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Scientific Method and Individual Thinker

George H. Mead

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The scientist in the ancient world found his test of reality in the evidence of the presence of the essence of the object. This evidence came by way of observation, even to the Platonist. Plato could treat this evidence as the awaking of memories of the ideal essence of the object seen in a world beyond the heavens during a former stage of the existence of the soul. In the language of Theatetus it was the agreement of fluctuating sensual content with the thought-content imprinted in or viewed by the soul. In Aristotle it is again the agreement of the organized sensuous experience with the vision which the mind gets of the essence of the object through the perceptual experience of a number of instances. That which gives the stamp of reality is the coincidence of the percept with a rational content which must in some sense be in the mind to insure knowledge, as it must be in the cosmos to insure existence, of the object. The relation of this test of reality to an analytical method is evident. Our perceptual world is always more crowded and confused than the ideal contents by which the reality of its meaning is to be tested. The aim of the analysis varies with the character of the science. In the case of Aristotle's theoretical sciences, such as mathematics and metaphysics, where one proceeds by demonstration from the given 177
existences, analysis isolates such elements as numbers, points, lines, surfaces, and solids, essences and essential accidents. Aristotle approaches nature, however, as he approaches the works of human art. Indeed, he speaks of nature as the artificer par excellence. In the study of nature, then, as in the study of the practical and productive arts, it is of the first importance that the observer

should have the idea—the final cause—as the means of deciphering the nature of living forms. Here analysis proceeds to isolate characters which are already present in forms whose functions are assumed to be known. By analogy such identities as that of fish fins with limbs of other vertebrates are assumed, and some very striking anticipations of modern biological conceptions and discoveries are reached. Aristotle recognizes that the theory of the nature of the form or essence must be supported by observation of the actual individual. What is lacking is any body of observation which has value apart from some theory. He tests his theory by the observed individual which is already an embodied theory, rather than by what we are wont to call the facts. He refers to other observers to disagree with them. He does not present their observations apart from their theories as material which has existential value, independent for the time being of any hypothesis. And it is consistent with this attitude that he never presents the observations of others in support of his own doctrine. His analysis within this field of biological observation does not bring him back to what, in modern science, are the data, but to general characters which make 178
up the definition of the form. His induction involves a gathering of individuals rather than of data. Thus analysis in the theoretical, the natural, the practical, and the productive sciences, leads back to universals. This is quite consistent with Aristotle's metaphysical position that since the matter of natural objects has reality through its realization in the form, whatever appears without such meaning can be accounted for only as the expression of the resistance which matter offers to this realization. This is the field of a blind necessity, not that of a constructive science.

Continuous advance in science has been possible only when analysis of the object of knowledge has supplied not elements of meanings as the objects have been conceived but elements abstracted from those meanings. That is, scientific advance implies a willingness to remain on terms of tolerant acceptance of the reality of what cannot be stated in the accepted doctrine of the time, but what must be stated in the form of contradiction with these accepted doctrines. The domain of what is usually connoted by the term facts or data belongs to the field lying between the old doctrine and the new. This field is not inhabited by the Aristotelian individual, for the individual is but the realization of the form or universal essence. When the new theory has displaced the old, the new individual appears in the place of its predecessor, but during the period within which the old theory is being dislodged and the new is arising, a consciously growing science finds itself occupied with what is on the one hand the débris 179

of the old and on the other the building material of the new. Obviously, this must find its immediate *raison d'être* in something other than the meaning that is gone or the meaning that is not yet here. It is true that the barest facts do not lack meaning, though a meaning which has been theirs in the past is lost. The meaning, however, that is still theirs is confessedly inadequate, otherwise there would be no scientific problem to be solved. Thus, when older theories of the spread of infectious diseases lost their validity because of instances where these explanations could not be applied, the diagnoses and accounts which could still be given of the cases of the sickness themselves were no explanation of the spread of the infection. The facts of the spread of the infection could be brought neither under a doctrine of contagion which was shattered by actual events nor under a doctrine of the germ theory of disease, which was as yet unborn. The logical import of the dependence of these facts upon observation, and hence upon the individual experience of the scientist, I shall have occasion to discuss later; what I am referring to here is that the conscious growth of science is accompanied by the appearance of this sort of material.

There were two fields of ancient science, those of mathematics and of astronomy, within which very considerable advance was achieved, a fact which would seem therefore to offer exception to the statement just made. The theory of the growth of mathematics is a disputed territory, but whether mathematical discovery and invention take place by steps which can be identified with those which mark the 180
advance in the experimental sciences or not, the individual processes in which the discoveries and inventions have arisen are almost uniformly lost to view in the demonstration which presents the results. It would be improper to state that no new data have arisen in the development of mathematics, in the face of such innovations as the minus quantity, the irrational, the imaginary, the infinitesimal, or the transfinite number, and yet the innovations appear as the recasting of the mathematical theories rather than as new facts. It is of course true that these advances have depended upon problems such as those which in the researches of Kepler and Galileo led to the early concepts of the infinitesimal procedure, and upon such undertakings as bringing the combined theories of geometry and algebra to bear upon the experiences of continuous change. For a century after the formulation of the infinitesimal method men were occupied in carrying the new tool of analysis into every field where its use promised advance. The conceptions of the method were uncritical. Its applications were the center of attention. The next century undertook to bring order into the concepts, consistency into the doctrine, and rigor into the reasoning. The dom-

inating trend of this movement was logical rather than methodological. The development was in the interest of the foundations of mathematics rather than in the use of mathematics as a method for solving scientific problems. Of course this has in no way interfered with the freedom of application of mathematical technique to the problems of physical science. On the contrary, it was on ac- 181
count of the richness and variety of the contents which the use of mathematical methods in the physical sciences imported into the doctrine that this logical housecleaning became necessary in mathematics. The movement has been not only logical as distinguished from methodological but logical as distinguished from metaphysical as well. It has abandoned a Euclidean space with its axioms as a metaphysical presupposition, and it has abandoned an Aristotelian subsumptive logic for which definition is a necessary presupposition. It recognizes that everything cannot be proved, but it does not undertake to state what the axiomata shall be; and it also recognizes that not everything can be defined, and does not undertake to determine what shall be defined implicitly and what explicitly. Its constants are logical constants, as the proposition, the class and the relation. With these and their like and with relatively few primitive ideas, which are represented by symbols, and used according to certain given postulates, it becomes possible to bring the whole body of mathematics within a single treatment. The development of this pure mathematics, which comes to be a logic of the mathematical sciences, has been made possible by such a generalization of number theory and theories of the elements of space and time that the rigor of mathematical reasoning is secured, while the physical scientist is left the widest freedom in the choice and construction of concepts and imagery for his hypotheses. The only compulsion is a logical compulsion. The metaphysical compulsion has disappeared from mathematics and the sciences 182
whose techniques it provides.

It was just this compulsion which confined ancient science. Euclidian geometry defined the limits of mathematics. Even mechanics was cultivated largely as a geometrical field. The metaphysical doctrine according to which physical objects had their own places and their own motions determined the limits within which astronomical speculations could be carried on. Within these limits Greek mathematical genius achieved marvelous results. The achievements of any period will be limited by two variables: the type of problem against which science formulates its methods, and the materials which analysis puts at the scientist's disposal in attacking the problems. The technical problems of the trisection of an angle and the duplication of a cube are illustrations of the problems which

characterize a geometrical doctrine that was finding its technique. There appears also the method of analysis of the problem into simpler problems, the assumption of the truth of the conclusion to be proved and the process of arguing from this to a known truth. The more fundamental problem which appears first as the squaring of the circle, which becomes that of the determination of the relation of the circle to its diameter and development of the method of exhaustion, leads up to the sphere, the regular polyhedra, to conic sections and the beginnings of trigonometry. Number was not freed from the relations of geometrical magnitudes, though Archimedes could conceive of a number greater or smaller than any assignable magnitude. With the method of exhaustion, 183
with the conceptions of number found in writings of Archimedes and others, with the beginnings of spherical geometry and trigonometry, and with the slow growth of algebra finding its highest expression in that last flaring up of Greek mathematical creation, the work of Diophantes; there were present all the conceptions which were necessary for attack upon the problems of velocities and changing velocities, and the development of the method of analysis which has been the revolutionary tool of Europe since the Renaissance. But the problems of a relation between the time and space of a motion that should change just as a motion, without reference to the essence of the object in motion, were problems which did not, perhaps could not, arise to confront the Greek mind. In any case its mathematics was firmly embedded in a Euclidian space. Though there are indications of some distrust, even in Greek times, of the parallel axiom, the suggestion that mathematical reasoning could be made rigorous and comprehensive independently of the specific content of axiom and definition was an impossible one for the Greek, because such a suggestion could be made only on the presupposition of a number theory and an algebra capable of stating a continuum in terms which are independent of the sensuous intuition of space and time and of the motion that takes place within space and time. In the same fashion mechanics came back to fundamental generalizations of experience with reference to motions which served as axioms of mechanics, both celestial and terrestrial: the assumptions of the natural motion of earthly substances to their 184
own places in straight lines, and of celestial bodies in circles and uniform velocities, of an equilibrium where equal weights operate at equal distances from the fulcrum.

The incommensurable of Pythagoras and the paradoxes of Zeno present the "no thoroughfares" of ancient mathematical thought. Neither the continuum of space nor of motion could be broken up into ultimate units, when incommensu-

rable ratios existed which could not be expressed, and when motion refused to be divided into positions of space or time since these are functions of motion. It was not until an algebraic theory of number led mathematicians to the use of expressions for the irrational, the minus, and the imaginary numbers through the logical development of generalized expressions, that problems could be formulated in which these irrational ratios and quantities were involved, though it is also true that the effort to deal with problems of this character was in no small degree responsible for the development of the algebra. Fixed metaphysical assumptions in regard to number, space, time, motion, and the nature of physical objects determined the limits within which scientific investigation could take place. Thus though the hypothesis of Copernicus and in all probability of Tycho Brahe were formulated by Greek astronomers, their physical doctrine was unable to use them because they were in flagrant contradiction with the definitions the ancient world gave to earthly and celestial bodies and their natural motions. The atomic doctrine with Democritus' thoroughgoing undertaking to substitute a quantitative for a qualitative conception of matter with the location of the qualitative aspects of the world in the experience of the soul appealed only to the Epicurean who used the theory as an exorcism to drive out of the universe the spirits which disturbed the calm of the philosopher. 185

There was only one field in which ancient science seemed to break away from the fixed assumptions of its metaphysics and from the definitions of natural objects which were the bases for their scientific inferences, this was the field of astronomy in the period after Eudoxus. Up to and including the theories of Eudoxus, physical and mathematical astronomy went hand in hand. Eudoxus' nests of spheres within spheres hung on different axes revolving in different uniform periods was the last attempt of the mathematician philosopher to state the anomalies of the heavens, and to account for the stations, the retrogressions, and varying velocities of planetary bodies by a theory resolving all phenomena of these bodies into motions of uniform velocities in perfect circles, and also placing these phenomena within a physical theory consistent with the prevailing conceptions of the science and philosophy of the time. As a physicist Aristotle felt the necessity of introducing further spheres between the nests of spheres assigned by Eudoxus to the planetary bodies, spheres whose peculiar motions should correct the tendency of the different groups of spheres to pass their motions on to each other. Since the form of the orbits of heavenly bodies and their velocities could not be considered to be the results of their masses and of their relative positions with reference to one another; since it was not pos- 186

sible to calculate the velocities and orbits from the physical characters of the bodies, since in a word these physical characters did not enter into the problem of calculating the positions of the bodies nor offer explanations for the anomalies which the mathematical astronomer had to explain, it was not strange that he disinterested himself from the metaphysical celestial mechanics of his time and concentrated his attention upon the geometrical hypotheses by means of which he could hope to resolve into uniform revolutions in circular orbits the anomalous motions of the planetary bodies. The introduction of the epicycle with the deferent and the eccentric as working hypotheses to solve the anomalies of the heavens is to be comprehended largely in view of the isolation of the mathematical as distinguished from the physical problem of astronomy. In no sense were these conceptions working hypotheses of a celestial mechanics. They were the only means of an age whose mathematics was almost entirely geometrical for accomplishing what a later generation could accomplish by an algebraic theory of functions. As has been pointed out, the undertaking of the ancient mathematical astronomer to resolve the motions of planetary bodies into circular, uniform, continuous, symmetrical movements is comparable to the theorem of Fourier which allows the mathematician to replace any one periodic function by a sum of circular functions. In other words, the astronomy of the Alexandrian period is a somewhat cumbrous development of the mathematical technique of the time to enable the astronomer to bring the anomalies 187
of the planetary bodies, as they increased under observation, within the axioms of a metaphysical physics. The genius exhibited in the development of the mathematical technique places the names of Apollonius of Perga, Hipparchus of Nicaea, and Ptolemy among the great mathematicians of the world, but they never felt themselves free to attack by their hypotheses the fundamental assumptions of the ancient metaphysical doctrine of the universe. Thus it was said of Hipparchus by Adrastus, a philosopher of the first century A. D., in explaining his preference for the epicycle to the eccentric as a means of analyzing the motions of the planetary bodies: “He preferred and adopted the principle of the epicycle as more probable to his mind, because it ordered the system of the heavens with more symmetry and with a more intimate dependence with reference to the center of the universe. Although he guarded himself from assuming the rôle of the physicist in devoting himself to the investigations of the real movements of the stars, and in undertaking to distinguish between the motions which nature has adopted from those which the appearances present to our eyes, he assumed that every planet revolved along an epicycle, the center of

which describes a circumference concentric with the earth." Even mathematical astronomy does not offer an exception to the scientific method of the ancient world, that of bringing to consciousness the concepts involved in their world of experience, organizing these concepts with reference to each, analyzing and restating them within the limits of their essential accidents, and assimilating the 188
concrete objects of experience to these typical forms as more or less complete realizations.

At the beginning of the process of Greek self-conscious reflection and analysis, the mind ran riot among the concepts and their characters until the contradictions which arose from these unsystematized speculations brought the Greek mind up to the problems of criticism and scientific method. Criticism led to the separation of the many from the one, the imperfect copy from the perfect type, the sensuous and passionate from the rational and the intrinsically good, the impermanent particular from the incorruptible universal. The line of demarcation ran between the lasting reality that answered to critical objective thought and the realm of perishing imperfect instances, of partially realized forms full of unmeaning differences due to distortion and imperfection, the realm answering to a sensuous passionate unreflective experience. It would be a quite inexcusable mistake to put all that falls on the wrong side of the line into a subjective experience, for these characters belonged not alone to the experience, but also to the passing show, to the world of imperfectly developed matter which belonged to the perceptual passionate experience. While it may not then be classed as subjective, the Greeks of the Sophistic period felt that this phase of existence was an experience which belongs to the man in his individual life, that life in which he revolts from the conventions of society, in which he questions accepted doctrine, in which he differentiates himself from his fellows. Protagoras seems 189
even to have undertaken to make this experience of the individual, the stuff of the known world. It is difficult adequately to assess Protagoras' undertaking. He seems to be insisting both that the man's experience as his own must be the measure of reality as known and on the other hand that these experiences present norms which offer a choice in conduct. If this is true Protagoras conceived of the individual's experience in its atypical and revolutionary form as not only real but the possible source of fuller realities than the world of convention. The undertaking failed both in philosophic doctrine and in practical politics. It failed in both fields because the subjectivist, both in theory and practice, did not succeed in finding a place for the universal character of the object, its meaning, in the mind of the individual and thus in finding in this experience the hypoth-

esis for the reconstruction of the real world. In the ancient world the atypical individual, the revolutionist, the non-conformist was a self-seeking adventurer or an anarchist, not an innovator or reformer, and subjectivism in ancient philosophy remained a skeptical attitude which could destroy but could not build up.

Hippocrates and his school came nearer consciously using the experience of the individual as the actual material of the object of knowledge. In the skeptical period in which they flourished they rejected on the one hand the magic of traditional medicine and on the other the empty theorizing that had been called out among the physicians by the philosophers. Their practical tasks held them to immediate experience. Their functions in the gymnasia gave their 190
medicine an interest in health as well as in disease, and directed their attention largely toward diet, exercise, and climate in the treatment even of disease. In its study they have left the most admirable sets of observations, including even accounts of acknowledged errors and the results of different treatments of cases, which ancient science can present. It was the misfortune of their science that it dealt with a complicated subject-matter dependent for its successful treatment upon the whole body of physical, chemical, and biological disciplines as well as the discovery and invention of complicated techniques. They were forced after all to adopt a hopelessly inadequate physiological theory—that of the four humors—with the corresponding doctrine of health and disease as the proper and improper mixture of these fluids. Their marvelously fine observation of symptoms led only to the definition of types and a medical practice which was capable of no consistent progress outside of certain fields of surgery. Thus even Greek medicine was unable to develop a different type of scientific method except in so far as it kept alive an empiricism which played a not unimportant part in post-Aristotelian philosophy. Within the field of astronomy in explaining the anomalies of the heavens involved in their metaphysical assumptions, they built up a marvelously perfect Euclidian geometry, for here refined and exhaustive definition of all the elements was possible. The problems involved in propositions to be proved appeared in the individual experience of the geometrician, but this experience in space was uniform with that of every one else and 191
took on a universal not an individual form. The test of the solution was given in a demonstration which holds for every one living in the same Euclidian space. When the mathematician found himself carried by his mathematical technique beyond the assumptions of a metaphysical physics he abandoned the field of physical astronomy and confined himself to the development of his mathemati-

cal expressions.

In other fields Greek science analyzed with varying success and critical skill only the conceptions found in the experience of their time and world. Nor did Greek thought succeed in formulating any adequate method by which the ultimate concepts in any field of science were to be determined. It is in Aristotle's statement of induction and the process of definition that we appreciate most clearly the inadequacy of their method. This inadequacy lies fundamentally in Aristotle's conception of observation which, as I have already noted, implies the recognition of an individual, that is, an object which is an embodied form or idea. The function of knowledge is to bring out this essence. The mind sees through the individuals the universal nature. The value of the observation lies, then, not in the controlled perception of certain data as observed facts, but in the insight with which he recognizes the nature of the object. When this nature has been seen it is to be analyzed into essential characters and thus formulated into the definition. In Aristotle's methodology there is no procedure by which the mind can deliberately question the experience of the community and by a 192
controlled method reconstruct its received world. Thus the natural sciences were as really fixed by the conceptions of the community as were the exact sciences by the conceptions of a Euclidian geometry and the mathematics which the Greeks formulated within it. The individual within whose peculiar experience arises a contradiction to the prevailing conceptions of the community and in whose creative intelligence appears the new hypothesis which makes possible a new heaven and a new earth could utilize his individual experience only in destructive skepticism. Subjectivism served in ancient thought to invalidate knowledge not to enlarge it.

Zeller has sketched a parallelism between the ideal state of Plato and the social structure of the medieval world. The philosopher-king is represented by the Pope, below him answering to the warrior class in the Platonic state stands the warrior class of the Holy Roman Empire, who in theory enforce the dictates of the Roman curia, while at the bottom in both communities stand the mass of the people bound to obedience to the powers above. There is, however, one profound difference between the two, and that is to be found in the relative positions of the ideal worlds that dominate each. Plato's ideal world beyond the heavens gives what reality it has to this through the participation by the world of becoming in the ideas. Opinion dimly sensed the ideas in the evanescent objects about it, and though Plato's memory theory of knowledge assumed that the ideas had been seen in former existence and men could thus recognize the

copies here, the ideal world was not within the mind but without. In a real 193
sense the Kingdom of Heaven was within men in the medieval world, as was the Holy Roman Empire. They were ideal communities that ought to exist on earth, and it was due to the depravity of men that they did not exist. From time to time men undertook in various upheavals to realize in some part these spiritual and political ideals which they carried within them. And men not only carried within them the ideas of a New Jerusalem in which the interest of one was the interest of all and of an earthly state ordered by a divine decree to fulfil this Christian ideal, but the determining causes of the present condition and the future realization depended also upon the inner attitudes and experiences of the individuals themselves.

Without carrying the analogy here too far, this relation between the experience of the individual and the world which may arise through the realization of his ideas is the basis of the most profound distinction between the ancient world and the modern. Before the logic of this attitude could appear in science a long period of intellectual and social growth was necessary. The most essential part of this growth was the slow but steady development of psychological doctrine which placed the objective world in the experience of the individual. It is not of interest here to bring out the modern epistemological problem that grew out of this, or to present this in the world of Leibnitzian monads that had no windows or in the Berkeleyan subjective idealism. What is of interest is to point out that this attitude established a functional relationship between even the subjective 194
experience of the individual and the object of knowledge. A skepticism based upon subjectivism might thereafter question the justification of the reference of experience beyond itself; it could not question knowledge and its immediate object.

Kant formalizes the relation of what was subjective and what was objective by identifying the former with the sensuous content of experience and the latter with the application of the forms of sensibility and understanding to this content. The relationship was formal and dead. Kant recognized no functional relationship between the nature of the *Mannigfaltigkeit* of sensuous experience and the forms into which it was poured. The forms remained external to the content, but the relationship was one which existed within experience, not without it, and within this experience could be found the necessity and universality which had been located in the world independent of experience. The melting of these fixed Kantian categories came with the spring floods of the romantic idealism that followed Kant.

The starting-point of this idealism was Kantian. Within experience lay the object of knowledge. The Idealist's principal undertaking was to overcome the skepticism that attached to the object of knowledge because of its reference to what lies outside itself. If, as Kant had undertaken to prove, the reality which knowledge implies must reach beyond experience, then, on the Kantian doctrine that knowledge lies within experience, knowledge itself is infected with skepticism. Kant's practical bridge from the world of experience to the world of things-in-themselves, which he walked by faith and not by sight, was found 195
in the postulates of the conduct of the self as a moral being, as a personality. The romantic idealists advance by the same road, though as romanticists not critical philosophers, they fashioned the world of reality, that transcends experience, out of experience itself, by centering the self in the absolute self and conceiving the whole infinite universe as the experience of the absolute self. The interesting phase of this development is that the form which experience takes in becoming objective is found in the nature and thought of the individual, and that this process of epistemological experience becomes thus a process of nature, if the objective is the natural. In Kant's terms our minds give laws to nature. But this nature constantly exhibits its dependence upon underlying noumena that must therefore transcend the laws given by the understanding. The Romanticist insists that this other reality must be the same stuff as that of experience, that in experience arise forms which transcend those which bound the experience in its earlier phase. If in experience the forms of the objective world are themselves involved, the process of knowledge sets no limits to itself, which it may not, does not, by implication transcend. As further indication of the shift by which thought had passed into possession of the world of things in themselves stands the antinomy which in Kantian experience marks the limit of our knowledge while in post-Kantian idealism it becomes the antithesis that leads to the synthesis upon the higher plane. Contradiction marks the phase at which the spirit becomes creative, not simply giving an empty formal law to 196
nature, but creating the concrete universe in which content and form merge in true actuality. The relation of the sensuous content to the conceptual form is not dead, as in Kant's doctrine. It is fused as perception into concept and carries its immediacy and concreteness of detail into the concrete universal as the complete organization of stimulation and response pass into the flexible habit. And yet in the Hegelian logic, the movement is always away from the perceptual experience toward the higher realm of the *Idee*. Thought is creative in the movement, but in its ultimate reality it transcends spatial and temporal expe-

rience, the experience with which the natural and mathematical sciences deal. Thought is not a means of solving the problems of this world as they arise, but a great process of realization in which this world is forever transcended. Its abstract particularities of sensuous detail belong only to the finite experience of the partial self. This world is, therefore, always incomplete in its reality and, in so far, always untrue. Truth and full reality belong not to the field of scientific investigation.

In its metaphysics Romantic Idealism, though it finds a place for scientific discovery and reconstruction, leaves these disdainfully behind, as incomplete phases of the ultimate process of reality, as infected with untruth and deceptive unwarranted claims. The world is still too much with us. We recognize here three striking results of the development of reflective consciousness in the modern world:—first, it is assumed that the objective world of knowledge can be placed within the experience of the individual without losing thereby its nature 197
as an object, that all characters of that object can be presented as belonging to that experience, whether adequately or not is another question; and second, it is assumed that the contradictions in its nature which are associated with its inclusion in individual experience, its references beyond itself when so included, may themselves be the starting-point of a reconstruction which at least carries that object beyond the experience within which these contradictions arose; and third, it is assumed that this growth takes place in a world of reality within which the incomplete experience of the individual is an essential part of the process, in which it is not a mere fiction, destroying reality by its representation, but is a growing-point in that reality itself.

These characters of philosophic interpretation, the inclusion of the object of knowledge in the individual experience and the turning of the conflicts in that experience into the occasion for the creation of new objects transcending these contradictions, are the characters in the conscious method, of modern science, which most profoundly distinguish it from the method of ancient science. This, of course, is tantamount to saying that they are those which mark the experimental method in science.

That phase of the method upon which I have touched already has been its occupation with the so-called data or facts as distinguished from Aristotelian individuals.

Whenever we reduce the objects of scientific investigation to facts and undertake to record them as such, they become events, happenings, whose hard fac- 198

tual character lies in the circumstance that they have taken place, and this quite independently of any explanation of their taking place. When they are explained they have ceased to be facts and have become instances of a law, that is, Aristotelian individuals, embodied theories, and their actuality as events is lost in the necessity of their occurrence as expressions of the law; with this change their particularity as events or happenings disappears. They are but the specific values of the equation when constants are substituted for variables. Before the equation is known or the law discovered they have no such ground of existence. Up to this point they find their ground for existence in their mere occurrence, to which the law which is to explain them must accommodate itself.

There are here suggested two points of view from which these facts may be regarded. Considered with reference to a uniformity or law by which they will be ordered and explained they are the phenomena with which the positivist deals; as existencies to be identified and localized before they are placed within such a uniformity they fall within the domain of the psychological philosopher who can at least place them in their relation to the other events in the experience of the individual who observes them. Considered as having a residual meaning apart from the law to which they have become exceptions, they can become the subject-matter of the rationalist. It is important that we recognize that neither the positivist nor the rationalist is able to identify the nature of the fact or datum to which they refer. I refer to such stubborn facts as those of the sporadic 199
appearance of infectious diseases before the germ theory of the disease was discovered. Here was a fact which contradicted the doctrine of the spread of the infection by contact. It appeared not as an instance of a law, but as an exception to a law. As such, its nature is found in its having happened at a given place and time. If the case had appeared in the midst of an epidemic, its nature as a case of the infectious disease would have been cared for in the accepted doctrine, and for its acceptance as an object of knowledge its location in space and time as an event would not have been required. Its geographical and historical traits would have followed from the theory of the infection, as we identify by our calculations the happy fulfilment of Thales' prophecy. The happening of an instance of a law is accounted for by the law. Its happening may and in most instances does escape observation, while as an exception to an accepted law it captures attention. Its nature as an event is, then, found in its appearance in the experience of some individual, whose observation is controlled and recorded as his experience. Without its reference to this individual's experience it could not appear as a fact for further scientific consideration.

Now the attitude of the positivist toward this fact is that induced by its relation to the law which is *subsequently* discovered. It has then fallen into place in a series, and his doctrine is that all laws are but uniformities of such events. He treats the fact when it is an exception to law as an instance of the new law 200
and assumes that the exception to the old law and the instance of the new are identical. And this is a great mistake,—the mistake made also by the neo-realist when he assumes that the object of knowledge is the same within and without the mind, that nothing happens to what is to be known when it by chance strays into the realm of conscious cognition. Any as yet unexplained exception to an old theory can happen only in the experience of an individual, and that which has its existence as an event in some one's biography is a different thing from the future instance which is not beholden to any one for its existence. Yet there are, as I indicated earlier, meanings in this exceptional event which, at least for the time, are unaffected by the exceptional character of the occurrence. For example, certain clinical symptoms by which an infectious disease is identified have remained unchanged in diagnosis since the days of Hippocrates. These characters remain as characters of the instance of the law of germ-origin when this law has been discovered. This may lead us to say that the exception which appears for the time being as a unique incident in a biography is identical with the instance of a germ-induced disease. Indeed, we are likely to go further and, in the assurance of the new doctrine, state that former exceptions can (or with adequate acquaintance with the facts could) be proved to be necessarily an instance of a disease carried by a germ. The positivist is therefore confident that the field of scientific knowledge is made up of events which are instances of uniform series, although under conditions of inadequate information some of 201
them appear as exceptions to the statements of uniformities, in truth the latter being no uniformities at all.

That this is not a true statement of the nature of the exception and of the instance, it is not difficult to show if we are willing to accept the accounts which the scientists themselves give of their own observation, the changing forms which the hypothesis assumes during the effort to reach a solution and the ultimate reconstruction which attends the final tested solution. Wherever we are fortunate enough, as in the biographies of men such as Darwin and Pasteur, to follow a number of the steps by which they recognized problems and worked out tenable hypotheses for their solution, we find that the direction which is given to attention in the early stage of scientific investigation is toward conflicts between current theories and observed phenomena, and that since the form which these

observations take is determined by the opposition, it is determined by a statement which itself is later abandoned. We find that the scope and character of the observations change at once when the investigator sets about gathering as much of the material as he can secure, and changes constantly as he formulates tentative hypotheses for the solution of the problem, which, moreover, generally changes its form during the investigation. I am aware that this change in the form of the data will be brushed aside by many as belonging only to the attitude of mind of the investigator, while it is assumed that the "facts" themselves, however selected and organized in his observation and thought, remain identi- 202
cal in their nature throughout. Indeed, the scientist himself carries with him in the whole procedure the confidence that the fact-structure of reality is unchanged, however varied are the forms of the observations which refer to the same entities.*

The analysis of the fact-structure of reality shows in the first place that the scientist undertakes to form such an hypothesis that all the data of observation will find their place in the objective world, and in the second place to bring them into such a structure that future experience will lead to anticipated results. He does not undertake to preserve facts in the form in which they existed in experience before the problem arose nor to construct a world independent of experience or that will not be subject itself to future reconstructions in experience. He merely insists that future reconstructions will take into account the 203
old in re-adjusting it to the new. In such a process it is evident that the change of the form in the data is not due to a subjective attitude of the investigator which can be abstracted from the facts. When Darwin, for instance, found that the marl dressings which farmers spread over their soil did not sink through the soil by the force of gravity as was supposed, but that the earthworm castings were thrown up above these dressings at nearly the same rate at which

*An analysis which has been many times carried out has made it clear that scientific data never do more than approximate the laws and entities upon which our science rests. It is equally evident that the forms of these laws and entities themselves shift in the reconstructions of incessant research, or where they seem most secure could consistently be changed, or at least could be fundamentally different were our psychological structure or even our conventions of thought different. I need only refer to the *Science et Hypothèse* of Poincaré and the *Problems of Science* of Enriques. The positivist who undertakes to carry the structure of the world back to the data of observation, and the uniformities appearing in the accepted hypotheses of growing sciences cannot maintain that we ever succeed in isolating data which must remain the same in the kaleidoscope of our research science; nor are we better served if we retreat to the ultimate elements of points and instants which our pure mathematics assumes and implicitly defines, and in connection with which it has worked out the modern theory of the number and continuous series, its statements of continuity and infinity.

they disappeared, he did not correct a subjective attitude of mind. He created in experience a humus which took the place of a former soil, and justified itself by fitting it into the whole process of disintegration of the earth's surface. It would be impossible to separate in the earlier experiences certain facts and certain attitudes of mind entertained by men with reference to these facts. Certain objects have replaced other objects. It is only after the process of analysis, which arose out of the conflicting observations, has broken up the old object that what was a part of the object, heavier-things-pushing-their way-through-soil-of-lighter-texture, can become a mere idea. Earlier it was an object. Until it could be tested the earthworm as the cause of the disappearance of the dressings was also Darwin's idea. It became fact. For science at least it is quite impossible to distinguish between what in an object must be fact and what may be idea. The distinction when it is made is dependent upon the form of the problem and is functional to its solution, not metaphysical. So little can a consistent line of cleavage between facts and ideas be indicated, that we can never tell where 204
in our world of observation the problem of science will arise, or what will be regarded as structure of reality or what erroneous idea.

There is a strong temptation to lodge these supposititious fact-structures in a world of conceptual objects, molecules, atoms, electrons, and the like. For these at least lie beyond the range of perception by their very definition. They seem to be in a realm of things-in-themselves. Yet they also are found now in the field of fact and now in that of ideas. Furthermore, a study of their structure as they exist in the world of constructive science shows that their infra-sensible character is due simply to the nature of our sense-processes, not to a different metaphysical nature. They occupy space, have measurable dimensions, mass, and are subject to the same laws of motion as are sensible objects. We even bring them indirectly into the field of vision and photograph their paths of motion.

The ultimate elements referred to above provide a consistent symbolism for the finding and formulating of applied mathematical sciences, within which lies the whole field of physics, including Euclidian geometry as well. However, they have succeeded in providing nothing more than a language and logic pruned of the obstinate contradictions, inaccuracies, and unanalyzed sensuous stuff of earlier mathematical science. Such a rationalistic doctrine can never present in an unchanged form the objects with which natural science deals in any of the stages of its investigation. It can deal only with ultimate elements and forms of propositions. It is compelled to fall back on a theory of analysis which reaches 205
ultimate elements and an assumption of inference as an indefinable. Such an

analysis is actually impossible either in the field of the conceptual objects into which physical science reduces physical objects, or in the field of sensuous experience. Atoms can be reduced into positive and negative electrical elements and these may, perhaps do, imply a structure of ether that again invites further analysis and so on ad infinitum. None of the hypothetical constructs carry with themselves the character of being ultimate elements unless they are purely metaphysical. If they are fashioned to meet the actual problems of scientific research they will admit of possible further analysis, because they must be located and defined in the continuity of space and time. They cannot *be* the points and instants of modern mathematical theory. Nor can we reach ultimate elements in sensuous experience, for this lies also within a continuum. Furthermore, our scientific analyses are dependent upon the form that our objects assume. There is no general analysis which research in science has ever used. The assumption that psychology provides us with an analysis of experience which can be carried to ultimate elements or facts, and which thereby provides the elements out of which the objects of our physical world must be constructed, denies to psychology its rights as a natural science of which it is so jealous, turning it into a Berkeleyan metaphysics.

This most modern form of rationalism being unable to find ultimate elements in the field of actual science is compelled to take what it can find there. Now 206
the results of the analysis of the classical English psychological school give the impression of being what Mr. Russell calls "hard facts," i.e., facts which cannot be broken up into others. They seem to be the data of experience. Moreover, the term hard is not so uncompromising as is the term element. A fact can be more or less hard, while an ultimate element cannot be more or less ultimate. Furthermore, the entirely formal character of the logic enables it to deal with equal facility with any content. One can operate with the more or less hard sense-data, putting them in to satisfy the seeming variables of the propositions, and reach conclusions which are formally correct. There is no necessity for scrutinizing the data under these circumstances, if one can only assume that the data are those which science is actually using. The difficulty is that no scientist ever analyzed his objects into such sense-data. They exist only in philosophical textbooks. Even the psychologists recognize that these sensations are abstractions which are not the elements out of which objects of sense are constructed. They are abstractions made from those objects whose ground for isolation is found in the peculiar problems of experimental psychology, such as those of color or tone perception. It would be impossible to make anything in terms of Berke-

leyan sense-data and of symbolic logic out of any scientific discovery. Research defines its problem by isolating certain facts which appear for the time being not as the sense-data of a solipsistic mind, but as experiences of an individual in a highly organized society, facts which, because they are in conflict with ac- 207
cepted doctrines, must be described so that they can be experienced by others under like conditions. The ground for the analysis which leads to such facts is found in the conflict between the accepted theory and the experience of the individual scientist. The analysis is strictly *ad hoc*. As far as possible the exception is stated in terms of accepted meanings. Only where the meaning is in contradiction with the experience does the fact appear as the happening to an individual and become a paragraph out of his biography. But as such an event, whose existence for science depends upon the acceptance of the description of him to whom it has happened, it must have all the setting of circumstantial evidence. Part of this circumstantial evidence is found in so-called scientific control, that is, the evidence that conditions were such that similar experiences could happen to others and could be described as they are described in the account given. Other parts of this evidence which we call corroborative are found in the statements of others which bear out details of this peculiar event, though it is important to note that these details have to be wrenched from their settings to give this corroborative value. To be most conclusive they must have no intentional connection with the experience of the scientist. In other words, those individuals who corroborate the facts are made, in spite of themselves, experiencers of the same facts. The perfection of this evidence is attained when the fact can happen to others and the observer simply details the conditions under which he made the observation, which can be then so perfectly reproduced that 208
others may repeat the exceptional experience.

This process is not an analysis of a known world into ultimate elements and their relations. Such an analysis never isolates this particular exception which constitutes the scientific problems as an individual experience. The extent to which the analysis is carried depends upon the exigencies of the problem. It is the indefinite variety of the problems which accounts for the indefinite variety of the facts. What constitutes them facts in the sense in which we are using the term is their *exceptional* nature; formally they appear as particular judgments, being denials of universal judgments, whether positive or negative. This exceptional nature robs the events of a reality which would have belonged to them as instances of a universal law. It leaves them, however, with the rest of their meaning. But the value which they have lost is just that which was essential

to give them their place in the world as it has existed for thought. Banished from that universally valid structure, their ground for existence is found in the experience of the puzzled observer. Such an observation was that of the moons of Jupiter made possible by the primitive telescope of Galileo. For those who lived in a Ptolemaic cosmos, these could have existence only as observations of individuals. As moons they had distinct meaning, circling Jupiter as our moon circles the earth, but being in contradiction with the Ptolemaic order they could depend for their existence only on the evidence of the senses, until a Copernican order could give them a local habitation and a name. Then they were observed 209
not as the experiences of individuals but as instances of planetary order in a heliocentric system. It would be palpably absurd to refer to them as mere sense-data, mere sensations. They are for the time being inexplicable experiences of certain individuals. They are inexplicable because they have a meaning which is at variance with the structure of the whole world to which they belong. They are the phenomena termed accidental by Aristotle and rejected as full realities by him, but which have become, in the habitat of individual experience, the headstone of the structure of modern research of science.

A rationalism which relegates implication to the indefinables cannot present the process of modern science. Implication is exactly that process by which these events pass from their individual existence into that of universal reality, and the scientist is at pains to define it as the experimental method. It is true that a proposition implies implication. But the proposition is the statement of the result of the process by which an object has arisen for knowledge and merely indicates the structure of the object. In discovery, invention, and research the escape from the exceptional, from the data of early stages of observation, is by way of an hypothesis; and every hypothesis so far as it is tenable and workable in its form is universal. No one would waste his time with a hypothesis which confessedly was not applicable to all instances of the problem. An hypothesis may be again and again abandoned, it may prove to be faulty and contradictory, but in so far as it is an instrument of research it is assumed to be universal and 210
to perfect a system which has broken down at the point indicated by the problem. Implication and more elaborated instances flow from the structure of this hypothesis. The classical illustration which stands at the door of modern experimental science is the hypothesis which Galileo formed of the rate of the velocity of a falling body. He conceived that this was in proportion to the time elapsed during the fall and then elaborated the consequences of this hypothesis by working it into the accepted mathematical doctrines of the physical world,

until it led to an anticipated result which would be actually secured and which would be so characteristic an instance of a falling body that it would answer to every other instance as he had defined them. In this fashion he defined his inference as the anticipation of a result because this result was a part of the world as he presented it amended by his hypothesis. It is true that back of the specific implication of this result lay a mass of other implications, many not even presented specifically in thought and many others presented by symbols which generalized innumerable instances. These implications are for the scientist more or less implicit meanings, but they are meanings each of which may be brought into question and tested in the same fashion if it should become an actual problem. Many of them which would not have occurred to Galileo as possible problems have been questioned since his day. What has remained after this period of determined questioning of the foundations of mathematics and the structure of the world of physical science is a method of agreement with oneself and others, in (a) the identification of the object of thought, in (b) 211
the accepted values of assent and denial called truth and falsehood, and in (c) referring to meaning, in its relation to what is meant. In any case the achievement of symbolic logic, with its indefinables and axioms has been to reduce this logic to a statement of the most generalized form of possible consistent thought intercourse, with entire abstraction from the content of the object to which it refers. If, however, we abstract from its value in giving a consistent theory of number, continuity, and infinity, this complete abstraction from the content has carried the conditions of thinking in agreement with self and others so far away from the actual problem of science that symbolic logic has never been used as a research method. It has indeed emphasized the fact that thinking deals with problems which have reference to uses to which it can be put, not to a metaphysical world lying beyond experience. Symbolic logic has to do with the world of discourse, not with the world of things.

What Russell pushes to one side as a happy guess is the actual process of implication by which, for example, the minute form in the diseased human system is identified with unicellular life and the history of the disease with the life history of this form. This identification implies reclassification of these forms and a treatment of the disease that answers to their life history. Having made this identification we anticipate the result of this treatment, calling it an inference.

Implication belongs to the reconstruction of the object. As long as no question 212
has arisen, the object is what it means or means what it is. It does not imply any feature of itself. When through conflict with the experience of the individual

some feature of the object is divorced from some meaning the relationship between these becomes a false implication. When a hypothetically reconstructed object finds us anticipating a result which accords with the nature of such objects we assert an implication of this meaning. To carry this relation of implication back into objects which are subject to no criticism or question would of course resolve the world into elements connected by external relations, with the added consequence that these elements can have no content, since every content in the face of such an analysis must be subject to further analysis. We reach inevitably symbols such as X, Y, and Z, which can symbolize nothing. Theoretically we can assume an implication between any elements of an object, but in this abstract assumption the symbolic logician overlooks the fact that he is also assuming some content which is not analyzed and which is the ground of the implication. In other words this logician confuses the scientific attitude of being ready to question anything with an attitude of being willing to question everything at once. It is only in an unquestioned objective world that the exceptional instance appears and it is only in such a world that an experimental science tests the implications of the hypothetically reconstructed object.

The guess is happy because it carries with it the consequences which follow from its fitting into the world, and the guess, in other words the hypothesis, 213
takes on this happy form solely because of the material reconstruction which by its nature removes the unhappy contradiction and promises the successful carrying out of the conflicting attitudes in the new objective world. There is no such thing as formal implication.

Where no reconstruction of the world is involved in our identification of objects that belong to it and where, therefore, no readjustment of conduct is demanded, such a logic symbolizes what takes place in our direct recognition of objects and our response to them. Then "X is a man implies X is mortal for all values of X" exactly symbolizes the attitude toward a man subject to a disease supposedly mortal. But it fails to symbolize the biological research which starting with inexplicable sporadic cases of an infectious disease carries over from the study of the life history of infusoria a hypothetical reconstruction of the history of disease and then acts upon the result of this assumption. Research-science presents a world whose form is always universal, but this universal form is neither a metaphysical assumption nor a fixed form of the understanding. While the scientist may as a metaphysician assume the existence of realities which lie beyond a possible experience, or be a Kantian or Neo-Kantian, neither of these attitudes is necessary for his research. He may be a positivist—a disciple of Hume or of

John Stuart Mill. He may be a pluralist who conceives, with William James, that the order which we detect in parts of the universe is possibly one that is rising out of the chaos and which may never be as universal as our hypothesis 214
demands. None of these attitudes has any bearing upon his scientific method. This simplifies his thinking, enables him to identify the object in which he is interested wherever he finds it, and to abstract in the world as he conceives it those features which carry with them the occurrence he is endeavoring to place. Especially it enables him to make his thought a part of the socially accepted and socially organized science to which his thought belongs. He is far too modest to demand that the world be as his inference demands.

He asks that his view of the world be cogent and convincing to all those whose thinking has made his own possible, and be an acceptable premise for the conduct of that society to which he belongs. The hypothesis has no universal and necessary characters except those that belong to the thought which preserves the same meanings to the same objects, the same relations between the same relata, the same attributes of assent and dissent under the same conditions, the same results of the same combinations of the same things. For scientific research the meanings, the relations with the relata, the assent and dissent, the combinations and the things combined are all in the world of experience. Thinking in its abstractions and identifications and reconstructions undertakes to preserve the values that it finds, and the necessity of its thinking lies in its ability to so identify, preserve, and combine what it has isolated that the thought structure will have an identical import under like conditions for the thinker with all other thinkers to whom these instruments of research conduct 215
are addressed. Whatever conclusions the scientist draws as necessary and universal results from his hypothesis for a world independent of his thought are due, not to the cogency of his logic, but to other considerations. For he knows if he reflects that another problem may arise which will in its solution change the face of the world built upon the present hypothesis. He will defend the inexorableness of his reasoning, but the premises may change. Even the contents of tridimensional space and sensuous time are not essential to the cogency of that reasoning nor can the unbroken web of the argument assure the content of the world as invariable. His universals, when applied to nature, are all hypothetical universals; hence the import of experiment as the test of an hypothesis. Experience does not rule out the possible cropping up of a new problem which may shift the values attained. Experience simply reveals that the new hypothesis fits into the meanings of the world which are not shaken; it shows that,

with the reconstruction which the hypothesis offers, it is possible for scientific conduct to proceed.

But if the universal character of the hypothesis and the tested theory belong to the instrumental character of thought in so reconstructing a world that has proved to be imperfect, and inadequate to conduct, the stuff of the world and of the new hypothesis are the same. At least this is true for the scientist who has no interest in an epistemological problem that does not affect his scientific undertakings in one way nor another. I have already pointed out that from the standpoint of logical and psychological analysis the things with which science 216
deals can be neither ultimate elements nor sense-data; but that they must be phases and characters and parts of things in some whole, parts which can only be isolated because of the conflict between an accepted meaning and some experience. I have pointed out that an analysis is guided by the practical demands of a solution of this conflict; that even that which is individual in its most unique sense in the conflict and in attempts at its solution does not enter into the field of psychology—which has its own problems peculiar to its science. Certain psychological problems belong to the problems of other sciences, as, for example, that of the personal equation belongs to astronomy or that of color vision to the theory of light. But they bulk small in these sciences. It cannot be successfully maintained that a scientific observation of the most unique sort, one which is accepted for the time being simply as a happening in this or that scientist's experience, is as such a psychological datum, for the data in psychological text-books have reference to *psychological* problems. Psychology deals with the consciousness of the individual in its dependence upon the physiological organism and upon those contents which detach themselves from the objects outside the individual and which are identified with his inner experience. It deals with the laws and processes and structures of this consciousness in all its experiences, not with *exceptional* experiences. It is necessary to emphasize again that for science these particular experiences arise within a world which is in its logical structure organized and universal. They arise only through the conflict of 217
the individual's experience with such an accepted structure. For science individual experience *presupposes* the organized structure; hence it cannot provide the material out of which the structure is built up. This is the error of both the positivist and of the psychological philosopher, if scientific procedure gives us in any sense a picture of the situation.

A sharp contrast appears between the accepted hypothesis with its universal form and the experiences which invalidate the earlier theory. The reality of

these experiences lies in their happening. They were unpredictable. They are not instances of a law. The later theory, the one which explains these occurrences, changes their character and status, making them necessary results of the world as that is conceived under this new doctrine. This new standpoint carries with it a backward view, which explains the erroneous doctrine, and accounts for the observations which invalidated it. Every new theory must take up into itself earlier doctrines and rationalize the earlier exceptions. A generalization of this attitude places the scientist in the position of anticipating later reconstructions. He then must conceive of his world as subject to continuous reconstructions. A familiar interpretation of his attitude is that the hypothesis is thus approaching nearer and nearer toward a reality which would never change if it could be attained, or, from the standpoint of the Hegelian toward a goal at infinity. The Hegelian also undertakes to make this continuous process of reconstruction an organic phase in reality and to identify with nature the pro- 218
cess of finding exceptions and of correcting them. The fundamental difference between this position and that of the scientist who looks before and after is that the Hegelian undertakes to make the exception in its exceptional character a part of the reality which transcends it, while the scientist usually relegates the exception to the experience of individuals who were simply caught in an error which later investigation removes.

The error remains as an historical incident explicable perhaps as a result of the conditions under which it occurred, but in so far as it was an error, not a part of reality. It is customary to speak of it as subjective, though this implies that we are putting the man who was unwittingly in error into the position of the one who has corrected it. To entertain that error in the face of its correction would be subjective. A result of this interpretation is that the theories are abstracted from the world and regarded as something outside it. It is assumed that the theories are mental or subjective and change while the facts remain unchanged. Even when it is assumed that theories and facts agree, men speak of a correspondence or parallelism between idea and the reality to which it refers. While this attitude seems to be that of science toward the disproved theories which lie behind it, it is not its attitude to the theories which it accepts. These are not regarded as merely parallel to realities, as abstracted from the structure of things. These meanings go into the makeup of the world. It is true that the scientist who looks before and after realizes that any specific meaning 219
which is now accepted may be questioned and discarded. If he carries his refection far enough he sees that a complete elimination of all the meanings which

might conceivably be so discredited would leave nothing but logical constants, a world with no facts in any sense. In this position he may of course take an agnostic attitude and be satisfied with the attitude of Hume or Mill or Russell. But if he does so, he will pass into the camp of the psychological philosophers and will have left the position of the scientist. The scientist always deals with an *actual* problem, and even when he looks before and after he does so in so far as he is facing in inquiry some actual problem. No actual problem could conceivably take on the form of a conflict involving the whole world of meaning. The conflict always arises between an individual experience and certain laws, certain meanings while others are unaffected. These others form the necessary field without which no conflict can arise. They give the man of research his [place to stand]* upon which he can formulate his problem and undertake its solution. The possible calling in question of any content, whatever it may be, means always that there is left a field of unquestioned reality. The attitude of the scientist never contemplates or could contemplate the possibility of a world in which there would be no reality by which to test his hypothetical solution of the problem that arises. Nor does this attitude when applied to past discarded theories necessarily carry with it the implication that these older theories were subjective ideas in men's minds, while the reality lay beside and beyond them unmingled with ideas. It always finds a standpoint from which these ideas in 220
the earlier situation are still recognized as reliable, for there are no scientific data without meanings. There could be no history of science on any other basis. No history of science goes back to ultimate elements or sense-data, or to any combination of bare data on one hand and logical elements on the other. The world of the scientist is always there as one in which reconstruction is taking place with continual shifting of problems, but as a real world within which the problems arise. The errors of the past and present appear as untenable hypotheses which could not bear the test of experiment if the experience were sufficiently enlarged and interpreted. But they are not mere errors to be thrown into the scrap heap. They become a part of a different phase of reality which a fuller history of the past records or a fuller account of the present interprets, giving them thereby their proper place in a real world.†

The completion of this program, however, awaits the solution of the scientific

*Mead has the Greek "($\pi o \upsilon\ \sigma \tau \omega$)", which is a bit of the quote from Archimedes: *Give me a place to stand, and I can move the world*.

†In other words, science assumes that every error is *ex post facto* explicable as a function of the real conditions under which it really arose. Hence, "consciousness," set over against Reality, was not its condition.

problem of the relation of the psychical and the physical with the attendant problem of the meaning of the so-called origin of consciousness in the history of the world. My own feeling is that these problems must be attacked from the standpoint of the social nature of so-called consciousness. The clear indications of this I find in the reference of our logical constants to the structure of thought as a means of communication, in the explanation of errors in the history of sci- 221
ence by their social determination, and in the interpretation of the inner field of experience as the importation of social intercourse into the conscious conduct of the individual. But whatever may be the solution of these problems, it must carry with it such a treatment of the experience of the individual that the latter will never be regarded merely as a subjective state, however inadequate it may have proved itself as a scientific hypothesis. This seems to me to be involved in the conception of psychology as a natural science and in any legitimate carrying out of the Hegelian program of giving reality and creative import to individual experience. The experience of the individual in its exceptional character is the growing-point of science, first of all in the recognition of data upon which the older theories break, and second in the hypothesis which arises in the individual and is tested by the experiment which reconstructs the world. A scientific history and a scientific psychology from which epistemology has been banished must place these observations and hypotheses together with erroneous conceptions and mistaken observations *within* the real world in such a fashion that their reference to the experience of the individual and to the world to which he belongs will be comprehensible. As I have indicated, the scientific theory of the physical and conscious individual in the world implied in this problem has still to be adequately developed. But there is implied in the conception of such a theory such a location of the process of thought in the process of reality as will 222
give it an import both in the meaning of things and in the individual's thinking. We have the beginning of such a doctrine in the conception of a functional value of consciousness in the conduct of living forms, and the development of reflective thought out of such a consciousness which puts it within the act and gives it the function of preparation where adjustment is necessary. Such a process creates the situation with reference to which the form acts. In all adjustment or adaptation the result is that the form which is adjusted finds that by its adjustment it has created an environment. The ancients by their formulation of the Ptolemaic theory committed themselves to the world in which the fixed values of the heavenly over against the earthly obtained. Such a world was the interpretation of the experience involved in their physical and social attitudes. They

could not accept the hypothesis of Aristarchus because it conflicted with the world which they had created, with the values which were determining values for them. The same was true of the hypothesis of Democritus. They could not, as they conceived the physical world, accept its purely quantitative character. The conception of a disinterested truth which we have cherished since the Middle Ages is itself a value that has a social basis as really as had the dogma of the church. The earliest statement of it was perhaps that of Francis Bacon. Freeing investigation from the church dogma and its attendant logic meant to him the freedom to find in nature what men needed and could use for the amelioration of their social and physical condition. The full implication of the doctrine has been recognized as that of freedom, freedom to effect not only values already 223
recognized, but freedom to attain as well such complete acquaintance with nature that new and unrecognized uses would be at our disposal; that is, that progress should be one toward any possible use to which increased knowledge might lead. The cult of increasing knowledge, of continually reconstructing the world, took the place both of the ancient conception of adequately organizing the world as presented in thought, and of the medieval conception of a systematic formulation on the basis of the statement in church dogma of social values. This modern conception proceeds from the standpoint not of formulating values, but giving society at the moment the largest possible number of alternatives of conduct, i.e., undertaking to fix from moment to moment the widest possible field of conduct. The purposes of conduct are to be determined in the presence of a field of alternative possibilities of action. The ends of conduct are not to be determined in advance, but in view of the interests that fuller knowledge of conditions awaken. So there appears a conception of determining the field that shall be quite independent of given values. A real world which consists not of an unchanged universe, but of a universe which may be continually readjusted according to the problems arising in the consciousness of the individuals within society. The seemingly fixed character of such a world is found in the generally fixed conditions which underlie the type of problems which we find. We determine the important conditions incident to the working out of the great problems which face us. Our conception of a given universe is formed in the 224
effort to mobilize all the material about us in relation to these problems—the structure of the self, the structure of matter, the physical process of life, the laws of change and the interrelation of changes. With reference to these problems certain conditions appear fixed and become the statement of the world by which we must determine by experimental test the viability of our hypotheses.

There arises then the conception of a world which is unquestioned over against any particular problem. While our science continually changes that world, at least it must be always realized as there. On the other hand, these conceptions are after all relative to the ends of social conduct which may be formulated in the presence of any freedom of action.

We postulate freedom of action as the condition of formulating the ends toward which our conduct shall be directed. Ancient thought assured itself of its ends of conduct and allowed these to determine the world which tested its hypothesis. We insist such ends may not be formulated until we know the field of possible action. The formulation of the ends is essentially a social undertaking and seems to follow the statement of the field of possible conduct, while in fact the statement of the possible field of conduct is actually dependent on the push toward action. A moving end which is continually reconstructing itself follows upon the continually enlarging field of opportunities of conduct.

The conception of a world of existence, then, is the result of the determination 225
at the moment of the conditions of the solution of the given problems. These problems constitute the conditions of conduct, and the ends of conduct can only be determined as we realize the possibilities which changing conditions carry with them. Our world of reality thus becomes independent of any special ends or purposes and we reach an entirely disinterested knowledge. And yet the value and import of this knowledge is found in our conduct and in our continually changing conditions. Knowledge for its own sake is the slogan of freedom, for it alone makes possible the continual reconstruction and enlargement of the ends of conduct.

The individual in his experiences is continually creating a world which becomes real through his discovery. In so far as new conduct arises under the conditions made possible by his experience and his hypothesis the world, which may be made the test of reality, has been modified and enlarged.

I have endeavored to present the world which is an implication of the scientific method of discovery with entire abstraction from any epistemological or metaphysical presuppositions or complications. Scientific method is indifferent to a world of things-in-themselves, or to the previous condition of philosophic servitude of those to whom its teachings are addressed. It is a method not of knowing the unchangeable but of determining the form of the world within which we live as it changes from moment to moment. It undertakes to tell us what we may expect to happen when we act in such or such a fashion. It has become a matter

of serious consideration for a philosophy which is interested in a world of things- 226
in-themselves, and the epistemological problem. For the cherished structures of the metaphysical world, having ceased to house the values of mankind, provide good working materials in the hypothetical structures of science, on condition of surrendering their metaphysical reality; and the epistemological problem, having seemingly died of inanition, has been found to be at bottom a problem of method or logic. My attempt has been to present what seems to me to be two capital instances of these transformations. Science always has a world of reality by which to test its hypotheses, but this world is not a world independent of scientific experience, but the immediate world surrounding us within which we must act. Our next action may find these conditions seriously changed, and then science will formulate this world so that in view of this problem we may logically construct our next plan of action. The plan of action should be made self-consistent and universal in its form, not that we may thus approach nearer to a self-consistent and universal reality which is independent of our conduct, but because our plan of action needs to be intelligent and generally applicable. Again science advances by the experiences of individuals, experiences which are different from the world in which they have arisen and which refer to a world which is not yet in existence, so far as scientific experience is concerned. But this relation to the old and new is not that of a subjective world to an objective universe, but is a process of logical reconstruction by which out of exceptions the new law arises to replace a structure that has become inadequate. 227

In both of these processes, that of determining the structure of experience which will test by experiment the legitimacy of the new hypothesis, and that of formulating the problem and the hypothesis for its solution, the individual functions in his full particularity, and yet in organic relationship with the society that is responsible for him. It is the import for scientific method of this relationship that promises most for the interpretation of the philosophic problems involved.