and exceptional to cases of a general and familiar principle and thus to bring them under control for interpretation and prediction.

As Professor James says:

> Think of heat as motion and whatever is true of motion will be true of heat; but we have a hundred experiences of motion for every one of heat. Think of rays passing through this lens as cases of bending toward the perpendicular, and you substitute for the comparatively unfamiliar lens the very familiar notion of a particular change in direction of a line, of which notion every day brings us countless examples.[4]



*Interest in the Future.* The change of attitude from conservative reliance upon the past, upon routine and custom, to faith in progress through the intelligent regulation of existing conditions is, of course, the reflex of the scientific method of experimentation. The empirical method inevitably magnifies the influences of the past; the experimental method throws into relief the possibilities of the future. The empirical method says, "*Wait* till there is a sufficient number of cases;" the experimental method says, "*Produce* the cases." The former depends upon nature's accidentally happening to present us with certain conjunctions of circumstances; the latter deliberately and intentionally endeavors to bring about the conjunction. By this method the notion of progress secures scientific warrant.

### Scientific Thinking Is Freed from Considerations of the Immediate and the Forceful

Ordinary experience is controlled largely by the direct strength and intensity of various occurrences. What is bright, sudden, loud, secures notice and is given a conspicuous rating. What is dim, feeble, and continuous gets ignored, or is regarded as of slight importance. Customary experience tends to the control of thinking by considerations of *direct and immediate strength* rather than by those of importance in the long run. Animals without the power of forecast and planning must, upon the whole, respond to the stimuli that are most urgent at the moment or cease to exist. These stimuli lose nothing of their direct urgency and

[4] *Psychology,* vol. II, p. 342.

clamorous insistency when the thinking power develops; and yet thinking demands the subordination of the immediate stimulus to the remote and distant. The feeble and the minute may be of much greater importance than the glaring and the big. The latter may be signs of a force that is already exhausting itself; the former may indicate the beginnings of a process in which the whole fortune of the individual is involved. The prime necessity for scientific thought is that the thinker be freed from the tyranny of sense stimuli and habit, and this emancipation is also the necessary condition of progress.

Consider the following quotation:

> When it first occurred to a reflecting mind that moving water had a property identical with human or brute force; namely, the property of setting other masses in motion, overcoming inertia and resistance, — when the sight of the stream suggested through this point of likeness the power of the animal, — a new addition was made to the class of prime movers; and when circumstances permitted, this power could become a substitute for the others. It may seem to the modern understanding, familiar with water wheels and drifting rafts, that the similarity here was an extremely obvious one. But if we put ourselves back into an early state of mind, when running water affected the mind *by its brilliancy, its roar and irregular devastation,* we may easily suppose that to identify this with animal muscular energy was by no means an obvious effort.[5]

### The Value of Abstraction

If we add to these obvious sensory features the various social customs and expectations that fix the attitude of the individual, the evil of the subjection of free and fertile suggestion to empirical considerations — that is, to the *past*

[5] Bain, *The Senses and Intellect,* third American ed., 1879, p. 492 (italics not in original).



and to more or less uncontrolled experience — becomes evident.

Abstraction is an indispensable element in even ordinary thinking. It is found in all analysis, in all observation that detaches a quality from a vague blur in which it has been absorbed so as to give it distinctness. But scientific abstraction lays hold upon *relations* that could not in any case be perceived by sense. Its character is well brought out in the quotation just made from Bain. Some man got away from the almost overpowering conspicuous traits of running water to grasp a relation, that of carrying power.

A notion of abstraction is sometimes advanced that neglects this property and makes it intellectually insignificant. It is supposed to be simply the power of attending to some quality that an object is already known to possess to the exclusion of all other traits and features. But while this act is, under some circumstances, of practical value, the logical value of abstraction consists in seizing upon some quality or relation not previously grasped at all, making it stand out. It was an act of abstraction when the wing of a bird was seen to be identical, morphologically, with the forearm or foreleg, of other mammals; when the pod of peas and beans was seen to be a modified form of leaf and stem. Abstracting gets the mind emancipated from conspicuous familiar traits that hold it fixed by their very familiarity. Thereby it acquires ability to dig underneath the already known to some unfamiliar property or relation that is intellectually much more significant because it makes possible a more analytic and more extensive inference.

### The Meaning of 'Experience'

The term *experience* may thus be interpreted with reference either to the *empirical* or to the *experimental* attitude of mind. Experience is not a rigid and closed thing; it is

vital, and hence growing. When dominated by the past, by custom and routine, it is often opposed to the reasonable, the thoughtful. But experience also includes the reflection that sets us free from the limiting influence of sense, appetite, and tradition. Experience may welcome and assimilate all that the most exact and penetrating thought discovers. Indeed, the business of education might be defined as an emancipation and enlargement of experience. Education takes the individual while he is relatively plastic, before he has become so indurated by isolated experiences as to be rendered hopelessly empirical in his habit of mind. The attitude of childhood is naïve, wondering, experimental; the world of man and nature is new. Right methods of education preserve and perfect this attitude, and thereby short-circuit for the individual the slow progress of the race, eliminating the waste that comes from inert routine and lazy dependence on the past. Abstract thought is imagination seeing familiar objects in a new light and thus opening new vistas in experience. Experiment follows the road thus open and tests its permanent value.

# PART THREE

# THE TRAINING OF THOUGHT