PART TWO: LOGICAL CONSIDERATIONS

CHAPTER SIX

THE ANALYSIS OF A COMPLETE ACT OF THOUGHT

After a brief consideration in the first chapter of the nature of reflective thinking, we turned, in the second, to the need for its training. Then we took up the resources, the difficulties, and the aim of its training. The purpose of this discussion was to set before the student the general problem of the training of mind. The purport of the second part, upon which we are now entering, is giving a fuller statement of the nature and normal growth of thinking, preparatory to considering in the concluding part the special problems that arise in connection with its education.

In this chapter we shall make an analysis of the process of thinking into its steps or elementary constituents, basing the analysis upon descriptions of a number of extremely simple, but genuine, cases of reflective experience.¹

1. "The other day when I was down town on 16th Street a clock caught my eye. I saw that the hands pointed to 12.20. This suggested that I had an engagement at 124th Street, at one o'clock. I reasoned that

¹ These are taken, almost verbatim, from the class papers of students.
as it had taken me an hour to come down on a surface car, I should probably be twenty minutes late if I returned the same way. I might save twenty minutes by a subway express. But was there a station near? If not, I might lose more than twenty minutes in looking for one. Then I thought of the elevated, and I saw there was such a line within two blocks. But where was the station? If it were several blocks above or below the street I was on, I should lose time instead of gaining it. My mind went back to the subway express as quicker than the elevated; furthermore, I remembered that it went nearer than the elevated to the part of 124th Street I wished to reach, so that time would be saved at the end of the journey. I concluded in favor of the subway, and reached my destination by one o’clock."

2. "Projecting nearly horizontally from the upper deck of the ferryboat on which I daily cross the river, is a long white pole, bearing a gilded ball at its tip. It suggested a flagpole when I first saw it; its color, shape, and gilded ball agreed with this idea, and these reasons seemed to justify me in this belief. But soon difficulties presented themselves. The pole was nearly horizontal, an unusual position for a flagpole; in the next place, there was no pulley, ring, or cord by which to attach a flag; finally, there were elsewhere two vertical staffs from which flags were occasionally flown. It seemed probable that the pole was not there for flag-flying.

"I then tried to imagine all possible purposes of such a pole, and to consider for which of these it was best suited: (a) Possibly it was an ornament. But as all the ferryboats and even the tugboats carried like poles,
this hypothesis was rejected. (b) Possibly it was the terminal of a wireless telegraph. But the same considerations made this improbable. Besides, the more natural place for such a terminal would be the highest part of the boat, on top of the pilot house. (c) Its purpose might be to point out the direction in which the boat is moving.

"In support of this conclusion, I discovered that the pole was lower than the pilot house, so that the steersman could easily see it. Moreover, the tip was enough higher than the base, so that, from the pilot's position, it must appear to project far out in front of the boat. Moreover, the pilot being near the front of the boat, he would need some such guide as to its direction. Tugboats would also need poles for such a purpose. This hypothesis was so much more probable than the others that I accepted it. I formed the conclusion that the pole was set up for the purpose of showing the pilot the direction in which the boat pointed, to enable him to steer correctly."

3. "In washing tumblers in hot soapsuds and placing them mouth downward on a plate, bubbles appeared on the outside of the mouth of the tumblers and then went inside. Why? The presence of bubbles suggests air, which I note must come from inside the tumbler. I see that the soapy water on the plate prevents escape of the air save as it may be caught in bubbles. But why should air leave the tumbler? There was no substance entering to force it out. It must have expanded. It expands by increase of heat or by decrease of pressure, or by both. Could the air have become heated after the tumbler was taken from the hot suds? Clearly not the air that was already entangled
in the water. If heated air was the cause, cold air must have entered in transferring the tumblers from the suds to the plate. I test to see if this supposition is true by taking several more tumblers out. Some I shake so as to make sure of entrapping cold air in them. Some I take out holding mouth downward in order to prevent cold air from entering. Bubbles appear on the outside of every one of the former and on none of the latter. I must be right in my inference. Air from the outside must have been expanded by the heat of the tumbler, which explains the appearance of the bubbles on the outside.

"But why do they then go inside? Cold contracts. The tumbler cooled and also the air inside it. Tension was removed, and hence bubbles appeared inside. To be sure of this, I test by placing a cup of ice on the tumbler while the bubbles are still forming outside. They soon reverse."

These three cases have been purposely selected so as to form a series from the more rudimentary to more complicated cases of reflection. The first illustrates the kind of thinking done by every one during the day's business, in which neither the data, nor the ways of dealing with them, take one outside the limits of everyday experience. The last furnishes a case in which neither problem nor mode of solution would have been likely to occur except to one with some prior scientific training. The second case forms a natural transition; its materials lie well within the bounds of everyday, unspecialized experience; but the problem, instead of being directly involved in the person's business, arises indirectly out of his activity, and accordingly appeals to a somewhat theoretic and impartial interest. We
shall deal, in a later chapter, with the evolution of abstract thinking out of that which is relatively practical and direct; here we are concerned only with the common elements found in all the types.

Upon examination, each instance reveals, more or less clearly, five logically distinct steps: (i) a felt difficulty; (ii) its location and definition; (iii) suggestion of possible solution; (iv) development by reasoning of the bearings of the suggestion; (v) further observation and experiment leading to its acceptance or rejection; that is, the conclusion of belief or disbelief.

1. The first and second steps frequently fuse into one. The difficulty may be felt with sufficient definiteness as to set the mind at once speculating upon its probable solution, or an undefined uneasiness and shock may come first, leading only later to definite attempt to find out what is the matter. Whether the two steps are distinct or blended, there is the factor emphasized in our original account of reflection—viz. the perplexity or problem. In the first of the three cases cited, the difficulty resides in the conflict between conditions at hand and a desired and intended result, between an end and the means for reaching it. The purpose of keeping an engagement at a certain time, and the existing hour taken in connection with the location, are not congruous. The object of thinking is to introduce congruity between the two. The given conditions cannot themselves be altered; time will not go backward nor will the distance between 16th Street and 124th Street shorten itself. The problem is the discovery of intervening terms which when inserted between the remoter end and the given means will harmonize them with each other.
In the second case, the difficulty experienced is the incompatibility of a suggested and (temporarily) accepted belief that the pole is a flagpole, with certain other facts. Suppose we symbolize the qualities that suggest flagpole by the letters $a, b, c$; those that oppose this suggestion by the letters $p, q, r$. There is, of course, nothing inconsistent in the qualities themselves; but in pulling the mind to different and incongruous conclusions they conflict—hence the problem. Here the object is the discovery of some object ($O$), of which $a, b, c$, and $p, q, r$, may all be appropriate traits—just as, in our first case, it is to discover a course of action which will combine existing conditions and a remoter result in a single whole. The method of solution is also the same: discovery of intermediate qualities (the position of the pilot house, of the pole, the need of an index to the boat's direction) symbolized by $d, g, l, o$, which bind together otherwise incompatible traits.

In the third case, an observer trained to the idea of natural laws or uniformities finds something odd or exceptional in the behavior of the bubbles. The problem is to reduce the apparent anomalies to instances of well-established laws. Here the method of solution is also to seek for intermediary terms which will connect, by regular linkage, the seemingly extraordinary movements of the bubbles with the conditions known to follow from processes supposed to be operative.

2. As already noted, the first two steps, the feeling of a discrepancy, or difficulty, and the acts of observation that serve to define the character of the difficulty may, in a given instance, telescope together. In cases of striking novelty or unusual perplexity, the difficulty, however, is likely to present itself at first as a shock, as
emotional disturbance, as a more or less vague feeling of the unexpected, of something queer, strange, funny, or disconcerting. In such instances, there are necessary observations deliberately calculated to bring to light just what is the trouble, or to make clear the specific character of the problem. In large measure, the existence or non-existence of this step makes the difference between reflection proper, or safeguarded critical inference and uncontrolled thinking. Where sufficient pains to locate the difficulty are not taken, suggestions for its resolution must be more or less random. Imagine a doctor called in to prescribe for a patient. The patient tells him some things that are wrong; his experienced eye, at a glance, takes in other signs of a certain disease. But if he permits the suggestion of this special disease to take possession prematurely of his mind, to become an accepted conclusion, his scientific thinking is by that much cut short. A large part of his technique, as a skilled practitioner, is to prevent the acceptance of the first suggestions that arise; even, indeed, to postpone the occurrence of any very definite suggestion till the trouble—the nature of the problem—has been thoroughly explored. In the case of a physician this proceeding is known as diagnosis, but a similar inspection is required in every novel and complicated situation to prevent rushing to a conclusion. The essence of critical thinking is suspended judgment; and the essence of this suspense is inquiry to determine the nature of the problem before proceeding to attempts at its solution. This, more than any other thing, transforms mere inference into tested inference, suggested conclusions into proof.

3. The third factor is suggestion. The situation in
which the perplexity occurs calls up something not present to the senses: the present location, the thought of subway or elevated train; the stick before the eyes, the idea of a flagpole, an ornament, an apparatus for wireless telegraphy; the soap bubbles, the law of expansion of bodies through heat and of their contraction through cold. (a) Suggestion is the very heart of inference; it involves going from what is present to something absent. Hence, it is more or less speculative, adventurous. Since inference goes beyond what is actually present, it involves a leap, a jump, the propriety of which cannot be absolutely warranted in advance, no matter what precautions be taken. Its control is indirect, on the one hand, involving the formation of habits of mind which are at once enterprising and cautious; and on the other hand, involving the selection and arrangement of the particular facts upon perception of which suggestion issues. (b) The suggested conclusion so far as it is not accepted but only tentatively entertained constitutes an idea. Synonyms for this are supposition, conjecture, guess, hypothesis, and (in elaborate cases) theory. Since suspended belief, or the postponement of a final conclusion pending further evidence, depends partly upon the presence of rival conjectures as to the best course to pursue or the probable explanation to favor, cultivation of a variety of alternative suggestions is an important factor in good thinking.

4. The process of developing the bearings—or, as they are more technically termed, the implications—of any idea with respect to any problem, is termed reasoning.\(^1\) As an idea is inferred from given facts, so reasoning

\(^1\) This term is sometimes extended to denote the entire reflective process—just as inference (which in the sense of test is best reserved for
sets out from an idea. The idea of elevated road is developed into the idea of difficulty of locating station, length of time occupied on the journey, distance of station at the other end from place to be reached. In the second case, the implication of a flagpole is seen to be a vertical position; of a wireless apparatus, location on a high part of the ship and, moreover, absence from every casual tugboat; while the idea of index to direction in which the boat moves, when developed, is found to cover all the details of the case.

Reasoning has the same effect upon a suggested solution as more intimate and extensive observation has upon the original problem. Acceptance of the suggestion in its first form is prevented by looking into it more thoroughly. Conjectures that seem plausible at first sight are often found unfit or even absurd when their full consequences are traced out. Even when reasoning out the bearings of a supposition does not lead to rejection, it develops the idea into a form in which it is more apposite to the problem. Only when, for example, the conjecture that a pole was an index-pole had been thought out into its bearings could its particular applicability to the case in hand be judged. Suggestions at first seemingly remote and wild are frequently so transformed by being elaborated into what follows from them as to become apt and fruitful. The development of an idea through reasoning helps at least to supply the intervening or intermediate terms that link together into a consistent whole apparently discrepant extremes (ante, p. 72).

the third step) is sometimes used in the same broad sense. But reasoning (or ratiocination) seems to be peculiarly adapted to express what the older writers called the “notional” or “dialectic” process of developing the meaning of a given idea.
5. The concluding and conclusive step is some kind of experimental corroboration, or verification, of the conjectural idea. Reasoning shows that if the idea be adopted, certain consequences follow. So far the conclusion is hypothetical or conditional. If we look and find present all the conditions demanded by the theory, and if we find the characteristic traits called for by rival alternatives to be lacking, the tendency to believe, to accept, is almost irresistible. Sometimes direct observation furnishes corroboration, as in the case of the pole on the boat. In other cases, as in that of the bubbles, experiment is required; that is, conditions are deliberately arranged in accord with the requirements of an idea or hypothesis to see if the results theoretically indicated by the idea actually occur. If it is found that the experimental results agree with the theoretical, or rationally deduced, results, and if there is reason to believe that only the conditions in question would yield such results, the confirmation is so strong as to induce a conclusion—at least until contrary facts shall indicate the advisability of its revision.

Observation exists at the beginning and again at the end of the process: at the beginning, to determine more definitely and precisely the nature of the difficulty to be dealt with; at the end, to test the value of some hypothetically entertained conclusion. Between those two termini of observation, we find the more distinctively mental aspects of the entire thought-cycle: (i) inference, the suggestion of an explanation or solution; and (ii) reasoning, the development of the bearings and implications of the suggestion. Reasoning requires some experimental observation to confirm it, while experiment can be economically and fruitfully conducted only
on the basis of an idea that has been tentatively developed by reasoning.

The disciplined, or logically trained, mind — the aim of the educative process — is the mind able to judge how far each of these steps needs to be carried in any particular situation. No cast-iron rules can be laid down. Each case has to be dealt with as it arises, on the basis of its importance and of the context in which it occurs. To take too much pains in one case is as foolish — as illogical — as to take too little in another. At one extreme, almost any conclusion that insures prompt and unified action may be better than any long delayed conclusion; while at the other, decision may have to be postponed for a long period — perhaps for a lifetime. The trained mind is the one that best grasps the degree of observation, forming of ideas, reasoning, and experimental testing required in any special case, and that profits the most, in future thinking, by mistakes made in the past. What is important is that the mind should be sensitive to problems and skilled in methods of attack and solution.