

be at first, you will be forced at length to correct them so long as your activity is moved by that sincere desire. Nay, no matter if you only half desire it, at first, that desire would at length conquer all others, could experience continue long enough. But the more veraciously truth is described² at the outset, the shorter by centuries will the road to it be.

² [Probably, "But the more voraciously truth is desired" etc.—Ed.]

XIII

[THE LOGIC OF ABDUCTION]

I [THE NATURE OF HYPOTHESIS]¹

All our knowledge may be said to rest upon *observed facts*. It is true that there are psychological states which antecede our observing facts as such. Thus, it is a fact that I see an inkstand before me; but before I can say that I am obliged to have impressions of sense into which no idea of an inkstand, or of any separate object, or of an "I," or of seeing, enter at all; and it is true that my judging that I see an inkstand before me is the product of mental operations upon these impressions of sense. But it is only when the cognition has become worked up into a proposition, or judgment of a fact, that I can exercise any direct control over the process; and it is idle to discuss the "legitimacy" of that which cannot be controlled. Observations of fact have, therefore, to be accepted as they occur.

But observed facts relate exclusively to the particular circumstances that happened to exist when they were observed. They do not relate to any future occasions upon which we may be in doubt how we ought to act. They, therefore, do not, in themselves, contain any practical knowledge.

Such knowledge must involve additions to the facts observed. The making of those additions is an operation which we can control; and it is evidently a process during which error is liable to creep in.

Any proposition added to observed facts, tending to make them applicable in any way to other circumstances than those under which they were observed, may be called a hypothesis.

¹ [From "Hume on Miracles," c. 1901. (Originally published in *C.P.*, VI, 356-358.) The heading "The Logic of Abduction" has been supplied for this edition.—Ed.]

seems to be floating in a limitless vacuity. It is of the very essence of thought and purpose that it should be special, just as truly as it is of the essence of either that it should be general. Yet it illustrates the point that the valuable idea must be eminently fruitful in special applications, while at the same time it is always growing to wider and wider alliances.

Classical antiquity was far too favorable to the sort of concept that was

*fortis, et in se ipso lotus, teres atque rotundus.*⁴

I often meet with such theories in philosophical books, especially in the works of theological students and of others who draw their ideas from antiquity. Such is the circular theory, which assumes itself and returns into itself—the aristocratical theory which holds itself aloof from vulgar facts. Logic has not the least objection to such a view, so long as it maintains its self-sufficiency, keeps itself strictly to itself, as its nobility obliges it to do, makes no pretension of meddling with the world of experience, and does not ask anybody to assent to it.

Auguste Comte, at the other extreme, would condemn every theory that was not "verifiable." Like the majority of Comte's ideas, this is a bad interpretation of a *truth*. An explanatory hypothesis, that is to say, a conception which does not limit its purpose to enabling the mind to grasp into one a variety of facts, but which seeks to connect those facts with our general conceptions of the universe, ought, in one sense, to be *verifiable*; that is to say, it ought to be little more than a ligament of numberless possible predictions concerning future experience, so that if they fail, it fails. Thus, when Schliemann entertained the hypothesis that there really had been a city of Troy and a Trojan War, this meant to his mind among other things that when he should come to make excavations at Hisarlik he would probably find remains of a city with evidences of a civilization more or less answering to the descriptions of the *Iliad*, and which would correspond with other probable finds at Mycenae, Ithaca, and elsewhere. So

⁴ [Horace, *Satires*, II. 7. 86.]

understood, Comte's maxim is sound. Nothing but that is an explanatory hypothesis. But Comte's own notion of a *verifiable* hypothesis was that it must not suppose anything that you are not able directly to observe.⁵ From such a rule it would be fair to infer that he would permit Mr. Schliemann to suppose he was going to find arms and utensils at Hisarlik, but would forbid him to suppose that they were either made or used by any human being, since no such beings could ever be detected by direct percept. He ought on the same principle to forbid us to suppose that a fossil skeleton had ever belonged to a living ichthyosaurus. This seems to be substantially the opinion of M. Poincaré at this day. The same doctrine would forbid us to believe in our memory of what happened at dinner-time today. I have for many years been an adherent of what is technically called Common Sense in philosophy, myself; and do not think that my Tychistic opinions conflict with that position; but I nevertheless think that such theories as that of Comte and Poincaré about verifiable hypotheses frequently deserve the most serious consideration; and the examination of them is never lost time; for it brings lessons not otherwise so easily learned. Of course with memory would have to go all opinions about everything not at this moment before our senses. You must not believe that you hear me speaking to you, but only that you hear certain sounds while you see before you a spot of black, white, and flesh color; and those sounds somehow seem to suggest certain ideas which you must not connect at all with the black and white spot. A man would have to devote years to training his mind to such habits of thought, and even then it is doubtful whether it would be possible. And what would be gained? If it would alter our beliefs as to what our sensuous experience is going to be, it would certainly be a change for the worse, since we do not find ourselves disappointed in any expectations due to common sense beliefs. If on the other hand it would not make any such difference, as I suppose it would not, why not allow us the harmless convenience of believing in these fictions, if they

⁵ [Cours de philosophie positive, 28^{me} leçon.]

pened by chance, because the possible theories, if not strictly innumerable, at any rate exceed a trillion—or the third power of a million; and therefore the chances are too overwhelmingly against the single true theory in the twenty or thirty thousand years during which man has been a thinking animal, ever having come into any man's head. Besides, you cannot seriously think that every little chicken that is hatched, has to rummage through all possible theories until it lights upon the good idea of picking up something and eating it. On the contrary, you think the chicken has an innate idea of doing this; that is to say, that it can think of this, but has no faculty of thinking anything else. The chicken you say pecks by instinct. But if you are going to think every poor chicken endowed with an innate tendency toward a positive truth, why should you think that to man alone this gift is denied? If you carefully consider with an unbiased mind all the circumstances of the early history of science and all the other facts bearing on the question, which are far too various to be specifically alluded to in this lecture, I am quite sure that you must be brought to acknowledge that man's mind has a natural adaptation to imagining correct theories of some kinds, and in particular to correct theories about forces, without some glimmer of which he could not form social ties and consequently could not reproduce his kind. In short, the instincts conducive to assimilation of food, and the instincts conducive to reproduction, must have involved from the beginning certain tendencies to think truly about physics, on the one hand, and about psychics, on the other. It is somehow more than a mere figure of speech to say that nature fecundates the mind of man with ideas which, when those ideas grow up, will resemble their father, Nature.

But if that be so, it must be good reasoning to say that a given hypothesis is good, as a hypothesis, because it is a natural one, or one readily embraced by the human mind. It must concern logic in the highest degree to ascertain precisely how far and under what limitations this maxim may be held. For of all beliefs, none is more natural than the belief that it is

natural for man to err. The logician ought to find out what the relation is between these two tendencies.

It behooves a man first of all to free his mind of those four idols of which Francis Bacon speaks in the first book of the *Novum Organum*. So much is the dictate of Ethics, itself. But after that, what? Descartes, as you know, maintained that if a man could only get a perfectly clear and distinct idea²—to which Leibniz added the third requirement that it should be adequate³—then that idea must be true. But this is far too severe. For never yet has any man attained to an apprehension perfectly clear and distinct, let alone its being adequate; and yet I suppose that true ideas have been entertained. Ordinary ideas of perception, which Descartes thought were most horribly confused, have nevertheless something in them that very nearly warrants their truth, if it does not quite so. "Seeing is believing," says the instinct of man.

The question is what theories and conceptions we *ought* to entertain. Now the word "ought" has no meaning except relatively to an *end*. That ought to be done which is conducive to a certain end. The inquiry therefore should begin with searching for the *end* of thinking. What do we think *for*? What is the physiological function of thought? If we say it is action, we must mean the government of action to some end. To what end? It must be something, good or admirable, regardless of any ulterior reason. This can only be the esthetically good. But what is esthetically good? Perhaps we may say the full expression of an idea? Thought, however, is in itself essentially of the nature of a sign. But a sign is not a sign unless it translates itself into another sign in which it is more fully developed. Thought requires achievement for its own development, and without this development it is nothing. Thought must live and grow in incessant new and higher translations, or it proves itself not to be genuine thought. But the mind loses itself in such general questions and

² *Meditations* III, *Method*, Pt. II, *Principles*, Pt. I, 30, 43, etc.]

³ [Leibniz's *Nouveaux Essais*, Bk. II, Ch. 31; *Discours*, XXIV, XXV.]

A hypothesis ought, at first, to be entertained interrogatively. Thereupon, it ought to be tested by experiment so far as practicable. There are two distinct processes, both of which may be performed rightly or wrongly. We may go wrong and be wasting time in so much as entertaining a hypothesis, even as a question. That is a subject for criticism in every case. There are some hypotheses which are of such a nature that they never can be tested at all. Whether such hypotheses ought to be entertained at all, and if so in what sense, is a serious question; . . . There are, moreover, many hypotheses in regard to which knowledge already in our possession may, at once, quite justifiably either raise them to the rank of opinions, or even positive beliefs, or cause their immediate rejection. This also is a matter to be considered. But it is the first process, that of entertaining the question, which will here be of foremost importance.

Before we go further, let us get the points stated above quite clear. By a *hypothesis*, I mean, not merely a supposition about an observed object, as when I suppose that a man is a Catholic priest because that would explain his dress, expression of countenance, and bearing, but also any other supposed truth from which would result such facts as have been observed, as when van't Hoff, having remarked that the osmotic pressure of one per cent solutions of a number of chemical substances was inversely proportional to their atomic weights, thought that perhaps the same relation would be found to exist between the same properties of any other chemical substance. The first starting of a hypothesis and the entertaining of it, whether as a simple interrogation or with any degree of confidence, is an inferential step which I propose to call *abduction*. This will include a preference for any one hypothesis over others which would equally explain the facts, so long as this preference is not based upon any previous knowledge bearing upon the truth of the hypotheses, nor on any testing of any of the hypotheses, after having admitted them on probation. I call all such inference by the peculiar name, *abduc-*

tion, because its legitimacy depends upon altogether different principles from those of other kinds of inference.

II [ON SELECTING HYPOTHESES]¹

If we are to give the names of Deduction, Induction, and Abduction to the three grand classes of inference, then Deduction must include every attempt at mathematical demonstration, whether it relate to single occurrences or to "probabilities," that is, to statistical ratios; Induction must mean the operation that induces an assent, with or without quantitative modification, to a proposition already put forward, this assent or modified assent being regarded as the provisional result of a method that must ultimately bring the truth to light; while Abduction must cover all the operations by which theories and conceptions are engendered.

How is it that man ever came by any correct theories about nature? We know by Induction that man has correct theories; for they produce predictions that are fulfilled. But by what process of thought were they ever brought to his mind? A chemist notices a surprising phenomenon. Now if he has a high admiration of Mill's *Logic*, as many chemists have, he will remember that Mill tells him that he must work on the principle that, under precisely the same circumstances, like phenomena are produced. Why does he then not note that this phenomenon was produced on such a day of the week, the planets presenting a certain configuration, his daughter having on a blue dress, he having dreamed of a white horse the night before, the milkman having been late that morning, and so on? The answer will be that in early days chemists did use to attend to some such circumstances, but that they have learned better. How have they learned this? By an induction. Very well, that induction must have been based upon a theory which the induction verified. How was it that man was ever led to entertain that true theory? You cannot say that it hap-

¹ [From the Eighth Lowell Lecture of 1908, entitled "How to Theorize." (Originally published in *C.P.*, V, 413-422.)]

be fictions? Decidedly we must be allowed these ideas, if only as cement for the matter of our sensations. At the same time, I protest that such permission would not be at all enough. Come, Poincaré, and Karl Pearson take what they consider to be the first impressions of sense, but which are really nothing of the sort, but are percepts that are products of psychical operations, and they separate these from all the intellectual part of our knowledge, and arbitrarily call the first *real* and the second *fictions*. These two words *real* and *fictive* bear no significations whatever except as marks of *good* and *bad*. But the truth is that what they call *bad* or *fictitious*, or *subjective*, the intellectual part of our knowledge, comprises all that is valuable on its own account, while what they mark *good*, or *real*, or *objective*, is nothing but the pretty vessel that carries the precious thought.

I can excuse a person who has lost a dear companion and whose reason is in danger of giving way under grief, for trying, on that account, to believe in a future life. I can more than excuse him because his usefulness is at stake, although I myself would not adopt a hypothesis, and would not even take it on probation, simply because the idea was pleasing to me. Without judging others, I should feel, for my own part, that that would be a crime against the integrity of the reason that God has lent to me. But if I had the choice between two hypotheses, the one more ideal and the other more materialistic, I should prefer to take the ideal one upon probation, simply because ideas are fruitful of consequences, while mere sensations are not so; so that the idealistic hypothesis would be the *more verifiable*, that is to say, would *predict more*, and could be put the more thoroughly to the test.

Upon this same principle, if two hypotheses present themselves, one of which can be satisfactorily tested in two or three days, while the testing of the other might occupy a month, the former should be tried first, even if its apparent likelihood is a good deal less.

It is a very grave mistake to attach much importance to the antecedent likelihood of hypotheses, except in extreme cases;

because likelihoods are mostly merely subjective, and have so little real value, that considering the remarkable opportunities which they will cause us to miss, in the long run attention to them does not pay. Every hypothesis should be put to the test by forcing it to make verifiable predictions. A hypothesis on which no verifiable predictions can be based should never be accepted, except with some mark attached to it to show that it is regarded as a mere convenient vehicle of thought—a mere matter of form.

In an extreme case, where the likelihood is of an unmistakably objective character, and is strongly supported by good inductions, I would allow it to cause the postponement of the testing of a hypothesis. For example, if a man came to me and pretended to be able to turn lead into gold, I should say to him, "My dear sir, I haven't time to make gold." But even then the likelihood would not weigh with me directly, as such, but because it would become a factor in what really is in all cases the leading consideration in Abduction, which is the question of Economy—Economy of money, time, thought, and energy.

It is Prof. Ernst Mach⁶ who has done the most to show the importance in logic of the consideration of Economy although I had written a paper on the subject as early as 1878. But Mach goes altogether too far. For he allows thought no other value than that of economizing experiences. This cannot for an instant be admitted. Sensation, to my thinking, has no value whatever except as a vehicle of thought.

Proposals for hypotheses inundate us in an overwhelming flood, while the process of verification to which each one must be subjected before it can count as at all an item, even of likely knowledge, is so very costly in time, energy, and money—and consequently in ideas which might have been had for that time, energy, and money, that Economy would override every other consideration even if there were any other serious considerations. In fact there are no others. For abduction

⁶ [See, e.g., "The Economical Nature of Physical Inquiry," in the *Popular Scientific Lectures* (1895).]

commits us to nothing. It merely causes a hypothesis to be set down upon our docket of cases to be tried.

I shall be asked, Do you really mean to say that we ought not to adopt any opinion whatever as an opinion until it has sustained the ordeal of furnishing a prediction that has been verified?

In order to answer that question, it will be requisite to inquire how an abduction can be justified, here understanding by abduction any mode or degree of acceptance of a proposition as a truth, because a fact or facts have been ascertained whose occurrence would necessarily or probably result in case that proposition were true. The abduction so defined amounts, you will remark, to observing a fact and then professing to say what idea it was that gave rise to that fact. One would think a man must be privy to the counsels of the Most High so to presume. The only justification possible, other than some such positive fact which would put quite another color upon the matter, is the justification of desperation. That is to say, that if he is not to say such things, he will be quite unable to know anything of positive fact.

In a general way, this justification certainly holds. If man had not had the gift, which every other animal has, of a mind adapted to his requirements, he not only could not have acquired any knowledge, but he could not have maintained his existence for a single generation. But he is provided with certain instincts, that is, with certain natural beliefs that are true. They relate in part to forces, in part to the action of minds. The manner in which he comes to have this knowledge seems to me tolerably clear. Certain uniformities, that is to say certain general ideas of action, prevail throughout the universe, and the reasoning mind is [itself a product of this universe. These same laws are thus, by logical necessity, incorporated in his own being. For example, what we call straight lines are nothing but one out of an innumerable multitude of families of nonsingular lines such that through any two points there is one and one only. The particular family of lines called straight has no geometrical properties

that distinguish it from any other of the innumerable families of lines of which there is one and one only through any two points. It is a law of *dynamics* that every dynamical relation between two points, no third point being concerned, except by combinations of such pairs, is altogether similar, except in quantity, to every such dynamical relation between any other two points on the same ray, or straight line. It is a consequence of this that a ray or straight line is the shortest distance between two points; whence, light appears to move along such lines; and that being the case, we recognize them by the eye, and call them straight. Thus, the faculty of sight naturally causes us to assign great prominence to such lines; and thus when we come to form a hypothesis about the motion of a particle left uninfluenced by any other, it becomes *natural* for us to suppose that it moves in a straight line. The reason this turns out true is, therefore, that this first law of motion is a corollary from a more general law which, governing all dynamics, governs light, and causes the idea of straightness to be a predominant one in our minds.

In this way, general considerations concerning the universe, strictly philosophical considerations, all but demonstrate that if the universe conforms, with any approach to accuracy, to certain highly pervasive laws, and if man's mind has been developed under the influence of those laws, it is to be expected that he should have a *natural light*, or *light of nature*, or *instinctive insight*, or genius, tending to make him guess those laws aright, or nearly aright. This conclusion is confirmed when we find that every species of animal is endowed with a similar genius. For they not only one and all have some correct notions of force, that is to say, some correct notions, though excessively narrow, of phenomena which we, with our broader conceptions, should call phenomena of force, and some similarly correct notions about the minds of their own kind and of other kinds, which are the two sufficient corydons of all our science, but they all have, furthermore, wonderful endowments of genius in other directions. Look at the little birds, of which all species are so nearly identical in their

physique, and yet what various forms of genius do they not display in modelling their nests? This would be impossible unless the ideas that are naturally predominant in their minds were true. It would be too contrary to analogy to suppose that similar gifts were wanting to man. Nor does the proof stop here. The history of science, especially the early history of modern science, on which I had the honor of giving some lectures in this hall some years ago,⁷ completes the proof by showing how few were the guesses that men of surpassing genius had to make before they rightly guessed the laws of nature. . . .

III [THE TESTING OF HYPOTHESES]¹

The operation of testing a hypothesis by experiment, which consists in remarking that, if it is true, observations made under certain conditions ought to have certain results, and then causing those conditions to be fulfilled, and noting the results, and, if they are favorable, extending a certain confidence to the hypothesis, I call *induction*. For example, suppose that I have been led to surmise that among our colored population there is a greater tendency toward female births than among our whites. I say, if that be so, the last census must show it. I examine the last census report and find that, sure enough, there was a somewhat greater proportion of female births among colored births than among white births in that census year. To accord a certain faith to my hypothesis on that account is legitimate. It is a strong induction. I have taken all the births of that year as a sample of all the births of years in general, so long as general conditions remain as they were then. It is a very large sample, quite unnecessarily so, were it not that the excess of the one ratio over the other is quite small. All induction whatever may be regarded as the inference that throughout a whole class a ratio will have about

⁷ [In 1869]

¹ [Another excerpt from "Hume on Miracles," *C.P.*, VI, 358-364.—Ed.]

the same value that it has in a random sample of that class, provided the nature of the ratio for which the sample is to be examined is specified (or virtually specified) in advance of the examination. So long as the class sampled consists of units, and the ratio in question is a ratio between counts of occurrences, induction is a comparatively simple affair. But suppose we wish to test the hypothesis that a man is a Catholic priest, that is, has all the characters that are common to Catholic priests and peculiar to them. Now characters are not units, nor do they consist of units, nor can they be counted, in such a sense that one count is right and every other wrong. Characters have to be estimated according to their significance. The consequence is that there will be a certain element of guesswork in such an induction; so that I call it an *abductive induction*. I might say to myself, let me think of some other character that belongs to Catholic priests, beside those that I have remarked in this man, a character which I can ascertain whether he possesses or not. All Catholic priests are more or less familiar with Latin pronounced in the Italian manner. If, then, this man is a Catholic priest, and I make some remark in Latin which a person not accustomed to the Italian pronunciation would not at once understand, and I pronounce it in that way, then if that man is a Catholic priest he will be so surprised that he cannot but betray his understanding of it. I make such a remark; and I notice that he does understand it. But how much weight am I to attach to that test? After all, it does not touch an essential characteristic of a priest or even of a Catholic. It must be acknowledged that it is but a weak confirmation, and all the more so, because it is quite uncertain how much weight should be attached to it. Nevertheless, it does and ought to incline me to believe that the man is a Catholic priest. It is an induction, because it is a test of the hypothesis by means of a prediction, which has been verified. But it is only an abductive induction, because it was a sampling of the characters of priests to see what proportion of them this man possessed, when characters cannot be counted, nor even weighed, except by guesswork. It also partakes of the

nature of abduction in involving an original suggestion; while typical induction has no originality in it, but only tests a suggestion already made.

In induction, it is not the fact predicted that in any degree necessitates the truth of the hypothesis or even renders it probable. It is the fact that it has been predicted successfully and that it is a haphazard specimen of all the predictions which might be based on the hypothesis and which constitute its practical truth. But it frequently happens that there are facts which, merely as facts, apart from the manner in which they have presented themselves, necessitate the truth, or the falsity, or the probability in some definite degree, of the hypothesis. For example, suppose the hypothesis to be that a man believes in the infallibility of the Pope. Then, if we ascertain in any way that he believes in the immaculate conception, in the confessional, and in prayers for the dead, or on the other hand that he disbelieves all or some of these things, either fact will be almost decisive of the truth or falsity of the proposition. Such inference is *deduction*. So if we ascertain that the man in question is a violent partisan in politics and in many other subjects. If, then, we find that he has given money toward a Catholic institution, we may fairly reason that such a man would not do that unless he believed in the Pope's infallibility. Or again, we might learn that he is one of five brothers whose opinions are identical on almost all subjects. If, then, we find that the other four all believe in the Pope's infallibility or all disbelieve it, this will affect our confidence in the hypothesis. This consideration will be strengthened by our general experience that while different members of a large family usually differ about most subjects, yet it mostly happens that they are either all Catholics or all Protestants. Those are four different varieties of deductive considerations which may legitimately influence our belief in a hypothesis.

These distinctions are perfectly clear in principle, which is all that is necessary, although it might sometimes be a nice question to say to which class a given inference belongs. It is

to be remarked that, in pure abduction, it can never be justifiable to accept the hypothesis otherwise than as an interrogation. But as long as that condition is observed, no positive falsity is to be feared; and therefore the whole question of what one out of a number of possible hypotheses ought to be entertained becomes purely a question of economy.

Let us suppose that there are thirty-two different possible ways of explaining a set of phenomena. Then, thirty-one hypotheses must be rejected. The most economical procedure, when it is practicable, will be to find some observable fact which, under conditions easily brought about, would result from sixteen of the hypotheses and not from any of the other sixteen. Such an experiment, if it can be devised, at once halves the number of hypotheses. Or if the experiment might give any one of four results each of which would be the necessary consequence of the truth of any one of eight of the hypotheses, the single experiment would divide the number of admissible hypotheses by four. When such an experiment, or anything approaching such an experiment, is possible, it is clear that it is unwise to adopt any other course. But unfortunately, it commonly happens that this method becomes exhausted before the hypotheses are reduced to a single one, so that nothing remains but to test the remainder each by itself.

Now the testing of a hypothesis is usually more or less costly. Not infrequently the whole life's labor of a number of able men is required to disprove a single hypothesis and get rid of it. Meantime the number of possible hypotheses concerning the truth or falsity of which we really know nothing, or next to nothing, may be very great. In questions of physics there is sometimes an infinite multitude of such possible hypotheses. The question of economy is clearly a very grave one.

In very many questions, the situation before us is this: We shall do better to abandon the whole attempt to learn the truth, however urgent may be our need of ascertaining it, unless we can trust to the human mind's having such a power of guessing right that before very many hypotheses shall have been tried, intelligent guessing may be expected to lead us to

the one which will support all tests, leaving the vast majority of possible hypotheses unexamined. Of course, it will be understood that in the testing process itself there need be no such assumption of mysterious guessing-powers. It is only in selecting the hypothesis to be tested that we are to be guided by that assumption.

If we subject the hypothesis, that the human mind has such a power in some degree, to inductive tests, we find that there are two classes of subjects in regard to which such an instinctive scent for the truth seems to be proved. One of these is in regard to the general modes of action [of] mechanical forces, including the doctrine of geometry; the other is in regard to the ways in which human beings and some quadrupeds think and feel. In fact, the two great branches of human science, physics and psychics, are but developments of that guessing-instinct under the corrective action of induction.

In those subjects, we may, with great confidence, follow the rule that that one of all admissible hypotheses which seems the simplest to the human mind ought to be taken up for examination first. Perhaps we cannot do better than to extend this rule to all subjects where a very simple hypothesis is at all admissible.

This rule has another advantage, which is that the simplest hypotheses are those of which the consequences are most readily deduced and compared with observation; so that, if they are wrong, they can be eliminated at less expense than any others.

This remark at once suggests another rule, namely, that if there be any hypothesis which we happen to be well provided with means for testing, or which, for any reason, promises not to detain us long, unless it be true, that hypothesis ought to be taken up early for examination. Sometimes, the very fact that a hypothesis is improbable recommends it for provisional acceptance on probation.

On the other hand, if one of the admissible hypotheses represents a marked probability of the nature of an objective fact, it may in the long run promote economy to give it an

early trial. By an objective probability I mean one which could be used to guarantee an insurance company or gamester against loss, because it expresses the real fact that among occurrences of a certain genus a certain proportion are of a certain species. Such is the probability of one/six that a die will turn up any particular face. Such a probability must be distinguished from a mere likelihood which is nothing better than the expression of our preconceived ideas. The confusion between those two kinds of probability is one of the main sources of human errors, especially in abduction, in which yielding to judgments of likelihood is a fertile source of waste of time and energy.

In some departments of science, where experimentation is easy, the testing of hypotheses may be performed with some promptitude. In other departments, especially in ancient history, it will extend beyond a human life, so that for the individual the result of the abduction is all that he can hope to live to see. So long as the scientific hypothesis does not offer any particular dangers to the individual, he will do well to content himself with that hypothesis which the wise application of principles of economy recommends to undying scientific research. On the other hand, if there are such dangers, the individual may, as a scientific man, entertain one hypothesis for probation, while he allows probabilities greater weight in deciding upon what hypothesis he shall base his individual behaviour. Thus, in metaphysics, the maxim called Occham's razor, to the effect that more elements must not be introduced into a hypothesis until it is absolutely proved that fewer are not sufficient, is a sound economic principle which ought to guide the scientific metaphysician. But centuries before it is absolutely proved that the simpler hypothesis is inadequate, it may have been made extremely probable that it is so, and the individual's behaviour may reasonably be based upon what the ultimate conclusion of science is likely to be.

In the department of ancient history, what is called "higher criticism"—that is to say, that particular color of non-textual criticism which has been dominant during the nineteenth

century, especially in Germany—has placed, and though it has of late years retreated from many of its positions, still continues to place, great reliance upon likelihoods. To such a pitch is this carried that, although we can have no knowledge of ancient history independent of Greek (and Latin) authors, yet the critics do not hesitate utterly to reject narratives attested sometimes by as many as a dozen ancient authorities—all the testimony there is, at any rate—because the events narrated do not seem to persons living in modern Germany to be likely. I could write a whole book, and not an unenterprising one, in illustration of this point. But scientific archaeology has, in our day, subjected those hypotheses to objective tests; and the uniform result has been to show that what seemed likelihoods to German professors were all but quite uniformly wrong and the ancient testimonies right. Thus the maxim of exact logical analysis, that "no regard at all, or very little indeed, ought to be paid to subjective likelihoods in abduction," has been fully confirmed by inductive tests.

IV [PRAGMATISM—THE LOGIC OF ABDUCTION]¹

If you carefully consider the question of pragmatism, you will see that it is nothing else than the question of the logic of abduction. That is, pragmatism proposes a certain maxim which, if sound, must render needless any further rule as to the admissibility of hypotheses to rank as hypotheses; that is to say, as explanations of phenomena held as hopeful suggestions; and, furthermore, this is *all* that the maxim of pragmatism really pretends to do, at least so far as it is confined to logic, and is not understood as a proposition in psychology. For the maxim of pragmatism is that a conception can have no logical effect or import differing from that of a second conception except so far as, taken in connection with other conceptions and intentions, it might conceivably

¹ [From the seventh of "Lectures on Pragmatism," delivered at Harvard University, 1903. (Originally published in *C.P.*, V, 121-124.)]

modify our practical conduct differently from that second conception. Now it is indisputable that no rule of abduction would be admitted by *any* philosopher which should prohibit on any formalistic grounds any inquiry as to how we ought in consistency to shape our practical conduct. Therefore, a maxim which looks only to possibly practical considerations will not need any supplement in order to exclude any hypotheses as inadmissible. What hypotheses it admits all philosophers would agree ought to be admitted. On the other hand, if it be true that nothing but such considerations has any logical effect or import whatever, it is plain that the maxim of pragmatism cannot cut off any kind of hypothesis which ought to be admitted. Thus, the maxim of pragmatism, if true, fully covers the entire logic of abduction. It remains to inquire whether this maxim may not have some *further* logical effect. If so, it must in some way affect inductive or deductive inference. But that pragmatism cannot interfere with induction is evident; because induction simply teaches us what we have to expect as a result of experimentation, and it is plain that any such expectation may conceivably concern practical conduct. In a certain sense it *must* affect deduction. Anything which gives a rule to abduction and so puts a limit upon admissible hypotheses will cut down the *premises* of deduction, and thereby will render a *reductio ad absurdum* and other equivalent forms of deduction possible which would not otherwise have been possible. But here three remarks may be made. First, to affect the *premises* of deduction is not to affect the logic of deduction. For in the process of deduction itself, no conception is introduced to which pragmatism could be supposed to object, except the acts of abstraction. Concerning that I have only time to say that pragmatism ought not to object to it. Secondly, no effect of pragmatism which is *consequent upon its effect on abduction* can go to show that pragmatism is anything more than a doctrine concerning the logic of abduction. Thirdly, if pragmatism is the doctrine that every conception is a conception of conceivable practical effects, it makes conception reach far beyond the practical. It allows any

flight of imagination, provided this imagination ultimately aligns upon a possible practical effect; and thus many hypotheses may seem at first glance to be excluded by the pragmatic maxim that are not really so excluded.

Admitting, then, that the question of Pragmatism is the question of Abduction, let us consider it under that form. What is good abduction? What should an explanatory hypothesis be to be worthy to rank as a hypothesis? Of course, it must explain the facts. But what other conditions ought it to fulfill to be good? The question of the goodness of anything is whether that thing fulfills its end. What, then, is the end of explanatory hypothesis? Its end is, (through subjection to the test of experiment,) to lead to the avoidance of all surprise and to the establishment of a habit of positive expectation that shall not be disappointed. Any hypothesis, therefore, may be admissible, in the absence of any special reasons to the contrary, provided it be capable of experimental verification, and only insofar as it is capable of such verification. This is approximately the doctrine of pragmatism. But just here a broad question opens out before us. What are we to understand by experimental verification? The answer to that involves the whole logic of induction.

Let me point out to you the different opinions which we actually find men holding today—perhaps not consistently, but thinking that they hold them—upon this subject. In the first place, we find men who maintain that no hypothesis ought to be admitted, even as a hypothesis, any further than its truth or its falsity is *capable* of being directly perceived. This, as well as I can make out, is what was in the mind of Auguste Comte,² who is generally assumed to have first formulated this maxim. Of course, this maxim of abduction supposes that, as people say, we "are to believe only what we actually see"; and there are well-known writers, and writers of no little intellectual force, who maintain that it is unscientific to make predictions—unscientific, therefore, to expect anything. One ought to restrict one's opinions to what one actually perceives.

² [See *Cours de philosophie positive*, 28^{me} leçon.]

I need hardly say that that position cannot be consistently maintained. It refutes itself, for it is *itself* an opinion relating to more than is actually in the field of momentary perception.

In the second place, there are those who hold that a theory which has sustained a number of experimental tests may be expected to sustain a number of other similar tests, and to have a general approximate truth, the justification of this being that this kind of inference must prove correct in the long run. . . . But these logicians refuse to admit that we can ever have a right to conclude definitely that a hypothesis is *exactly* true, that is that it should be able to sustain experimental tests in endless series; for, they urge, no hypothesis can be subjected to an endless series of tests. They are willing we should say that a theory is true, because, all our ideas being more or less vague and approximate, what we mean by saying that a theory is true can only be that it is very near true. But they will not allow us to say that anything put forth as an anticipation of experience should assert exactitude, because exactitude in experience would imply experiences in endless series, which is impossible.

In the third place, the great body of scientific men hold that it is too much to say that induction must be restricted to that for which there can be *positive* experimental evidence. They urge that the rationale of induction as it is understood by logicians of the second group, themselves, entitles us to hold a theory, provided it be such that if it involve any falsity, experiment must some day detect that falsity. We, therefore, have a right, they will say, to infer that something *never* will happen, provided it be of such a nature that it could not occur without being detected.