COSMIC EVOLUTION

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COSMIC EVOLUTION

OUTLINES OF COSMIC IDEALISM

BY

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TO MY FRIENDS OF THE ARISTOTELIAN SOCIETY IN WHOSE SYMPATHETIC AND STIMULATING ENVIRONMENT THIS VOLUME WAS CONCEIVED

PREFACE

THE time has come for a synthesis of the scattered elements of the new story of creation into an imaginative whole. The data have accumulated with tremendous rapidity in the last generation. But the philosophic interpretation of the data into a world-view, on the one hand consistent with the facts revealed by science and, on the other, giving a significant place to the highest aspirations of the human soul, remains halting and inadequate. There can be no doubt that the general drift of modern science has been toward materialism, in spite of the avowals of well-meaning popularizers of science to the contrary. It is necessary to separate the results of science from a materialistic metaphysics which has been falsely confused with science. To see the true significance of evolution requires both a painstaking survey of the facts as we know them, including the facts of our spiritual as well as our sensuous experience, and a weaving of the many-coloured strands into a harmonious web in the spirit of "natural piety." When this is done, it may be found that what is fundamental in the insight of ages past appears as the golden thread in the new woof.

The philosophic attitude of this book (as well as my previous volumes—*Time and Reality,* 1904; *Truth and Reality,* 1911; *A Realistic Universe,* 1916)—may be characterized as *empirical realism* and *cosmic idealism.*

I have the precedent of Immanuel Kant for using two titles in describing my philosophy. Kant in his *Critique of Pure Reason* characterizes his philosophy as empirical realism and critical idealism. Unfortunately critical idealism proved incompatible with empirical realism, and the latter was submerged in the speculative movement which followed Kant. It is rather to British thought that we must look for the continuous empirical tradition; and of this tradition I should like to regard myself as a part. In my philosophy, empirical realism indicates the method and cosmic idealism the conclusion. Empirical realism emphasizes my purpose to save the appearances, to use a phrase of Plato's. Cosmic idealism is an attempt at a synthesis of the various aspects of reality as creatively revealed in human experience. Such a synthesis must mean not merely a descriptive survey of these aspects in the manner of the sciences, but an evaluation of them into a hierarchical system, which shall show their relative claims. Some aspects overlap; and while they cannot be said to be more real than other aspects, they are worth more for the comprehensive understanding of reality. How far I have been successful, my philosophy itself must show. At best, in so stupendous an undertaking, our efforts must prove provisional. The task of interpreting reality is infinite and relative to the creative advance of human thought. In the immortal language of a recent philosopher, "What is great in man is that he is a bridge and not a goal." I should be glad to be a bridge. The new story of creation is a "research magnificent," requiring the co-operation of countless workers for ages. Only the mere outline is now discernible and even this is subject to change.

The structure of this book may be compared to the structure of a symphony. The work starts with a prelude, an introductory chapter on "Cosmic Evolution," which states the main argument in somewhat general terms with a somewhat imaginative appeal to human interest, so as to beguile the reader to go on. The body of the work consists of three parts or movements which repeat with variations the same theme, that of cosmic interaction. In the first part, the theme is stated in terms of the general theory of evolution, the story of our earth in its setting in the cosmos; in the second part, the theme is stated in terms of human nature and its evolutionary levels; in the third part, the theme is stated in terms of the theory of relativity and its cosmic implications. Each movement works up to the same climax and therefore has a certain completeness of its own, but all three movements belong to the total development of the theme. In my opinion the concept of mind and the concept of relativity are as critical for a true philosophy of the universe as is the concept of evolution. The work ends with a postlude or finale which sums up in a somewhat lyric way the meaning of the whole under the title "Cosmic Religion."

As is not unusual, the last chapter was written first, *i.e.*, in its original form. The germinal idea came to me as an inspiration from a talk I had with Professor T. C. Chamberlin, the famous geologist, at the Quadrangle Club of the University of Chicago, in the summer of 1919, which impressed me with the fact that everything evolves from the crust of the earth. That inspiration crystallized into a paper which I entitled "The Religion of Mother Earth," which was published in the *Hibbert Journal*, July, 1921. It had already undergone transformations which made the original title somewhat of a misnomer, and so I have rechristened it "Cosmic Religion" in this book. The subconscious reverberations of this new idea did not take on definite structure until I read Professor S. Alexander's book, *Space, Time and Deity*, in the autumn of 1920. The reading of Alexander's book proved an epoch in my life, for it made me conscious that I must undertake an interpretation of evolution which should furnish an alternative to the emergence theory so masterfully set forth by him. And so I was moved to write the paper on "Cosmic Evolution" which gives an epitome of my theory. It was written mostly before the open fire in the smoking room of the University of London Club, whose kindly privileges I enjoyed during the winter I spent in London. Here it was my privilege to discuss the progress of the paper with some of the brilliant minds of England, in the genial atmosphere of smoke and English hospitality. In March, 1921, Professor H. Wildon Carr arranged for me to present my theory on Cosmic Evolution before the Aristotelian Society of London. This gave me an opportunity to take part in an intellectual tournament with some of the greatest minds of England—minds knightly in their sense of fair play, possessed of great learning and dialectic skill but above all by love of the truth. I wish I might be able to state the argument here as convincingly as I did that night. But somehow thought can never be as real in impersonal writing as under the inspiration of the living dialectic of a great occasion. But, at any rate, I have done my best to build out the argument to meet the points raised in the discussion of that evening. The paper, "Cosmic Evolution," was published in the Proceedings of the Aristotelian Society, 1920-'21, and is incorporated as Chapter I of this book. I feel indebted to the Psychological Society of Cambridge and the Philosophical Society of Oxford for inviting me to read before them the paper on "Sensation, Imagination and Consciousness"—afterwards published in the *Psychological Review,* November 1921, and largely embodied in Chapter IV of this book. Each society gave me a searching and stimulating evening of discussion.

Perhaps I may add a suggestion to the general reader who is not a student of philosophy. If he does not have the time and patience to read the entire book, the first three and the last chapters will give a general idea of the author's interpretation of evolution and do not assume more preparation than the cultured reader in our age would possess. For the reading of Part II an elementary knowledge of physiology and psychology is desirable. Chapter VI, "Theories of Relativity," is of general interest at present. The interpretation of relativity has perhaps cost me as much labour as the rest of the book. I have made the subject as clear as I could make it without mathematics and by means of concrete illustrations. In Chapter VIII, I have tried to bring out the cosmic implications of relativity. Chapter VII has to do with the philosophic bearings of relativity and will probably be of interest chiefly to students of philosophy. Those who are afraid of anything written by a philosopher might start with the last chapter. The book is so constructed that every part, chapter, and section has a unity of its own; and the headings in the table of contents may serve to guide the reader to his interest. But the reader who wants to understand the world-view expressed in the book should read the book as a whole. If he has the persistence to travel the whole distance, even the more arid parts, he may come upon an oasis of refreshment here and there to reward him for his toil. To students of philosophy I need not explain that this book, in their terminology, is a treatise on Cosmology and that it links up with the last chapter of *A Realistic Universe*, which is a treatise on Metaphysics. The sequence of *Truth and Reality*, *A Realistic Universe*, and *Cosmic Evolution* may be used as a general survey of the problems of philosophy. To these I hope to add before long a study in the philosophy of religion.

I wish to thank the *Hibbert Journal*, The Aristotelian Socity, and the *Psychological Review* for allowing me to use the articles printed by them, as indicated above. I also wish to thank my colleagues, Professor W. M. Patton and Professor C. H. Gingrich, for reading the proof and for many suggestions. And finally I wish to thank my students of all the years for their perpetual faith and kindly encouragement.

Northfield, Minnesota, U. S. A.
September 1, 1925.

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INTERACTION AND COSMIC EVOLUTION

CHAPTER I

COSMIC EVOLUTION

Introductory Survey

The Problem

There is a fascination about creating a world from the beginning. So we shall always have our cosmogonies. But the temptation is, not only in philosophy and religion but also in science, to adopt the geocentric point of view. We are prone to treat the evolution of our earth as an independent drama. Science finds it convenient to proceed from the simple to the more complex. This, no doubt, has its justification as a device of method. Science deals with sequences and the predictions based on their recurrence. It cannot explain why one event follows another. This is the province of philosophy or religion, not of science. Science ascertains that life appears on the earth under certain conditions. It should not say, though it is prone to say, that the previous events or conditions gave rise to life or created life. It should, however, aim at a complete inventory of the conditions.

It was observed long ago by Heraclitus that there must be an upward and a downward path in the movement of reality. Science sees only the downward path. It starts with the unequal distribution of energy, and observes that motion is produced by energy flowing from a higher level to a lower level. Its characteristic law is the law of degradation of energy. Everything tends towards the level of unavailable intra-molecular vibration or dispersed heat. The universe of science is on the road to bankruptcy. What is more, if the universe is thus a running-down concern, be the loss of energy ever so small in each transaction, so long as it is a finite quantity, the universe must have gone dead ages ago. But somehow the universe seems to be a going concern, and this should give us pause. It would seem, at any rate, that in the cosmos as a whole there is perpetual motion.

Science misses the significance of this fact because of its bias. It selects certain aspects that suit its convenience. It is interested in description and prediction, and therefore emphasizes the quantitative and measurable aspects. Hence its partiality for the lower grades of existence, in short, for the inorganic, and its attempt to reduce everything else to physical and mechanical terms. It fails to see the significance of the aspects it selects within the life of the whole, and therefore lands in absurdity. It deals with the past, with the stream of reality as it congeals into habits and structures and their uniformities. The onward sweep, the creative passing of nature, escapes it (or at most receives consideration only so far as it can be stated in quantitative symbols). It is absorbed in particulars and so misses the concrete flow of the real world. Yet to understand the downward path we must understand the upward path, to understand the part we must understand its interactions within the whole.

Because of the bias of science and of its geocentric point of view, it is under the necessity of accounting for the higher levels, such as life and intelligence, as having been produced by the preceding stages. Thus we have to account for life in terms of the lifeless and intelligence in terms of the unintelligent. Chance becomes the absolute arbiter of evolution. But this makes it impossible to account for order and meaning in the world.

In order that we may discover system in the facts of perception, there must be the basis of system in the facts themselves, as well as in the mind which selects and constructs. The mind itself, moreover, is not a thing apart in the cosmos, but is itself the product of cosmic evolution. The demand for system in it cannot be alien to the cosmos. Now the characteristics which are necessary for any system whatsoever are diversity, recurrence, and order. Unless there is diversity in our material we shall have no basis for constructing systems, for there will be nothing to systematize. Further, unless our diverse facts or variables recur, *i.e.*, unless they have such a constancy or generality as enables us to identify them again and deal with them as the same for the purpose in question, whether it be a mathematical problem or a chemical analysis, we obviously cannot have system. In a world where nothing recurs, we can say nothing about it, for there remains neither any mind to say anything nor any object to say anything about. Finally, there must be an implied order in the facts with which we deal. Else we shall never discover order. And it is the business of science to discover order, not to impose an arbitrary order. If you hold that order for science is merely a matter of convenience, then we should reply that, in a world without order, one way of reading the facts could be no more convenient than another, for in such a world there could be no basis for the prediction of events. The events of the scientist's mind would be equally crazy with the outer events and no agreement would be possible. We must, then, presuppose order in the cosmos, if we are going to have science. Is it possible that this order itself is the product of chance?

Science and Teleology

Science is becoming gradually aware that we cannot account for the order even in physical nature on the basis of mere chance. The investigations of Professor Henderson lead him to the conclusion that there is "revealed an order or pattern in the properties of the elements." [1] This order, to be sure, is "hidden, when one considers the properties of matter abstractly and statically, for it is recognizable and intelligible *only* through its effects. It becomes evident only when time is taken into consideration. It has a dynamical significance and relates to evolution." [2] It is an order, moreover, that we discover in nature. It

[1] *The Order of Nature,* Lawrence J. Henderson, p. 184.
[2] *Ibid.,* pp. 184, 185.

is no more subjective than the periodic law of elements. But it is a dynamic order, and has significance only in a moving equilibrium such as nature is. It is in the relation of inorganic evolution to organic evolution that this significance becomes especially clear. Henderson comes to the conclusion that the complicated set of conditions necessary for the existence of life imply such an orderly selection: "There is, in truth, not one chance in countless millions that the many unique properties of carbon, hydrogen, and oxygen, and especially of their stable compounds, water and carbonic acid, which chiefly make up the atmosphere of a new planet, should simultaneously occur in the three elements otherwise than through the operation of a natural law which somehow connects them together. There is no greater probability that these unique properties should be without due (*i.e.*, relevant) cause uniquely favourable to the organic mechanism. These are no mere accidents; an explanation is to seek. It must be admitted, however, that no explanation is at hand." [3] And no explanation is possible so long as we look upon geological evolution as an isolated affair. But more of this later. The probability of order can at any rate be statistically established. "We can, on no account, unless we are to abandon the principle of probability which is the basis of every scientific induction, deny this connection, in character an adaptation, between the diversities of matter and the diversity of evolution. . . . Other things being equal, there is a maximum 'freedom' for such evolution on account of a certain unique arrangement of unique properties of matter. The chance that this unique ensemble of properties should occur by 'accident' is almost infinitely small (*i.e.*, less than any probability which can be practically considered). The chance that each of the unit properties of the ensemble by itself and in co-operation with the others, should accidentally contribute to this 'freedom' a maximum increment is also infinitely small. Therefore there is a relevant causal connection between

[3] *The Fitness of the Environment*, Lawrence J. Henderson, p. 276.

the properties of the elements and the 'freedom' of evolution."[4] By "freedom" is meant freedom of trial and error experimentation with a chance of "considerable success."

Following the lead of Willard Gibbs, Henderson endeavours to bring his argument to a focus by laying down certain postulates. One has to do with the conservation of properties. "The properties of elements are to be regarded as fully determined from the earliest conceivable epoch and perfectly changeless in time."[5] This postulate does not rest merely on *a priori* reasoning, but on experimental evidence. Spectral analysis identifies the presence of the same elements with the same properties in other parts of the cosmos, and that seems to hold irrespective of the age and temperature of the celestial bodies. We know also that meteoric iron has the same specific gravity and properties as terrestrial.[6] In the absence of evidence to the contrary, we may then regard the properties of elements as constant. Again, the characteristics of systems may be treated as independent of the properties of any particular energy complex. We may then lay it down as a postulate that "the abstract characteristics of systems must also be fully determined and absolutely changeless in time."[7] The separation of the characteristics of systems from the matrix of properties and conditions has, of course, its statistical convenience. But we must not forget that we are dealing here with a logical abstraction. The human mind is itself an energy system among energy systems. It is part of the cosmos. Because it possesses the characteristics of system, it can discover system in the objective world. But it can do so only because the objective world itself possesses the characteristics of system, *i.e.*, because there is the necessary diversity, recurrence and order in its events. The fitness of the properties and elements for system can, therefore, not be an accident as it is in the Kantian philosophy where the mind is treated

[4] *The Order of Nature,* pp. 190, 191.
[5] *Ibid.,* p. 201.
[6] Faraday Lecture by Professor Richards, 1911.
[7] *The Order of Nature,* p. 202.

as a thing apart. Henderson states the fitness of the facts for system in the following proposition: "The relation between the numerous properties of hydrogen, carbon, and oxygen severally and in co-operation (relatively to the same relation between the properties of all the other elements), and the necessary conditions of existence in respect of number, diversity, and durability, as these conditions are defined by Willard Gibbs is not merely contingent."[8]

What is of interest to us is that inorganic nature is such that it makes possible the discovery of systems in its behaviour; that, moreover, this order is forward-looking or an adaptation to the appearance and development of life. Henderson's statistical evidence points to the conclusion that the fulfillment of the conditions for life—involving, as they do, the establishing of the proper quantitative proportions, the concentration and availability of certain necessary elements such as carbon, hydrogen, and oxygen, and their compounds water and carbonic acid, with the ensemble of characteristics and conditions necessary for the existence and development of life—is so complicated that it is infinitely improbable that it should have happened by chance. "Hence we are obliged to regard this collocation of properties as in some intelligible sense a preparation for the processes of planetary evolution,"[9] and "as possessing a teleological character." Further than this Henderson does not go. He does not show why the processes on our earth should have a teleological character, and no such explanation is possible so long as we limit our attention to our earth and its conditions.

If we now pass from the inorganic to the organic level of existence we find the same problem, only more complicated. No one has faced the problem with greater candour than Professor Osborn. While Osborn adopts the physicochemical theory of life, he does so without committing himself to materialism. "Without being either a *mechanist* or *materialist,* one may hold the opinion that life is a

[8] *Ibid.,* p. 202.
[9] *Ibid.,* pp. 191, 192.

continuation of the evolutionary process rather than an exception to the rest of the cosmos, because both mechanism and materialism are words borrowed from other sources which do not in the least convey the impression which the activities of the cosmos make upon us. This impression is that of limitless and ordered energy." [10] The evolution of life upon our planet must be regarded as a distinctly new step in the process of development. "As compared with stellar evolution, *living matter does not follow the old evolutionary order,* but represents a new assemblage of energies and new types of action, reaction, and interaction —to use the terms of thermodynamics—between the chemical elements which may be as old as the cosmos itself, unless they prove to represent an evolution from still simpler elements. The evolutionary process now takes an entirely new and different direction . . . essentially constructive. . . . It is a continuous creation or creative evolution." [11] But how is such a creative step, with the series of creative steps to follow, possible? It is not impossible that some new element may be discovered in life compounds. But it is more probable "that unknown principles of action, reaction, and interaction" between living forms await such discovery. The difference between the lowliest organisms and inorganic compounds does not seem to him so vast but that we may discover the bridge— "namely, whether it is solely physico-chemical in its energies, or whether it includes a *plus* energy or element which may have distinguished life from the beginning." [12] But in any case "there is positive disproof of an internal perfecting principle or entelechy which would impel animals to evolve in a given direction, regardless of the direct, reversed, or alternating directions taken by the organism in seeking its life environment or physical environment. . . . The conclusive evidence against an *élan vital* or internal perfecting tendency, however, is that these

[10] *The Origin and Evolution of Life,* Henry Fairfield Osborn, p. 3
[11] *Ibid.,* pp. 4, 5.
[12] *Ibid.,* p. 281.

characters do not spring autonomously at any one time; they may be dormant or rudimentary for great periods of time. . . . They require something to call them forth, to make them *active* so to speak."[13] This arousing of a latent new character may be effected through chemical messengers "by stimulating the transformation of energy at a specific point."

As regards the arising of new forms, Osborn rejects emphatically the doctrine of chance which, since Darwin, has been fashionable with writers on evolution. "I have long maintained that this opinion is a biological dogma . . . which has gained credence through constant reiteration, for I do not think that it has ever been demonstrated through the actual observation of any evolutionary series." As a matter of fact, the series of life forms on the earth has not been such as we should expect on the basis of chance. The existence of law in the evolution of life is no longer a matter of opinion but of direct observation. So far as law is concerned, we observe that the evolution of life forms is like that of the stars; their origin and evolution as revealed through palæontology go to prove that Aristotle was essentially right when he said that "nature produces those things which, being continuously moved by a certain principle contained in themselves, arrive at a certain end."[14] This end is no "supernatural or teleological interposition through an externally creative power." It is a law immanent in the process itself. But it does not seem as though a law immanent in the process, such as Osborn postulates, could account for the process taking on new form and character. On the basis of an immanent law it would seem rather that the

[13] *Ibid.*, p. 279

[14] *Ibid*, p 9. Osborn has ample support for his theory of immanence in Aristotle's biological treatises and also in the Metaphysics, especially when Aristotle is concerned with the criticism of the transcendence of the Platonic Ideas. See T. Gomperz, *Greek Thinkers,* Eng tr., vol. iv, pp. 82, 132 But in Aristotle's theology Plato's transcendentalism asserts itself in the "Unmoved Mover," the God above the world of change See Met, Bk. XII, W D. Ross's scholarly edition and translation. We shall return to Aristotle's philosophy of evolution in Chapter III.

process should remain eternally what it is. But this is just what it does not seem to do if we take account of geological evolution alone. Only the whole is self-sustaining, self-contriving, and moves by its own law. Each part moves as it does by virtue of the actions, reactions, and interactions of the part within the whole.

We may analyze the fundamental law of life into four factors: "In each organism the phenomena of life represent the action, reaction, and interaction of four complexes of physico-chemical energy, namely, those of (1) the inorganic environment, (2) the developing organism (protoplasm and body-chromatin), (3) the germ or heredity chromatin, (4) the life environment. Upon the resultant actions, reactions, and interactions of potential and kinetic energy in each organism, selection is constantly operating wherever there is competition with the corresponding actions, reactions, and interactions of other organisms."[15] The Darwinian principle of natural selection is thus given a subordinate, though a real, place. Since the beginning of life there has been competition of organisms with other organisms as well as the survival selection of the inorganic environment. But "selection is not a form of energy nor a part of the energy complex; it is an arbiter between different complexes and forms of energy; it antedates the origin of life as remarked by Henderson."[16] To quote but one illustration of the inadequacy of natural selection as an explanatory principle: "The general fact that the slow-breeding elephants evolved very much more rapidly than the frequently breeding rodents, such as the mice and rats (Muridæ) is one of the many evidences that the rate of evolution may not be governed by the frequency of natural selection and elimination."[17] Neither the origin nor the development of life can be accounted for by this principle. Moreover, many species have disappeared, so far as we can see, without the interference of natural selec-

[15] *Ibid*, p. 21.
[16] *Ibid.*, p. 20.
[17] *Ibid.*, p. 271.

tion—by some internal rhythm which we do not understand. Special emphasis is laid on the continuity and guiding influence of the heredity chromatin. But while it is supposed to be the presiding genius of all phases of development, we are ignorant as to how it accomplishes this. "We are equally ignorant as to how the chromatin responds to the actions, reactions, and interactions of the body cells, of the life environment, and of the physical environment, so as to call forth a new and adaptive character, unless it be through some infinitely complex system of chemical messengers and other catalytic agencies." [18] Surely a large bill of ignorance, which hardly justifies all the superlatives with which biologists invest it. In some way it is evidently subject to modification. Osborn suggests that as there is a centrifugal action whereby certain cells of the reproductive glands affect, in an important way, all the body cells, including the brain centre of intelligence, so it is likely that there is a "centripetal action whereby chemical messengers from any part of the body specifically affect the heredity germ and thus the new generation to which it will give rise." The heredity germ is not entirely indifferent to the external environment. "Taking the whole history of vertebrate life from the beginning, we observe that every prolonged old adaptive phase in a similar habitat becomes impressed in the heredity characters of the chromatin. Throughout the development the chromatin always retains, more or less, potentiality of repeating the embryonic, immature, and more rarely some of the mature structures of older adaptive phases in the older environments. This is the law of ancestral repetition." [19]

If the causes of evolution are obscure, the sequences are becoming increasingly clear. "What we have gained during the past century is positive knowledge of the chief modes of evolution; we know almost the entire history of the transformation of many different kinds of mammals. These modes, as distinguished from unknown *causes*, are

[18] *Ibid.*, p. 98
[19] *Ibid.*, p. 152.

expressed in the following laws: first, the *law of continuity; natura non fecit saltum,* there is prevailing continuity in the change of form and proportion in evolution as in growth."[20] Perrin Smith, in the case of the cephalopod molluscs and the Triassic ammonites, "observes that the evolution of form continues uninterruptedly, even when there is no evidence whatever of environmental change. Conversely environmental change does not necessarily induce evolution—for example, during the Age of Mammals, although the mammals developed an infinite variety of widely different forms, the reptiles show very little change."[21] This graduated character of change in the evolution of life was clearly expressed in the mutations of Waagen, who discovered a complete fossil series of ammonites in 1869, and formulated Waagen's law. "It is that certain new characters arise definitely and continuously and, as Osborn has shown, adaptively."[22] Osborn does not forget the fact of mutations in the more recent sense, but he feels that they play a minor role, accounting for no more than one-fifth of the variations in mammal evolution. Biologists may object to such a stepmotherly treatment of a current hypothesis. Perhaps it cannot be brushed aside so lightly. But the difference may not be so great as appears. The concept of mutations is not without its ambiguity, since any variation which persists in heredity is called a mutation. It becomes, therefore, to a considerable extent a matter of definition. This we must leave to those concerned. One thing is certain, viz., that in many processes we observe a graded and orderly sequence leading towards a specific end. As Bergson has so well pointed out, the mere fact that variations come in sudden leaps would, no more than small variations, account for the adaptation of such a complicated organ as the eye for seeing. It would rather increase than lessen the difficulty. If we must reject an innate *élan vital,* we must

[20] *Ibid.,* p. 251.
[21] *Ibid.,* p. 251.
[22] *Ibid.,* p. 139.

seek the clue for such adaptation in cosmic interaction. We can agree at least that if there had been no light there would have been no eyes. This is no accidental correspondence. We must rather suppose that it is due to the organizing presence of light patterns that the organism was led to contrive eyes. This has been, moreover, a trial and error process, upon the successes and failures of which natural selection has acted.

This leads us to the second law, "the *law of rectigradation,* under which many important new characters appear definitely, and take an adaptive direction from the start." [23] Thus we "observe in the characters springing from the heredity chromatin a *predetermination* of another kind, namely, the origin through causes we do not understand of a tendency toward an independent appearance or birth at different periods of geologic time of similar new and useful characters," not in the ancestral body forms.[24] The discovery of this law, with which Osborn's name is especially associated, is the strongest argument for order in evolution as opposed to blind chance. "The third law is the *law of acceleration and retardation,* witnessed both in racial and individual development, whereby each character has its own velocity, or rate of development, which displays itself both in the time of its origin, in its rate of evolution, and its rate of individual development." [25] The last law underlies the profound changes of proportion as illustrated in mammals, for example the long neck of the giraffe and the short neck of the elephant. Few new characters are observed to originate in mammals. The changes are due for the most part to loss of characters and changes in proportion. This individuality of characters, their separate rate of movement, and their co-ordination, furnish to-day the bulk of descriptive explanation of life forms and functions. Their evolution exemplifies the law of compensation. The special development of one character means the

[23] *Ibid.,* pp. 251, 252.
[24] *Ibid.,* pp. 251, 252.
[25] *Ibid.,* p. 252.

sacrifice of others, as in the case of the extra toes of the horse. The sacrificed parts are never regained, and in this sense chromatin evolution is irreversible. Reversal of adaptation must be regarded as "the reversal of function rather than of structure." [26]

Cosmic Levels and Interaction.

Such are some of the problems of evolution. But *how* shall we account for the appearance of life as a new synthesis of energies, for the appearance of new characters, new species and individuals in the life process, and for the order and adaptiveness of the evolutionary series? [27] No doubt the biologist must fix his mind on Osborn's four causes, viz., the inorganic environment, the developing organism (protoplasm and body chromatin), the germ or heredity chromatin, and the life environment, with their action, reaction, and interaction. But these obviously do not account for the adaptiveness of the physical level for the emergence of life, nor for the origin of the organic level of energy with its new and unique ensemble of properties, nor for the emergence of new properties and their adaptive order and organization in the evolutionary series. If you assume that these characters are stimulated by chemical messengers, you must still account for the origin and order of properties and show how chemical messengers are stimulated and controlled. The scientist may be satisfied to trace the sequences and their apparent conditions; but the philosopher cannot stop here. He must furnish a *rationale* of the process as a whole; and this the one-way series of the earth's evolution cannot furnish by itself. I

[26] *Ibid.*, p. 198.

[27] The discontinuous character of the evolutionary series has impressed me for many years, in fact ever since I began philosophizing. In an article in the *Psychol Rev.*, 1906, entitled "Mind as Instinct" (reprinted in *Truth and Reality*, 1911, as Chapter II), I pointed out the discontinuous stages in human development; in Chapter III, "Categories of Intelligence," in the same book, I dealt with levels of intelligence; in *A Realistic Universe*, 1916, Chapters III and XVII, I emphasized the hierarchy of energy systems with their unique characteristics, and suggested that there must be levels in the cosmos to account for the levels of evolution.

do not see any reason for assuming that the inorganic environment has any special wisdom for guiding and controlling the evolutionary process. We must take account also of cosmic interaction and control. The interaction with the sun is important, but it is not sufficient. I would rather be a sun-worshipper than a materialist. But solar energy cannot communicate what the sun does not possess.

It is evident, at any rate, that the evolutionary process implies factors which are not indigenous to our earth taken in isolation, or even as a storehouse of solar energy. To say that the new factors are due to creative evolution is merely another way of stating that they appear in a certain sequence on our earth. It does not explain why they appear. Nor are we greatly aided by the suggestion of Arrhenius that the simplest forms of life are carried by dust particles and sown into interstellar space, to be picked up somehow by moving masses. Apart from the difficulties involved in such an hypothesis, it could not explain why a planet should evolve so as to be prepared for life; nor could it explain the evolution of new characters and forms. The step from the spores to the cell seems as insurmountable as the step from the inorganic to the spore. And how should we account for the appearance of new characters and their adaptive order? They must be wise spores to account for all this. Is it not more reasonable to assume that life-giving patterns from the cosmic continuum shape themselves a body even as light patterns shape themselves an eye?

If the gulf from the inorganic to the organic is insuperable on the basis of mechanism and chance, so is the gulf from the organic to the mental. "There is no alchemy by which we may get golden conduct out of leaden instincts (so Herbert Spencer told us very truly)." [28] So there is no alchemy by means of which we can compound automatic reflexes into selective thought. It is false to oppose thought to conation. Thought is but the will-to-know. And thought can know the order implied in itself and the

[28] *The Idea of Progress*, W. R. Inge, p. 33.

universe only by a trial and error process until it gradually finds the successful method. This is as true in the realms of the good and the beautiful as in the realm of the true. For true means true for an interest which seeks fulfilment, and the final interest is to live and to live more abundantly. Thought must thus be understood as an energy system, selecting, rejecting, co-ordinating and integrating the energy characters communicated to it. Its function is a double one—that of discovering the order of the energy patterns with which it deals, and that of communicating its energy pattern to a special part of the matter of its environment. It thus recreates or reconstructs its world and gives rise to science, morality, art, and religion, according to the aspect emphasized: science as the product of the will to know, morality as the objectification of the desire to live harmoniously in social relations, beauty as the desire for disinterested enjoyment, and religion as the desire for personal communion with the universe. But thought cannot be understood as isolated and cut off from the rest of the universe. It can arise only in the interactions of social relations. It presupposes an intersubjective continuum. Just as the organism has been evolved so as to respond to the physical continua of light, heat, chemical change, and material impact, so it has been differentiated for the purpose of mental interaction—the response to other subjects or personalities. Only so could we become aware of other minds. If we say with McDougall [29] that we respond sympathetically because of various modifications or inlets of our instincts, this only pushes the problem further back into the history of the race. Just as the eye has been created in response to light, so these inlets have been created in response to the mental continuum. Neither has happened by a series of accidents, but as a result of an adaptive growth in response to the requirements of the universe. In this social interaction we find that fruitful contacts are established when a higher level of culture comes into touch with a

[29] *An Introduction to Social Psychology*, 1915, pp. 93, 94.

lower level of culture, given, of course, the creative response of mind. So the possibility of thought at all and the progress of thought are possible because of the flow from a higher level of organization in the cosmos to a lower level. For in the last analysis thought is part of the cosmic order communicated to our organism when it is prepared, and increasingly as it becomes further prepared. The limit for us of perfect order, perfect system, is the dawning consciousness of the order and system which prevail in the universe and strive for *rapport* with us.

Modern philosophy has been inclined to follow the lead of science and to regard the universe as a one-way series proceeding from the simple to the more complex. The aspect which philosophers have selected as the ultimate stuff of things varies, but the difficulty is fundamentally the same. They may start with material atoms or electrons and their chance combinations. They may go further back and start with a homogeneous fluid stiffened into vortex rings by introducing motion. They may even try to compound the world out of neutral stuff by means of velocity. They may presuppose nothing but the geometrical concept of space-time and its growing complexities of transformation. We have here no interest in the details of such attempts nor in their logical consistency. In every case we have the same difficulty, namely, that of showing why such combinations should yield anything but the facts with which we started; why matter should yield anything but matter, space-time anything but space-time. To say that the higher levels of existence emerge from the simpler levels is to beg the question. How could they emerge from them? How can any process lift itself by its bootstraps? We are really asked to believe in a series of miracles which have no intelligible basis in what is supposed to precede.

It is probable, however, that the constitution of the universe may be pluralistic, that our cosmic continuum may be a complex of many levels, that the higher stages or levels, with their characteristics and order, are not created by the earlier ones, even though they may succeed them in our geological series, but are due to a give and take process in the universe, higher levels being due to higher levels elsewhere. Thus life may not emerge merely from inorganic elements and their ensemble of conditions, but may imply, besides, the communication of unique energy patterns which furnish the impetus to the unique synthesis of the specific ensemble. We know that our earth cannot be regarded as an independent entity in the universe. It floats in a continuum of energies of vast complexity. It is a torpedo driven and directed by electromagnetic waves through infinite space. And as the earth's physical motion and direction is thus furnished by the continuum of which it is a part, may not its order of development be thus dictated in interaction with its unique constitution and its cumulative character of development? We have here the *plus* energy which makes upward evolution possible, which winds the cosmic clock. We know that the development of life would not be possible on the earth except for the action and storing of solar energy. We know that plants owe their symmetry of development to the action of solar rays. May it not be that the process as a whole imitates the order of the larger cosmos as the flatfish through its eyes imitates the pattern upon which it lies, not knowing what it is doing? The universe as a whole may be a system of compensating rhythms where worlds grow up and die as parts of a self-sustaining whole. The life cycles of the earth no more happen by chance than those of the individual organism which is a part of its history. It is absurd to suppose that the cosmic system as a whole emerges from chaos. In the rhythmic whole the higher levels may always be compresent with and interpenetrate the simpler levels of existence and the whole may be dominated by creative genius. Law and order on the simpler levels may be due to the directing by such universal genius communicated from part to part, ever present to create according to the unique conditions. The rôle of matter may be to furnish the storage of energy and the complexity of conditions, which are required for such creativeness.

It is absurd to deny this because of the limitation of our instruments if the facts point that way. Our instruments —our seismographs, our telephones, our Crookes' tubes, our sense-organs—are necessarily attuned to special types of impulse. Now the only instruments that could respond to life patterns are certain complexities and conditions of matter that nature furnishes, and that we have tried in vain to imitate. The only instruments that can respond to thought patterns of energy are neural systems of a certain complexity and intensity. The only instrument that can respond in the way of spiritual communion is a devout heart. In each case the impulse which makes possible a new synthesis comes from without—from the larger order of the universe. This is the element of grace, the divine gift which makes us, finites, more than we are and wiser than we know. It is this which impregnates the existing order and endows it with the hidden potentiality by means of which it can create new steps, be it the new syntheses in inorganic nature and their ordered procession to life, the adaptive series of life forms, or the new inventions in art, science, and morality. It is true that every noble thought and every holy desire comes from above. It is a cosmic inspiration for which we, through a process of infinite and painful trial and error experimentation—for cosmic ages unconscious and now partly conscious—furnish the body, the vehicle, the conditions, and at length the responsive soul. In every case the genius in nature is wiser than we with our artificial manipulations and our attempts to imitate nature, for nature has devised instruments for the selective response to light waves with their complexity; it has originated life compounds with their unique capacity for response to the universe; it has devised a complicated nervous system for the reaction to thought patterns, long before we have become conscious of the existence of such instruments. We are like ants moving on an immense sphere who, because of the limitation of their senses, might imagine that they live in flat land and construct a geometry of two dimensions. But just as an unusually wise ant might discover the discrepancy of its theory with the behaviour of the universe and infer another dimension, so we through our failure to give a reasonable account of our world must learn to discover other dimensions of the reality that lies about us, and in which we live and move and have our being. While, moreover, we are apt to notice the creative discontinuities in nature only when they become striking and wrench our habits of thought, such as the passing from one level of reality to another—from the inorganic to the organic, from habit to thought—we must remember that the creative passing of nature within each level no less requires explanation. It is just as difficult to explain how the combination of hydrogen and oxygen in the proportion H_2O can, under certain conditions, produce the unique ensemble of properties that we call water, as how certain chemical elements in a certain proportion and under certain unknown conditions can produce life. In each case we must add the genius of nature. We may be confident that the creative order which has brought us hither and which evokes our admiration and awe has its sufficient reason. If Aphrodite did rise in her full-formed beauty from the mists of the sea, it was not altogether owing to the potencies of salt water. There was also the cosmic genius of Zeus.

We may think of the universe as a sort of organism or superorganism. Now we know that the organism develops as it does, not merely through the action and reaction of its parts, but by virtue of the interaction of its parts. And by interaction we mean "what is going on between material parts which are connected with each other by other parts and cannot be analyzed at all by the two great dynamic principles alone without a knowledge of the structure which connects the interacting parts." [30] We have been concerned in the past mainly with the interact-

[30] *The Origin and Evolution of Life,* by H. F. Osborn, p. 15.

ing function of nerve impulses. But latterly we are learning that "an interacting enzyme, hormone, or other chemical messenger circulating in the blood may profoundly modify the growth of a great organism."[31] Thus "every physico-chemical action and reaction concerned in the transformation, conservation and dissipation of energy produces also, either as a direct result or as a by-product, a physico-chemical agent of interaction which permeates and affects the organism as a whole or affects only some special part."[32] In the complex economy of plants, chemical messengers, in the absence of a nervous system, furnish the sole means of interaction. But they are no less important in the animal economy as is adumbrated in the effects on growth and proportion of such ductless glands as the pituitary body and the thyroid and parathyroid glands. It is by means of these messengers that the body acts as an organic whole. What is more: "The so-called organs of internal secretion are not unique, but the bones, muscles, skin, brain, and every part of the body are furnishing internal secretions necessary to the development and proper functioning of all the other organs of the body."[33]

If we look upon the universe as an organic whole, then we must suppose that the parts not only act and react, but that they also interact. Through such interaction every part of the universe comes to participate, in so far as it is prepared to participate, in the energy patterns—the complexity, order and development—of other parts, and is thus stimulated and controlled, *i.e.*, subject to its own reaction as determined by its process of development. Since in the universe as a whole all the levels of reality may be supposed eternally to coexist, there would thus be provided the rationale for the evolution in any one part of the cosmos from a lower to a higher level of existence without introducing magic. How energy patterns are

[31] *Ibid*, p. 15.
[32] *Ibid*, p. 16.
[33] *Ibid.*, pp. 289, 290.

emitted and transmitted from part to part of the cosmos is a problem which must wait for further investigation. We are familiar with some energy patterns which are thus transmitted, such as light and radiant heat. Lately we have become acquainted with a variety of energy rays, the existence of which we had not suspected. I have maintained elsewhere that in social interaction we must assume an intermental continuum of energy, or rather that our minds are differentiations and concentrations within such a continuum. This seems the only alternative to solipsism. What, except prejudice, can there be in the way of our supposing that our earth in its actions and reactions transmits through the common continuum energy waves which correspond to its characteristic complexity of composition, form and development, such impulses finding their way to other parts of the universe, there to undergo selection and response in so far as conditions are prepared? For we must remember that not only electrical, chemical, radioactive and other inorganic energies are part of the earth's life and control; but organic, mental and even the most spiritual energies are part of its unity and life. And we have reason to believe that in its interactions with other parts of the cosmos the earth acts not only through differential impulses but as a unique whole, under one control.

I do not say that the body of matter is communicated in the form that our senses reveal. But neither is the parathyroid gland transmitted to our toes. What it does transmit is its characteristic action in the form of a secretion. We know that the violin in the hands of the skilful player transmits in its tone-quality all the qualities of the complex structure and its manipulation, the qualities of its strings, its bridge, its body (the nature of the wood and its age as well as its form), the bow, the atmospheric effects, the peculiar touch of the player, the personality of the player, the harmonies of the musical composition. All these qualities and impulses are transmitted by means of the air to the complex reagent, the expert listener, who selects and identifies the various elements—the make of the violin, the composition, the player, etc. And the expert listener can identify the various instruments and their unique contribution in symphonal orchestration. So the spectrum reveals the chemical elements with their properties and periodicity in distant stars. The electric current carries the living voice and will of the speaker over distances of hundreds of miles and communicates them in kind to the human instrument at the receiver; and this instrument is stimulated to a special type of action or inhibited in a special way. It responds to the logic as well as to the energy of the personality at the other end of the telephone, where physical, chemical, neural, and mental forms of energy with all their complexities contribute to the production of the impulse sent. If we substitute our earth for the human individual, we must suppose that it communicates, whatever be the medium, in the impulses it sends out, the whole complexity of the energies of its constitution, with its order and movement, to be received selectively and in kind by such cosmic instruments as are prepared to receive them. And so reciprocally does the earth receive the complex impulses which constitute the entire life in epitome of the vast array of celestial worlds which with our humble earth go to constitute the whole. Receives, but responds only to those energy forms for which its organization is prepared. There may be an indefinite number of higher levels to which we fail to respond for lack of proper organization—waiting for the appropriate conditions, as life and mind waited for such conditions. As mind or intelligence with us is fundamentally social, a focus of mental interactions, so there may be in the cosmos a continuum of spiritual interactions of various levels of which we are ignorant or at best catch a glimpse in the intuitions of genius, in mystical communion, in the intimations of beauty and immortality. Thus the law of mutual aid holds in the cosmic economy. Cosmic genius points the way, sets the ideal for us, pitiable creatures of a day.

There is no reason to suppose that, in the universe as a whole, all possible levels do not coexist. If our universe is a rhythmic whole, then it must exist at the top as well as at the bottom. In the system as a whole, each level is instrumental to the next level—the inorganic level to the organic, the organic to the mental, the mental to spiritual appreciation and communion. At the same time it is the higher level which communicates its order to the lower—the lower like a cosmic virgin being prepared through processes of growth which it cannot understand for the golden shower of Jupiter, the fructifying impulse of the higher level to which it responds in the fulness of time. The upward path which prevents each level from running down to dead unavailability is produced by the higher level which thus compensates for the downward trend and makes the whole a moving, living whole. The highest level of all regulates, orders, and runs up the lower levels as the artesian pressure at the top makes the water rise towards its source, or, to change the figure, as Maxwell's omniscient demon selects and sorts the unequal velocities of the molecules, atoms, electrons, so as to make energy run up instead of down. We know that the genius of living matter thus winds up the energy of inorganic matter. In an infinite time and in an infinite universe, there is no reason why all the levels should not coexist and interact, though the torch of light of the higher levels is now carried by some, now by others of the material worlds according as they are duly and truly prepared to act as its bearers, worthy and well qualified to be its incarnations, even as thought, in our human economy, is carried now by one set of cells, now by another, but thought itself is continuous. Our spectrum is too short to react upon the whole series of light waves; our human resonators are too limited to respond to but a small part of the world of tones, and so our mind is too limited to respond to but a limited part of the order of the whole with its unique ensembles of energies of all gradations. Perhaps future man, if the race does not commit suicide through blindness and fratricide, may be able to respond to harmonies that are hidden to us as we are able to respond to things undreamed of by Pithecanthropus. At any rate, we may be sure that somewhere such response exists. And the divinity of the future, of new orders of creativeness, is but the divinity eternally present, incarnating itself into new forms of matter according to a law of its own that we cannot fathom. Our little earth is but an island in the sea of being, surcharged and directed by the genius of the whole.

One thing is certain: the real unit of reality is not our earth, nor even our solar system. There was a time when the individual took himself to be the unit of human life and ruled out everything except what ministered to his limited desires. We have advanced to the point where we regard the nation as the unit of human life, but still show a barbarous indifference, if not murderous hate, towards other nations. We know by tragic experience that our human universe is too narrow to make room for all the real human values. In the realm of nature we were for long geocentric; we have become, for some purposes, heliocentric. We must learn that the cosmos is the true unit of reality. It is true that astronomy has taught us that our earth has no independent existence. It is but a cinder from the sun, depending upon it for energy. And the sun is but a mediocre member in the society of worlds, a differentiation and concentration of the total stuff of the whole, and owes its energy to this. The spectroscope has taught us that elements and properties are universal. We know that light, radiant heat, and gravity are aspects of an electrical continuum in which all worlds float. We know that form or order is as universal as the space and time and energy in which it weaves its harmonies. Yet somehow we imagine that the evolution of our earth is a thing apart. We do not realize that its life is part of the rhythm of the whole; that, not only its energy, but its order and phases are what they are because of the space and time relations and the interactions within the rhythmic whole; that life and mind on our earth are as dependent upon this interaction as are our gravitational movements. Within the cosmic whole no part liveth unto itself nor dieth unto itself, but it lives and dies in obedience to the life and order of the whole. Worlds, like individuals, have their seasons of budding springtime, summer bloom, multi-coloured autumn, and grey winter, but the cosmos has all seasons for its own. In the deathless rhythm of the universe the life-giving forms of each level of existence fly like winged messengers from system to system, the higher to the lower, to take effect on those that are prepared, as the moon's silver rays stir the heart of youth to love and tender meditation. What science fails to realize is the spirit that moves over the deeps of seeming chaos, the divinity that streams like light through all, courses like life-blood through the whole, draws like an eternal magnet all to itself.

What we find in the actual world are different levels of energy coexisting and interpenetrating in diverse degrees. This fact is independent of our ignorance of the *modus operandi* of these levels. The universe contains all that our earth reveals and more besides. It is the *plus* which makes motion, evolution, progress on our earth possible. We cannot refuse recognition to anything that makes itself known to us as having reality, be it electricity, matter, life, mind, spirit. There is no reason for regarding the higher levels in the universe as secondary to the lower. If our bias leads us to consider the lower levels as the sole reality, we come to an impasse even in accounting for their behaviour. The reality we know is due somehow to interaction within the cosmos. While the lower furnish the body or instrument to the higher, the latter furnish the vitalizing and orderly touch to the lower. They are thus interdependent. In regarding the lower as the conditions for the manifestations of the higher, we must remember that not only the complexity, but the duration and order of development must be taken into account. The conditions are cumulative. Moreover, the levels are eternal and constant. Without dogmatizing about the details of exchange, we must hold to conservation, not only for the universe as a whole, but for each level; for if there had been continuous encroachment of one level upon another, this process must have run its course in infinite time. There must, therefore, be compensations in the actions, reactions, and interactions of the various levels.

Our universe must make room for all the diversities there are in the concrete world of experience, for the stupid and the brilliant, for the sane and the insane, for the good and the bad, for merry laughter and brooding melancholy, for the quick and the dead. And it must contain all facts in their unique significance and movement. It must contain streams of change, of indefinite diversity, with their respective elements and properties, and their discrete pulsations from the throbbing hearts of the cosmos, multiple histories with their diverse paces, their intersections, their unique durations and significance, with their relative constants making possible characterization and prediction. We also require limpid space as the playground of energies, for we must have distance to spread our stars, and we must have freedom of movement. And we must have consciousness, the neutral light universally present, variously coloured by energy patterns and, in some stages of complexity and intensity, by significance and value—the awareness and "enjoyment" of relations. And we must have order and law, else were the dance of energies the dizzy whirl of the insane.

There is ample room for relativity in the interaction of the parts of such a world even though the order of the whole be eternal. There are not only the blazing spots moving through space at different rates with their changing perspectives of space-time and the curvature of light in the neighbourhood of gravitational fields, but every property, be it in the inorganic, organic or mental field, moves by its own velocity, its own retardation and acceleration, aside from the movement of the unique ensemble of which it is a part. When we deal with such complexes as personal histories, we must take account, not merely of the external stimuli with their character, velocity, and interrelations, but also of the still more complicated physiological organism which is the immediate condition of mental processes. The mental processes themselves constitute a highly complicated ensemble, where we must take account not merely of the general movement with its duration and order, but also of the several movements of the constituent processes with their unique character, duration, and interrelations. There should, then, be sufficient opportunity for the exercise of the ingenuity of the most venturesome mathematician, a sufficient basis for all the dimensions that he can desire in even a superficial description of the universe. This, moreover, does not take account of the creative passing of nature, the real future, which must necessarily lie outside the methods of science. We cannot predict the next creative step. We can know only in retrospect, when the step is an accomplished fact. So the cosmic dance whirls on. All are in the dance, from the largest sun to the smallest electrons, in all sorts of gyrations, the leaders ever shifting, as in a Virginia reel. Only the order, properties, and levels are eternal.

There must, then, be an eternal hierarchy of levels in the universe. Law and order on the lower levels are due to an interpenetration by the higher levels, even before these can become effective in unique and concrete forms, expressive of their own true character. Such expressions must wait for the proper conditions and the proper stage of development. These levels, with their various types of organization, are not mere abstract forms, as Plato's Ideas, but energy patterns, existing in the concrete and effective in the concrete. The physical bearers or incarnations of this hierarchy of levels vary from time to time. The hot spots of conscious intelligence shift, but the genius of the whole remains the same, ever operative from the highest level to the lowest and back again. In infinite time the standard of realization must somehow be eternal.

The perfection we seek must, therefore, exist, energizing and inspiring those that can respond. Plato's mistake lies in regarding reality as pure static forms and in discrediting the world of matter and motion as phenomenal. But, in such a world, form hangs frozen in the empyrean and remains ineffective, while the concrete world becomes chaotic. The real world is a flowing world, with such order and constancy as make prediction to a degree possible. But is there evolution in the whole? There obviously cannot be the evolution of new levels, for then we should have the whole problem of something coming from nothing. But if time is real and duration is real, then there must be enrichment within the process, and the process as a whole cannot be regarded as merely circular, as the ancients thought; but must be regarded rather as a spiral, like the recurrent octaves in the musical scale or the recurrent melody in the symphony, with the opportunity of creating ever new symphonies. Out of some eighty elements the chemist can create an indefinite number of compounds. Out of a few thousand tones musical genius can create an indefinite number of tonal harmonies. What cannot the genius of the universe create with its endless variety of material, world without end?

There remains the problem of evil. Obviously no theory of the universe can make the amount of evil in the world less than it actually is, but it can show the place of evil in the whole. We have seen that the world as we know it is a pluralistic world of multiple energy patterns, histories, and levels. Evil must show itself in the relation of energy patterns to each other and the whole. It is part of the problem of adaptation. Now each energy pattern adapts itself to, or rather appropriates, new energy patterns, by a trial and error process. This is as true on the lowest level as on the highest level of existence. In every such tentative experimentation, whether on the inorganic, organic, or mental levels, or in their relation to each other, illusion and error are possible. It is in the realm of thinking and volition that we are best acquainted with such experimentation, but they are equally real in the other realms of reality. It is of interest that while the Hebrews thought of evil as sin and the Greeks thought of it as error, the Hebrew word for sin and the Greek word for error alike mean missing the mark. We know better than they could know that the target is a moving target, that we are moving as groups and individuals in divergent lines from each other and the target. But the target must become a common target in order to be effective. The wonder is how we can help missing it. If the universe with its various movements and paces were a world of chance, we could never hope for adaptation; and adjustment, goodness, harmony would be words unknown. But even in a world orderly on the whole there is abundant opportunity for conflict. The conflicts arising may be internal conflicts owing to defective organization—to lack of adaptation within the complexity of the energy patterns which go to constitute the individual in question—or may be external conflicts due to external relations. In either case there will be groping and error, with eventual success or elimination as a result of the selective process. The adaptation, moreover, is never completed in the changing complexities of the universe, and therefore, the process of trial and error is never finished. There is thus a certain blindness and relativity implied in the very nature of adjustment within a complex changing world. This is what makes the tragedy but also the zest of existence. History is not the mere dialectic staging of forms of thought. Thought itself is relative to history in the concrete, to the infinitely complex movements of an order greater than itself. But in the words of the ancient Xenophanes: "By seeking we can find out better," or at any rate the race can learn through our failures. At best our understanding is relative and limited. The historian selects according to his bias or the bias of the Weltgeist, and becomes an optimist or pessimist. But the optimism of one may be the pessimism of the other. The striving for economic equality fills the conservative with foreboding and the radical with hope. But only the genius of the universe knows the full meaning of it all.

The universe must be regarded as a vast symphony with the orchestral instrumentation of worlds. It is our souls that are dead and irresponsive. We need to awaken with Siegfried to the meaning of the song of birds, the myriad-voiced murmur of the forest, the portent of the north wind making ghostly music in the pines, and the soothing south wind carrying love and languor to the heart, the buds of spring suggesting dreams of love, harbingers of the ever-lasting cycle of awakening nature, the buzzy hum of bees in summer fields, the yellow leaves of autumn, with the shadow of sadness of approaching death—death which is but the preparation for a new cycle of life, the rhythm of anabolism and catabolism, the systole and diastole of nature's heart. Could we but feel and understand this cycle, we should understand the meaning of the whole. In this cosmic symphony there are the dominant theme and the subsidiary themes—the dominant carried by the worlds which embody for the time being the highest levels of reality, the subsidiary themes carried by worlds in intermediate stages of development down to the lowest, all with varying cadences and each with a movement and figure of its own, but each reinforcing by its unique quality the melody and harmony of the whole, with realistic interlacing of themes, with recapitulation, by various groups of instruments, of the main theme, with relief and contrast, with movements in *dur* and *moll* subsiding to pianissimo and rising to their characteristic crescendo, forms interblending like a delicate pastel drawing, with varying orchestral tinting, but all parts of the effective synchronization of the whole, discords of drums and cymbals somehow drowned and fused in the harmony of the victorious movement, rising in spiral periodicity in infinite time, with wholes embodied in larger wholes, but the harmony of the prevailing theme and of the whole eternal.

CHAPTER II

Evolution as Creative Adaptation

The Tragedy of Science

"Nothing happens without a reason." Thus spoke the ancient Leucippus, father of atomism, perhaps the most momentous hypothesis in the history of science. It is the province of science to make our experience reasonable, and philosophy is merely a more persistent attempt in the same direction. But while science has insisted that material effects must have adequate material causes, it has not been equally ready to admit that spiritual effects must have adequate spiritual causes. Science has felt satisfied when it has taken account of the mechanical aspect of the world with its quantitative categories. But the organization of reality is as real as its quantity, changes in form are as real as changes in motion. And in the last analysis they are inseparable. Science has been the victim of vicious bifurcation. It has dealt with abstractions. And it is helpless to piece together its *disjecta membra*. The intellectual chaos which confronts our confused thinking is only equalled by the moral chaos in which we find ourselves. We have come to separate man from the cosmos, and the instincts and faculties of man from his environment. Hence the tragedy of a philosophy which views man and his ideals as an accident within the universe in which he lives and moves and has his being.

The tragic outcome of the materialistic drift of modern civilization has been eloquently expressed by one of its brilliant representatives, Bertrand Russell:

> That Man is the product of causes which had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and

> his beliefs are but the outcome of accidental collocations of atoms; that no fire, no heroism, no intensity of thought and feeling, can preserve an individual life beyond the grave; that all the labours of the ages, all the devotion, all the inspiration, all the noon-day brightness of human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of Man's achievement must inevitably be buried beneath the débris of a universe in ruins—all these things, if not quite beyond dispute, are yet so nearly certain, that no philosophy which rejects them can hope to stand. Only within the scaffolding of these truths, only on the firm foundation of unyielding despair, can the soul's habitation henceforth be safely built.[1]

What prospect does such a philosophy offer for man's striving? What setting can it give to man's ideals?

> How, in such an alien and inhuman world can so powerless a creature as man preserve his aspirations untarnished? A strange mystery it is that Nature, omnipotent but blind, in the revolutions of her secular hurryings through the abysses of space, has brought forth at last a child, subject still to her power, but gifted with sight, with knowledge of good and evil, with the capacity of judging all the works of his unthinking Mother. In spite of Death, the mark and seal of the parental control, Man is yet free during his brief years, to examine, to criticize, to know, and in imagination to create. To him alone in the world with which he is acquainted this freedom belongs; and in this lies his superiority to the resistless forces which control his outward life.[2]

Such a situation is indeed paradoxical. But perhaps the paradox lies rather in man's superficial thinking, than in the cosmos that brought him forth. Have we not for-

[1] *Mysticism and Logic,* pp. 47, 48.
[2] *Ibid.,* p. 48.

gotten the fundamental postulate of science, as old as Leucippus, viz., that nothing happens without a reason? Materialism has substituted magic for sober thought. The whole process of evolution becomes a succession of miracles without intelligible ground in the process. The appearance in a world of chance of any order at all, the emergence of life, with its series of forms and organs, the final appearance of intelligence and a sense of beauty—all are miracles. The materialistic scientist has a truly marvellous appetite for the miraculous. So long as the scientist merely gives a descriptive account of the series of forms and stages in the history of our earth, we can find no fault with him. But when he essays to deal with causes, we have a right to demand that his account shall be reasonable. When he boasts of explanation, we do not expect to be offered magic. Materialism offers the most astounding instance of credulity in history. And when its motley brood of nasty and cheap philosophies pretend to a monopoly of scientific method, it must make Olympus shake with laughter.

A generation ago there were scientists who hesitated to make chance the arbiter of the whole history of evolution. They would make an exception of man. Wallace felt that a "divine influx" is necessary in order to account for the appearance of man. But what about the various steps in creative evolution leading up to man? Can they be accounted for as accidental variation and natural selection? Evolutionists were no doubt right that if these can be accounted for by chance, then man can be no exception. Man, too, emerges by gradual steps from simpler forms. But what about evolution as a whole? Can our parochial geocentric point of view account for the emergence of the series of new characters and forms culminating in man as we know him? I hold that the earth must not be conceived merely as a chaos of disordered motions evolving in isolation, but must be conceived as part of a larger whole. The history of the earth can be understood only as a space-time creative adaptation to a system of cosmic control. The cosmos in whose womb our earth is begotten, and within whose control it lives its life cycle, is adequate to account for the evolution and nature of its offspring.

The Vicious Bifurcation

It is our besetting sin of bifurcation which is responsible for most, if not all, of our absurd paradoxes in science and philosophy. We abstract man from nature, mind from body, the qualities from the thing, the individual from his environment, the earth from the cosmos, and then land in absurdities. We become victims of language—of conjunctions and prepositions. Language tends to separate what in reality is inseparable. When we say man *and* nature, heredity *and* environment, we separate what reality has joined together. We try to understand the parts without the matrix, while it is only in their specific matrix that their functions can exist and be understood. The history of thought describes a zigzag between the poles of our false dichotomy. By emphasizing now heredity, now environment; now mind, now body; now the individual, now society; now the particular, now the universal; now pluralism, now monism, the history of thought tries to compensate for its artificial bifurcations. But the oscillation is fruitless of results, because the abstractions cannot function as abstractions and therefore cannot be understood as abstractions.

The false antithesis can be illustrated in the customary bifurcation of heredity and environment in the life cycle of the organism. I can do no better than quote Dr. Sumner:

> The sum-total of causal agencies which result in the production of a complete organism from a fertilized ovum are commonly grouped under two heads: (a) the material constitution of the fertilized ovum itself, particularly of its chromosomes; and (b) external influences which act upon the developing organism,

> from the moment of fertilization to the close of the life cycle. This classification corresponds in the main to the familiar antithesis between heredity and environment, nature and nurture. As a matter of fact, the distinction thus drawn is largely a chronological one, the influences acting before fertilization being lumped together along with "nature," those acting after that event being assigned to "nurture." If we insist that heredity relates only to the "intrinsic" factors in the situation—to the material constitution of the "germ-plasm" independent of environmental influence at *any* period—it seems to me we are dealing with something purely imaginary. There never is a period in the history of the germ-cells or their forerunners when they are not vitally dependent upon their living environment. Every step in their history involves an interaction between certain factors which may be called "intrinsic" and other factors which are external to these. What is "intrinsic" at one moment may have been "extrinsic" the moment before.[3]

The distinction between heredity and environment must be regarded as one of practical convenience, not as an absolute one. I agree with Dr. Summer's "somewhat paradoxical thesis that the organism and its environment constitute an inseparable whole; that if we could detach all environmental elements from this complex, there would be no organism left." [4]

The tendency has been to look upon the life stream in too abstract a fashion. We must take account of the whole milieu in which the organism develops and of which it is a part.

> At all stages of ontogeny the course of development may be altered by extrinsic stimuli but earlier

[3] "The Organism and its Environment," Dr. Francis B Sumner, the *Scientific Monthly,* Vol. XIV, pp. 230, 231.
[4] *Ibid.,* p. 231.

> stages may be more profoundly influenced than later ones.[5]

Throughout the process of development from the egg, we must take account of relations of exchange and control from the more inclusive system of energy. This can be experimentally shown in the case of the simpler organisms.

> If the usual medium in which the egg develops—sea water, say—is modified by changing its physical character (density), or its chemical composition, then this change in environment produces a structural change in the character of the embryo, or larva, into which the egg develops. In a word, the experiments of the students of Entwicklungs-Mechanik show that while there are strong intrinsic influences in the egg, which guide its development under usual or normal environmental conditions along a definite path, yet any sufficient modification of the extrinsic conditions (environment) affecting the developing egg or embryo can change this path and produce a modified individual.[6]

While, on the whole, the so-called hereditary traits show a considerable permanence, it must not be forgotten that the seeming permanence of the hereditary constitution presupposes a permanence in the conditions of the environment. If Alpine plants change their characteristics when transported to the lowlands and become like their lowland kin, this does not show merely that heredity is permanent and only temporarily modified by environment, but rather that the characteristics of these plants are a function of both heredity and environment. Again, if cyclopean monsters can be produced by Stockard and others through using a medium of magnesium solutions or other means, this does not show that the fish and other animals used for the experiment are absolutely symmetri-

[5] E. G. Conklin, *Heredity and Environment*, 2nd Ed., p. 342.

[6] Vernon Kellogg, "Heredity and Environment," the *Atlantic Monthly*, June, 1922, p. 731.

cally two-eyed and only abnormally develop into one-eyed monsters, but it shows that the development of symmetrical eyes is in part a function of the usual medium in which such animals develop.

The life cycle of the individual is the result of a delicate equilibrium involving not merely the germ plasm, but its relation to the internal system of body cells and to the external system of energies. Radical changes in any of these systems will affect the characteristics of the individual. Changes in the external system of energies in the way of pressure, temperature, chemical composition, and the still more subtle medium of electromagnetic waves will affect the character of the organism. The artificial treatment of spermatozoa before a fertilization by means of X-rays, radium rays, etc., has produced various monstrosities. The influences are especially potent during the period of maturation and in the earlier stages of development, but throughout the life history of the individual external influences are potent. This is especially true of the human individual on account of the long period of plasticity after birth, when the external milieu is potent to shape his characteristics. Hence the importance of education in the broad sense of the social influences brought to bear upon the human individual in childhood and adolescence. We have come to mistrust the theory of faculties and instincts as abstracted from the environment and conceived as absolute characters of the individual.

Neither can the internal system of cells and their mutual control be ignored if we would understand the developmental series. A classic experiment on frogs' eggs shows that if one of the daughter cells into which the egg first divides is killed and the dead part is left attached, the other cell will produce a half-frog embryo. If, on the other hand, the two cells are separated entirely, the remaining cell will develop into a whole-frog embryo of approximately half the size. Recently we have learned that various chemical messengers, the hormones, communicated to the blood by certain ductless glands such as the thyroid and parathyroid and other glands profoundly influence the proportion and rate of growth of the organism. Electro-vital messengers from the nervous system in a similar fashion not only serve to knit the organism together into an executive system but to control growth. The whole internal economy is thus knit together by distance action, chemical and vito-electrical. We cannot afford to ignore the interaction of the various parts in the development of the cell into the organism. While we cannot say that the fate of any part of the egg or any cleavage cell is "a function of its position" as Driesch holds, neither can we afford to ignore relations. It has been shown that, within the economy of the whole and under stable conditions, certain specific tissues or organs of the later developed embryo have their origin from specific single cells in the four—or eight—or sixteen-cell stage of the developing egg. To this extent there is preformation, but it is a preformation which is a function of the total ensemble.

Again, the factors which enter into fertilization constitute an exceedingly complex system and each makes its unique contribution within the economy of the total life system.

> The fact remains that at the time of fertilization the hereditary potencies of the two germ cells are not equal, the polarity, symmetry, type of cleavage, and the pattern, or relative positions and proportions of future organs, being foreshadowed in the cytoplasm of the egg cell, while only the differentiations of later development are influenced by the sperm. In short, the egg cytoplasm determines the early development and the egg nuclei control only later differentiations. We are vertebrates because our mothers were vertebrates and produced eggs of the vertebrate pattern, but the color of our skin, hair and eyes, our sex, stature, and mental peculiarities were determined by the sperm as well as the egg from which we came.

> There is evidence that the chromosomes of the egg and sperm are the seat of differential factors or determiners for Mendelian characters, but the general polarity, symmetry and pattern of the embryo are egg characters which were determined before fertilization.[7]

At any rate we can be sure that the egg and sperm cells in sexual reproduction constitute an immensely complex system of determinants where each makes its unique contribution, even though we cannot separate this contribution from the total ensemble. We know that all these characters, including sex, are subject to variation in the total energy setting.

What I have tried to emphasize is that the life cycle of an individual organism must be understood as a function of three systems of energy factors in delicate equilibrium within themselves and in relation to one another. The reproductive cells which carry on the life stream cannot exist in isolation nor can they be ascribed characters in isolation. The character of the individual organism is the result of the delicate balance and interaction of the heredity cells with the body cells and with the total external environment. The constancy of traits depends upon constancy in these systems. On the other hand, variation of any of these systems may lead to variation of traits. The constancy of what we call heredity in the gross is as truly a function of the constancy of the total external environment as it is of the heredity cells. It is not my purpose to minimize the importance of the heredity cells. In the same external environment, human beings bring forth human beings and apes produce apes. Species have a considerable constancy over long periods of time. And it is also a well-known fact that stock counts, *i.e.*, the individual tends to resemble his ancestors in recognizable traits. But it must not, therefore, be forgotten that hereditary traits are the result of energy exchange with

[7] E. G. Conklin, *Heredity and Environment*, 2nd Ed., pp 184, 185.

the environment and that their constancy and variation cannot be understood apart from the larger milieu.[8]

If we now pass from ontogeny, the individual life cycle, to phylogeny, the cycle of generations, we have the problem, on the one hand, of accounting for the constancy of traits, and, on the other hand, of accounting for new characters and species. Biology cannot be said to have been successful in accounting for either of these satisfactorily; and scepticism has broken out among the biologists themselves. The Darwinian theory has slid over both by means of its magic formula of chance variations and natural selection. Darwin himself found it necessary to invoke other factors, such as the Lamarckian conception of the inheritance of acquired characters, but the inheritance of such characters in the Lamarckian sense, *i.e.*, as a result of function, seems at best doubtful and has been discarded by Darwin's more orthodox followers. It is im-

[8] The feeling that "the science of genetics has, in the past, suffered from too narrow a point of view," has been expressed recently by so distinguished an authority as Dr. Charles B. Davenport: "No physiologist can fail to recognize that all development is under the control of agencies external to the developing center. In the earliest stages of development, indeed, the processes of differentiation seem to have a remarkable independence of environment Even though the organism be turned inside out, as in the case of the lithium larvæ of sea urchins produced by Herbst many years ago, still the spicules and other differentiating characters will be laid down in nearly normal fashion But every student of plant genetics knows that the final form is dependent upon conditions of nutrition, temperature and the like, and students of human development are aware of the influence which the nervous system exerts upon the production of hormones. This nervous system is, of course, the organic complex which is most directly affected by external conditions and the production of hormones which has so marked an influence upon development. What is true in later stages is, no doubt, true in still earlier ones and thus one can see the basis for the conviction which has for a long time been held by thoughtful medical men that various kinds of shocks, or poisons introduced into the body, affect the development of the fœtus The striking cases of resemblance in close relatives and especially in identical twins occur where conditions of life are nearly uniform in the developmental period Where these conditions affect differently the individuals with the same germ plasm the end result is a morphological difference The student of genetics must take into account, therefore, chromosomes, hormones, other developmental impulses and environmental conditions if he would know all the factors that determine development." The *Scientific Monthly,* Vol. XX, pp. 497, 498. Dr. Davenport's article came out after this chapter was written, but I could not refrain from quoting his excellent summary of the case.

possible here to enumerate all the difficulties which beset the Darwinian theory. We can mention only a few. In the first place, the idea that the variations happen by chance is contradicted by the evidence of palæontology which shows that the process of evolution has been on the whole more orderly than chance could explain. Many life series, at any rate, show a comparatively steady direction toward useful adaptation.[9] And the process as a whole has fewer blind alleys than chance would indicate. It is incredible that the system of such a complex organ as the human eye should have developed by chance without reference to environmental control. Large variations, such as the recent mutation theory emphasizes, would complicate the problem, rather than simplify it. The factors involved in such an adjustment are practically innumerable; and it is inconceivable that the variation of one factor should coincide by chance with the variation of all the other factors so as to produce one common direction tending towards a specific adaptation.

While to Darwin the possibility of variation seemed practically infinite, we know now that most of the variations are fluctuations due to the interaction of causes within the life cycle of the individual and are not inherited. The range of the inheritable variations would be comparatively small and quite insufficient to furnish the material for the evolutionary process on the Darwinian theory.. Nor does the theory furnish any explanation of why some variations are inherited and others not. To call the latter mutations and the former fluctuations is a matter of words and does not explain. It is not necessary, moreover, that variations should be useful, if they ever could be useful by chance, in order to survive. It is only necessary that they should not be such as to make survival impossible. Many of the variations are merely negative, *i.e.,* they consist in subtraction of characters rather than

[9] This has been experimentally proved by Professor R. R Gates and other biologists. See *The Mutation Factor in Evolution with Particular Reference to Œnothera,* London, 1915.

addition. Many variations, such as various markings, cannot be shown to have any relation to survival. Other variations, such as blindness, while disadvantageous, may not cause the disappearance of the organisms in question. They may mean survival in a different habitat where eyes do not count. They may mean bad adaptation to survival in a certain habitat, but not sufficiently bad to eliminate the species because of its enormous fecundity and other compensations. The cumulation of variations, therefore, is not determined by usefulness; and even variations which result in useful adaptation, after they have reached a certain cumulative growth, cannot be useful in the long ages during which the cumulation is brought about.

The principle of natural selection is indeed an important contribution to biology. But it is a negative, not an architectonic, principle. It does not explain why variations appear, why they cumulate, why they assume an organization in the way of more successful adaptation. Organisms must, of course, be able to maintain themselves in their life environment and in the physical environment, in order to leave descendants and determine the character of the race. But that is all natural selection tells us. It does not explain the traits and organization of organisms nor why they become well or badly adapted to their specific environment.

The Mendelian conception of life is essentially atomic. It holds that the stream of life consists of certain unit characters which are capable of being combined and segregated in certain predictable ways. It emphasizes the fact that different characters are capable of travelling with an individual velocity and therefore can vary independently of the variation of other characters. The characters themselves are conceived as constant in the germ plasm, and waiting to be segregated. They may for the time being exist in a blend where they may be dominant or suppressed—the long-character by the short-character, one eye colour by another, smoothness by hairiness, etc.;

but the tendency is for characters to run pure eventually; and by artificial selection we can vastly hasten this process. The characters themselves are conceived as invariant in the germ plasm except for mutations that may occur now and then, and which in Darwinian fashion are conceived as spontaneous, *i.e.*, independent of the body changes and the external environment. No account is given of the origin of these mutations. They are accepted as facts. But, given mutations, we can produce new species by breeding pure. On this score Mendelism is subject to all the objections we have previously raised against chance variation. It is easy to say that, considering the multitude of factors involved in heredity, new syntheses may be produced from these characters. But no control is provided for their production. Granting that they might be produced, why should they stick? Why should they not, like other blends, be subject to segregation? The experimental evidence of mutation seems to be mostly concerned with loss of characters—lack of wings, defective eyes or lack of eyes, etc. But what accounts for the privation? And how could the series of new species and new organs for adaptation arise from lack of characters? Some geneticists are becoming sceptical of accounting for evolution along this line, and such a distinguished pioneer as Professor Bateson has come to the conclusion that "we have no reason to assume that any accumulations of characters of the same order [*i.e.*, "transferable" or segregating ones] would culminate in the production of distinct species."[10]

Mendelism, in brief, is a theory of the shuffling and reshuffling of certain original characters which have no relation to the nature of the environment or the changes of the environment. It does not attempt to account for the origin of these characters; and their organization into unique ensembles which happen to be adapted to life conditions is unintelligible on this theory. But can we go indefinitely far back in the history of these characters? Are all human traits present in the primates and the char-

[10] *Science*, January 20, 1922, quoted by Dr. Sumner.

acteristics of these in the mammals that preceded them, and the characteristics of these in their reptile ancestors and so on, back to the prevertebrates, the worms, the unicellular animals, and the spores? Finally, does matter possess the characters of the ancestral protoplasm? Or shall we simply say that chance has produced them by creative synthesis? The theory makes evolution absurd and it is no wonder that at least one distinguished geneticist has thrown Darwinism overboard.[11] That is more honest than the attempt to cover up the contradiction between the point of view of original characters and the theory of the evolution of characters by emergence or creative synthesis from earlier ones. This destroys the fundamental conception of unit characters. And it offers no explanation of how new characters could emerge and assume new and adaptive organization—all in independence of the environment.

The vitalists have been well-intentioned in trying to combat materialism, but the solution which vitalism proposes is illusory. Vitalism is in the same plight as Mendelism. Like Mendelism it is fundamentally atomistic. The determinants of the life process, phylogenetic and ontogenetic, would have to be present from the beginning. They would have to be independent of the environment and the course of geological evolution. They would have to account for reversals in evolution as well as continuous evolution. They would have to be latent for vast geologic ages. It does not matter for our purpose whether vitalism is stated in terms of entelechies—life-forms, which are supposed to be immanent in the process and to guide the various phases of racial and individual development—or in terms of an original vital impulse which splits into its component impulses in acting upon matter. In either case the emergence of characters and the organization of characters remain to be explained. If the characters are all present from the beginning, what accounts for their gradual emergence in geologic time? If their organization

[11] Heribert Nilsson, Festskrift, Lund University, 1918.

is independent of the environment, how account for the adaptiveness of this organization to the characteristics of the environment? It may simplify matters to start with a vital impulse and so avoid the necessity of accounting for the origin of life. But can we ignore the relation of the vital impulse to the previous stages of geological evolution? Geology and astronomy make it clear that there was a stage in the development of our planet when life did not exist and could not exist. Where did the entelechies or the inherent potencies of the vital impulse come from? To deny with Bergson the reality of matter and make it the mere appearance of the downward trend of life is mere mysticism. If matter is not real, how could it serve as the resistance against which the vital impulse breaks up like a sky-rocket into its inherent complexity, with progressive adaptation and reversal of function to fit a changing environment? That any age should take seriously such an incoherent mixture of mysticism and science is evidence of nothing so much as a want of logical thinking.

The theories of evolution which are based upon the bifurcation of nature into an environment, on the one hand, and a life stream independent of it, on the other, all land us in absurdities. They fail to account for evolution as we know it. But evidence seems to indicate that the "germ-plasm" is not so isolated as Weismann supposed. It is admitted that the germ-plasm is continuous with the organism in the circulation of the blood. Egg cells and sperm cells and their combination, the oosperms, cannot exist without nourishment. But the blood is a more complex energy-system than Weismann supposed. It transmits the chemical messengers from the various ductless glands. It alters with mental excitement as has been shown definitely in the case of intense emotions. Anger and fear, through their action upon the adrenal gland, stimulate the production of sugar in the blood and alter profoundly its energy. Evidently the blood is not indifferent to the psychological situation. Perhaps Empedocles was not so far wrong when he conceived the blood as the seat of the soul! In any case, the heredity factors cannot be regarded as completely isolated from the chemical and vito-electric conditions of the organism. Energies, communicated through the blood, may certainly change the life history of the next generation, as shown in alcoholism and other effects of drugs; and through induction, *i.e.,* being carried in the blood of the new individual, toxins may influence the fate of later generations. There is some evidence that changes in the energy system of the blood may lead to permanent modifications.

> One of the most interesting and convincing cases of the inheritance of an experimentally induced character has been reported by Guyer and Smith with respect to certain eye defects in rabbits. They injected the pulped lenses of rabbits into fowls and, after the fowls had become sensitized to this foreign protein by the formation of anti-lens substances, their serum was injected into pregnant female rabbits. The effects on the injected rabbits were severe and many of them died, but there was no evidence that their eyes or lenses suffered injury; furthermore there was no evidence of any specific injury to their ovarian eggs, since in subsequent breeding they produced no young with eye defects. On the other hand, some of the embryo *in utero* did suffer specific injury; some were born with opaque lenses; sometimes their lenses were reduced in size, and when the lens was small, the whole eye was usually small; sometimes the eyeball had collapsed leaving no traces of pupil or iris; finally these changes frequently increased and progressed after birth.[12]

Such eye defects have been proved to be inherited for at least five generations, and instead of decreasing have become more pronounced in successive generations; they are inherited through the male as well as the female and

[12] E. G. Conklin, *Heredity and Environment*, 5th Ed., pp. 247, 248.

are therefore not merely induced through the cytoplasm, the protoplasmic envelop of the nucleus of the egg. The authors of the experiment suggest "that the degenerating eyes are themselves directly or indirectly originating antibodies or other chemical substances in the blood serum of their bearers which in turn affect the germ cells." [13] At any rate, the fact that the germ cells are accessible through the blood opens a large door. We know also, what Weismann did not dream, that the germ cells, and every other part of the organism, are accessible to outside energies such as radium rays, X-rays, and other wave lengths which pass through the various structures of the body without hindrance. We know that the germ cells can be profoundly altered by artificial treatment with such waves. The action of such energies and their variation within the total matrix of nature, of which the germ cells are a part, must influence in an important way the life history of these cells. Altogether it does not seem so remarkable that there should be variation in the basis of heredity as that there should be as much constancy as we find. This constancy is no doubt in a measure due to the inertia of the heredity factors, but in the last analysis it is due to the relative constancy of the environment over periods of time and the equilibrium of the external and internal energies.

If we envisage the process of evolution from the perspective of geological history, we find that epochs of revolutionary changes of the earth's crust with the accompanying changes of temperature, moisture and electromagnetic conditions have been equally revolutionary in the changes of life forms. This seems natural enough if we remember that life is a development of the crust of the earth under the nurture and control of cosmic influences. It goes to show that in order to understand the evolution of life we must understand it as an integral aspect of the evolution of the earth; and we must understand the evolution of the earth as part of cosmic evolution with its phases and

[13] Quoted by Conklin, *Ibid.*, p. 248.

its dynamic equilibrium. The palæontological record is necessarily incomplete, since there must be hard parts before there can be any direct record. The earliest life forms can only be known indirectly as agencies in the formations of the earth's crust.

The geologist sees the history of the earth as a series of great rhythms including minor rhythms. Contractions of the earth's crust giving rise to great elevations, accompanied by aridity and cold, have alternated with periods of wearing down of the crust to a comparatively uniform level with great humidity and more uniform temperature. Just as we observe that in periods of the breaking of the crust of custom under severe strain and conflict, new social forms appear rapidly while many of the old forms disappear, so we find in the larger history of the earth that periods of the breaking of the earth's crust are periods of great plasticity and great creative syntheses when new life forms emerge rapidly while many old forms disappear, the evolutionary process moving with greatly increased acceleration. Thus the Palæozoic era is ushered in with the Grand Canyon upheaval and accompanying climatic changes, when it is supposed that vertebrate life first made its appearance. With the rhythmic contractions which led up to the high Appalachian level we have the closing of the Palæozoic era, the age of reptiles, and the ushering in of the Mesozoic with the evolution of birds and mammals and the flourishing of the mighty dinosaurs. The Laramide level of the earth's crust marks the disappearance of the dinosaurs and the end of the Mesozoic era, and ushers in the Cenozoic with a great development of mammal life including the primates, man's direct ancestors. With the rhythmic rising of the crust in the Pleistocene period, and the accompanying climatic changes, we can watch man in the making, starting to reshape his environment; and in the throes of the last glacial epoch of the Pleistocene, *Homo sapiens*, the direct progenitor of historic man, the great destroyer and builder, the creator of art and civilization, appears. On the crest of the Cascadian crust with its rhythms and tremors and tensions we now live, or, more exactly, we are part of it; and the end is not yet.

> Thus time has wrought great changes in earth and sea, and these changes, acting directly or through climate, have always found somewhere in the unending chain of living beings certain groups whose plasticity permitted their adaptation to the newly arising conditions. The great heart of nature beats, its throbbing stimulates the pulse of life, and not until that heart is stilled forever will the rhythmic tide of evolution cease to flow.[14]

It has been recognized for some time that there have been cycles of elevations and depressions of the earth's crust, and that with these variations of elevation there have been great variations of temperature as indicated, on the one hand, by the great coal-beds which have been found both in the arctic and antarctic regions, and, on the other hand, by the glaciers which at various times have covered a large part of the "temperate zones." But it is only recently that a reasonable explanation has been offered for these cycles. "Joly has lately offered an explanation of this cycle based upon the radioactivity of the rocks of the earth's crust. Assuming the lower basaltic strata to contain the same percentage of radioactive material as is found in those basaltic rocks available for examination at the surface, he finds that the heat developed in the lower layers is greater than that actually being carried off by conduction in the upper layers. In consequence, the lower strata must eventually melt, and suffer a diminution in density. But because the melted rock makes better thermal contact with the overlying strata than did the solid form, and also because the melted rock is a better conductor (or rather convector) of heat than the solid form, it will now lose heat more rapidly than

[14] G. S. Lull's essay, "The Pulse of Life," in *The Evolution of the Earth and Its Inhabitants,* Yale Press, 1918. See especially Lull's excellent diagram, p. 111.

before, cool and solidify with an increase of density, cracking loose from the surface layers, and again making poor thermal contact. The cycle then begins over again. In consequence of this periodic alteration in density of the underlying strata, the balance or isostacy of continents and oceans is disturbed, and elevations and depressions are produced. For this cycle Joly assigns a period of 40 million years." [15] With these rhythms of the earth's crust there have taken place great changes in the flora and fauna of the earth, which is to be expected, for life is part of the crust of the earth and therefore the pulse of life must vary with the pulse of the earth. Aside from the periodicities of the earth's crust there are certain periodicities of solar energy as indicated in the variations of sun-spots. Attempts have been made to correlate epochs of human history with these pulsations of solar energy. Thus a Russian scientist, Tchijewski, has attempted to show that revolutionary periods in human history correspond with the maximal periods of sun-spots. This is too simple an explanation, since it ignores historical factors. But it seems reasonable that a great increase in solar pulsation should quicken the pulse of life and liberate the energies of men. We must wait for further evidence. In general we may be sure that the pulse of life varies with the pulse of the earth and that the pulse of the earth varies with the pulse of the cosmos.

We must recognize the evolution of the earth as a unit. The pulse of life is part of the throbbing of our earth. We must conceive the evolution of its various forms, including life forms, as integral parts of its history, moving under cosmic control. We must place ourselves inside, instead of outside, the earth's history if we would understand our place in evolution. For, after all, we and our civilization are part of the history of the earth, creative organizations of its crust. Life forms arise as specializations of this crust; they maintain themselves subject to

[15] Article: "The Master Key," by Dr. Paul R. Heyl, the *Scientific Monthly,* Vol. V, XIX, pp. 7 and 8.

its equilibrium of forces, including the equilibrium of the specific life environment of which the particular life forms are a part. Life forms which cannot maintain themselves in the struggle of forces, inorganic and organic, are doomed. This is the significance of natural selection.

The Efficient Cause of Evolution

We must now endeavour to discover the efficient cause which can account for evolution in the concrete. We can, of course, shirk the responsibility of causal explanation by saying simply of each particular form, species, and level that it emerges. This may be excusable as a matter of mere description. Everything that happens somehow emerges. Science may confine itself to tracing sequences. But when we essay to offer an explanation of these sequences—and science does in part pretend to do so—we must show how new characteristics and forms emerge; and this means at least an attempt to exhibit the total matrix from which things emerge. If we offer a scheme of categories from which things are supposed to emerge, we at least expose ourselves to criticism. We have a right to ask: Is the scheme of categories well founded? Is it implied in the constitution of reality? And, finally, is it adequate to account for the emergence of the facts in question?

It must be clear now that we cannot separate life from the geological and cosmic environment if we would understand its evolution. We cannot regard the evolution of life as a mere internal process which is separated from the body cells and the external environment and in which the environment plays the merely accidental rôle of segregating characters or splitting up the vital impulse into its ingredients. We cannot account for the characteristics of the organism as due merely to original unit characters, because, if we go back far enough, we come to a stage when such a type or species did not exist, and eventually we come to a stage in the earth's evolution when life did not exist at all. The impetus to evolution must come, in the last analysis, from the cosmic environment, and is not merely potential from within. But, on the other hand, evolution is not merely a function of the environment, for all organisms do not respond in the same way to the same stimulus, they do not all have the same organization nor the same rate of evolution. During the great age of mammal evolution the reptiles remained comparatively constant. Various organic forms have their history, duration, inertia, etc., in accordance with their own rhythm.

All agree that the great problem of evolution is a problem of organization. Even if we admit an original life impulse, a spore transported from some other sphere, the problem of organization still remains. And it is more reasonable to assume that life is indigenous to our earth in the cosmic economy. We must understand this organization in terms of interaction between the complex system of energies of our earth, on the one hand, and the cosmic environment, on the other. Life must adapt itself to the character of its environment if it is to persist. There must be an exchange of energy between the part and the larger whole if the part is to live. In the creative adaptation of the particular life series to its environment lies the efficient cause of evolution. In this adaptation the specific life-system of energies must respond to its specific environment in a unique way, having reference, on the one hand, to the dynamic equilibrium of the environment and, on the other, to the dynamic duration and organization of life.

The movement of evolution in the large, the appearance of new organs and new species, is due to interaction between the particular system of life energies and the environment This interaction in the case of the unicellular organisms seems comparatively direct—the protoplasm responding to stimuli of light, pressure, chemical composition, and gravity, by certain internal changes or rearrangements which, if compatible, enable the organism to live. In multicellular organisms the response of the organism is more indirect. The environment continues to act upon the organism. The organism in turn responds by processes of growth and differentiation in a trial and error process. This process is controlled not merely by the action of the environment but by the whole internal milieu or system of milieux with its composition, duration, and unique organization. Not even a pigment spot could be produced by light through its direct action. Light does not produce pigment spots on water. It does not produce pigment spots on the jelly-fish impartially over the whole surface. Light starts the life energies at the surface, but the response depends upon the whole life system—its complexity, duration, and organization. The environment furnishes the original and persistent stimulus. The environment also furnishes the survival conditions of the organism. The organism must establish a minimum exchange of energy with the environment and be able to cope with its minimum requirements of competition. To effect this exchange the life stream itself must produce the growth and differentiation of structure according to the character and unique control of its milieu.

We must understand adaptation, then, as a trial and error process to effect energy exchange between the stream of life and its environment. We must appreciate, moreover, the tremendous complexity of the problem of adaptation. No one has stated the problem so clearly as M. Rabaud:

> Every living substance is a colloidal complex in which the diverse components exist in definite proportions in relation to each other; but these proportions correspond to a certain system of exchanges, or, in other words, to a certain milieu. If the milieu changes, the system of exchanges varies and the proportions are modified. But it is clear that the properties of a body of living substance depend strictly, not only on its qualitative composition, but also on its quantitative composition. According to the case, it will be more or less sensitive to light—and to such

> light—to temperature, to the state of humidity, to diverse vibrations. And, to speak precisely, the establishing of the differentiations is nothing but the production of a series of modifications in the proportions of the diverse cellular components in functional relation with the changes of the milieu. Every multicellular organism is in fact an ensemble of internal milieux which are in a dependent relation one to the other and in the last analysis to the external milieu; each one of these milieux differs necessarily from its neighbours at the end of a certain time, and each determines for the cells which are included in it the systems of special exchanges. The living compound which forms the cells shows the conservation of the original substance, but it does not conserve the same proportions of the components; consequently one at least of the general properties of the substance considered becomes for it preponderant; it becomes differentiated.[16]

The impetus to the differentiation of life lies in the last analysis in the characteristics of the environment. If there were no differences in the environment, there would be no impetus to differentiation in the life substance. Life strives to adapt itself to the characteristics of the environment. But this adaptation is a complicated process. While the energy patterns of the environment furnish the initial and constant impulse to adaptation, and furnish in the end the criterion of the success of the adaptation, the adaptation itself must be carried out by the particular life compound with its ensemble of milieux according to its own system of control. It is a trial and error process of adaptation. The complexity, the history, and the specific organization of the life system condition its creative adaptation to the particular energy pattern of the environment. Hence it is easy to see why life shows such

[16] E Rabaud, "L'adaptation et l'évolution," *Revue Philosophique,* January-February, 1922, p. 80.

variety of differentiation to the general characteristics of the environment. Without light there would be no eyes, without sound there would be no ears, yet the response to light patterns and sound patterns varies largely in the realm of living things. I quote again from the brilliant statement by M. Rabaud:

> All organisms are not sensitive to the same vibrations, they do not hear the same sounds, they do not see the same colours; there are here radical differences which result from analogous, but not concordant, differentiations and often bear witness to an independent origin. From a general point of view these differences have a great interest for us; they show that the formation of distinct tissues and organs corresponds nowise to the immediate necessities created by the external conditions. In a multicellular organism, the differentiations are brought about by the fact that the cells accumulate and determine the formation of internal milieux. The differentiations are brought about first of all as functions of these internal milieux and not by the controlling effort of a particular external influence. Light does not create the visual cells, nor sound the auditory cells, nor digestion the digestive cells. Light, sound waves, chemical substances do not determine a local modification at the point where they strike; but they determine a series of modifications which are interlinked and which concern all the internal milieux and the ensemble of exchanges. Hence, if the variations of metabolism depend, at the point of departure, upon the action of light, upon vibrations, upon diverse substances, yet the modifications of the organism which follow are not necessarily in immediate rapport with the initial stimulus. The differentiations with reference to this will be various; they cannot be predicted. Plants do not see nor hear, and not all animals have differentiated organs of vision or hear-

> ing: all organisms, however, are sensitive to light and to vibrations. It is after the grouping of cells into tissues and organs is once accomplished that their special sensibility to such a component of the milieux is manifest and that these organs, within the organism of which they are a part, play a determined rôle. They do not play this rôle, however, except in functional relation with all the other parts and in the measure that the correlations between the diverse parts permit the continuation of the exchanges."[17]

It is here that the Darwinian principle of natural selection shows itself. The external environment has the first and last word. It, in the last analysis, through its diverse energy patterns gives the impetus to differentiation on the part of the organism; and it finally determines the success or failure of the trial and error process of creative adaptation. If the process results in rapport, at any rate to the extent of maintaining the necessary energy exchanges with the environment, then the organism survives and with it the differentiation.

In the creative adaptation of the stream of life to the energy patterns of the cosmic environment we have the efficient cause of the evolutionary process. Evolution is indeed to be understood as creative synthesis, as productive reorganization, but it cannot be understood as a synthesis of chance or as a reorganization independent of the environment with which life must effect energy exchange. It is a creative synthesis for which all the necessary conditions are supplied. It must account for the emergence and organization of characters; and must not merely make them emerge by magic from simpler antecedents. It must furnish a cause which is adequate to the effect. It is not by chance that life emerged in geological history, nor is it by chance that the series of life forms have emerged. Life is a creative adaptation of the energies of matter under certain conditions—themselves the

[17] *Ibid.*, p. 81.

result of cosmic adaptation—to the energy structure of the cosmos. And new organic characters and changes in form are the progressive differentiations of living matter through a process of creative trial and error adaptation to respond to the energy patterns of the cosmos.

The cosmic environment acts upon matter, or, better, the cosmic whole stimulates the part, for the earth and the parts of the earth develop in the womb of the cosmos, and under its control. Under favourable qualitative and quantitative conditions the specific stimulus pattern from without overcomes the inertia of the particular structure of matter and starts a process of adaptive response from within the system to meet the action from without. It is thus that new characters and new organs and new life forms emerge. The action may have to do merely with the adaptation of the individual organism to its environment and may leave no apparent trace on the next generation. It may cumulate its adaptive effect in the hereditary basis of life until it reaches a certain quantum, quantitatively and qualitatively, and emerge after ages of maturation. It may emerge by degrees until the impulse results in a complete adaptation. It may, under plastic conditions of stress and strain, emerge comparatively suddenly. But one thing is certain; it does not emerge by chance in isolation from the cosmic whole, but as a creative response to the characteristics of the cosmic structure.

Nothing happens by chance, and it is not by chance that organisms have developed eyes, ears, and other sense organs. Our senses are creative adaptations to specific energy patterns of the cosmic environment. If these energy patterns had not pre-existed in the cosmic environment and acted upon the organic matter, there would have been no impulse to develop organs of response. When the particular organic adaptation has been made, we can take account of the objective energy pattern and adjust ourselves to it. We do not directly sense the organ of adaptation, but we sense the pattern for which it is made. We do not see our eyes, but we see light; we do not hear our ears, but we hear sound. The organism responds to the energy patterns that set it in special motion to establish rapport with them.

It is not by chance that the organism has developed duration patterns as well as space patterns—the duration pattern of reflexes which span generations, the pattern of habit which conserves the effect of individual action, the duration pattern of memory which makes it possible to re-live the record of the past in a new setting. Such duration patterns involve profound changes in the structure of the organism, and we must believe that these changes owe their impetus to the cosmic environment. We must understand reality as having not merely a spatial pattern, but a temporal or dynamic constitution of various grades of complexity; and we must believe that the life stream in its geological evolution responds creatively to this temporal structure of the universe and hence comes to assume temporal patterns of increasing complexity. Cumulative habit-taking is not a property of inorganic matter, much less is the qualitatively different and more complicated duration pattern of imaginative recall. And it is absurd to suppose that the immensely complicated organization at the basis of cumulative habit and the still more complicated organization presupposed by imaginative recall should have emerged by chance.

It is not by chance that intelligence, creative imagination, the sense of beauty, have developed in living matter. They are creative responses to the energy structure of reality. If seeing is a complicated adaptation, involving a trial and error process of organization of appropriate organs, under the impulse of light to see light, so thinking is a still more complicated adaptation, involving still greater differentiation and organization that thinking may be possible and that thinking may take account of the logical structure of the universe. The sense of beauty is a complicated trial and error adaptation under the impulse communicated by an energy organization of beauty to recognize and enjoy beauty. Thus a soul is created in matter by creative adaptation to the cosmos to respond to soul; and in due time when the adaptation is complete it opens to the beauty and order of the cosmos, as flowers open full-blown to the sunlight to unfold in beauty and bear their proper fruit. If art seems a creative addition to nature, it is in the last analysis nature which creates the creative artist, for he is part of nature, contrived under nature's impulse and responsive to nature's inspiration. So we can say in the words of Shakespere:

> Yet nature is made better by no mean
> But nature makes that mean: so, over that art
> Which you say adds to nature, is an art
> That nature makes.

CHAPTER III

Evolution as Cosmic Interaction

It is not without misgiving that we try to rise in imagination to the dizzy heights of reality whence we may survey cosmic evolution as a whole. In trying to do so, we feel in the same frame of mind as Plato in the *Timæus* when he essayed a similar task:

> Socrates.—And now, Timæus, you I suppose are to follow, first offering up a prayer to the gods as is customary.
>
> Timæus.—All men, Socrates, who have any degree of right feeling do this at the beginning of every enterprise great or small—they always call upon the gods. And we, too, who are going to discourse of the nature of the universe, whether created or uncreated, if we be not altogether out of our wits, must invoke and pray the gods and goddesses that we may say all things in a manner pleasing to them and consistent with ourselves. Let this, then, be our invocation to the gods, to which I add an exhortation to myself that I may set forth this high argument in the manner which will be most intelligible to you, and will most accord with my own intent.[1]

In both the invocation and exhortation we now join. The magnitude of the problem has grown greatly since the days of Plato; and while we cannot hope to equal his genius, the data at our disposal are vastly more complex and add to our responsibility.

Two Points of View of Evolution

It would be foolish to enter upon this stupendous task

[1] *Timæus,* Section 27, Jowett's translation.

without taking counsel with the past. In surveying the tendencies of the past, two points of view stand out with striking contrast. These we may call, for the sake of brevity, the Aristotelian and the Darwinian.

The Greek point of view, which finds its sublime expression in Plato and Aristotle, emphasizes form. It predicates a finite world, final causes, immutable species, determination of the lower by the higher. Reality for it is a closed system in which particular cycles run their course in obedience to the Idea of the good and the beautiful. Spiritual systems are supreme. It takes account of the world, as Spinoza would say, *sub specie æternitatis*. It gives but grudging recognition to the world of change, which is at best but a poor imitation of the eternal. It despises the infinite and formless.

The modern point of view which finds its typical expression in Darwinism emphasizes change, history, mechanical causes, flux of species, determination of the higher by the lower. History runs on like an old man's tale without beginning, middle, or end, without any guiding plot. It is infinite and formless. Chance rules supreme. It despises final causes.

We may take Aristotle as the representative of the Greek type of teleological explanation both because he envisaged evolution on a cosmic scale and because later teleological theories hark back to him. To Aristotle[2] we owe the supreme insight that if there is to be advance in nature toward higher levels, those levels must exist.

> The truth is, nothing is set in motion by chance: there must have been always some underlying cause, just as is the case now; a thing is moved this way by its nature, that way by force—whether of the mind or something else.

We must interpret motion in the past by what we know

[2] The following quotations are from Aristotle's *Metaphysics,* Book XII, Chapters 6 and 7, C. M. Bakewell's translation in *Source Book in Ancient Philosophy.*

of motion at present. If we find at present that later levels in a particular series are possible because they somehow pre-exist in reality and are determining causes of the temporal succession of levels; if we find that acorns grow into oaks because there are oaks and children grow into adults because there are adults, then we must believe that in the evolutionary process as a whole, the advance to higher levels in a particular series is due to the fact that these levels pre-exist as guiding causes. While it is true that in a particular life history the simpler stages are prior in time to the more complex and so seem to produce them, yet if we look at reality as a whole, the more advanced stages are prior to the more elementary stages; the actual is prior to the potential and furnishes the plus factor which makes a given level of development potential of a higher one. The stream of evolution does not rise higher than its source.

It is impossible to project evolution into a single history and account for the stages of development. There must, somehow, be adequate complexity in the structure of the cosmos to account for the advance in any temporal process.

> If it is true that actuality is prior to potentiality, it follows that we must not suppose that Chaos and Night existed for an indefinite time, but rather that the same things that exist now existed always, moving like a circle, returning upon itself, or in some other way. Now if the same world exists always in the circular process there must be something that always abides and that is actually operative in one and the same way. But the process of coming into being and passing away is possible only on the assumption that there is something else that exists always and exerts its activity now in this way and now in that; and so it must exert its activity in one way with reference to itself, in another way with reference to something other than itself. It must therefore exert its activity

> either with reference to the primal heavens (the heaven of the fixed stars) or with reference to another and a different principle. Now it must of necessity be with reference to the primal heavens, for that in turn is cause both of its own movement and of the movement of the lower heavens (*i.e.,* the planetary region, the sun, etc.). And so the heaven of the fixed stars is superior, for it is the cause of the eternally uniform motion while the lower heaven is the cause of the diversity of motion. Evidently both are causes of the eternally diverse motion. And in this way the different kinds of motion are related to each other. What need therefore to seek for other principles?

The levels of reality must coexist in the cosmos. If it were not so, "all things would have to spring from Night or from Chaos or from the non-existent." For Aristotle the qualitative levels of motion are also spatial levels. His levels, like Plato's, are fundamentally levels of value, and nature must be obliging enough to stage its motions in space in accordance with the hierarchy of values. This simplifies matters very much for Aristotle with his geocentric point of view. It is also congenial to his staging of the doctrine of the mean, so fundamental in Greek thought.

> There exists (1) something always moving with ceaseless motion, and its motion is cyclical. This is shown too not merely by our argument but also by the actual fact. Consequently the primal heavens are everlasting. Furthermore there exists (2) that to which these impart motion. And since that which both imparts motion and has motion imparted to it is in the mean position there exists also (3) something which imparts motion without itself having motion imparted to it—something which is eternal, which is an individual substance and wholly actual.

The final source of motion must be "a principle of such a nature that its very substance is its being actually operative. Further, substances of this sort must be immaterial; for they must be eternal if anything at all is eternal. They must therefore be pure actuality." Matter cannot put itself in motion, and hence its motion must be derived from immaterial motion.

There is in fact one substance which is absolutely self-moving and that is God, who is pure self-contemplation moving in a cycle of complete isolation or indifference to the rest of the cosmos. God contemplates only his own perfection. He is for Aristotle the ideal philosopher:

> God's life is like that of which we catch a glimpse when our life is at its best. . . . If then God is always as well off as we are now and then, how wonderful it is! And if He is always better off, it is still more wonderful. But such is the fact. And life belongs to Him; for the activity of mind is life, and He is that activity. Pure self-activity of reason is God's most blessed and everlasting life. We say that God is living, eternal, perfect; and continuous and everlasting life is God's, for God is eternal life.

If we ask, then, how God can move the world since He is indifferent to the world in His pure, simple, perfect actuality, we are told that this is the way this highest actuality imparts motion:

> It is like the object of desire or the object of thought, for these impart motion without being moved themselves.

The efficient cause, therefore, must be found in the lower stages, for it is the love in them for the ideal of perfection, for the eternal type, which spurs them on. But whence the impulse?

It is easy to show that, in the last analysis, Aristotle's theory furnishes no efficient cause of the evolutionary process—of the emergence of properties, forms, and levels in our temporal world. There is a hiatus between the actual and potential—the eternal hierarchy of values and our temporal world of change—which he does not bridge. The conception of an isolated level of activity, such as Aristotle's pure actuality, is a mere abstraction. We know activity only as exchange. We do not know it in isolation. And it is an ineffective abstraction because of its isolation. When Aristotle tries to account for the diversity of motions and forms in our actual world, he is shot through with inconsistencies. All motion is communicated from form to matter, from the higher levels to the lower, yet matter is made to account for the diversity of motion. All form proceeds, in the last analysis, from the pure simple actuality of God, yet there is indefinite diversity of form. How does form become pluralized or individuated? Is it through matter? But matter is formless and has no form except what is communicated to it. Here we have problems which were to perplex ages to come. Perhaps Aristotle really meant to attribute rectilinear motion to matter in isolation, rather than to deprive it of all motion, and perhaps he meant to attribute merely the curvature of motion to higher levels, and perhaps it was because of this intuition of world curvature that he came to have the idea of natural places into which the constituent elements move—a sort of geodesic path. If so, Aristotle is the real founder of the general theory of relativity. But, in fact, Aristotle, like philosophers generally, after having stated certain general principles, does not take pains to show how a world, such as we know in part, could be derived in detail from these general principles. Instead of accounting for the evolution of the world as it appears, he takes it for granted and merely adds his æsthetic superstructure in accordance with his personal tastes.

For Aristotle there is, as a matter of fact, no real evolution, no emergence of new forms in our terrestrial world. Oaks have always produced acorns, hens have laid eggs, human beings have generated children; and the offspring in each case conforms to type. Why then worry about how the types themselves have come to exist? So long as we deal with the repetition of the past, we can follow

Aristotle's conception that form must be immanent in the process, potentiality coming to its own in actuality. There is always an entelechy or form which guides every particular process. And what the world is, it always has been. Why bother oneself about how these entelechies or forms came to arise in our earth history? The supreme service of Aristotle is his insight that form does not arise by chance from chaos, that where there is a potential there must be an actual sufficient to explain its motion, that the whole must have the necessary complexity to account for the motion of its parts. He had the good sense of not postulating a causality of the future. Final causes in the sense of the end term of the temporal series acting upon the preceding terms are an illusion. The later events in the series have no way of directing the earlier events. Nor can causality from behind account for more than there is in the antecedents. If there is direction in the process it is not due to the first event, any more than to the last. It is due somehow to the compresence of factors in actuality. But Aristotle provided no efficient cause for temporal origins in the earth history in which we live and of which we are a part. He accepted a world ready-made.

Compared to the æsthetic structure of Aristotle, modern evolutionism is drab and formless. It tries to derive order from chaos. It emphasizes the temporal sequence of events. It treats geological history in isolation from the cosmic whole. The later characters, forms, and levels of evolution emerge by chance from earlier and simpler stages which do not possess them. By some magic the antecedent factors are supposed to yield new forms and characters. By chance variation the structure of protoplasm is supposed to be built up from inorganic matter, and by further chance variation the various life characters and forms appear. Intelligence is but a favourable chance variation of material antecedents. Chance is God. All happens by emergence. Of course, if science limits itself to description and merely tabulates sequences, no fault need be found with its account. But science aims at explanation and it is no explanation to say that the later appearances emerge from the earlier appearances. We have a series of leaps, of unexplained discontinuities. To be sure, we have natural selection, which is supposed to account for the adaptiveness of structures to the environment. But natural selection is a negative principle at best. It can produce nothing. It is merely stating that what cannot survive perishes, which is a truism.

There are many forms of modern cosmology. But they all proceed from the lower to the higher, from chaos to cosmos. They may take matter for granted as Spencer does, and conceive evolution as a passing from the homogeneous to the heterogeneous with a corresponding dissipation of motion, unmindful of the bankruptcy involved in such a process. They may try to evolve matter from some homogeneous ether by the introduction of motion which is supposed to stiffen the medium into vortex rings, etc., etc., but it is not clear where the motion with its diversity is going to come from; the properties of the ether are manufactured *ad hoc* and everything happens by chance. No attempt is made to account for the structure of the world as we know it. Modern evolutionism lacks any guiding field. Even if the influence of the environment is admitted, as the palæontologists have been prone to do, the environment which is assumed is itself a chance affair and therefore does not help us to account for structure.

The assumption by the pan-psychists and vitalists that, because properties and forms emerge in the process, they must have been present in the antecedents, that the atoms must have soul if they produce soul, or that everything is contained in some original life impulse which merely needs to be split up, or that there are entelechies of all individuals present somehow from the beginning, is even more absurd than the materialistic account. If we are to have any solid ground for inference and are not to lapse into mysticism, we must proceed from evidence, and there is no evidence of the properties of life or of soul in inorganic matter. Whoever was fool enough to suppose that even the properties of water are present in hydrogen or oxygen gas? Science recognizes that the appearance of new properties and forms is due to organization, to creative synthesis. The problem is how to account for the impetus to organization. It is not reasonable to suppose that the highly complicated structure of the atom originated from electrons by chance, or that the periodic law of the elements originated by chance. And if it is absurd to suppose that the structure of inorganic matter originated by chance, how much more absurd is it to suppose that life compounds so originated! Modern science has become remarkably well equipped with physical instruments, with microscopes and telescopes. What it lacks is the creative imagination of the Greeks. Whoever saw the organization of a college in a microscope or telescope, much less the order of the cosmos? There is more to nature than abstract elements. There is genius in the humblest structure of nature—in the wind, in the sea, in the simplest phenomena of life—which is too deep for utterance.

How long shall men waste their energies in the futile attempt to build the edifice of civilization of bricks without mortar? And how in the babel of noisy materialistic philosophies can the still small voice of sanity make itself heard? We must understand events not as mere chance occurrences, but as aspects of wholes, not mere space-wholes, not mere simultaneous sections of the temporal stream, but as space-time wholes or perspectives, in which time figures as an aspect as well as space, in which, in short, facts owe their significance to their duration and their trend, their backward and forward look. We must see the events in dynamic energy relations in which the future is as much part of the facts as the present and past and in which the elements can be seen to imply an organizing pattern. If evolution is rooted in chance, it is unaccountable how the parts, with their individual motions, should evolve so as to produce a co-operative system adapted to its environment. How in such a world could there be "a universally creative tropism" toward higher levels of organization? Even if by some miracle such order could be consummated, the destructive forces must sooner or later reclaim their own; and chaos would rule again with no trace of the fleeting order that chance had superposed. But no such order could ever happen. Of all philosophies, materialism makes the greatest demands upon man's credulity. The synthetic chemistry of nature has an adequate cause; and it is only man's laziness and blindness which prevent him from seeking to discover the architecture of nature. It is the formlessness of men's minds which makes them see nature as chance. While it is not true to say that our minds make the system of nature, it is true that only a systematic mind can discover system in nature. In nature's order there is a sufficient reason for all that happens.

The fallacy which underlies the various types of emergence theories is that we can account for new forms and characters in terms of the simpler antecedents in the series. This is a violation of the law of Leucippus that nothing happens without a reason. Why should new characters and forms appear from antecedents which do not possess them? It is true that in chemistry we find that compounds may have different characters from the elements in isolation. But this is not a spontaneous result of the elements. It can only happen because of the action of the environment. Hydrogen and oxygen combine into the compound H_2O under certain conditions of electrolysis or temperature. We must take into account the organizing relation of the cosmos as well as the elements. The elements assume a new form with new properties only under the impetus of a larger whole. It is futile to try to make the abstract factors of our analysis yield the new event. Causality can never be understood as a simple series of antecedents and consequents in time. To understand causality we must take account of the controlling field as well as the antecedent factors. Causality is never a determination from event to event in a particular time series.

This is equally true whatever may be the factors with which we start. The heterogeneous does not emerge from the homogeneous by means of motion unless the motion contains somehow the basis of heterogeneity and the principle of organization. We may start, as the "new realism" does, with neutral entities and then propose to condense these into various qualitative series by means of velocity—from roughness to the richness of music.[3] The neutralists throw in an organizing relation *ad hoc* and let creative synthesis do the work. Anything can be made of neutral stuff if you just provide creative synthesis. This is about as intelligent as the suggestion of an ignorant country legislator when it was proposed to buy a dozen gondolas for a public lagoon. He sagely remarked that the proposition was wasteful and that in his opinion it would be sufficient to buy a couple and then let nature take her course. Nature is prolific, it is true; but she cannot breed from wooden abstractions.

The most impressive attempt to evolve the richness of reality from abstract postulates is that of Professor S. Alexander in his fascinating book, *Space, Time and Deity*. Alexander starts with nothing but the mathematical abstractions of space and time; and out of this gossamer stuff he attempts to weave a cosmos:

> Space and Time have no reality apart from each other, but are aspects or attributes of one reality, Space-Time or motion. This is the stuff of which all existents are composed; and it breaks up of itself into these complexes within the one all-embracing stuff.[4]

It is to be remembered that neither space nor time has such potency in itself. This can be found only in their combination. Time-instants must be wedded to space-

[3] E. B. Holt's essay in *The New Realism,* 1912; also his *The Concept of Consciousness,* 1919. For a criticism see *A Realistic Universe,* J. E. Boodin, 1916, pp. 95-99.

[4] *Space, Time and Deity,* Vol. II, p. 428.

points, or rather they always exist in indissoluble union and cannot in fact be put asunder. Minkowski had suggested as early as 1908 that our description of physical events must be four-dimensional, *i.e.*, in terms of space-time. The same idea has been elaborated in the theory of relativity. But what for Minkowski and Einstein is a descriptive device becomes for Alexander a metaphysical postulate. The artificial abstractions of geometry become the primitive stuff out of which the world is generated. If we proceed by analytical abstraction from the concrete flow of reality, we arrive at pure motion without anything moving; and abstract motion can be analyzed into the abstract concepts of space and time—the combination of space-points with time-instants. Why not reverse the process and by synthetic chemistry generate reality out of its last abstractions? No doubt exists in Alexander's mind that the abstract concepts of mathematics are attributes of the real world. They are not for him, as for Henri Poincaré, pragmatic conventions contributed by the human mind and relative to the needs of description. They must meet the needs of metaphysical interpretation. They are legislative to reality, and constitutive of reality. Given space-time, we can account for everything by increasing complexity. It does not occur to Alexander that in the various stages of abstraction something may have been left out of the living dialectic of reality, and that, without this something more, our intellectual abstractions are unreal and barren.

For Alexander everything emerges from the complexities of space-time. The abstractions of space and time are invested with metaphysical properties which have nothing to do with the mathematical origin of these concepts. Space becomes a metaphysical continuum and not just a mathematical continuum, and thus space furnishes continuity to the instants of time. Space also has the property of conserving the instants of time. Space furnishes the continuity and time the content. Time is like a fly specking diversity over the blank continuum of space. Alexander further assumes a nisus of events in space-time. This nisus seems to be a sort of agent directing toward ever higher syntheses. In other words, the matrix of space-time possesses all the attributes necessary to account for reality. We can derive the abstract categories from space-time by abstracting "certain fundamental features which belong to every existent generated within the universe of Space-Time." We thus get substance, causality, etc.

> Besides these fundamental features, things possess quality which is the empirical feature of things. Qualities form a hierarchy, the quality of each level of existence being identical with a certain complexity or collocation of elements on the next lower level. The quality performs to its equivalent lower existence the office which mind performs to its neural basis.

Thus we may speak of colour as the soul of the vibrations of light.

> Mind and body do but exemplify, therefore, a relation which holds universally. Accordingly Time is the mind of Space and any quality the mind of its body, or to speak more accurately, mind and any other quality are the different distinctive complexities of Time which exist as qualities.[5]

Alexander reverses the Kantian conception of time. Instead of regarding time as a form of the mind, "we must say that mind is a form of time." [6] For mind "is but the last complexity of Time which is known to us in finite existence." [7] Minds, as existents within space-time,

> enter into various relations of a perfectly general character with other things and with one another. These account for the familiar features of mental life: knowing, freedom, values, and the like.[8]

[5] The above quotations in this paragraph are from Alexander's remarkable summary, Vol. II, pp. 428, 429.
[6] *Ibid.*, p. 44.
[7] *Ibid*, p 345.
[8] *Ibid.*, p. 429.

But ahead, always ahead is God, who is conceived at any stage of development as the next stage, the uncreated which is about to emerge from the complexities of Space-Time. Thus, before life emerged, life was God to the inorganic stage. "In the hierarchy of qualities the next higher quality to the highest attained is deity." [9] But there is also in Alexander the pantheistic note.

> God is the whole universe engaged in process towards the emergence of this new quality, and religion is the sentiment in us that we are drawn towards Time, and caught in the movement of the world to a higher level of existence.[10]

Such is the potency of space-time with the fertile imagination of Alexander added. But what about the potencies of the postulates themselves? Why should ensembles of space-points and time-instants have such fertility when wedded to each other and taken in perspective? And what accounts for the nisus towards more complex levels with their souls? What is to prevent time and space if left to themselves from running riot—running any way whatsoever, downward as well as upward? And what is to prevent us from conceiving any space-time synthesis as complete? There is no longer any difficulty of conceiving infinite series and ensembles of infinite series as complete. Of course, any postulates will do if we are willing to accept the thesis that the emergent qualities in empirical evolution are due to the postulates. But should we not enquire into the adequacy of the postulates? Can we make our concepts mean anything we want them to mean in order to do the work we want them to do? It would seem as though, if we want such abstract names to do so much work, we should at least pay them extra. (Or is capitalizing them sufficient honour?) But such work is magic, not logic.

[9] *Ibid*, p. 429.
[10] *Ibid.*, p. 429. In order to get the sweep and seductiveness of Alexander's argument it is necessary to read the book.

And a magnificent magician Alexander is. His book makes the Arabian Nights' Tales tame to one who can follow. But we always feel that there is more in the mind of the manipulator, to account for such wonderful appearances, than the abstractions he exhibits to us. The rest of us, at any rate, no matter how we manipulate the abstract concepts of space and time, seem to get nothing but space and time out of them.

We can, of course, take refuge in some general concept like the Absolute of Hegel or the Unconscious Will of Schopenhauer or the Creative Imagination of Douglas Fawcett and make such an inclusive concept responsible for everything. Hegel's Absolute is a rather skilful manipulation of the psychological furniture of its author; and at least it has resources of its own, greater than those supplied by the antecedent categories at any stage. But the selection of the categories and their transition show much more of the psychological bias of the manipulator than of strict logical implication. Schopenhauer's Unconscious can do anything, if you once admit that everything that happens is the product of the Unconscious. Creative Imagination is more fruitful as a universal category than formal implication; but we must still show how it creates in the concrete. And not all creativeness is of the order that we ordinarily denote by creative imagination.

In a large sense the order of the whole manifests itself in the order of the parts, but the parts are not mere functions of the whole, as the monistic theories all imply. Of course, if we mean by the Absolute all parts in concrete relations within the control of the whole, and contributing their individual determinations and histories to the significance of the whole, then everything would seem to follow, but we should still like to understand the relation of whole and part in our concrete world of change. The absolutistic systems have seemed too much like staging abstract categories. We should like to have some credentials that they can really do the work they undertake. For, after all, our absolutes are man-made and, if scrutinized closely, they can be seen to bear the original stamp of "made in Germany." If the process of evolution is to be understood as the mere emergence from simpler antecedents, then psychological monism becomes indistinguishable from materialistic monism. The problem which both materialism and idealism must face is that of an adequate efficient cause to account for evolution in the concrete.

The Conception of Cosmic Interaction

But we must not become misologists and despair of the possibility of knowledge. Nor have the attempts in the past been in vain. The Greeks have shown us the importance of form, of the pre-existence of structure, if we are to understand evolution. The modern evolutionists have shown us the importance of recognizing real history, real change, and studying the emerging qualities in their serial order. In the theory of cosmic interaction we hope to combine the Greek love of form with the modern respect for process. Thus we hope to establish an efficient cause for evolution. Let us recur to a concrete instance already used in another chapter.

We have seen that it is incredible that chance should account for the adaptive organization, over periods of millions of years, of the enormous number of factors involved in the response of seeing light. Such adaptation, we have seen, can only be explained by the constant action of light patterns, in a medium of suitable density, temperature, and chemical composition, upon the properties and duration of the life stream. It is vastly more incredible that the infinitely more complicated organization involved in the adaptation we know as creative thought should emerge by chance. Here too we must postulate interaction if we would have a sufficient reason. During untold ages the cosmic environment must have acted upon our earth to steer the process of geological evolution, before the structural conditions could appear which made the divine flash of thought possible. For as in the case of sight the functioning of seeing could only occur when the structural conditions were complete, so in the case of thought the function of thinking, the unique response to the logical pattern of our world, could only occur when, in the course of the long ages of trial and error adaptation, the structural conditions were complete for the act of thinking. The adaptive organization implied in thinking involves not only the creation of specific sense organs to respond to the various stimuli of nature, but it involves the creation of a nervous system with its duration patterns of habit and concrete memory, the creation of language mechanisms with their cerebral and terminal organization for expression, the creation of an organization which controls expression with reference to a social milieu and which can respond by a creative trial and error process of analysis and synthesis to the objective structure of the environment —an organization which is linked up with the affective and motor systems so as to make possible an enjoyment of realization on the one hand and a proper executive mechanism for its trial and error procedure on the other.

It is no explanation to say that such an ensemble of structures has evolved because it is useful. Thought, no more than the organization for seeing, could be useful until the organization for the unique response was complete. The assumption that such an organization could arise by accidental variations in the germ plasm in isolation from the cosmic environment and without any guiding control is too absurd to be entertained by a reasonable mind. The only possible sufficient reason for the evolution of the function of thinking is the interaction of the geological process including the stream of life with a cosmic constitution which has a logical pattern. The constant impetus to the evolution of thinking, as to seeing, must come from the cosmic whole of which the history of the earth is a part, and to which it comes to respond differentially through a trial and error process. As the result of this process, there appears in the fulness of time the flash of thought, as there appears the flash of light. As the flatfish imitates on its back, through a trial and error process, the pattern upon which it lies, not knowing what it is doing, so the geological life stream, by a trial and error process, strives to imitate through the ages the pervasive energy constitution within which it lives and moves and has its being. And, as in the case of vision, light acts to produce an impulse in the stream of life to prepare the specific structural adaptation for seeing light during vast ages before it can be seen as light, so the thought structure of the cosmos produces an impulse in the geological process to produce a structural adaptation to respond to thought during the long ages before the geological process is prepared to recognize thought. Both the sense of sight and intelligence must be understood, in the last analysis, as parts of an integral process of creative adaptation to cosmic structure.

In evolution it is the later adaptations that overlap and reveal more completely the nature of the cosmic control which furnishes, in the last analysis, both the impetus and the guiding field of the evolutionary process in any part of the cosmos. So far from creative thought being an accidental addition to sense responses and to habit and memory patterns, it is the creative thought pattern of the cosmos which stimulates geological history to its trial and error procedure to produce the sense organization, with its differential methods of response, and the duration organization with its habit and memory patterns as integral parts of the process of thought adaptation. The thought pattern organization is not produced in isolation from the pattern responses that precede it. Without sense organization, and without habit and memory organization there could be no thought organization, but thought structure is not a mere complication of simpler structures but a further integration in which these structures figure as instrumental parts. The thought adaptation, like the structural adaptation for seeing, must be regarded from the point of cosmic evolution as an integral dynamic process of which sense organization and duration organization are stages. So light produces adaptive trial and error responses which, once the adaptation is complete, may be regarded as stages in the complete adaptation to seeing. The light tropism of primitive organisms, the pigment spot of the jelly-fish, the lensless eye, the non-focusing eye, the focusing eye, the eye responding to the yellow-blue series of colours, may be regarded as stages in the history of complete light adaptation, integral to the adaptive response of the higher animals with their bifocal vision and their differential response to colour.

The question may be raised, if there is a cosmic environment which stimulates to adaptation in the cosmic parts and furnishes a guiding field for the part-histories, such as our geological history, why does evolution, as we know it, radiate in various directions? And why should it seem truncated, why does it stop short of the larger integral adaptation which we find in a few favoured instances? The answer is that evolution is never a simple function of the environmental field. We must take account of the nature of matter with its inertia and its diversity of impulses and motions. If there were no cosmic guiding field, there would be no evolution. But it is also true that if there were no reacting matter, there would be no evolution. Evolution is a complex function involving not merely the character of the cosmic guiding field, but the reacting individual as well. Evolution is an adaptive organization of matter to respond to its cosmic field. Hence we must not forget to give due credit to matter. Evolution may be spoken of as the incarnation of the energy patterns of the cosmic environment into material bodies. Hence the unequal inertia of matter and the elementary impulses and properties of matter count. Philosophers have sometimes inveighed against the inertia of matter, but they have forgotten to give credit for the docility of matter. The motions of matter can be curved within the guiding field. The character of matter makes cumulative adaptive structure possible even if matter of itself cannot produce the order implied. The impulse to creativeness must come from the cosmic guiding field. But this impulse is conditioned by the inertia of matter with its characteristics, duration and organization at any one time.

We must try to envisage geological evolution as a whole in relation to its cosmic guiding field. We are all accustomed to think of the course of the earth in space as due to its guiding field. The motion of the earth in space cannot be understood by attending to the earth in isolation from the rest of the cosmos. What is true of the motion of the earth in space is also true of the motion of the earth in time. The history of the earth can no more be understood than can its course in space by attending to the earth in isolation from the cosmos. In each case we must strive to understand the structure of its guiding field if we would understand the direction of its motion. Nor can we in either case understand the motion of the earth if we neglect to take into account the material energy system of the earth itself. The direction of the earth's motion is in neither case a simple function of its cosmic environment. We must consider the integral field with the earth as part of it, if we would understand the curvature of the earth's path. The course of the earth in cosmic space and the course of its evolution are alike determined by adjustment, the adaptation of the earth to the structure of the cosmos. The course of the evolution of the earth is no more a matter of chance than are its space relations. Nothing emerges in the history of the earth which is not determined by the interaction of the earth's milieu of energies with the structure of its cosmic environment. If the stream of life pulsates in adjustment with the total pulse of Mother Earth, so the evolution of the earth pulsates in adjustment with the rhythm of the cosmos. Our geocentric blindness to this fact no more alters the fact than our geocentric blindness for ages to the earth's motion in space altered the fact of that motion. Our earth is as little self-sustaining in its evolutionary course as it is in its space relations. Only the whole is self-sustaining; and we must understand the geometry of the earth's history, as we have come to understand the geometry of its space relations, in terms of the dynamic geometry of the whole.

Preformism and Epigenesis Reconciled

Once we understand the fundamental fact that the evolution of the earth is determined by cosmic interaction, then the emerging of characters and forms in the history of the earth ceases to be a matter of magic. "Nothing happens without a sufficient reason" becomes applicable to events in history as it has already been applied to motions in space. We have then a key to the classical antinomy of preformism and epigenesis. Preformism, broadly speaking, has insisted that the emergence of characters and individual forms in the present must be foreshadowed in the past; that the form of the individual is present in the structure of the germ cell, and this in turn in its constituting factors, and so back indefinitely. But it is an indisputable fact that new characters and forms appear. Are these latent, then, in the past? But why are they called forth at a particular time? Is the whole order of evolution latent in the simplest beginnings? Is the history of life with its varying forms, its radiations, its reversals of direction with a changing environment latent in the original protoplasm; and not only that but in the preceding inorganic stages of the earth's evolution? It is a theory not only lacking evidence, but logically incredible. It is true that somehow there must be reason for the order which we find in evolution, but we cannot account for this order solely in terms of the antecedent events, projected in one perspective.

The theory of epigenesis in its most general terms emphasizes novelty. It lays hold of the fact that new characters, organs, and forms appear. The new events are supposed to be a synthesis of pre-existent characters, but the later form does not exist in the preceding events. The present is not the mere unravelling of the past. There are additions. And these additions, if not cut short by natural selection, cumulate in a certain direction until new forms, new organs appear which can play a part in life adjustments. But all this is supposed to happen in isolation from the environment of the germ plasm. It is due to spontaneous variations in the presumably isolated basis of heredity. This theory retires behind its professed ignorance of how the variations occur; it furnishes no explanation of why the variations should accumulate in a certain direction so as to emerge eventually in forms and organs which are adapted to a specific environment. Lately the magic phrase, creative synthesis, is made to account for new characters and forms. It is pointed out that the compound, water, has different properties from those of the separate elements, hydrogen and oxygen. These new properties are said to be due to a creative synthesis of the properties of hydrogen and oxygen. But water does not arise fortuitously from mere hydrogen gas and oxygen gas in isolation from the environment. Not only must there be quantitative proportions, but there must be quantitative energy conditions such as heat or electricity. It is by determinate action of the environment that the two gases enter into synthesis and assume new properties. The value of the theory of epigenesis is that it emphasizes that there are new events in the series, that evolution means creative addition and not the mere squeezing out of characters and forms from antecedents which show no evidence of them.

The fact is that preformism and epigenesis are abstractions, unintelligible and contradictory when taken by themselves. And yet from the point of view of the whole, each has its truth. There is preformation in the whole in relation to the history of any part of the cosmos. It is not an accident that geological history runs its course as it does. On the other hand, each history is marked by creative additions which cumulate into more complex structures. The later events are not mere repetitions of the earlier. They are not implicit in the earlier. Both preformism and epigenesis find their explanation in cosmic interaction—in the creative adaptation of the part to the impetus communicated to it by cosmic structure elsewhere. This does not mean mere repetition, mere imitation of the pre-existent structure. The processes of adaptation of the less developed history may not be characteristic of the more advanced history elsewhere. Every history adapts itself by a trial and error process characteristic of its milieu, resulting from its own composition, conditions, and history. The effects of the cosmic environment are masked by the complexity of the adaptation of the more developed organisms, but they are real nevertheless; it still holds that the life process is one of adaptation to accomplish energy exchange. The structure which results is itself the product of the process of creative adaptation. It is correspondingly unique and not copied from elsewhere.

The law of rectigradation which means that variations, as observed in many life series, cumulate in the direction of an adaptive response, now gets its true setting. The law of rectigradation is not an abstraction, inherent in life and matter in isolation and working without reference to the action of the environment. It is the result of the interaction of the geological stream of life with the cosmos. The seeming preadaptation or fitness of the earlier for the later stages is due to the fact that what is future in the geological series is compresent in its structural characteristics with the geological series, owing to more advanced histories elsewhere in the cosmos, with which the life process is striving to effect energy exchange.

Coexistent Levels in Cosmic Evolution

The universe cannot be understood as one history proceeding from chaos to cosmos by chance combination of elements and natural selection. Rather must we understand reality as a rhythm of multiple histories which exist at different levels and which interact. The order of evolution at lower levels must be determined by interaction of the lower level with the higher levels. We find this relation exemplified in social evolution which itself is part of cosmic evolution. Here we have individual histories of various degrees of maturity—childhood, youth, manhood, old age. Childhood does not develop in isolation from the later levels of maturity. But these coexist with childhood and through the organization, which they embody as tradition, furnish a guiding field to the new generation. The new generation in turn responds by creative adaptation to the social structure embodied in older generations and thus takes on the forms of social organization. This relation of interaction holds not only between the younger and older generations within one group or civilization, but it holds also between different groups and civilizations. Less mature groups come in contact with more advanced, and adapt themselves to the more mature civilization in accordance with their history and genius.

Social evolution is not complete in itself and therefore cannot fully exemplify cosmic evolution, for social evolution is but part of the evolution of life which moves in rhythm with the more inclusive evolution of the earth; and the whole of geological evolution, with its various histories and levels, moves within a cosmic field. But at any rate social evolution exemplifies the organizing impulse which comes from more developed histories to less developed histories. Without such a stratification of levels in society there could be no creative advance in human history, not to mention the fact that there could be no biological survival. In fact, the nurture of the younger generation by the older with its milieu of habits is the condition of the existence of all higher animal life. The point I wish to emphasize is that in the portion of cosmic evolution of which we have the most intimate acquaintance, viz., social evolution, the creative advance of nature is conditioned by the coexistence of levels and the fructification of the lower levels by the higher. Even the cosmic gift of creative genius with its creative adaptation is conditioned by this stratification of social life. Genius, to become fruitful, cannot live in isolation. It must interact with the level of tradition, attained through the ages, in order to enrich that tradition with its creative adaptation. This adaptation means the fructifying of tradition with a new rapport with cosmic genius.

If we once realize that in the universe as a whole higher and lower levels coexist, then we can at least see the possibility that the creative advance in any one history is due to the interaction of that history with higher levels in the cosmos. As in social evolution the adaptation of the less advanced stage of development to the more advanced is conditioned by the history and structure of the less advanced, so on the larger scale of cosmic interaction we must not conceive the advance of a lower level as a simple function of the higher, but must conceive such adaptation as conditioned by the history and structure of the lower. But in their generic features, at any rate, the past, present, and future may be conceived as coexisting in the cosmos as a whole. The past, present, and future levels of the developmental history of our earth may be conceived to exist in their generic structural characteristics yonder in the various histories of the cosmos as the various stages of a human individual, in their generic features coexist in the overlapping generations of the race. The repetition is not exact, since each generation, human and cosmic, has its own motion, duration, and unique structure; and therefore it is an adaptation with variations. In cosmic histories, as in human, there is evidence of accidents, and a particular history may not complete its growth-span whether from internal instability or unfavourable external conditions.

As over against the conception of evolution as one history proceeding from the homogeneous to the heterogeneous, from chaos to order by chance, I conceive the cosmos as a structure consisting of a plurality of histories of different levels interacting upon each other. In order to account for evolution as we know it, these levels must be not merely quantitative, having reference to the intensity of energy potentials—though they must be this in a self-running cosmos; but there must also be qualitative levels having reference to organization and furnishing an impulse to organization in other levels. The great motto of Leucippus, "Nothing happens without a reason," applies to the organization of energy as well as its quantity. A new direction of organization can no more take place without an impulse from without than can a new space direction of motion. And as the impulse to a new direction of motion is conditioned by the inertia of the moving body, so the impulse to new organization is conditioned at each stage by the inertia of the organization already existing. We cannot, of course, separate the quantitative and qualitative aspects of evolution. But neither is one a simple function of the other. The period of maximum intensity of energy seems to be the period of minimum organization, nor can qualitative evolution go on below a certain minimum intensity. A golden mean of intensity is required for the maximum of qualitative evolution. But mere variation in intensity cannot produce organization. The impulse to organization must come from pre-existent organization.

From the point of view of geological history we have a series of discontinuous steps. In some fashion the earth is a cumulative condensation within the nebulous state of matter which preceded our solar sytem. The geological strata indicate that for vast ages there was no life upon our planet. But in the meantime the earth, while increasing in mass, was also undergoing an evolution in the proportional distribution and combination of elements and the establishing of such conditions of temperature, density, moisture, etc., as are necessary to life. In due time life appeared in the form of those micro-organisms which are the antecedents of our bacterial life and which have left their record indirectly in certain geological changes in the earth's crust. The appearance of the simplest forms of life is unlike anything which preceded as a system of energies. But the creative passing from these to the protozoa is no less a leap; and the passing from the unicellular organism to the multicellular marks the beginning of an even more remarkable series of transformations. At a very early stage the life process splits into two branches, the vegetable and the animal; the former remarkable for its adaptation for the storing of energy, the latter for its adaptation for converting energy into action. If we follow the latter development, we note the gradual emergence of new forms of structural organization until man finally appears. With the growing complexity of physiological organization appears a series of developmental steps towards intelligence—sense differentiation, habit, memory, language mechanisms, culminating in creative thought, social organization, the sense of beauty, the feeling of religious reverence.

This marvellous series of transformations in the earth's history cannot be the result of the primal constitution of matter in isolation. It is due, we believe, somehow to the interaction of matter with its cosmic environment. The cosmos must somehow possess the stratification of structure which can give impulse to the creative evolution of our earth. The earth, even physically viewed, is not isolated. It is a condensation within an electromagnetic field and is part of that field. Aside from the evidence of the interaction of matter upon matter in the gravitational relation, we know now some forty different types of radiant energy which are communicated to the earth from the cosmos. The eye, we have seen, is a creative adaptation of organic bodies to a certain range of these waves. But there are other waves of shorter wave lengths such as ultra violet, X-rays, and gamma rays. And there are waves of longer wave length, down to those used in wireless communication. These are complexities which we have been able to discover by improved physical instruments, but they probably indicate only a small part of the complexity of the cosmic influences that reach our earth. Some of these cosmic energies not only act from outside on material bodies but are inducted into material bodies such as electricity, and some can pass through material bodies as in the case of X-rays. So far from being isolated, the matter of our earth is a centre of exchange in a cosmos of undreamed-of complexity. If this is true of the material adaptation of our earth, it must be true in a vastly greater degree of its spiritual adaptation.

The Evolution of Matter and Cosmic Levels

If we look at the problem of evolution from the cosmic instead of the geological point of view, we find various worlds in various stages of material evolution. All the cosmic generations coexist in the depths of space. We find all the ages of evolution from diffuse nebulæ to worlds that have passed into senility and become dark and cold, though the astronomer's instruments can still identify many of them, for matter always radiates in all its stages. The spectroscope shows that in this vast array of worlds, irrespective of their ages and conditions, the same elements and properties of matter can in general be identified as on our earth. Sometimes new elements have been identified in the stars before they were known on earth. Do the elements themselves evolve in the cosmic laboratory? Certain it is that atomic matter is an organization of simpler units. We know now that matter is not a mere homogeneous plenum as the ancients thought, but a marvellous hierarchical organization. Compound substances are an organization of molecules, every such substance having its own architecture and range of adaptation. The molecules, again, are an organization of atoms and have their own architecture. The marvellous structure of certain crystals and certain metals has now been revealed by X-ray photographs. And the atoms, so long regarded as indivisible, are now conceived as miniature solar systems—negative charges of electricity, the electrons, moving with reference to a positively charged nucleus, within the constellation of the atom. The mass of an electron is said to be about 1/1850 of the mass of a hydrogen atom. Almost the entire gravitational mass of the atom is, therefore, due to the nucleus. The real units of modern physics are not the eighty-eight known chemical elements but the two types of electrically charged matter—the electron with its negative charge and the nucleus with its positive charge. Within the atom like charges repel each other and unlike charges attract each other according to the law of the inverse square. The elements are now conceived as organizations of these two types of constituents with increasing complexity. With the complexity go greater degrees of freedom or instability, which is seen in the inverse process, the breaking down of the highly complex radioactive elements and their degeneration to helium and lead. We are as ignorant of the variations of cosmic weather which cause the breakdown of the radioactive elements as we are of the conditions of their synthesis.

The relation of the elements to each other has been of great interest to science ever since Mendeleef discovered the periodic law of elements in 1870. It seemed to him significant that the elements could be arranged in a series on the basis of atomic weight and that the other elements could be treated as multiples of hydrogen. (This proved to be approximate, but the discrepancy seems to be in a way to be explained on the basis that mass may be generated by velocity.) But more significant proved the discovery of certain periodicities in the atomic table, *i.e.*, the recurrence of certain characteristics in elements which makes it convenient to group them together, as, for example, the alkalis. It was possible in this way to predict elements in the series in advance which greatly aided discovery. The question naturally occurred whether other elements might not be regarded as evolved from hydrogen atoms. But this was speculative, until the discovery of the radioactive elements towards the end of the nineteenth century revolutionized our conception of matter. Recent spectral analysis has made it possible to give a more adequate explanation of the periodic law, basing it upon the structure of the atom instead of its weight, which had long proved an inadequate method. The atomic number is determined by the number of nuclei or positive charges.

These remain constant so long as the atom exists, while the negative charges vary. Thus hydrogen, the first element, carries one positive charge; helium, the second, carries two positive charges; lithium, the third, carries three positive charges, and so on up to uranium the ninety-second element, which carries ninety-two positive charges. There are at this writing (1924) four vacant places in the atomic series. In its neutral or unelectrified state an atom carries an equal number of positive and negative charges or satellite electrons. Thus hydrogen in its neutral state carries one satellite, helium two satellites, lithium three, and uranium ninety-two.[11]

The arrangement or orbits of these electrons with reference to their nuclei is the interesting problem both for chemical and physical purposes, though our knowledge is in its infancy. In general there is agreement that electrons exist in various orbits or energy levels. For explaining chemical change, the outer orbit is of chief significance. If an atom is deficient one electron in its outer orbit, it will combine under suitable conditions with an atom having an extra electron in its outer orbit. There will then be exchange, or rather flow of energy from superabundance to deficiency. But in chemical synthesis, while the extra electron enters the deficient orbit, it also figures in the orbit of its own atom. It thus establishes a bond. The same principle is illustrated where an element is short two electrons in its outer ring and combines with an atom having two extra, where the bond would consist of two

[11] I have said nothing about the electrons and nuclei, boxed within the interior of the atom. "The nuclei of all the ninety-two elements are probably made up of hydrogen nuclei, of which there are in uranium two hundred and thirty-eight (the atomic weight of the element), but only ninety-two of these 'have no lids on' and are neutralized by ninety-two outer revolving electrons. Uranium is the last and ninety-second element of the list. . . . Elements which, having the same number of 'open boxes,' have the same properties, but have different numbers of 'closed boxes' and therefore different weights, are called isotopes." *Science and Religion*, by J Arthur Thomson, New York, 1925, Appendix 2 by David Landsborough Thomson, p. 266 The discovery of isotopes—elements alike in structural characteristics but differing in weight—seems to make it possible to explain the discrepancy between the order based upon weight and that based upon structure.

electrons. Thus a simple explanation is found for chemical synthesis and valency. But chemical synthesis is only an example of the law that all change is exchange, that all synthesis is sharing, whether it is chemical sharing or the sharing of common interests in the bond of society. Atoms which have no deficiency and no abundance are self-contained or inert. These also have their analogues in human society. Why we speak of the state of an atom, when it has a deficiency of electrons, as positively electrified, and of the state of an atom, when it has a superfluity of electrons, as negatively electrified is one of the anomalies of language. The shifting of electrons from one orbit or level to another is a problem of great interest to physics. For physics explains absorption, the gulping in of energy, as the shifting from an inner orbit to an outer orbit, while it accounts for radiation of energy, the emitting of the waves that give us our spectral bands, as the shrinking from an outer to an inner orbit within the atom. This shifting is finite and indicated by integral numbers. Those who conceive an electron as an ether stress would say that it is a shifting from one equilibrium to another in the ether. But the language of electrons is in favour at present.

When science is thus able to arrange the elements in a structural hierarchy with recurring periodicities, and to account for physical and chemical changes on the basis of the dynamic complexities of such an arrangement, it is difficult to escape the feeling that the atoms stand in some sort of genetic relation in nature. We can not say that they are arithmetically compounded of hydrogen atoms, because each atom has its unique pattern, but at any rate hydrogen occupies the first place in the synthetic process. In the radioactive elements we have evidence of an inverse process of evolution—the dissolution of more complex elements through various stages of uranium and radium to helium and lead. Here we have a spontaneous alchemy of elements, though from more complex to simpler elements. Moreover, Rutherford and others have succeeded in breaking down artificially such elements as nitrogen into hydrogen and helium atoms, by bombarding them with the so-called alpha rays—the spontaneously dissociated nuclei—of uranium with their enormous energy. True, the human chemist has not been able to synthesize what he has been able to dissolve, but what about the genius of nature? If radioactive elements are breaking down in the cosmic laboratory, there must be a law of compensation or there would be no radioactive elements to break down.

It is not necessary to suppose that radioactive elements in other parts of the cosmos are limited to those which we have identified upon our earth.

> Perhaps in the extreme conditions of pressure and temperature prevailing in the deep interiors of stars the process of disintegration is greatly accelerated and is going on in all substances.[12]

It is generally believed now by astronomers that the enormous supply of heat generated by stars is due in part to the liberation of sub-atomic energy. According to Eddington the immense internal heat of the giant stars causes the satellite negative electrons within the constellation of the atom to be detached from their positive nucleus, thus mutilating the atom, if not completely disintegrating it.[13] The origin of the atom is a problem still waiting solution. But we may be sure that if elements disintegrate, they are also reconstructed, and that this does not happen by chance but in accordance with cosmic control; else they would not reappear in the various parts of the cosmos with such regularity and universality as they do. It is true that we are not entitled to say on the evidence available that the elements are present in the same proportion everywhere and that there are no new

[12] F. R. Moulton, *An Introduction to Astronomy,* Revised Edition, 1920, p. 535.

[13] See A. S. Eddington's article, "The Interior of a Star," the *Scientific Monthly,* Vol. XVII, p 255 ff.

elements anywhere. There is at least one element in the sun's corona which has not been identified on the earth. Nor can we assert dogmatically that the elements remain constant throughout the entire history of a star, since we know of elements which disintegrate within our own solar system. It would seem, however, that there are definite cycles repeating themselves in the main in all the worlds, according to a law of cosmic synthesis. While the constitution of atomic matter seems to be the same everywhere, it is not necessary to suppose that life histories of various worlds are mere repetitions of histories elsewhere. The conditions must vary in various histories, and therefore the creative adaptations must vary. We have no reason to assume mere uniformity in either time or space. If there is give and take between different worlds in the cosmos, so that the past history of one part of the cosmos is conserved in another, with varying repetition according to the unique adaptation of each to the rest of the cosmos, then cosmic evolution, viewed from any one history, may well be cumulative, and the recurrence or rhythm may be spiral instead of circular.

We find it congenial, on logical grounds, at any rate, to assume that matter with its complicated structure is an evolution, the result of interaction. We know that material energy left to itself tends to a level of diffuse motion. If we conceive matter in isolation from the hierarchical structure of levels in the universe, we have chaos—certain primal entities such as electrons, darting hither and thither, without organization. We have an image of such a state in the Brownian movement. Such a diffuse level as the final goal of energy is implied in the second law of thermodynamics. It is that in every transaction of energy some energy escapes or becomes unavailable, and that in the course of time all energy must reach the diffuse state. But since the loss is finite, the universe should have run its course and reached the dead level. The second law of thermodynamics assumes levels as existing somehow. It merely emphasizes the empirical fact that so far as our control is concerned, energy tends to equal distribution and hence to disappearance as available energy. But if the cosmos is self-sustaining, there must be a running up process to compensate for the running down process; and the levels within the cosmos as a whole must be eternal. Matter of itself could never have emerged from its hypothetical diffuse state to produce levels. Chaos must have remained chaos except for the impulse from a cosmic constitution which contains the necessary complexity within itself. The organization of matter must be due to the interaction of matter with pre-existent levels of organization. In the last analysis the diversity in the structure of matter is due to its interaction with the cosmic constitution. The elements of matter are not neutral; they possess motion and inertia. Else no interactions could exist and therefore no evolution. Evolution is a compound motion which implies the motion of the constituent elements plus their curvature within the specific field of control and, in the last analysis, within the field of cosmic control.

The fact is that matter does not exist as *mere* matter. Chaos is a mere abstraction of our thought which lays hold of one aspect of change, the running down process, without taking account of the compensatory aspect, the running up process. Matter always exists in various stages of organization. It never escapes the control of the cosmic field, though it escapes from a particular control for the time being. Inorganic matter is controlled for the time being in a particular series by living matter and enters into the organization of living matter. But when the particular cycle is complete and the particular control ceases, matter tends to return to the inorganic level, though under certain conditions the stored energy may remain for ages. Witness the strata of coal. There is always the centrifugal tendency of matter which is curved for the time being into a particular cosmic field. But the particular rhythm runs its course and so do the complex rhythms which hold in control the particular rhythms.

Worlds are born, grow to maturity, and die, but the cosmic control is constant. Everything evolves except the law of the whole.

Matter, then, as we know it, owes its organization and definite properties to its being part of a cosmic system of hierarchical control. The marvellous structure of the atom and molecule, the periodic law of the elements, the mathematical order of nature which we strive to decipher, the symmetry and beauty of matter, its dynamic adaptiveness to enter into higher systems of control in the evolution of worlds—all is due to its moving within the field of cosmic control, to its interaction with the larger universe. Matter in the abstract is capable of no habits of cumulative duration or creative synthesis. It owes these capacities to its organization within cosmic control. Just as in the hierarchy of the organism, the reflex centres owe their definiteness of function—their graduated and localized response to stimuli—to the control exercised by the higher levels of the cerebrum, and lapse to the diffuse level of the mass-reflex when this connection is broken, so matter in the cosmos owes its definiteness of function, its mathematical laws, to its existing as an integral part of the cosmic hierarchy of control, which never lapses, though particular controls lapse. The interactions in nature are never between matter in the abstract and higher levels in the abstract. The exchanges of energy in nature are between different levels of organization and different histories of organization where each part, from an atom to a solar system, moves with a history and organization of its own which condition its transactions within the cosmic field, its osmosis and dialysis, its inductive capacity, its creative synthesis and stages of development. The abstraction of matter and the abstraction of system would remain barren if conceived in isolation, as Plato tried to conceive them. The transactions in reality are between concrete systems, between organizations of matter at various levels. We do not know of any form in the abstract, or any matter in the abstract, except within the field of abstract thought. But here they are barren.

Cosmic interaction means not merely the creative contribution of the higher levels to the lower, but also of the lower to the higher. As in the human organism the skeletal structure, the assimilative, respiratory, and circulatory systems and the various centres of reflex control are a necessary basis for the higher level of intelligence and contribute their share to it while borrowing guidance from it, so in the evolution of the earth and in the cosmic economy generally we may say that if body without soul is blind, soul without body is an abstraction. Matter needs form no more than form needs matter. In a cosmos where the levels of matter always exist in integral relation with the levels of soul, body is not blind nor soul lame. Without either matter or form, organization and evolution would be impossible.

In the human economy, we know that levels coexist as integral parts of the whole, and that higher levels can guide lower levels while lower levels can contribute to the sustenance, stability, and mechanism of higher levels. Can we conceive such an integral control within the cosmos? We must remember that human nature is part and product of the cosmos. Hence there *can* be such integration, and there *must* be to account for the evolution of human nature. Do lower levels sometimes become dissociated from the control for a period, as cancer cells escape from the control of the organism, until the diseased part is eliminated and its energy worked up into more adapted synthesis? Evidently since cancer growth and other excrescences, physical and moral, are parts of the cosmos, it must be that the parts by virtue of their own impulse and inertia sometimes fail of adaptation and must be eliminated by cosmic selection. No part is a mere function of the cosmic whole. If the lower levels were a simple function of the higher, we should indeed have perfect imitation, perfect uniformity. We should have no discrepancy, no tragedy, but neither should we have creative evolution or individuality. The relation, however, is one of interaction, not of one-sided dependence. Parts sometimes lag in cosmic readjustment. Sometimes they become stereotyped and are unable to respond to changing conditions. They may fail to reach an equilibrium among themselves. Hence an evolution built upon various histories and their consequent need for creative adaptation must necessarily bring conflict and tragedy as part of the process.

The theory of cosmic interaction as outlined above is logically convincing in its main features. We may be sure that in a self-sustaining cosmos there must be an upward as well as a downward path and that therefore the levels of energy are eternal. We may be sure too that new characters, forms and qualitative levels do not emerge in our geological history by chance, but that they must be due somehow to the interaction of our earth with a dynamic constitution of the cosmos which possesses the necessary stratification. But can we form any conception in detail of the transactions of our earth with the cosmos which would make our theory plausible? We have seen that the cosmos consists of various worlds in various stages of evolution. Within the cosmos, worlds, like individuals, have their rhythmic span. The pioneers of Greek thought already had an intuition of coexisting worlds running their course within the whole. Of this we have now sufficient evidence. We may be sure that it is not an accident that there coexist various cosmic histories in various stages. And we may be sure that in cosmic evolution generally, as well as in social evolution, creative advance is due to the fructifying of lower levels of development by higher levels. But can we conceive any effective interaction between such world histories? Unless we can discover an efficient cause linking the various worlds together, the conception of cosmic interaction must remain theoretical, however congenial to reason. The mere fact that various levels of evolution coexist in the cosmos does not prove that they can interact, even if we could be sure that all the levels always coexist from the lowest to the highest stage of development. And we cannot be sure of that, unless we can conceive these worlds as linked in an efficient relationship. Our sense of cosmic isolation is not easily broken through. We are appalled by the indifference of space, and our imagination stands baffled by the magnitudes of stellar distances. While we can take account of interactions and creative adaptations within our geological milieu and history, how can we make the idea of creative adaptation convincing on a cosmic scale? What mechanism can we show for such interaction that would make it plausible?

The Mechanism of Cosmic Energy Exchange

The problem of discovering the method of energy exchange over the vast distances of cosmic space is a stupendous one and will require not only patient investigation but great creative imagination. The conception of the relation of world histories to one another in the cosmos is in much the same position as that of gravitational facts before Newton and that of biological facts before Darwin. We have a mass of descriptive data, but we have hitherto lacked an efficient principle to link the data together. But we must make the most of such hints as science furnishes. We know that the parts of our universe are not actually isolated in space. They are linked by the gravitational field and the electromagnetic field, whatever may be the relation between these fields. But we must believe that the parts of the cosmos are linked in time as well as in space. That means that the history of one part of the cosmos has reference to the history of another part of the cosmos. The events in one world history are not indifferent to the events in another world history, but exercise control upon that history in determining its course in time, as worlds within the gravitation field exercise control upon one another's course in space. If we must treat the earth as a unit from the point of view of gravitation control in space, so we must treat geological history as a unit from the point of view of the backward and forward looking control in time, bearing in mind all the while that the temporal view, the creative advance of nature, includes the spatial as a cross-section of itself.

We must conceive the cosmos, in the last analysis, not merely as a space equilibrium but as a space-time equilibrium, meaning by time here not mere clock-time but the creative passing of nature or history. It is absurd to suppose that the creative passing of nature is a function of clock-time. That our universe is in a real sense an equilibrium we are bound to believe on the basis of scientific evidence, direct and indirect. It is a necessary implication from the facts of science. We must postulate in electrodynamics that every electron has one equilibrium and only one, and that it owes this equilibrium to the geometrical structure of the cosmic field or, if we prefer, to cosmic curvature. We have also come to realize that the material world must be regarded as a closed world. Without entering upon the question of the finitude of the world, we must conceive the material world as having such an energy curvature from part to part that no matter or energy escapes into an infinite void. This follows logically from the self-sustaining character of our universe, for if matter or energy kept escaping, the world could not keep running. It is rendered plausible, moreover, by the newly-discovered curvature of light within a gravitational field.

But the conception of our universe as a dynamic equilibrium has further and more significant implications. If the cosmos is once conceived as one closed control, then not only must the total energy be constant and all the parts down to the electron be conceived as in a state of equilibrium at any one moment, but the parts must be in equilibrium in time as well as space, so that a variation of the course of nature in one part must have compensations in other parts. A dynamic equilibrium means, therefore, not merely that as the quantity or intensity of energy varies in any one part of the cosmos there must be corresponding variation in intensity in other parts of the cosmic field, but it means also that the variation of phases and types of organization in one part will tend to produce corresponding variation in other parts. As the intensity levels are constant in the whole though varying from part to part, so the phases and levels of organization are constant in the whole though varying from part to part. That means that while the parts vary in intensity, the maximum level of intensity and the minimum level of intensity and the variations in between are constant for the cosmos as a whole. Else the quantity of energy would not be constant. It means also that, while the phases and levels of organization vary from part to part of the cosmos, all the phases and levels are constant or coexist eternally for the cosmos as a whole. This follows from the conception of a cosmic field of control. Every part of the cosmos is determined in its energy, phases, properties, and organization by adjustment with other parts within the cosmic field, which is itself determined by the total adjustment of parts to each other.

But if every part is determined as regards its energy, phases, and properties by adjustment within a dynamic equilibrium of multiple worlds, then it must be clear that no part evolves of itself. The history of our earth is what it is by virtue of its space-time relation to the dynamic equilibrium of the cosmic whole, and without taking account of this relation, the energy system of the earth is unintelligible. Nothing moves in isolation. Everything moves in fields controlled, in the last analysis, by the total field. The conception of a cosmic dynamic equilibrium weaves the worlds together into a cosmic plot. Once we see that the course of the movement of the part, in time as well as space, is determined by adjustment with other parts within the curvature of the whole, that the quantity of energy, the phases, properties, and organization of any part exist by adjustment or adaptation within the total equilibrium, we have a key to geological evolution, the evolution of which we know most and which interests us most. For the conception of a cosmic dynamic equilibrium is not merely a quantitative conception, but fundamentally a conception of structure. To use mathematical language, the geometrical structure of any one space-time field or history is determined by adjustment with the structure of other space-time fields or histories. In the last analysis, the conception of a cosmic dynamic equilibrium is a conception of structural equilibrium. At first glance the significant fact seems to be that the structural aspect of history varies with the intensity of the space-time field. But closer examination shows that the variation of cosmic intensities is determined by the structure of the cosmic field. A cosmic field, such as our solar system or our earth, does not develop a certain dynamic structure because of the variation in intensity within the field, but the variation in intensity within the particular field is due to cosmic curvature. The state of our earth or our solar system is controlled by adjustment with the cosmic equilibrium. The energy of our system pulsates with the throb of the cosmos. The earth or sun contracts or expands with the heart beats of the cosmic system. It is to structural adjustment with this system with its various space-time energy levels that our earth system owes its direction in space-time.

Everything, no doubt, could be seen to follow from the law of dynamic equilibrium could we follow it in detail. For if the universe is self-moving and self-maintaining, then not only must it be a closed system, curved on itself so that nothing can escape into the void, but there must be a balance of exchanges and rhythms within the system, so that the shifting of potentials and the shifting of structure in any history is controlled by adjustment within the cosmic field. Nothing, we have seen, moves in isolation, but everything moves in fields, controlled, in the last analysis, by the total field. But our knowledge is limited and our imagination is weak and our prejudices are strong. We must therefore try to make the problem concrete by approaching it from a more familiar angle, using analogy to help our abstract logic. We shall use the analogy of the human organism, approaching the macrocosm from the microcosm. Since the human organism is itself part of the cosmos, the relation is more than analogy. We may find in the economy of the organism an image of the economy of the cosmos. If our imagination finds it difficult to grasp how vastly separated worlds can have any commerce with each other so far as qualitative phases and levels are concerned, we can see in the concrete the interaction between the parts of the organism.

We know that the human individual is a complex system consisting of interacting levels of energy, higher levels controlling lower levels and in turn presupposing these as instrumental to the life of the organism as a whole. How is interaction between distant parts of the organism possible? Recent scientific discoveries have thrown a vast deal of light upon the mechanism of energy exchange and control within the organism.

> Sherrington points out that in higher animals there exist two chief methods by which the various chemical and physiological activities are integrated or made to work in harmony, namely (1) integration by transport of chemical substances (usually special metabolic products) from region to region, chiefly in the blood stream. This is seen in the effects of the various growth-determining hormones (thyroid, pituitary, ovary, etc.) or of the hormones determining glandular secretion or rate of respiration. And (2) there is integration by transmission of physiological influence, excitatory and inhibitory, to a distance through the living protoplasm without material transport between the regions; the chief example of this type of process is nervous transmission. The nervous system is the chief integrating and co-ordinating system in higher animals; nervous transmission, however, is merely a specialized form of a type of transmission present everywhere in protoplasm. If the

> metabolic processes underlying (*e.g.*) muscular contraction can be thus controlled at a distance, it is not difficult to believe that those underlying growth can be similarly controlled. This mode of activity has been called physiological distance action, after the analogy of chemical distance action, and our problem is to determine its physico-chemical nature. One of its most characteristic manifestations is seen in the transmission of growth-inhibiting and other formative and correlating influence in growing and developing organisms.[14]

In the higher organisms, then, we have an illustration of the interaction of parts at a distance through the transmission of energy patterns of two types, viz., chemical secretions from various glands, which are transmitted throughout the body mostly through the medium of the blood, and vito-electrical patterns which are carried by nerves and also by direct protoplasmic induction. The relative proportion, size and structure of the parts of the organism, as well as their executive relation within the behaviour of the organism, is determined by interaction made possible by such distance messengers within the organism. If such control exists within the organism is it not possible that the growth of the organism is subject to control from outside by similar influences?

> If the biolectric currents have a direct influence on growth, we should expect that electric currents led into the growing systems from outside sources would have a similar influence.

That this is so is indicated by experimental evidence, which shows that the artificially-controlled electric current, not merely in the lower organisms but in the higher plants as well, can influence the formative growth-movements in a polar manner.

[14] The quotations in this paragraph are from an article on "Growth in Living and Non-living Systems," by Ralph S. Lillie, the *Scientific Monthly,* Vol. XIV, p. 127, with some rearrangement.

> If the growth processes in living organisms are thus subject to artificial electrical control, it seems reasonable to infer that the natural or physiological methods of control in normal growth and development are also in large part electrical. The biolectric currents would thus become essential formative factors, just as they are essential factors in excitation and transmission; organic polarity, as Matthews suggested, would become electrical polarity.[15]

It is reasonable to suppose that vital processes of growth as well as inorganic processes are influenced by external energy patterns. It seems that the lateral symmetry of plants is due to the action of light, while their up and down direction is probably due to gravitation. In the last analysis, must we not seek the explanation alike of the life history of the individual organism with its dynamic patterns and of the life history of the earth with its complexity, in the interaction of the energy systems of the earth with the cosmic environment? Is it not reasonable to suppose that the cosmic equilibrium is knit together, as is the equilibrium of the particular system of the organism, by energy patterns communicated at a distance from cosmic history to cosmic history within the cosmic whole, the whole being a superorganic unity? We have, at any rate, an analogy in the higher organisms of how the process of evolution in any particular part of the cosmos, such as our earth, may be stimulated and controlled by influences from other parts of the cosmos. The creative response by the part, however, would vary with its history and cumulative structure as the amœba responds to light but does not see light because of its lack of necessary differentiation and organization.

We must grant, I think, that all matter in all its types and stages of evolution—inorganic matter, organic matter, minded matter—radiates typical energy patterns, expressing not only the intensity of the structures from which they

[15] *Ibid.*, pp. 129, 130.

originate but their unique organization, just as within the control of the organism neural messengers from the various centres of the nervous system and chemical messengers from the various glands carry not only a certain quantity of energy but formative patterns from their sources to the various parts of the organism. But it is still difficult to conceive how vastly separated world histories can have any effective commerce so far as qualitative levels and phases are concerned. That there is an integral gravitational and electromagnetic control within the cosmos we have now become accustomed to believe, though the distances for effective control are just as vast in the realm of quantitative control as in the realm of qualitative control. Our imagination is aided, however, by new discoveries in science as regards quanta communication of energy.

On the undulatory theory of energy-communication, it is true that energy patterns from far parts of the cosmos would be too spent to exercise any effective control. But it has recently been discovered[16] that between wave radiations of energy, such as light and X-rays, and electron radiations of atomic matter there is a quantitative relation. This means not only that wave radiation falling on atomic matter can cause the ejection of electrons, and, vice versa, that electrons falling on matter can cause ether waves, but that the wave radiation can communicate a certain quantum of energy irrespective of the distance it has travelled. The velocity of the electron, started by the impact of the wave pulse, depends upon the wave length only, not on its amplitude. And the wave length is constant for any distance. It is as though energy travelled in parcels instead of by undulations, though it seems to be carried by undulations. Radiations of matter in distant parts of the cosmos may therefore start characteristic waves in the ether and these in turn may deliver their message through their action upon matter at distant

[16] See article, "Electrons and Ether Waves," by Sir William Bragg, the *Scientific Monthly*, Vol. XIV, pp. 153-160.

parts of the cosmos and there set going characteristic radiations of matter. We know, too, that one form of energy can act as carrier for another form which itself might not be effective except for short distances. Thus in the radio telephone, the voice and characteristic form of expression with the meaning pattern involved is communicated by means of a powerful current of electricity to ether waves, which in turn deliver the unique patterns to the listener equipped with the proper instrument at the other end. The message thus carried sets going characteristic emotions, thoughts, and actions in the listener in accordance with his mental history and structure. As both the speaker and the listener are part of a common social field with its traditions, there is a certain pre-established adaptedness between them which could not occur by accident. An Englishman does not by accident understand Chinese, with the tradition which it implies.

As in the terrestrial field, so in the cosmic field various centres send out waves with resulting interference. In fact, it is the phenomena of interference in the case of radiant energy like light which furnish the strongest ground for believing in some sort of undulatory theory. Some wave lengths are reinforced and some are diminished by interference on the way. In the case of reinforcement of the transmitting waves, the original impulses may reach the earth with considerable intensity, as is the case in the reinforcement of wireless waves. A sun wave might reinforce a wave from a distant star with corresponding augmentation. But the significant aspect in the relation is the wave length, so far as the velocity of the disattached electron is concerned. The amplitude or strength of the stimulating wave has to do not with the velocity, but with the number of electrons disattached; but of course the number would add to the effectiveness of the wave.

To make our illustration more concrete: Suppose evolution in any world history, as is the case with geological history, has reached the stage of organic matter. Organic matter will send forth radiations characteristic of organic matter and of the particular type of organic matter. These radiations will be taken up by the electromagnetic medium and delivered at another part of the cosmos where matter is encountered. It may not there give rise to a life response, any more than light striking the protoplasm of the amœba is responded to as light, but it will act and it will give to matter an impetus towards life, and when favourable conditions have arisen, the creative adaptation of life will result. The same could be illustrated in the case of intelligence. Minded matter sends out radiations characteristic of mind and of the particular type of mind, as we all know, in human communication, whether the communication is mediated by air waves or by wireless waves. Every such radiation of minded matter is sent out into the cosmos, however mediated, and eventually reaches matter elsewhere and acts upon this matter. It may not be responded to as mind, but it gives an impulse to matter which may in the ages give rise to a characteristic response of mind to mind. Whether it is the organized inorganic elements with their various types or organic matter with its various types or minded matter with its various types, it holds that the organization of matter is a creative response to organized matter, and a particular type of organized matter is a creative response to a particular type of organized matter, be it inorganic matter or organic matter or minded matter. This is the meaning of cosmic interaction in the concrete.

This does not mean that any one cycle of the cosmos is a mere repetition of a cycle elsewhere, for the motion, quantity, proportion and duration of matter are not the same everywhere. The creative response of any part depends not merely on the stimulus, but on the milieu of the part responding, and this depends upon the history, composition, and structure of the part. We can see this illustrated in social communication among human beings. They may be under the influence of the same customs and traditions. They all have certain resemblances in chemical composition and in the biological traits of heredity. But they are never exactly the same and may not respond exactly in the same way to the same stimuli. They differ in the range of response and in the quality of response. Only a few respond by a significant creative adaptation which is the beginning of a new series of adaptations. The sun shines upon the just and the unjust, but they do not all respond in the same way. Cosmic influences, cosmic energy patterns covering the whole range of evolution are communicated to all parts of the cosmos, but the responses are various according to the stage of adaptation of the various parts. But, in any case, the influences act and by their combined impetus steer the particular cosmic history toward creative adaptation. Thus in the history of the earth the various types and stages of life and intelligence have emerged as creative adaptations to the impulses of the cosmic environment. And we have no reason to believe that the evolution of the earth has run its course. If there is a nisus toward divinity, it is because divinity, the supreme organization of harmony, beauty, goodness, and love, is active throughout the cosmos, stimulating the evolution of every part in the direction of divinity. As light stimulates towards the adaptation to seeing light, so divinity stimulates towards communion with itself. Light beats upon our earth-born beings, and permeates them, that it may stimulate in them the organization to see light; life beats upon them to awaken them to receive life; thought acts to create the response of creative thought; beauty acts to produce the creative response to beauty; God acts eternally to produce the creative response to God.

Materialism, Idealism, and Cosmic Interaction

We have been blinded to the relation of our geological evolution to the cosmos by the crude materialism which has hitherto beset our modern scientific thinking. Anxious to get away as far as possible from the arbitrary fiat of the creationism of theological speculation, science has gone to the other extreme and treated geological evolution as a thing apart from the cosmos and determined by blind chance. It has extolled the potencies of matter and proceeded on the supposition that the order of geological evolution with its complex variety of pattern is the result of chance variation and natural selection. It has been unmindful of the fact that it has merely substituted arbitrary Chance for an arbitrary God. The emergence of new characters, forms, and levels has been just as miraculous as before. No explanation of evolution as an orderly temporal process has been furnished. The theory of cosmic interaction and creative adaptation of the part to the structure of the whole gives the rationale of evolution. The individual part responds to the impulse from without according to its history and pattern structure. Selection, inhibition, integration and response—osmosis, induction, intuition—are conditioned at any one stage by the unique dynamic organization of the part. Hence we have the recognition of individuality and *a priori* synthesis. But the part is what it is because of its long history of creative adaptation to the dynamic structure of the whole. Hence we have the recognition of unity. Leibnitz and Spinoza both have their say. Finally, no part can survive which does not enter in some degree into rapport with the whole. Hence the reality of natural selection, the contribution of Darwin.

The details of cosmic interaction await ages of scientific investigation. Of one thing I feel sure: no properties, forms, or levels emerge in the history of our earth without the guidance of a pre-existent cosmic structure. Matter behaves as it does, it is capable of being understood as having logical structure because it is subject to control from higher levels. Matter in the course of its trial and error process of adaptation comes to assume new structure and functions under the organizing control of the cosmic field. It comes to express itself in new pattern responses to the complex order of the environment. Thus we have the periodic law of the elements with their graded scale of complexity and degrees of freedom. Thus we have the ordered quantitative determinations of matter, statable in mathematical laws. Thus we have levels superimposed upon levels in any one series, with qualitatively new control and new functions, organic, neural, mental—and whatever other levels there may be. The organization of our earth into a system fitted for life, the appearance of levels of life, intelligence, creative imagination, the intuition of divinity—these are possible because there are levels of life, intelligence, creative imagination, divinity in the cosmos. And these organizations of energy are somehow in active intercourse with our earth. From the point of view of the whole, the actuality is prior to the potentiality.

In emphasizing the rôle of cosmic control, I do not mean to minimize the rôle of matter. Matter, even in its most elementary form of primal constituents, must furnish the raw material of organization. We cannot conceive the graded series of the evolution of structures, with their conservation of the past into the present and with their hierarchical levels, without matter. We know evolution and levels, from the lowest level of organization to the highest, through matter. Life, thought, beauty, God must be incarnate in matter to be effective in the cosmos. There can be no energy exchange from one type of energy to another except through the action upon matter. There is nothing degraded or evil about matter, as the mystics have always maintained. Nor is matter non-being in the sense of being unreal. It is through the organization of matter that reality, as we know it, has its existence. Deny the reality of matter and we have the abstraction of mere form—an abstraction of our reason, eternal but ineffective. But if matter is essential to cosmic interaction and evolution, we must also remember that matter by itself is an impotent abstraction. It would remain in its state of diffuse motion. It could not organize itself. It could not raise itself to new levels. There must be a plus factor. This we have found in a hierarchical cosmic constitution within which matter interacts, and through impulses from which it rises by creative adaptation to various levels of organization. Matter dissociated from higher levels of control tends ever to run down to the diffuse state, and would so run down if it were not for the control of cosmic genius which utilizes it in ever new combinations through the pattern impulses communicated from the whole.

It must be clear now that there could be no evolution in a monistic world, whether it be conceived as matter or spirit. There could be no levels in a world of matter, because matter by itself could not rise above itself. But neither could there be evolution of spirit by itself. An absolute spirit cannot degrade itself into matter, any more than mere matter can rise to spirit. If we conceive evolution as one series proceeding of itself from the lowest to the highest level, it makes no difference whether we conceive the lowest stage in material or psychological terms, whether we call it blind matter or blind will, we can never make such a stuff organize itself into new forms and levels by itself. We can never make chance account for organization.

Since psychological monism has been unable to account for the existence and characteristics of the lower levels, such as those of inorganic matter, it has naturally tried to get rid of them by treating them as appearances or as due to finite points of view. Says Royce:

> The vast contrast which we have been taught to make between material and conscious processes depends merely upon the accidents of the human point of view. . . . We have no right to speak of really unconscious Nature, but only of uncommunicative Nature. . . . In case of Nature in general, as in case of the particular portions of Nature known as our fellow-men, we are dealing with phenomenal signs of a vast conscious process, whose relation to Time varies greatly, but whose general characters are throughout the same. From this point of view, evolution would be a series of processes suggesting to us various degrees and types of conscious processes.

> These processes in the case of so-called inorganic matter are very remote from us.[17]

Just how we can account for grades of psychological processes within one perfect logical unity of experience is not easy to see. But in any case the psychological monist is bound to project his universe on one level. There can be no grades or degrees of reality from the point of view of the absolute experience. They are merely grades to us finites, though just how the absolute unity could appear as grades to us, its integral parts—synthesized into its perfect unity and having no other existence—is difficult to see. For the absolute unity of experience is precisely what we know when we know ourselves clearly and distinctly. There can be no difference in kind between the finite individual and the absolute, for this would preclude the finite knowing the absolute. How there can be a difference in degree is one of the irrational aspects of a theory which claims to be completely rational. The dilemma of psychological monism is that it must either insist upon the eternal unity and perfection of reality in terms of human experience—and then evolution becomes mere appearance; or it must try to evolve the higher grades of reality from some lower unconscious stuff; but then it cannot account for evolution, for it then becomes indistinguishable from materialism. It furnishes no cause of evolution.

The essential difference between materialism and psychological idealism is that materialism emphasizes the lower levels of reality—the levels of inorganic matter—and tries to derive the higher levels as mere functions of the lower; while psychological idealism selects some higher level, such as thought, and tries to derive the lower levels as functions somehow of this. Both fail to do justice to the complexity of the real world. Both fail to account for evolution with its emergence of new characters, forms, and levels. The theory of cosmic interaction can

[17] *World and Individual,* Vol. II, p. 224, *seq*, quoted by Dean Inge.

embody the aspects emphasized by both materialism and idealism. The claims of materialism are duly met if it appears that matter and the properties of matter are eternal in the economy of the universe, even though we must hold that matter is not the whole of reality, nor does it exist in isolation, nor are its organization and properties in the whole those of matter in isolation. The claims of idealism are given due recognition if it is shown that life, thought, the sense of beauty, communion with God, are eternal and intrinsic aspects of the whole of reality and that the higher levels exercise a measure of guidance over the lower while they also require the lower for their realization.

The fact is that if the levels of matter, life and mind, coexist and interact in the cosmos, the long controversy between materialism and idealism loses its point. Mind has its permanent claim, and matter has its permanent claim to reality within the whole, and neither exists in isolation. While mind is higher in the scale and therefore more valuable, it is not more real than matter, nor is it more necessary than matter to the economy of the whole. Mind requires the organization of matter for its realization as much as matter of a lower order requires mind for its guidance, and both are aspects of the hierarchical organization of the cosmos. Mind, so far as we know, can only exist as an organization of matter, though it is more than inorganic matter and more than protoplasmic matter; and mind can only become effective by acting upon matter by means of matter. Hence it ill befits mind to despise matter. And it ill befits it to despise itself by making itself a function of something lower than itself.

The claims of the emergence theory, so far as it is truly descriptive, are recognized, viz., there is creative synthesis and emergence of properties, forms, levels, but a rationale is furnished for this emergence in the conception of interaction of the particular history with the structure of the cosmos. The claims of final causes, on the other hand, are set clear, since in the cosmos as a whole all the levels of organization ever coexist, and the higher levels furnish the impulse to creative adaptation in the lower. But the higher stages of evolution do not exist in isolation from the lower stages as Plato's world of abstract forms. They are not immaterial merely, but evidence themselves as higher types of organization of matter; they can therefore exercise control over the lower stages, not only when the lower stages are integrated into the higher, but when existing as less developed histories. Reality everywhere has form or structure by virtue of the control of the whole. There is the logic of the whole, though this is not necessarily the logic of the psychological structure of our mind. And this logic of the whole reveals itself not only in the striving of thought for logical form, but in the striving for wholes of beauty and in the creating of social unities.

God is the highest level of the cosmos. There can be no question of the existence of God, for whatever the quality of the highest level to which we strive to adapt ourselves in our best, this is God. God is for us the unique and perfect realization of matter. For we cannot conceive the highest level as isolated. It must radiate its characteristic pattern. God must be creative. But God does not radiate into the void as Plotinus' One. God is incarnate in matter and acts upon matter that matter may, by a trial and error process, orient itself to God. God must become known through matter divinely organized. God is the supreme cosmic genius operating from the highest to the lowest, radiating out energy patterns to be responded to by the parts of the cosmos as each can respond. For each part responds in beauty by creative adaptation according to its character and complexity—the sunset, the flower, the animal, the creative soul. God's creativeness is a protean creativeness, not limited like ours by a specific aim. Rather does God radiate from the fulness of His life as light radiates, as music radiates, as love radiates. It is the kindly radiation of constructive genius, potent to heal and to build. The schoolmen used to say that God is present everywhere by His activity, but not by His essence. If we mean by this that the divine synthesis at its highest requires a perfection of organization and levels of organization far surpassing ours, and that this organization involves a unique structure and can only be responded to in kind where this perfection of organization has been attained, then we can see why God cannot be responded to in essence by us any more than light can be responded to in essence by the amœba. But we cannot separate essence and activity. God radiates Himself, his unique, supermind pattern, to act, to guide, and to steer towards recognition of Himself even as light acts to produce rapport with light long before there can be response to light in kind. As we open our souls to the divine genius in the universe we get inspiration and become creative according to our stage of development, as the sunset, the flower, and the child manifest this creativeness according to their stage, though it is given to us in some moments to become consciously creative and thus to enter in a measure into the law of creativeness.

If there is a nisus towards God in our imperfect evolution, due to our trial and error adaptation to the divine impetus, yet we cannot presume now to share the quality of God in kind any more than the dog who shares the friendship of a Newton can hope to share the mind of Newton. There must be an element of mysticism in all religion. Clearly God dwells in a light to which no man can come. In the homely language of Heraclitus: Man is a monkey compared to God. There is a difference in quality which separates us from being God in essence. Yet we may be sure that all holy desires, all lofty thoughts, all aspirations after better things are responses to His fructifying influence upon us. The overarching superconsciousness, supermind, supergenius comprehends the cosmos in its wholeness as the creative artist alone can comprehend. We can only understand dimly and partly, because we can only create dimly and partly. Only the creator can truly understand.

How petty from this vantage point seems the narrow pragmatic view which makes man with his biological satisfactions the centre of the universe. From the humanist point of view, thought, beauty, God exist for the satisfaction of man. Man creates them for himself. Rather should we say from our cosmic point of view that thought stimulates the life process in us to creative intelligence, beauty stimulates to create and appreciate beauty, and God stimulates to creative communion with God. Thus it is true in the words of Augustine that God makes us for Himself and therefore we cannot be satisfied until we establish creative rapport with Him.

PART II

HUMAN NATURE AND COSMIC EVOLUTION

CHAPTER IV

Sensation, Imagination, and Mind

The Organism and the Cosmos

We shall now shift our perspective from nature to human nature, from the cosmos to man, from the macrocosm to the microcosm. All the while, however, we must bear in mind that the bifurcation of nature and human nature is an artificial one. Human nature can only be understood as part of nature, the evolution of man can only be understood as part of cosmic evolution. In this profounder sense, human nature is as old as the cosmos. This must be obvious enough when we deal with human nature from the spectator's point of view, and consider it as a physiological organism, as we do in this chapter. We find that we cannot understand the human organism, and in particular its nervous system, without understanding the history of that organism as part of the larger story of evolution.

> If we picture to ourselves the evolution of the nervous system of man, we must imagine the formation of the chemical elements from the electrons of the stellar laboratories, the combination of certain of these elements into organic aggregates and the formation of unicellular organisms, the development of multicellular types in whose organization muscles appear, then receptors, and finally adjustors or central nervous organs culminating in the brain of man. Such a series forms superficially a seemingly natural and smooth sequence and yet when it is examined closely, it proves to be a succession of breaks and contradictions.[1]

[1] G. H Parker, "The Evolution of the Nervous System," in the *Evolution of Man,* edited by G. A. Baitsell, Yale Press, 1922, p. 99.

It is a series of discontinuous steps where the elements enter into new creative syntheses and take on new patterns of organization. This series can only be understood, we have seen, as creative adaptation of the part to the whole, where the structure of the whole furnishes the impetus to organization and the part responds by a trial and error process according to its own milieu of energies. The problem of evolution is a problem of organization.

> No one now entertains seriously the view once put forward by Haeckel in the heyday of the evolutionary movement that since human beings have souls every atom of their bodies must have part of such a soul. . . . If the peculiarities of volitional action are not to be discovered in the chemical elements that make up the substance in which it occurs, they must be ascribed to the organization of this substance, that is, to the way in which the elements of this substance are put together and interact amongst themselves. From this standpoint certain chemical elements organized as nervous protoplasm have a greater degree of freedom in their action than when the same elements are organized in the form of lifeless molecules.[2]

To understand this new organization with its greater degree of freedom it is not only necessary to understand the elements of the compound and their quantitative relations, but we should have to know also the total situation of nature in which the synthesis takes place. It is because the situation of nature is largely constant that we come to fix our attention on the elements and their immediate conditions.

If we limit our attention more specifically to the nervous system, we find that this has a long history. The nervous system, as we know it in man and the higher animals, consists in organs for receiving stimuli, or receptors; organs for redirecting stimuli, or adjustors; and organs for reacting appropriately to stimuli, or effectors. But this is not

[2] *Ibid.*, p. 100.

typical of animal structure throughout the scale. In the simplest organisms there is merely protoplasmic reception, conduction, and response. There is no differentiated nervous system. In the sponges we seem to have merely effectors or triggers which are set off directly by the external stimulus. In the sea-anemone we have receptors and effectors, but no adjustors. The sea-anemone is a sac-like animal with a single aperture which leads into a large central cavity. A nerve net extends from the surface of the musculature of the organism.

> This nerve-net nowhere shows a special contraction but extends rather uniformly throughout the body and thus affords an easy path over which impulses may spread from the surface of the animal to its musculature.[3]

We have in the sea-anemone and organisms of its type a pure instance of what Dr. Head calls protopathic action. The stimulation is diffuse and the organism responds by mass-reflex, *i.e.*, by the contraction or expansion of the whole organism. Such diffuse response seems to persist in the higher organisms, though ordinarily masked by the epicritic control of the adjustor centres. It is only under pathological conditions when the connections with the central nervous system have been functionally severed that we find something like the mass-reflex of such organisms as the sea-anemone. Of course the relation is only approximate, since the lower centres may still remain intact. It seems, however, that in the highest organisms the epicritic functions of discriminate reaction are centralized more particularly in the cortex of the cerebrum. But of that we shall speak later.

An interesting problem arises as regards the relation of the sense qualities, as we perceive them, to the characteristics of the external stimulus. That there is such a relation we cannot doubt. The sense organs and the nervous system have developed in the long process of evolution

[3] *Ibid.*, p. 87.

as creative adaptations to the environment and therefore cannot be indifferent to the environment. They are adaptations both to the quantity and quality of stimuli. No one to-day takes the monadism of Leibnitz seriously as a scientific theory, though even in Leibnitz' world we have the appearance of adaptation, and appearances are the data of science. But granting, as we must, that there is a real relation between sense qualities, as we perceive them, and the character of the stimulus, how must we conceive this relation? Is it a relation of simple induction where the characteristics of the external stimulus, colour for example, are carried to the central organs just as they are in the external environment? Aside from the physical difficulties involved in the conception of the direct induction through the sense organs and the nerves of vibration rates of billions per second, there are physiological difficulties. There is no evidence of any sensory response below a certain intensity of the stimulus, though of course there may be other response. Again the quality of colour varies with the intensity of the light and not merely with the wave length. Then there are phenomena of colour contrast and negative after-sensations which cannot be accounted for as simple physical relations.

A more plausible theory is the contraction theory of M. Bergson. According to this theory

> we seize, in the act of perception, something which outruns perception itself, although the material universe is not essentially different or distinct from the representation which we have of it. In one sense, my perception is indeed truly within me, since it contracts into a single moment of my duration that which taken in itself, spreads over an incalculable number of moments. But if you abolish my consciousness, the material universe exists exactly as it was; only since you have removed that particular rhythm of duration which was the condition of my action upon things, these things draw back into themselves, mark

> as many moments in their own existence as science distinguishes in it; and sensible qualities, without vanishing, are spread and diluted in an incomparably more divided duration. . . . Now bring back consciousness, and with it the exigencies of life: at long, very long intervals, and by as many leaps over enormous periods of the inner history of things, quasi-instantaneous views will be taken, views which this time are bound to be pictorial, and of which the more vivid colours will condense an infinity of elementary repetitions and changes.[4]

The difference between the light vibrations as they exist in nature outside our organisms, and colour qualities as we perceive them, is for M. Bergson a difference in rhythm.

> In reality there is no one rhythm of duration; it is possible to imagine many different rhythms which, slower or faster, measure the degree of tension or relaxation of different kinds of consciousness, and thereby fix their respective places in the scale of being.[5]

Nature, as we perceive it, is not essentially different from nature outside us, but owing to the rhythm of our perception it is more condensed.

> To perceive consists in condensing enormous periods of an infinitely diluted existence into a few more differentiated moments of an intenser life, and in thus summing up a very long history. To perceive means to immobilize.

M. Bergson would account for the discontinuity of the colour qualities as we perceive them by the condensation of vibrations.

> May we not conceive, for instance, that the irreducibility of two perceived colours is due mainly to

[4] *Matter and Memory*, pp. 275-277.
[5] *Ibid.*, p. 275.

> the narrow duration into which are contracted the billions of vibrations which they execute in one of our moments? If we could stretch out this duration, that is to say, live it at a slower rhythm, should we not, as the rhythm slowed down, see these colours pale and lengthen into successive impressions, still coloured, no doubt, but nearer and nearer to coincidence with pure vibrations? In cases where the rhythm of the movement is slow enough to tally with the habits of our consciousness,—as in the case of the deep notes of the musical scale, for instance,—we do not feel that the quality perceived analyzes itself into repeated and successive vibrations, bound together by an inner continuity.[6]

We can conceive a consciousness of a higher degree of tension than our own consciousness. Such a consciousness might contract the whole history of humanity into a very brief span without altering its significance.

The plausibility of M. Bergson's theory lies, of course, in his animistic conception of nature. He passes from human consciousness to nature by a relaxation of the tension to which he conceives human consciousness is due. Nature becomes then a diluted form of what we find in human consciousness. But the analogy of the varying rates of dream consciousness is irrelevant to the relation of consciousness and matter. Again, the relation between stimulus and sense quality is conceived too simply. To be sure, M. Bergson recognizes that the rhythm in human nature is not a simple induction from external nature. Human nature has a rhythm of its own which involves a condensation of the rhythm of nature. But why should the condensation of vibrations give rise to colour qualities? And why should increasing condensation give rise to a discontinuous series of colour qualities? We have seen, moreover, that perceived colour quality varies not only with vibration rate, but the intensity of light. And

[6] *Ibid.*, pp. 268, 269.

how are we to account for colour contrast and negative after-sensations on the basis of condensation? The relation between the quality as perceived and the characteristic stimulus is indeed a quantum relation both as regards vibration rate and intensity, but the relation must be conceived as of the nature of creative synthesis rather than as a mere quantitative variation of tension in the perceiving organism.

The difficulty with naïve realism is that it starts with a false bifurcation of nature and human nature. It then reads the sense qualities into nature and makes them independent of human nature. It ascribes colour to the vibrations of light. According to the same reasoning, the qualities of taste must belong to the taste stimuli, the olfactory qualities to the olfactory stimuli, etc. According to epistemological idealism, on the other hand, the sense qualities are the contribution of the perceiving mind. Epistemological realism and epistemological idealism thus emphasize different sides of the bifurcation of nature and human nature, the former placing the sense qualities on the side of nature, the latter on the side of human nature. We shall arrive at the truth of the matter only when we view sense qualities as functions of the creative interaction of the energies of physical nature with the organization of human nature, its sense-organs, and nervous system. We have no reason to believe that ether waves possess the quality of colour or that taste stimuli are sweet, bitter, sour, and salt. Nor have we any reason to believe that these qualities exist in physical nature in a more diluted form, as M. Bergson holds. Still less can we believe that they are created by human nature without reference to physical nature. There is every reason, on the contrary, to believe that they are the creative result of adaptive interaction between physical nature and the organism. To understand, moreover, the definite discriminatory pattern-responses to stimuli which we find in the normal human being, we must take account not merely of the specific organization of the sense organs, but we must also take account of the structural hierarchy of the nervous system and the control exercised by the higher centres over the lower. This will be brought out more clearly in the sequel.

The Protopathic and Epicritic Levels

In the annals of psychology nothing more heroic has been recorded than Dr. Head's subjecting himself to vivisection in cutting certain nerves that supply the superficial organs of cutaneous sensation.[7] The evidence thus arrived at has been corroborated by a mass of pathological cases, especially from the late war. The evidence is so familiar that it will only be necessary to state it in outline. The elimination of the functioning of the superficial organs strips bare the deeper sensibility and reveals its quality. These deeper organs of muscles, joints, and tendons respond to pressure and to pain. They furnish a fairly accurate localization in space. And it is they which furnish the impressions which, when conducted to the cortical field, give us the sense of passive posture or three-dimensional space.

When recovery begins to take place, the primitive punctate or protopathic system becomes active and confuses the process of localization. The protopathic system responds, through its punctate organs, to pressure, hot and cold, and pain. But its responses are diffuse, massive and primarily affective. It informs us, not of the qualities of things, but of how stimuli affect the organism. It centres in the optic thalamus rather than the cortex. It is adapted for defensive withdrawal of the body, not for differential reaction having reference to the part affected. Its responses are crude and non-discriminative. It is characterized by the "all or none" reaction. It responds to extensity of stimulation, not to graduated intensity. Nor does it respond to localized stimulation. The stimulations

[7] For a summary of the epoch-making work of Dr. Henry Head, with Dr. W. H R Rivers and other collaborators, see Dr Head's article, "Sensation and the Cerebral Cortex," *Brain,* 41, Part II. Of this I have made use in this section.

radiate to distant parts. They lack control. It cannot discriminate the two points of the compass. It is different when the healing process is complete and the epicritic system appears. This superimposes control upon the crude mass response of the protopathic system. The sense stimulation no longer spreads to distant parts. We can now project points, *i.e.*, respond to the locality stimulated. The "all or none" type of reaction disappears and the response is approximately graded according to variations in intensity. We can now take account of the physical qualities of things as well as the affective qualities. We can discriminate simultaneous and successive points in two-dimensional space. Adaptation, which is absent on the protopathic level, returns. All this, of course, presupposes the intactness of the central nervous system. The epicritic system is ultimately centred in the cortex, as the protopathic in the optic thalamus.

The sense-organs are characterized by structural differentiation, and upon their reaction to external stimuli depend in the last analysis the different sense qualities. If we compare the sense organs to resonators, they are at any rate not neutral resonators, but contribute a differential quality of their own. They are specific energies. The cold spots will respond to temperatures below 22° C. with a characteristic cold quality. But they will also respond, in the absence of inhibition from the hot-spots, with an ice-cold sensation to temperatures of 45° C., which when applied to the hot-spots or the general surface give us a sensation of pleasant warmth. In the absence of the functioning of the cold-spots, the hot-spots respond to stimuli of 22° C. with a characteristic warm sensation. Sensations, in other words, are compound energies. They depend, to be sure, on the character of the stimulus, but they depend also on the energy complex of the sense-organs. This is especially evident in the case of the chemical senses which at any rate include all but hearing, if not the latter. It is as absurd to suppose that the physical vibrations, which our physical instruments reveal, are red or green, as to suppose that they are cold or painful. It happens that we carry a polychromatic camera in our heads. But we can also construct polychromatic cameras that can see colours. Neither the cameras in our heads nor the artificial cameras can see colour unless they possess the specific energies to respond in a characteristic way. Sensations are ordinarily physico-physiological processes, though they can, under certain conditions, be produced by the organism independently of the physical stimulus. We have no evidence that they can be produced in the absence of the specific conditions furnished by the sense-organs or similar organs. Even in the case of sound, though we carry a harp in our ears, be it the basilar membrane or some other organ, we know that harps respond with a quality of their own. Sounds, too, are compound energies.

While we hold to the specific energies of the senses, this does not mean that sensations are transmitted to the cortex just as they result from the reaction of the senses. The evidence of Dr. Head and others shows that the crude sensations undergo selective analysis and new integrations on the way to the cortex. This, however, does not necessarily mean a change of specific quality. We are not in a position to dogmatize about the difference which the various neural patterns make to the sensory impulses as they are permitted to pass the hierarchy of "vigilances." [8] But, at any rate as regards the cortical field, pathological evidence goes to show that there is no raising of the threshold unless the cortical injury be very extensive. The difference between the normal reactions and the pathological may be reduced to one of "clearness." There is a lack of "clearness," "pointedness," "sharpness" in the case of a cortical lesion affecting certain parts. This leads to uncertainty, hesitation, guessing, and hallucination. It is a failure in discrimination or a difference in attention. What holds on the cortical level probably holds in the case of the

[8] The term "vigilance" as used in this connection by Dr. Head has no anthropomorphic significance.

neural levels below it and their pattern reactions. In any case there is no reason to suppose that the characteristic qualities of sense-impulses are altered. And what is true of sense-impulses, holds equally of affective qualities. While the optic thalamus seems to be peculiarly the centre of these qualities, the discrimination of intensive gradation within these qualities and their weaving into the complex patterns of emotions and sentiments, with their objective reference, must be peculiarly the work of the cortex. In any case the affective qualities do not owe their nature to consciousness.

Selection and Integration in Terms of Neural Levels

If the evidence disproves the subjectivistic interpretation of sensations, it no less breaks down the subjective view of the selection and integration of sensations. We can state the selective and integrative functions in purely physiological terms. They are present at all the levels of neural reaction. We can thus give a physiological statement of the "subject-object" relation. For the subject relation means the selection of data with reference to certain ends, whether these ends are ingrained in our nervous structure as a result of biological heredity or are further elaborated in terms of the life history of the individual. Obviously the first subject reactions must be biological, as individual history must start somewhere; but throughout individual history our selective activity is fundamentally determined by biological patterns, however much overlaid by individual experience. At each level of the nervous system, selection is conditioned by the unique neural pattern of that level as it is organized in terms of race and individual history. The object consists of the afferent impulses which are selected and integrated by the pattern, or rather hierarchy of patterns, and which thus become effective in guiding conduct. The afferent impulses may figure as part of either the subject relation or object relation. They are part of the object relation when they are selected as data to be integrated and acted upon. They are part of the subject relation in so far as they are the rebound of the selective activity and figure as part of its tension, as, for example, the motor sensations in active attention. They become, then, means of selection, not data which are selected.

Let us now try to make our meaning clearer by examining the functions of the central nervous system at various levels. The nervous system consists of a hierarchy of fields of energy or controls. These fields must be thought of in physiological rather than in structural terms, though of course they have structure. The structure, however, is too complicated for us to follow its internal dynamics. It is fraught with a past of indefinite duration of which we know little. We must therefore be pragmatic and judge neural structures by their functions. While these energy fields differ vastly in complexity and in their characteristic patterns, they have certain essential characteristics in common. Their part is to select, sort into kinds, suppress incompatible impulses and facilitate compatible, and finally redirect or integrate these impulses so that they may be carried out in accordance with the needs of the organism. Their adaptation throughout is of the trial and error kind; and it is clear that natural selection has acted effectively to eliminate the conspicuous failures of nature's experimentation, even though natural selection as a purely negative agency is barren so far as producing adaptation is concerned.

The sorting process begins at the first synaptic junction in the spinal chord. The sensory impulses of hot, cold and pain cross to the other side and travel along separate secondary paths. The tactile impulses travel both along the posterior columns and along secondary paths as far as the top of the spinal chord before they all cross into secondary tracts. Like impulses are grouped together from all three systems—epicritic, protopathic, and deeper sensibility. Thus the tactual sensations from the three systems are combined. Impulses of hot, cold, pressure, and pain proceed along separate paths to the optic thalamus which is the centre for the crude discrimination of these sensations, but especially the centre for the affective qualities of comfort and discomfort. The three sensory qualities of space are bound up with the tactile impulses along the posterior columns of the spinal chord; but above it they follow each a separate path through the fillet of the optic thalamus to the cerebellum and cerebrum.

The cerebellum has to do with the control and regulation of the postural and tonic aspects of muscular activity which involves complex discriminations and adjustments, though we do not ordinarily associate consciousness with such activity. The cortex is the organ of objective cognition. On it depend, in the first place, the more delicate discriminations of data. It is only at the cortical level that we discriminate graduated intensities of stimuli. It is also the supreme organ for spatial discrimination in the three dimensions—point localization, discrimination in two-dimensional space, such as the two compass points, and the sense of posture. The last implies a cumulative sense of positional values, or what Dr. Head calls a schema, which, however, must be understood as a cortical pattern reaction and not a contribution by consciousness. The cortex discriminates the physical qualities of size, shape, weight, and texture and makes graduated comparisons possible within those qualities. It also has the capacity of recognizing a series of minute and vibratory differences, thus giving us our immediate sense of duration. With the recognition of sense differences goes the projection of lines of reference to the parts affected, without which the information conveyed would be of no practical value, and this capacity depends primarily upon the cortex.

Imagination Patterns and Sensations

The cortex is not only the great organ for objective discrimination but also the great organ for establishing relations between data. For this complex pattern reaction of the cortex, we may use the term "meaning." Pathology[9] indicates a considerable specialization within the cortex for meaning reactions. The meaning of single words or names may exist when the propositional meaning of words is lost and vice versa. Both kinds of meaning are lost in deep semantic disorders. Meaning to a certain extent may exist in spite of failure of verbal expression. The patient may still be able to point to things signified. However crude such recognition in the absence of language expression may be, it should give us pause from identifying meaning entirely with language mechanisms,[10] valuable though the latter are as instruments of meaning, and indeed indispensable for its abstract elaboration. There is, of course, ample evidence for language mechanisms taking the place of thought, but then we no longer have the process of thinking.

It is evident that the great superiority of the cortex lies in the perspectives which the meaning patterns make possible. As it is equipped with the "long distance receptors in space," especially sight (as pointed out by Sherrington), so it is equipped with long distance receptors in time. While in the lower centres, such as those of the spinal chord, the past endures as condensed in their present structure, this responds only to present stimuli. The cortex, on the other hand, through its memory patterns can respond differentially to distant events in time. Again, through its anticipation patterns, it can project events into the future and build the bridge before coming to it. This hierarchy of relation patterns in the cortex, from the comparatively passive revival of past experience to the active reconstruction of experience to meet new events we shall call imagination. It is not necessary for our purpose to distinguish between imagination and thought. Or rather thought is one type of imagination. It is constructive

[9] See Dr Henry Head's article, "Disorders of Symbolic Thinking and Expression," *Brit. J of Psychol.*, II, Part 2.

[10] Professor John Watson in his brilliant paper, "Thinking and Language Mechanisms," before the Oxford Congress of Philosophy, 1920, seems to identify thought entirely with language mechanisms.

imagination as contrasted with reproductive, though sometimes we limit thought to constructive imagination which works with abstract symbols. This distinction has tended perhaps to draw the line too sharply between thought and artistic invention. Thought may work with concrete imagery, while artistic imagination may be singularly lacking in such material.

What I want to emphasize is that constructive imagination or thought is as genuine a type of neural pattern as is the reflex arc or the primitive instinct. In the absence of its specific cortical pattern, thought cannot be aroused any more than a reflex can be aroused in the absence of the specific neural pattern. You cannot make an idiot think, try as you may. Thought is not an instinct, as Graham Wallas [11] intimates. It is a far more complicated pattern. It may be aroused by curiosity or any other instinctive activity; it may also be aroused by sensations. But it may act from its own peculiar restlessness, one thought process stimulating another. Thought is not to be regarded as a beast of burden of our lower propensities, as the anti-intellectualists maintain, though it may be evoked, and should be evoked, to guide and control the instincts. It may, however, work for its own creative satisfaction. Its bodily expression varies with temperament. It may be organic, as in what Fouillé calls the "sensitive temperament", and then one can think best by lying flat on one's back; or it may be motor, and then one can think best by giving the large muscles play. It is essentially social, and so implies the need for expression of which language is both a social and neural pattern.

And now we must say a word about images. The pathological evidence indicates that images play at most an unimportant part in behaviour. Postural images may be present as vivid as ever in a cortical lesion on one side of the cerebrum, but such images are impotent to guide postural adjustment. They lead neither to effective recognition nor appropriate expression. Evidently images have

[11] *The Great Society,* 1914, pp. 48, 49.

been much overrated by traditional psychology. But what are they? Since Galton there can be no doubt that there are marked differences in concrete types of imagination, *i.e.*, in the relation of imagination patterns to the different organs. Some peoples' imagination relates more to the eyes, others' to the ears, etc. But this does not mean that the cortex fabricates a peculiar content, whether sensations or images, nor that it stores content. There is no more reason to suppose that the cortex stores or fabricates content than to suppose that the spinal chord does so. The neural centres of the various levels are systems of energy patterns of increasing complexity and uniqueness. They are not store-houses of content. What they store are lines of motion as potential energy. All content is sensational and exists only in the degree that the senses are active. All the real evidence points that way.

In the first place, it is impossible to distinguish between imaginative content and sensational content at the minimal level of intensities. This is what gives rise to the troublesome complication of "expectant attention" in our experiments. If imaginative content had a unique quality, as some maintain, this confusion should not exist. We should no more confuse an image with its corresponding sensation than we confuse colour with pressure, even at minimal intensities. In the second place, much at least of what has been supposed to be imaginative content is proved upon inspection to be sensational. This is particularly obvious in regard to motor imagination. But there is good reason to believe that it holds of all the types of content in imaginative activity. In the third place, we can arouse bona fide sensations through imagination. Imagine yourself riding on the back of a tiger, and you will find that you have veridic sensations of shiver all over. To a certain extent you can control the succession of colour fields in the case of visual imagination when it is directed to producing colour fields on the retina, and some experimenters claim to have complete control. Moreover, if you extrovert your attention in the case of a vivid visual image, you will find it on the retinal field. At least that has been my experience. Of course the pattern is cortical. A Scotch plaid would not happen by chance on the retinal field.

The anatomical mechanism, by which such sensational content is furnished, in the case of imaginative activities, is obscure for the most part. In the case of motor imagination the sensational content is sufficiently explained by the close connection between meaning patterns and expression patterns in the cortex. The sensational content is the afferent result of this arc. But we cannot see how the motor adjustment of the eye could give us anything but motor sensations. It could not account for the variety of visual patterns that imagination furnishes. And the same problem meets us in the other sense departments. There is, to be sure, a close connection between incipient articulation and internal hearing, but it hardly seems sufficient to account for the range of auditory values of a symphony, considering the limited range of our vocal organs. They couldn't very well supply what they cannot produce, though they no doubt are contributory. It has, however, been definitely proved that there are centrifugal sensory fibers running from the sensory centres of the cortex to the sense organs as well as centripetal sensory fibres from the sense-organs to the cortex.[12] Such centrifugal fibres have been found where they seemed least likely, viz., in the ear. We have here, it would seem, the required physiological mechanism to account for imaginative content.

We may hold, I think, that the imaginative patterns in

[12] *Outlines of Psychology,* O. Külpe, trans. by Titchener, 3d Ed., 1909, pp. 84, 85. The evidence in regard to the eye to which Külpe refers has since been corroborated and extended to the other senses. Külpe uses the hypothesis of centrifugal sensory conduction to account for (1) the effect of inadequate stimulation upon the brain-stem; (2) the phenomena of after-sensation, *e.g.,* that an exclusively monocular stimulation gives rise to a sensation in the unstimulated eye; (3) the so-called positive after-image, a secondary sensation of the same quality as the primary sensation but occurring after a short pause; (4) certain facts in connection with "centrally excited" sensations, such as illusions and hallucinations. He still holds to the hypothesis of cortically excited sensations, independent of the periphery, for the ordinary imaginal processes.

the cortex are connected by lines of motion, centrifugal as well as centripetal, with the sense-organs of the body; that what is stored is not content but lines of motion, thus connecting the meaning patterns with the parts of the body; that imaginative revival means that these energy patterns are brought into play and communicate their motion outward to the sense-organs, which, if the excitement is sufficient to overcome their inertia, respond by sending sense impulses to the cortex. Unusually high excitement in the cortex would tend to produce illusion and hallucination. We can thus account for the proof-reader's errors and for our supplying the pianissimo treble notes which the player only feigns supplying; and we can understand why people see life-size ghosts with clothes on, just as they expect or fear they will. Individual variations of permeability in the direction of certain sense-organs would account for the relative dominance or absence of certain types of imagery. The fact that images do not ordinarily come ready-made but are the result of fixation by attention, voluntary or involuntary; that, moreover, they increase with attention in vividness and definiteness until they result, as they often do, in veridic, and not merely nascent sensations; that under such circumstances, if we are careful observers, we can notice a corresponding excitement in the sense-organs—all this fits in with the abóve theory. Cases of insistent images can be shown to be due to an insistent cortical pattern which has established unusual permeability for itself in a certain sensory direction. We can account for negative after-images, resulting from imagination, which, however rare, are now acknowledged to be veridic, *i.e.*, some observers in imagining red have succeeded in getting a negative after-image or green. The theory would also help to explain various phenomena of centrally initiated pain sensations, so familiar to the pathologist. But the psychological reader can easily multiply instances where the theory would be useful.

It is not difficult to account for what has been termed imageless thought on the above theory. In the first place, there is wide variation as regards the presence of concrete imagery and in some individuals it is largely absent. But further than that, when the attention is absorbed in the search for abstract relations, there is a tendency to suppress the revival of sensational impulses, for these might confuse rather than increase the effective working of attention. The law of economy operates to suppress the useless and to emphasize that which tends to further the end involved. It seems, moreover, that a continuous tendency to suppress concrete imagery leads to atrophy of the functions of revival in that direction or, in other terms, tends permanently to block expression of that type. We recall as a familiar instance of this the regret expressed by Darwin in his later life that he was no longer able to enjoy music or poetry which had been an important part of his life in his earlier years. Coupled with this regret was a feeling that such loss of concrete appreciation had probably caused a deterioration of a moral kind.

It has been suggested as an objection to the above theory of imagination that people who have lost an arm or a leg still have the feeling of a "phantom" arm or leg, which, according to some, seems shrunk and smaller than the other. The evidence is by no means unambiguous, but it would seem that in such cases it is visual imagination and not tactual which furnishes the pattern. Dr. Head has shown that the image of the phantom limb, which may exist in cases of lesions on one side of the cortex, has no value in recognition or postural adjustment. If the patient's affected hand is moved after his eyes are closed, and he is asked to indicate its position, with the other hand, he will point to the place where it was when he saw it. As to the sense of shrinkage or shortening, that would seem to be a matter to be interpreted in terms of tactual sensibility. Since the sensational response to the projected sensory lines is actually cut short and shrunk in bulk, the fact would be just what we should expect on the theory we have advanced. On the other hand, if the sensory processes are cortically produced there seems to be no reason for any shrinkage. Another objection which has been raised is that persons whose eyes have been removed, including the retina, still have visual imagination. It is necessary to have more definite facts before attempting to answer such an objection. In the first place, the term image has been and is a very ambiguous word; and it is therefore difficult to know what people mean when they speak of an image. There would still be meaning patterns directed towards the eyes, though there were no concrete imagery. Again, the actual facts of the operations would have to be established. In the nature of the case there could be no objective test, and the introspective test must always be uncertain. Furthermore, we are under a peculiar difficulty in the case of the end organ of vision, owing to its being, as it were, a projected part of the cortex. We cannot be sure how much is included in the organ of vision.[13] But in both of the above objections the facts are still too much in the nature of old wives' tales to be taken seriously; the important thing is that the theory should meet the ordinary and established facts.

Suppression and Neural Levels

The sorting and integration of sensory impulses would be useless except for another function of the nervous system, viz., that of selective inhibition or, to use Dr. Rivers's term, suppression. A certain "vigilance" is exercised by each neural level which permits only those impulses to pass which fit in with the general set. There is a constant struggle for dominance amongst incompatible impulses at the various levels. Were all allowed to reach the highest level of discrimination, there would be endless confusion. But only the victors reach the higher levels. Which among several competing impulses emerges as victor depends not

[13] If in the case of vision the sensory neurones of some centre or perhaps the receptor cells in the cortex itself have a differentiation corresponding to that usually attributed to the retina, then when the synaptic connections with the centrifugal sensory fibres are once established in the cortex, the centrally initiated motion would only need to travel to the synaptic junction of the centrifugal with the centripetal fibres next below the centre in question to produce the required afferent current.

merely upon the quality, intensity, and duration of the competing impulses but implies the entire history of the nerve-centre,—the duration of previous lines of motion, whether of race history or individual history, as structure or potential energy. And we must take account not only of the set of the individual centre, but of its relation to the levels above it which under normal conditions to a large extent control its behaviour. Prepotency is, therefore, a very complex affair and can be studied by us only as revealed in function.

It is easy to illustrate the fact of suppression in connection with sensory impulses. Suppose you apply a metal disc of a temperature of 45° C. to the back of your hand. You stimulate not only the hot spots, but the cold spots, the pressure spots and the pain spots. Yet the sensation is one of pleasant warmth. The other impulses, under normal conditions, do not reach the cortex. This does not mean that they are absent. Pathological cases show us that they are always present, ready to come to light when the epicritic control is removed. Visceral sensations are always present, but it is only under abnormal conditions that they reach the highest discriminative centres, and this because their information becomes important for self-preservation. The suppressed sensations, moreover, may count, even when they do not reach the higher levels, in guiding reflexes of the lower centres.

It is, however, not only in connection with sensory impulses that the nervous system selects the compatible and suppresses the incompatible. The principle holds throughout. Dr. Rivers [1] has shown how within the cortical level there are various strata, due in the first place to organic evolution, with recapitulation in part at least of its main periods, but overlaid in the course of individual development. Here we have again the struggle for dominance of the various tendencies of the more primitive levels, on the one hand, and the epicritic control by the later levels, on the other. The earlier strata, such as the

[1] W. H. R. Rivers, *Instinct and the Unconscious*, 1920.

infantile level, the childhood level, the adolescent level, etc., do not disappear in the later life of the individual, but the crust of custom of the upper level exercises strict "vigilance" over them, and we may not under ordinary circumstances suspect their presence. Their suppression may, however, very much complicate the life of the individual; and they are ready to assert themselves with excessive vigour when the ordinary "vigilance" is relaxed. How to reduce the suppressed tendencies to a minimum by integrating them into a comprehensive scheme and sublimating them into the activities of normal life is a problem not only for the physician but for society at large.

Neural Functioning Illustrated in More Complete Reactions

Our emphasis so far has been upon the sensory and cognitive functioning of the organism. But we might have selected the more complete reactions with equal effect. The cognitive aspect does not exist by itself, but is bound up with the executive and affective aspects, and their complicated systems of patterns. The more thoroughgoing is the cognitive or informative function, the more definite and adequate are the affective and motor aspects. In the case of the reflex arc, the simplest complete neural act, we have the selection of sense impulses, the suppression of incompatible impulses, the integration of impulses into the prevailing pattern, and finally the projection of lines of action to the part affected. This of course assumes the intactness of the central nervous system. In the conflict for dominance in the neural centres, the physical law of summation of forces, as Sherrington [14] points out, does not hold. When the flexor reflex and the extensor reflex conflict, the result is not an algebraical summation, but one or the other becomes prepotent; the other is suppressed. Orderly succession of adjustments means the supersession of one reflex or group of reflexes by another. It means the

[14] Chas. S. Sherrington, *The Integrative Action of the Nervous System*, 1906, pp. 112, 118.

passing from one reflex pattern to another, determined in part by the quality and intensity of the stimulus, in part by the set at the time of the neural centre,—this set being due to its previous stimulation and constitution on the one hand, and its relation to the higher centres on the other. Thus co-ordination is established as between reflexes, and the ends of the organism are furthered.

The simplest neural centres thus reveal the essential traits of group conduct. "The nervous system," says Sherrington, "is in a certain sense the highest expression of what the French physiologists term the *milieu interne*."[15] We may look at nerve-cells from three points of view. In the first place, we must take account of them as individuals.

> Nerve-cells like all other cells lead individual lives—they breathe, they assimilate, they dispense their own stores of energy, they repair their own substantial waste; each is, in short, a living unit, with its nutrition more or less centred in itself.[16]

In this respect nerve cells are like other living cells. In the second place, nerve cells present a high degree of contagion.

> They have in exceptional measure the power to spatially transmit (conduct) states of excitement (nerve-impulses) generated within them.[17]

When we approach the problem from the social point of view we find a similar relation between individual organisms. This phenomenon is especially prominent in the case of crowd excitement and certain artificial and pathological states. In the third place, the reactions of nerve cells have the function of integration.

> In the multicellular animal, especially in those higher reactions which constitute its behaviour as a social unit in the natural economy, it is nervous reac-

[15] *Ibid.*, p. 4.
[16] *Ibid.*, p. 2.
[17] *Ibid.*, p. 2.

> tion which *par excellence* integrates it, welds it together from its components, and constitutes it from a mere collection of organs an animal individual.[18]

The simplest level of conduct, that of the reflex arc, thus foreshadows the characteristics of the most complex levels of behaviour, including the interactions of the highest organisms.

If we turn now to the instincts and emotions, we find the same fundamental functions of selection, suppression, integration, and projection. They have, as McDougall has pointed out, their cognitive, affective and motor aspects. Cannon [19] has shown that emotions owe their specific and unique character to their being neural pattern reactions, resembling in this respect reflexes such as sneezing, though of course vastly more complicated. "They are ingrained in the nervous organization," and respond "instantly and spontaneously when the appropriate 'situation' actual or vividly imagined is present." They are among the higher animals for the most part cortical patterns, but Sherrington's experiments on decorticated dogs and cats show that "at least one such pattern, that of anger, persists after the removal of the cerebral hemispheres." We cannot, it is true, neglect expression as a factor in emotions. They "gain expression through discharges along the neurones of the autonomic nervous system," and in this way get what James called their "bulk." But the setting off of the autonomic system depends upon the intensity of the emotional stimulus rather than its specific character and could not possibly differentiate the emotions.

That the emotion patterns are genuine energy patterns is shown by their effect upon secretions and muscular contractions and by their stimulation of the adrenal gland which increases blood sugar in intense excitement. It is also shown in pain and great emotion by the "hastening

[18] *Ibid.*, p. 2.
[19] See Walter B Cannon, *Bodily Changes in Pain, Hunger, Fear and Rage*, 1920, especially pp. 280-283.

of the coagulation of blood" and in general by the "energizing influence" which "the fierce emotions" exercise.

The sentiments, again, as Shand [20] has shown, manifest still greater complexity of pattern. This is due in part to inherited connections between emotions.

> Every primary impulse, whether it is independent or belongs to a primary emotion, is innately connected with the systems of fear, anger, joy and sorrow in such a way that when opposed, it tends to arouse anger; when satisfied, joy; when frustrated, sorrow; and when it anticipates frustration, fear; these symptoms being similarly connected together.

In the case of such a complex sentiment as maternal love, the innate connections are immensely complicated. But the complexity of patterns increases vastly in the course of individual experience as the emotions become organized in terms of patterns of imagination and their objective implications. In general,

> every sentiment tends to include in its system all the emotions, thoughts, volitional processes and qualities of character which are of advantage to it for the attainment of its ends, and to reject all such constituents as are either superfluous or antagonistic.

The sentiments tend to form a hierarchy in which greater systems are superimposed upon lesser systems, including the bodily systems,[21] until a character is formed,—the more inclusive systems exercising "vigilance" over the more primitive. They are in Shand's phrase, "forces; they work in certain ways and in certain directions. They are within us to perform certain functions." [22]

That the meaning patterns of the cortex are an integral part of the complex volitional arc and issue in certain definite motor patterns for the control of conduct is

[20] See Dr. A. F. Shand, *The Foundations of Character,* pp. 35-106.
[21] *Ibid.,* p. 27.
[22] *Ibid.,* p. 178.

attested by the whole trend of modern psychology. The motor patterns owe their definiteness and control to the meaning patterns and in turn make them effective. No impression without expression is a psychological commonplace and holds of the cerebral levels as well as of the lower levels. Language patterns are only one form of this expression, though socially a very fundamental one. All the facts go to indicate that we must regard the nervous system as a hierarchy of energy systems with increasing complexity and interconnection as we proceed to the upper centres. Each level has its own quality or functions which pathological evidence has enabled us to dissociate from the total system.

We must not forget the integrity of the nervous system, when we talk about the reaction of nerve centres. It is a singular fact that the lower centres owe their definite and stereotyped functioning to the control by the upper centres. In the case of stimuli of high intensity, the control is broken; and then the lower centres act in an indeterminate and unpredictable way. When through accident the lower spinal centres become separated from the upper part of the nervous system, they respond by mass reflex and in other diffuse ways. They no longer project their response to definite points, but relapse to the old defensive reactions of withdrawal of the entire part of the body.

If it is true that the lower centres are dependent upon the upper, it is no less true that the upper are dependent upon the lower. This dependence, moreover, is not merely an executive dependence, but concerns the whole life of the upper centres. We all know how deeply rooted are the instincts and emotions in the primitive reflexes of the organism. And the sentiments in turn are rooted in the emotions. But imagination, too, even in its highest stages of creative organization, is closely dependent upon the primitive part of us. I have in mind, not merely the serious complications of the sex life which often accompany intense work of the higher type, but the more positive fact that our higher activities draw their energy, colour, and zest from their aliveness to sense experience and the passions. This will no doubt be recognized with reference to the more sentimental imaginative activities, but it is true of abstract thought, too. No person who is a mere intellectualist is likely to make any profound discovery or to move the imagination of human beings. The really great thinkers are poets at heart. And it is when we *express* the emotions rather than when we *repress* them that thought takes wings, that creative imagination comes to free and momentous expression. Your dry-as-dust intellect may do valuable secondary service, but it is not likely to do first class work. You must have a *passion* for beauty or your fellow men or something greater than yourself to sustain great thought. There is something almost infantile and primitive about genius that ensures youthful freshness to its work and makes its world a world of perpetual wonder. This is merely another way of saying that the great and fruitful intellect is not a mere cerebral language machine but lives clear down to his toes. All the levels are tapped and converge to give reality to his thought. The whole organism, and not least the despised parts below the diaphragm, contribute their vital share to the real life of creativeness. Your whole cubic capacity must be alive, to borrow an expression from William James, if you are to do your best intellectual work.

Mind as a Social System of Patterns

The study of individual behaviour in the abstract does not require the concept of mind. Individual psychology is an unreal abstraction. We can, it is true, study the human individual as a system of indicative signs or implied meanings, just as we study geological strata or the life of plants. But this is behaviour as the physiologist studies it and should be called what it is, viz., physiology. The issue has been confused by the fact that psychology in the past has followed no consistent principle of explanation. When it has dealt with the more elementary processes of habit, emotion, and sense perception, it has leaned on physiology, or pretended to do so. When, on the other hand, it has dealt with the more complex processes, such as the sentiments, thinking, and will, it has fallen back on social psychology. It has, as a matter of fact, started with the adult behaviour of the psychologist as differentiated, integrated and stereotyped through social relations, but has abstracted from those relations. Instead of treating of the individual within the matrix of social relations, under the control of which he acquires his habits, attitudes, and perspectives, it has made him an abstract entity. It has forgotten that the world as it exists for the psychologist, with its things, qualities, and relations, its values and attitudes, its play of free ideas and its organized will, is the product of social communication and interaction, made possible by a highly evolved language and tradition. The physiologist, who starts with the simple reflex of the nervous system and follows this through more complex levels of selection, integration, and control, is at any rate consistent in his explanation. In the most complex behaviour of the organism he sees the play of ever more complex mechanical causes. And though these may not furnish the sufficient reason of the behaviour, they are at any rate an index of behaviour, and make a consistent story. It is assumed that the organic mechanism in its entirety—neural, chemical, physical—would indicate all the various complexities of behaviour, could we follow it, which we cannot. At any rate, it is all we have so long as we deal with the individual organism in the abstract.

Mind is essentially a system of intersubjective meanings or valuations, and of controls as resulting therefrom. We may speak of mind as a superorganic system of relations as we may speak of life as a superchemical system. In any case each is a unique type of energy system with characteristics of its own. In the absence of expression, mind is inchoate and ineffective. It can at best be regarded as potential from the spectator's point of view. The formative idea is the soul, whether in the individual or in the group. And this is created in social relations and can only be understood through social relations. Mind comprises, it is true, relations to the physical world as well as to the social. But the former exist as meanings only because they are selected and integrated into social patterns. The physico-organic concept of mechanism employed by physiology is itself such a socially constructed system of patterns and should be worked so far as it can be worked. But it proves inadequate when we come to deal with social relations. I may add in passing that it is not necessary that the formative idea or system of ideas should be conscious at all times. It is at most only partly conscious at any one time; and at times, as in sleep, it may not be conscious at all. The mental patterns are, no more than the neural patterns, dependent on consciousness for their existence, though they cannot have significance without consciousness.[23]

It is only when we are concerned with expressive signs, with social relations, that the concept of mind becomes necessary. Here we have a new perspective of relations, a new reading of the facts. We no longer deal with neural patterns except as instrumental to the new type of relations. We are concerned with a new type of energy field where will relations, the craving for association and reciprocal sympathy, the intention to express and to be understood, the desire to share in a common life, become the important facts. We have to do with teleological causes—the realization of needs and interests in social relations. We are concerned only indirectly and instrumentally with mechanical causes and effects. Here we have selection, inhibition, facilitation, reinforcement, and integration of conative impulses, obeying in the main the same laws that we have become familiar with in the physiological field. There is the grouping of like impulses with like, there is the struggle for dominance and the selective inhibition of the incompatible impulses, the facilitation of the compat-

[23] I have dealt more fully with the relation of the concepts of consciousness and mind in *A Realistic Universe,* Part II, Macmillan, 1916.

ible and their integration into a common direction by the controlling pattern or set of will relations. In this pattern, duration plays an even more important part than in the physiological patterns, for here we have the past conserved, not merely in the slowly formed patterns of biological heredity, but also in the cumulative tradition, embodied in language, art and institutions, and moulding the habits of each generation, through education and social sanctions, into conformity with itself. And we have the projection of the future, which is not merely the projection of the past but has a forward-looking implication—due to our being part of a larger cosmic order which we cannot understand, but which somehow determines our course and our survival conditions. We have fusion, as in the orchestration of a vast number of musical instruments of varying timbre, of the various complex energy patterns of individuals and groups into a common tradition and a common life; and here, as in the physiological field, we have to take account of the quality, the intensity and the number of components as well as the total situation of the controlling energy field. This forms a continuum of a unique sort, cutting the individuals into various planes, protopathic or epicritic, according to the type of control and the situation at the time.

The fact that we are so organized that every instinct and emotion is provided with selective inlets or receptors for sympathetic response to corresponding instincts and emotions in others, and that, further, we can only realize our nature and find our satisfaction in association with others, goes to show that the evolution of life has assumed a new type of energy pattern in which the group is the unit rather than the individual, just as in the multicellular organism the organic whole becomes the unit of control rather than the cell. The types of group-unity vary all the way from the nutritive unity in the lowest stages of animal life, through the organic family of the bee, to organized self-planning society. The future is dark to us, but judging from human history so far and from our newly gained psychology of human nature, it would seem that if the race is to survive it must evolve a pattern of social relations which furnishes, on the one hand, a maximum freedom for individual human nature and, on the other hand, a maximum of sympathetic co-operation for common ends. Only such races as can meet these two tests are likely to survive in the long run.

Whether we translate the facts into mental or physiological terms, it is clear that we must explain behaviour in terms of energy systems or patterns and their action, reaction and interaction with the energy patterns of the environment. The subject-object relation now becomes one of significant selection on the basis of past and future perspectives. With the aid of language mechanisms, meaning patterns, ingrained by heredity and organized by personal experience, function as judgements, expressed, supplemented, and corrected in terms of social relations, present and past. Selected impulses now become data for conscious construction and reconstruction to meet the needs of life. And life includes pure thought. It takes delight in successful action, theoretical as well as practical. But in any case, the process is a trial and error process. The final test of proper thinking is proper conduct within the dominant purpose. This is as true in the realm of theoretical construction as in the sphere of practical judgment.

Mind patterns may express themselves not merely in immediate social relations, but also in forms of matter, institutions and language. A great genius may express his meaning in musical patterns of vast complexity like a symphony of Beethoven, or in sculpture like the Zeus of Phidias. He may express his thought in the building of cathedrals, or in systems of philosophy, or in great epics. And these patterns, with the will communicated to them, continue to live in the history of the race long after the creator has passed away, thus giving his mind a continuous vitality in history for long periods of time—perhaps latent for centuries but always ready to spring into renaissance when the proper conditions arise. Thus it is that English culture has been organized and continues to be organized through the ongoing genius of a Shakespere, who in turn is ever reconstructed in the living tradition of the race. So Plato lives through the centuries and makes us Greeks, while we in turn give his genius the colouring and vitality of our time. Such influences are lines of motion entering into ever new systems, yet always retaining their individuality as the historic pageant passes, dwindles or grows, through the endless perspectives of space-time.

Having once been compelled to introduce the conception of mind in order to understand social relations, we can now return to the individual and study his behaviour from the social point of view. Strip the individual of all social reference and nothing remains but a bare physiological automaton. But it is different when we consider the individual as part of the group. It is obvious that meaning and language are the articulation of the need for expression and reciprocal sympathy, *i.e.*, they are group planes which intersect individuals. Creative imagination, whether concrete or abstract, exists to organize and give form to this need for expression and mutual understanding. The sentiments are emotional patterns moulded upon social objects in the course of group relations. Even the instincts are all equipped with inlets for social sympathy. They are highly contagious. The cerebrum, in short, becomes an organ for social interactions, past, present and future, *i.e.*, it is an organ of mind.

As for the other neural levels, they too acquire new significance. It has been customary to start with reflex arcs and to judge the other reactions by that type. If we start with the assumptions of the physical sciences, it is natural to treat this arc as purely physico-mechanical. And having once made this assumption, there is no place where we can stop; and we are under the necessity of projecting the whole of conduct on the plane of the physico-mechanical. But we can now interpret the functioning of the lower centres from the social point of view. They have their own reality, their own contribution to make to the life of social relations. This fact is unfortunately overlaid and obscured in our artificial society. The cortex is pre-eminently an abstract language mechanism, and its increasing tyranny over the lower centres, owing to extreme centralization of functions, tends to suppress unduly the more primitive functions. Under artificial conditions such as hypnosis and the spontaneous trance, and in the less abstract life of primitive peoples, we have an opportunity to observe a more immediate sense of social relations which is largely suppressed in us except under conditions of extreme crowd excitement. The increasingly abstract epicritic control gives us our intellectualistic theories of individualism, so foreign to primitive society. In genius there seems to be an unusual persistence of the concrete type of immediacy and hence an unusual liveliness of the immediate and first-hand values.

The question may well be raised whether the extreme cortical centralization of the organism, with the consequent suppression of the primitive sense of rhythm, movement, and concrete imagination, which is the course of civilization, is not a tendency to senility and therefore self-defeating. If the psychic attitudes make a difference, directly or indirectly, to the blood, and if the blood in turn makes a difference to the germ-cells, then it may well be that the absence of proper stimuli and interactions may cause certain tendencies in the germ-cells to atrophy, or at any rate to make them available only under such exceptional conditions as to make them of little service. This should give us pause in our artificial and murderous civilization.

It is evident that we must look upon the human individual as a hierarchy of pattern-controls, where the lower levels borrow definiteness of response from the higher levels and the latter in turn use the lower as instruments in their realization. The growth and adaptation of the organism cannot be understood as a fortuitous interaction of the parts of the organism. There is implied an integral control of the whole through which the parts are organized and set their bounds. We cannot, for example, throw the entire responsibility for the adaptive growth of the organism upon the ductless glands, important though they are in the effective life of the whole. For the ductless glands must in turn be controlled in order to serve the economy of the whole.

> If there is too little thyroxin secreted into the blood by the thyroid gland of a child, this whole gland weighing hardly more than an ounce, that child may become a *cretin* with not only dreadful physical deformity, but with the deformed or incomplete mind of an idiot. If there is a little too much, the child may have a goiter, protruding eyeballs, a too rapid heart and a restless, irritable brain. The pituitary gland weighs one-sixtieth of an ounce, but if it is removed death ensues. If its secretions are too small in amount during childhood, growth is inhibited and a dwarf is produced, usually with psychic derangements; if too large in amount giantism occurs often with accompanying imbecility. The secretions (called adrenalin) of the adrenal glands, two small bodies lying near the kidneys and weighing about one-seventh of an ounce each, have, almost certainly, a marked effect on our nervous system, revealed by strong emotional responses to the variation in the amount of the secretions. Crile declares that "apparently adrenalin alone can cause the brain greatly to increase its work."[24]

But important as the secretions from the ductless glands are in the economy of the organism, we cannot attribute to them the final control in the life of the organism. We must still ask the question: What controls the growth and activity of the ductless glands in such delicate har-

[24] Vernon L. Kellogg, *Mind and Heredity*, 1923, pp. 102, 103.

mony with the whole? Obviously there must be a whole-control which guides the process of differentiation and integration of functions. And this genius of the whole must be the result of the interaction of the developing organism with the cosmos. It is only in this interaction that the actuality of the whole is created. And in the case of the normal human individual this whole-pattern, this actuality of the process of creative adaptation, includes the mental level as its final stage of development and the final control to which the other levels become instruments.

CHAPTER V

The Minded Organism and the Cosmos

The Mind-Body Relation

Sancta simplicitas! a martyr for the truth is said to have exclaimed when an old woman brought a few sticks to lay on the pyre on which he was being burned. But it is not only the pious who sin from too much simplicity in their loyalty to tradition. The scientist often falls into the same sin from too much sophistication. Science has more than once sacrificed truth to its simple faith in mechanism. It has been a tradition in science to explain the complex from the simple and to ignore the quality of the complex. Thus in explaining human behaviour, it has been customary to start with the reflex arc and to attempt to explain the more complicated functions in terms of this. The functions of the lower centres, such as the spinal chord, have been assumed to be purely reflex functions; and in turn the functions which are bound up somehow with the cerebrum have been regarded as only reflex functions of greater complexity, differing from the former merely in degree. Thus man becomes an automaton. But there are limitations to such an approach. It ignores the effect of the interrelation of the lower centres with the higher centres. We know now that in the higher organisms, the functioning of the lower centres is not explainable entirely in terms of these. We must take account of the control exercised by the higher centres. There is a *qualitative* and not merely a quantitative difference in the functioning of the lower centres when they are in integral relation to the higher centres from that when they are dissociated from the higher centres. In the integral relation the responses are graded and discriminative. They also have a space pattern and temporal pattern which are absent in dissociation. The physiologist has learned to study the life of a human individual as a system of controls constituting a more or less definite hierarchy. The lower centres of the nervous system owe their definite stereotyped character to the fact that they are under the influence of more complex centres. They have indeed their own life and characteristics, but it is only when they are functionally dissociated from the hierarchy of controls that they show their own peculiar character. They then act by mass reflex instead of responding to localized stimulation. They no longer respond to graduated intensity, but by the all-or-none reaction, *i.e.*, if they respond at all, they respond in the same way.

To the behaviourist it seems that all that is necessary is to be thoroughgoing in our physiological account of neurones and synapses and their relation to the rest of the organism with its glands and muscles, etc., and then we shall have a complete account of conduct. But there is another level, another type of control, which must be taken into account if we are to understand human behaviour, however complete may be our physiological description. Mental behaviour is known in a different way from physiological. Impulses, emotions, desires, sentiments, judgments, volitions are known as unique facts and not as vito-electrical or chemical changes. We have to do here with a new quality of control which must be understood in its own terms. And mental control, like cerebral control, overlaps. We have now come to realize that physiological functioning cannot be understood independently of mental functioning. Emotions, beliefs, attitudes, exercise control over physiological reactions. They not only influence the executive set and tone of the nervous and muscular systems, but alter the secretion of the glands and, indirectly, at any rate, the composition and energy of the blood. It is hopeless, therefore, to try to understand the action of the human organism in terms of purely physiological categories.

The physiological method is at home in dealing with the simplest types of life, but it does not suffice in dealing with the higher organisms. Here we require new categories. If we have been wrong in supposing that the reflex actions of the spinal chord and other subcortical centres can be explained without reference to the cerebrum, so we are equally sinning against truth in ignoring the controlling influence of the mental field. The set of the cortex in attention, the working of its mechanism of synaptic habits in sustained thought, can as little be understood without taking account of the mental field of interest as can the definite reactions of the spinal chord without the characteristic pattern of the cortex. There is a vast difference between the operation of the mechanism of cerebral habit, which we approximate in purely automatic reactions, and its operation in creative imagination, even if we neglect for the time the fact that in a creature with mind the habits themselves are forged under the control of the dominant interest.

It may be argued that, though the physiological categories are not adequate to *explain* human conduct, yet physiological changes—muscular, glandular, neural, —sufficiently *indicate* behaviour. In this case we could have a complete descriptive account in physiological terms even though this should prove inadequate as a causal explanation. Such types of behaviour as imply purpose and thought could then be identified and described purely through their physiological expression if we could follow this thoroughly. This would be like trying to study the differential reaction of the cerebrum by studying the reflexes of the spinal chord. It assumes that a lower level of functioning can completely express a higher level. But even granting this assumption, we should still be wrong in attributing the behaviour in question to the lower level—in ascribing the differential quality of the cerebrum to the spinal chord and still more in ascribing the differential quality of mind to the cerebrum. But, further than that, such a monistic theory of expression and control runs amuck against the plurality and relativity within the hierarchy of levels. The lower levels are not mere functions of the higher levels. They have their own history which antedates, as a matter of fact, that of the higher in the stream of heredity. They have their own organization, their own inertia and within certain limits their own life. Hence the control exercised by the higher levels over the lower is relative. The integration is not absolute. Even under conditions of normal integration, the reflexes of muscles and glands respond only in certain quanta relations and in certain general ways to the intricate shadings of feelings and thoughts, as we come to know them in social intercommunication. Bodily expression is at best a rough and inadequate medium for indicating the nuances of mind. It is through the artificial and spiritualized medium of language and art that minds enter into the possession of a common world of meanings.

We can neither express the lower levels as functions of the higher levels, nor can we express the higher levels as functions of the lower. The body is not just a transparent vesture through which we can read the innermost workings of mind. Nor is mind a mere chiaroscuro of bodily changes. We cannot project the behaviour of the human individual on one plane. The monistic conception of control is too simple to meet the actual facts, whether it be the monism of the materialistic physiologist who tries to explain all behaviour in terms of physiological reflexes, or of the psychological idealist who tries to express it in terms of categories of meaning and purpose. We shall not have a true account of human life unless we are willing to give due recognition to all the levels in the hierarchy of human organization with their inertia and relativity. We are indeed physiological mechanisms—vito-electrical and chemical—but we are not just physiological mechanisms. And we cannot understand even the functioning of these unless we give due recognition to the more that we are. Physiological mechanisms do not act by themselves but in integral relation with mental attitudes. We are minds too and not just physiological mechanisms. But, on the other hand, we are not abstract minds. We must understand mind in its integral relation with the whole organism. Without this, mind becomes an emaciated ghost, an impotent abstraction. The life of mind, as we know it, includes the organism with the whole gamut of its activities within a unique control and in integral relation with its cosmic environment of which the social environment is a part.

Psychology has come to recognize that at any rate in emotion we must take account of the entire organism with its evolutionary history and its relation to the environment, and not merely of its intellectual aspect. To be sure the James-Lange theory goes to the opposite extreme and tries to express the emotion entirely in afferent terms. But a mass of sensations can express neither the origin nor the nature of an emotion. It presupposes first of all a certain psychological set in the way of interest; and the specific emotion which is stimulated—fear, anger, laughter, etc.—can be understood only with reference to this set. The same external stimulus may give rise to any one of several emotions according to the integral situation at the time. A man who confronts you with clenched fists may give rise to fear or anger or laughter in accordance with your perception of the situation. And the emotion that results owes its unique character to the whole situation as perceived and not to the mere mechanical fusion of a mass of sensations. The James-Lange theory is right, however, in insisting that an emotion is not just an intellectual abstraction, but involves the functioning of the entire organism in a specific way in response to the external environment.

In conceiving the environment, we must take account not merely of the physical stimulus and its evolutionary relation to the organism, but we must take account also of the social environment with its sanctions. Our perception of the situation is not just a perception of a physical stimulus, but of its significance in terms of the social milieu in which we have been brought up and in which we move. This determines not only the mode of reaction, but it determines largely the specific emotion which we feel. A piece of cloth dragged in the dust might stimulate no emotion at all. But if the piece of cloth is our country's flag, and if the act is perceived as an insult by another nation, then our anger rises at once. How we show our anger as a nation may differ widely according to circumstances, and in any case is controlled by certain formalities between national groups which differ widely from the primitive response. If physical conflict results, it shows little relation in method to the animal conflict of the jungle.

But it is not only in emotion that we must take account of the integral relation of mind to the organism and the environment, physical and social. It is true of the whole gamut of psychological functions. Perception is not an abstract faculty but the integral functioning of an interest in relation to a present situation where the interest itself presupposes a real duration of past experience which furnishes the guiding field and where the whole tension of the organism, including cerebral mechanisms, bodily posture, and the adjustment of the sense organs, are integral parts of the functioning of this interest in this specific environment. In memory, both in the making and in recall, we must likewise take account of the control by an interest, working through cerebral mechanisms and in integral relation to the entire organism, striving to meet a specific situation or problem, which in turn owes its significance to our past experience as members of a particular civilization. Creative imagining or thought involves still greater definiteness of control, still greater complexity of experience, still greater complexity of neural mechanisms, still greater complexity of relations to organic, physical, and social milieux. Here must be included the capacity of using language as signs of absent situations and the capacity of analysis or taking account of abstract aspects of complicated situations.

What is important to note here is that mental functioning is not something apart from organic functioning, but organic functioning at a new level, under a higher control not expressible in terms of chemical or vito-electrical categories. In the case of mental control, the whole set of the organism is changed, including the functioning of cerebral and other neural mechanisms, muscles, glands, skeletal posture, heart, lungs, etc.—all of which organs in turn contribute their sensory and affective complement to the mental situation. The elements of the organism—chemical and neural—may be supposed to be the same, but they exist in a new set or organization. The cells of the spinal chord, for example, may be conceived as functioning at different levels—as part of the spinal chord structure with its history, as part of the cerebral hierarchy with the new creative synthesis this involves, and as part of a unique mental control.

We may with Alexander speak of the organism, functioning at the mental level, as minded organism, to indicate this integral relation. In the words of Thomas Aquinas:

> Body and soul are not two actually existing substances, but out of the two of them is made one substance actually existing: for a man's body is not the same in actuality when the soul is present as when it is absent: it is the soul which gives actual being.[1]

But if we use the Aristotelian language of potentiality and actuality we must be careful not to read into the lower levels more than belongs to them. We cannot agree with Alexander that

> each new type of existence when it emerges is expressible completely or without residue in terms of the

[1] *Contra Gentiles*, ii, 69.

> lower stage, and therefore indirectly in terms of all lower stages; mind in terms of living process, life in terms of physico-chemical process, sense quality like colour in terms of matter with its movements, matter itself in terms of motion.[2]

Mind is not expressible in neural categories, not even those of the cerebrum. It marks a new level of organization, a new quality of behaviour, a new pattern control in which the whole organism functions differently from the levels of reflex and habit, including even the cerebrum. For all that the physiological conception of the cerebrum can express is a mechanical system of increasingly complex reflexes and habits. To say that mind emerges from the physiological categories of reflexes and neural habits conveys no meaning. No doubt mind emerges in the life-stream, but it does not emerge by magic from non-mental categories. It emerges by creative trial and error adaptation to a cosmic environment which possesses the character of mind.

When Aristotle and Aquinas speak of the human mind as the actuality of the human body, they take the human type with its heredity for granted. Given human heredity in its normal environment, we may expect a human being to complete its growth span and to manifest the characteristics of the typical stages of this growth. Neither Aristotle nor Aquinas were concerned with the evolution of the human species from lower types. If we take humanity at a certain stage of development for granted, and if we take a certain type of environment for granted, then we may speak of the stages of human development as realization or actualization of the potentialities of a human individual, bearing in mind that this actualization is a creative development involving a certain growth span and a certain complexity of milieux. An individual may then be spoken of as having a characteristic entelechy, form, or quality. This is merely saying that the individual in ques-

[2] *Space, Time and Deity,* Vol. II, p. 67.

tion is a unique organization, the creative outcome of all the co-operative factors. Aristotle does not try to account for the characteristic entelechy of a human individual or of the human species. He merely notes that there is a certain characteristic form or organization which not only emerges in the life history of the individual but which is latent in this history from the beginning and guides the development. Aquinas has here the advantage in being able to invoke the creative activity of God, who adds a characteristic soul.

We cannot here enter into the theological problem of creation. But we may agree with Aquinas that mind is a creative addition. From an evolutionary point of view, mind is an incarnation due to the interaction of matter in its history with a cosmos which possesses the mental level. It is not a miraculous emergence from non-mental categories, nor is it added arbitrarily from without, as it naturally would seem to a mind foreign to the evolutionary conception of life. When mind does appear in the fulness of time, it is a unique level of control interpenetrating the lower levels and giving new quality and tone to the functioning of all the levels. We have no longer a mere physiological organization of organic mechanisms. But we have a mental organization of life, a minded organism. We have a new type of functioning in relation to the environment. For mind, as we know it, is not an abstract entity, but an energy system. It is the abstract word which perpetuates the idea that mind is either a thing apart or nothing; and a thing apart is indistinguishable from nothing. Here extremes meet. For if we can account for the functioning of the organism without mind, then mind becomes superfluous. It is because mind overlaps, because it makes a difference to the total functioning of the organism, that we require the concept of mind in our account of human behaviour. Mind, as we know it, is minding. It is dynamic. And the same is true of its characteristic traits. They are not abstract faculties but types of functioning. We should say not perception, but perceiving, not thought, but thinking, and this functioning includes the milieu.

We cannot regard mind and body as two separate sets of facts accidentally joined. Our modern conception of the relation of soul and body was vitiated at the start by the false bifurcation which Descartes fastened upon modern thought. Descartes conceived mind and body as two absolutely distinct substances—mind being conceived as a thinking, non-extended entity situated somewhere in the brain, body as an extended non-thinking thing including the life of the organism with its functions. Without mind, the organism for Descartes is an automaton whose behaviour can be stated in the laws of mechanics. Descartes conceived animals below man as such automata. In man mind can exercise a certain regulative function, without altering the quantity of motion in the body. In more recent terminology it might be compared to a catalytic agent which may suspend or delay physical operations without affecting the quantity of their energy. Mind for Descartes has a characteristic activity of its own, that of thinking or clear and distinct ideas, though being situated in the brain at the junction of the nerve currents (in the pineal gland), it is more or less perturbed by the commotion going on in the body, and hence we have emotions, passions, and the secondary sense qualities. The ideal situation for mind would be, of course, when it works in isolation from the body, as he supposed it does in pure mathematical thought. The mind can see most clearly when it is a disinterested spectator of the sense world.

The question naturally arose how such disparate entities as mind and body could have any commerce with each other. How can an unextended idea budge an extended atom in the fashion required by the billiard ball conception of action and reaction? Descartes himself recognized the difficulty, and when pressed in the matter admitted that the action of the one could only be regarded as the occasion of the action of the other. In other words, we cannot imagine how the interaction takes place, but the fact of interaction must be accepted. It was natural, however, that his successors should speculate about the mode of interaction and the Occasionalists tried to supply the efficient cause. It is not the first time that philosophers when they have created an impasse by their false abstractions have invoked the assistance of theology to patch up their difficulty. For Geulincx, God acts as mediator between mind and body, producing corresponding changes in either on the occasion of change in the other. The events then appear as though there were interaction. Events in mind are followed by events in body, and vice versa, and all goes merry as a marriage bell.

But somebody is always taking the joy out of life for the speculative philosopher, and someone threw a monkey-wrench into the speculative machinery by asking how mind could know what happened in the physical world, being completely isolated in fact. Malebranche tried to get around the difficulty of occasionalism by a brilliant detour. At least mind knows mind and the human mind exists somehow in the mind of God, its creator. In the mind of God, there are ideas of the events in the physical world and their interrelations, for the physical world is but the fiat of God, the realization of his ideas in space and time, and everything in the physical world happens in accordance with the ideas of God. These are the real agents in the physical world. Hence what does our mind require but to watch the scenery in the mind of God where our mind lives, moves, and has its being? The difficulty of knowing the physical world has been bravely overcome, but the physical world has disappeared in the effort.

In the meantime, Spinoza, brought up on the Cartesian dualism, had come to the conclusion that mind and matter can no more meet than east and west. They cannot act upon each other, yet there is correspondence. Hence why not assume that, instead of being substances, mind and body are but aspects or attributes of one substance, two different languages, as it were, in which the true substance expresses itself? On such a theory correspondence can be accounted for without running amuck against the difficulties of interaction. It is a magnificent attempt to bridge a false dualism. But to an honest mind like Spinoza's who wishes to be fair to all the facts, there are difficulties. If mind is a series of ideas corresponding with physical changes, *idea corporis,* then it is clear that the linkage of causes and effects is the same; but the real nexus of causality becomes physical, and mind becomes what Huxley has called an epiphenomenon. On the other hand, if activity in our experience means purposive control or, as Spinoza states it, clear and distinct ideas, then bodily states, with their sensations and affections, become confused states of mind; and we lay hold on reality as we reduce these states to system and in the last analysis as we know them in the intellectual love of the whole, which for Spinoza is God. This gives an exalted status to soul and its destiny but gives a doubtful status to body.

The theory of parallelism has played a considerable rôle in recent thought. The fact is that psychology has not succeeded in emancipating itself from the Cartesian dualism; and parallelism has seemed a convenient half-way house to metaphysical idealism or metaphysical materialism according to the philosophic bias of the psychologist. But parallelism does not bear scrutiny as a scientific hypothesis. I do not think we need to take seriously the theoretical objection that parallelism between such disparate facts as mental and physical is absurd. For parallelism, as Spinoza uses the term, means correspondence, and we can conceive a one to one correspondence between disparate sets of facts. The visual musical score corresponds thus with the auditory symphony, though they are entirely disparate sets of facts. The real objection is that the theory of parallelism runs counter to evidence.

We know since Weber that the relation between physical stimuli and psychological discrimination is a quantum relation. Physiological processes must reach a certain intensity before they can overcome the inertia of the mental energy system. Weber investigated this relation in the field of sense perception. The law of inertia holds not merely for the minimal threshold of a specific sense such as pressure, *i.e.*, for perceiving the physico-physiological process at all, but it holds also for the difference threshold, *i.e.*, perceiving an increase of stimulus. A certain finite fraction of the stimulus must be added in order that a difference may be observed. To be sure, if this were an absolute relation, we could still establish a simple mathematical correspondence between psychological differences and finite physico-physiological quanta, as Fechner attempted. This would not be parallelism, however, in Spinoza's sense, which implies infinitesimal correspondence, *i.e.*, correspondence between quanta indefinitely small, as small as you like, approaching zero. Leibnitz tried indeed to establish such correspondence by assuming unconscious mental processes which by their summation should become conscious. But aside from the absence of evidence of such processes, the problem would be merely transferred from the relation between physiological and mental processes to the relation between unconscious and conscious mental processes. Here, at any rate, the finite quantum relation would reappear. It is simpler to assume that physico-physiological differences which cannot be taken account of by mind do not exist for mind.

Fechner's theory of an absolute finite correspondence between physico-physiological processes and psychological processes breaks down for two reasons. The correspondence within any one sense-domain is relative to the range of the relation. Our discrimination is more acute for a certain portion of this range, aside from the fact that there is a certain minimal threshold and a certain maximal threshold where there is no discrimination. But the correspondence is also relative to the psychological situation at the time—to the competition within the field of attention. Differences which are discriminated under some psychological conditions are not discriminated under other conditions though they are of the same physical intensity. Hence we cannot establish any absolute correspondence whether infinitesimal or finite. The evidence shows, however, that there is a quantum relation between physico-physiological processes on one hand and mental processes on the other. While this relation has been investigated thoroughly only within the field of sense perception, we have reason to believe that it holds for the relation between physico-physiological and mental processes generally. In other words, it requires a certain quantum of physiological intensity, varying under various conditions, for the mental level to be awake to physico-physiological processes. And, on the other hand, we have reason to believe that it requires a certain quantum of mental intensity to produce certain characteristic differences in physiological processes. The effect of intense emotional excitement upon certain glands, as for instance the effect of intense emotions of fear and anger upon the secretions of the adrenal gland, has now been investigated, not to speak of the more obvious effects upon the muscular, respiratory, and circulatory systems. But here, too, the relation is relative both to mental complexity and to the inertia of the physiological processes. Whether, therefore, we approach the problem from the relation of physico-physiological processes to mind or mental processes to body, the assumption of an absolute one to one parallelism breaks down in the light of evidence.

There is a further difficulty when the question of knowledge is raised: mind conceived as parallel to body and having by hypothesis no commerce with body can know nothing about body, not even its existence. No wonder, then, that psychological idealism gives short shrift, without even Christian burial, to the Cartesian concept of body. For is it not a ghost of the philosophical imagination? There is in reality only mind—subjective mind, the life of ideas in their cognitive unity. Body is but the appearance of one mind to another in the external relation of sense perception, and this relation itself is due to our finite limitations. In reality everything hangs together by internal relations, *i.e.*, by relations of meaning and value. When we know reality as it is, taking our own subjective experience as the model, it is through and through mind; and in the last analysis it must be conceived as one all-inclusive mind having many modes, a stupendous philosopher. We do not need to worry further about the mind-body problem. The problem itself is a fiction of our imagination, since there is no body.

This seems to settle the matter. But the modern materialist, fortified by the Darwinian theory of evolution, goes back to Descartes' starting-point with new weapons. Did not Descartes hold that animal behaviour is explicable without soul, in terms of mechanics? But have we not learned since Darwin that the difference between animal structure and behaviour and that of human structure and behaviour is one of degree merely? The human brain is very much like that of the higher animals, though somewhat heavier in proportion to the total body weight than that of other mammal brains (though not of some birds). It seems more complex in its external anatomical features and must be more complex in function (though we know very little of the internal dynamics of the cerebrum, except what physiology has stolen from psychology and attributed to the brain). If we grant that mental functions are entirely dependent upon bodily structure, what can prevent the materialist from holding that what we are pleased to call mind *is* the functioning of bodily structure at a certain level of complexity? Descartes was on the right track in dealing with animal behaviour, but was haunted by the old ghost-soul in dealing with human behaviour. Hence his absurd dualism of mind and body, and the confusion of philosophic theory that followed.

But the materialistic theory founders on the rock of evidence. Psychological processes cannot be reduced to neural mechanics. No doubt we must take account of reflexes and neural habits as real facts; but they are not adequate to explain mental functioning. There is more to memory and recognition than just neural mechanism. There is a control based upon interest, a teleological category. And this is still more obvious in organized purposive behaviour. We are not just creatures of reflex and habit. We must, in some types of behaviour, recognize a teleological control of reflexes and habits. Meaningful behaviour is a new level of organization. We can appeal to one another as minds; and knowing one another as minds is different from the interactions of physiological organisms. Minded organisms behave differently from organisms limited to chemical responses and neural habit. A new sort of co-operation is possible on the mental level—that of sharing in a common world of ideas and intelligent preparation for the future. Mind can act to change the course of physiological processes as shown in psychotherapy. There is, moreover, a mental pathology—confusions, obsessions, diseased complexes of ideas, which can be cured only through the appeal to the mind, if at all. Physiological materialism is based upon the assumption that we can express higher levels in terms of lower levels. But it misses the quality of the higher levels; and it fails, as we have seen, to give a true account of the functioning of the lower, since this functioning is in part due to their relation to the higher. Materialism is a dogma which men must always ignore in their practical relations with each other. It is true, of course, that we are physiological mechanisms, but we are more than physiological mechanisms. And we cannot even understand physiological functioning in a human being without taking account of this more. From the point of view of cosmic evolution, it would be truer to say that the body is evolved for the mind or, in the language of Plotinus, that the soul makes the body, than to say that the mind is a mere function of the body, for a minded organism is the whole, the actuality, which creative adaptation has striven, at least in favoured instances, to accomplish. Mind is not added as an accident to the process of material evolution.

Physiological materialism and psychological idealism have been compensatory in the history of thought. They have emphasized different aspects of the artificial bifurcation into mind and body. Materialism has emphasized the reality of body, the importance of the physical organization, and has contributed to the understanding of the physiological mechanism. But it has missed the significance of the higher types of behaviour; and because of its one-sidedness it has even failed to account for physiological functioning in the higher organisms. Psychological idealism has emphasized the importance of mind, of significant behaviour; and in this it has based itself upon the solid facts of experience. But in failing to recognize the rôle of matter in the economy of minded organization, it has failed to understand even mental functioning. Both physiological materialism and psychological idealism, in attempting to project the facts of human life on one plane, have failed to see the real relation of mind and body. Mind needs body no more than body needs mind in the true economy of human behaviour. If an artificial dualism, whether as interaction or parallelism, fails to meet the evidence as regards human behaviour, so does an artificial monism which, proceeding from the artificial bifurcation of mind and body, tries to account for the facts in terms of one member of the dichotomy.

Nor does the instrumental dualism of M. Bergson, however picturesque it may be, explain the true relation of mind and body. M. Bergson, it seems, regards the brain and organism as an intermediary between sensation and movement.

> All the facts and all the analogies are in favor of a theory which regards the brain as only an intermediary between sensation and movement, which sees in this aggregate of sensations and movements the pointed end of mental life—a point ever pressed forward into the tissue of events, and, attributing thus to the body the sole function of directing memory towards the real and of binding it to the present, considers memory itself as absolutely independent of matter. In this sense, the brain contributes to the

> recall of useful recollection, but still more to the provisional banishment of all the others. We cannot see how memory could settle within matter; but we do clearly understand how—according to the profound saying of a contemporary philosopher (Ravaisson)—materiality begets oblivion.[3]

The human mind seems to be a tremendous reservoir of memories and other psychological processes which press against the gate of the dam but can only get through in part because of the constraint of the body.

> It would seem that the human mind ceaselessly presses with the totality of its memory against the door which the body may half open to it: hence the play of fancy and the work of imagination—so many liberties which the mind takes with nature. It is none the less true that the orientation of our consciousness toward action appears to be the fundamental law of our psychical life.[4]

No doubt M. Bergson has the right intuition when he emphasizes, as against physiological materialism, the distinctive and real life of the mind. But as usual he offers us a metaphor in lieu of explanation. We are not concerned here with the fact that in Bergson's metaphysics matter has no status, that it is merely the downward trend of life. In dealing with the relation of mind to body, at any rate, he accepts the old dualism. It is true that mind furnishes a plus element which is not expressible as physiological mechanism. It is true also that where the level of mind exists and functions, physiological mechanism must be regarded as instrumental to mind. But mind and body do not exist as abstract compartments in the fashion that Bergson pictures them.

Without going into detail here as to the nature of memory and imagination, we must insist that the relation of

[3] *Matter and Memory,* p. 232, translation by Paul and Palmer, 1911.
[4] *Ibid.,* p. 235.

mind and body in mental functioning is an integral relation and not a mere external relation. Mind does not live in independence of body, nor body of mind. But mind carries on its characteristic activities through the body mechanisms and the body mechanisms function in a different way because of the integral relation to the mental level, as the spinal cord functions differently because of its integral relation to the cerebrum. If mind and body cannot be stated as two aspects of the same thing, as in Spinozistic parallelism, neither can they be stated as two independent compartments having, as Professor Carr would say, a merely tangential relation to each other. Mind must be conceived as interpenetrating the whole body organization and giving it a new trend and quality. In the evolution of our earth from inorganic matter to organic matter, and from organic matter to minded matter, new levels are creatively added in the interaction of geological history with the structure of the cosmos. Life and soul are not latent in the geological process from the beginning as metaphysical vitalism would have us believe. This runs counter to the evidence as we have it.

It must be clear now that modern theories of mind and body—starting with the Cartesian dualism of extended thing and thinking thing, and then trying vainly to make east and west meet, and equally vainly to state one in terms of the other—have been futile and ended in an impasse. We must take a fresh start and in doing so we must go back for historic orientation, not to Descartes, but to Aristotle and Thomas Aquinas. Body and soul constitute one integral unity in minded control. "A man's body is not the same in actuality when the soul is present as when it is absent" or, in more modern terminology, the physiological organism with its hierarchy of structures does not function in the same way when it is in integral relation with the mental level as when it is dissociated from this level. The mental level superimposes a new set upon the whole hierarchy of physiological mechanisms, as the integral relation to the cerebrum superimposes a new set upon all the centres below it. It is not a question of mind *and* organism, but a minded organism. Mind as we know it is not exclusive of the body, but a new control, a new organization superimposed upon the vito-electrical levels of the organism as these are superimposed in a hierarchy upon one another. A new quality is added to behaviour with the advent of mind. Mind, therefore, is not statable in terms of physiological processes. It is a plus factor and gives a new direction and tone to these processes. Minded behaviour is a unique quality of behaviour. It is not the actuality of the body, but a new actuality, the actuality of a completer life, a creative addition in the course of evolution of a new pattern control, a new energy system, not resolvable into the categories of physico-chemical nor into those of neural systems. It establishes a new level of normality and abnormality. It functions not merely to delay physiological processes, but it gives a new organization to the life of the organism. It is meaningful behaviour and not merely mechanical behaviour.

We cannot emphasize too strongly that mind is a unique energy field with a structure of its own. But we must also remember that it overlaps. Its control is pervasive. The whole scale of physiological reactions—sense reactions, spinal cord reactions, muscular reactions, secretions —are different because of it. The whole functioning of the organism in relation to its environment—its responses and inhibitions—is different from what it would be under some other type of control. We must take behaviour as an integral whole. Mind, organism, environment constitute a unit in behaviour. And we must recognize the mental type of behaviour for what it is. Minded behaviour is a real type of behaviour, and we cannot separate mind from its behaviour. Neither can we reduce minded behaviour to non-mental behaviour as materialism does, though the physiological levels come to participate in mind as the spinal chord participates in the pattern structure of the cerebrum.

There is a sense in which the mind as an energy pattern is present in the body and is a quality of the body. It is the sense in which the cerebrum can be said to be present in the spinal cord and to be a quality of the spinal cord. The cerebrum does by its distance messengers communicate its pattern to the spinal cord, and the spinal cord has a different quality of reaction because of this control. Yet the structure of the cerebrum as such is not present in the spinal cord. The spinal cord cannot function as the cerebrum. The cerebrum has a unique structure and a unique mode of functioning of its own. The spinal cord responds as it can by virtue of its own history and structure to the energy pattern of the cerebrum. And so while the mental energy level communicates its pattern through distance messengers to the various levels of the physiological hierarchy—cerebrum, thalami, spinal cord, etc.—these respond as they can by virtue of their own history and organization. But they cannot respond as mind. Only mind can respond to mind in kind. The mental level has a unique structure and a unique mode of functioning of its own. It is the whole integral relation which can be spoken of as minded, not the parts. Perhaps this is what the schoolmen meant when they spoke of presence in activity but not in essence, though we must not separate essence and activity. It is the essence which is active. This we express when we speak of mind as an energy pattern. We may say that mind is related to the cerebrum in the same way that the cerebrum is related to the subcortical centres, remembering that mind overlaps and is the ordering pattern of the whole.

But the question may still be raised: *How* can mind influence or control matter? If we were limited to the Cartesian concepts of matter and mind, this would indeed be an insuperable difficulty. But science no longer conceives of the atom as an impenetrable bit of extension with a constant geometrical shape. The atom to-day is conceived as a complex energy system. Extension is no longer conceived as an absolute property of matter, but as relative and functional, as are all other properties. The appearance of continuous extension in three dimensions, which matter in the gross presents, is itself due to the interaction of a certain external energy system of electric charges with our sense organs and nervous system. To the physicist with his more adequate instruments of thought and observation, matter is far from being a continuous extension. It is an energy organization of vast complexity. Even inertia, the most fundamental property of matter, is conceived in energy terms by such physicists as Einstein. Science has travelled a long distance from the little homogeneous and impenetrable blocks of Leucippus. On the other hand, mind is no longer conceived as an abstract ghost. It is known through activity, function; it is an energy organization. Once we state the relation of mind to body in energy terms, it ceases, at any rate, to be an absurdity as it turned out with the Cartesians. We are familiar with energy exchange between different types of energy systems and so are no longer frightened by abstractions. The question becomes one of evidence; and we have increasing evidence of the effects of mental attitudes and feelings upon physiological processes, and vice versa. If the tone of the organic system affects mental health and activity, it is equally true that mental tone affects bodily health and well-being. And we have experimental evidence as to the quantitative effects of mental processes upon the secretion of glands and other physiological processes.

Nor need the epistemological problem raised by the psychological idealist trouble us. We grant that we must get our evidence of the body from sense experience either directly or by implication from sense experience. Without raising the metaphysical problem here, we must insist that we know reality through its functions within our experience. Now, some bodies respond as minded bodies, or, if we prefer, a minded organization of sense properties. Other bodies do not respond as minded bodies. Whether we speak of bodies as material bodies or as groups of sense properties and possible sense properties does not affect the problem, since what we mean by matter is a certain type of energy organization or group of properties and possible properties. The distinction of minded body and mechanical body remains as real as ever; and practically we must distinguish between them and we must investigate scientifically the difference in behaviour of the two. No change in terminology can destroy the difference in function of various organisms or of the hierarchy of functions within the same organism. We cannot ignore mind if we would understand human bodily functioning, neither can we ignore body—its levels of organization and inertia—if we would understand mental functioning. We must be fair to all the facts as we can see them.

In recent physical theory, the interest has shifted from abstract entities and their particular external relations to energy fields with their curvature within which the entities move. The physical unit of an electron in motion is not just the electron, but the electron with its energy field, and this field in turn must be conceived within a cosmic field with its unique curvature. We must conceive the minded organism as a group of physiological mechanisms moving within a mental field with its unique structure, and this field in turn must be understood in relation to other mental fields, and all must be understood with reference to the cosmic field and its unique structure. It is in the creative adaptation of physiological evolution to this cosmic field that minded organism arises, that a new level is added to the physiological levels, bending them within its unique curvature.

The Individual in the Environment

We have seen that the bifurcation of mind and body leads to an impasse and that the integral unit is the minded organism. We must now show that the bifurcation of mind and environment is equally impossible. The tendency in the past has been to conceive human traits in too abstract a fashion, as though they existed apart from the interaction of the individual with his environment. This shows itself in the sharp separation we are accustomed to make between nature and nurture in the individual life history. On the contrary, we must conceive individual traits as functions of the interaction between the system of energies which constitutes the stream of heredity, on the one hand, and the various systems of energies which constitute the environment, physical and social, on the other. These two factors are never separated; there never exists such a thing as an individual in the abstract or an environment in the abstract, but the two form one integral whole. The individual life stream cannot exist in isolation. It is part of an integral whole of interacting energies and draws literally its life blood from it. With this clearly in mind we can see how artificial it is to attempt to describe individual traits as due either to individual nature alone or to nurture alone. Some traits, such as the purely organic characteristics, and such adaptations as the reflexes and vague instincts existing at birth, are due to the fairly uniform interactions between individual life history and its prenatal environment. Hence we are apt to treat them as independent of the environment. But prenatal reflexes and instincts in the higher animals are due to a long period of interaction between the developing embryo and the body life of the mother. The latter is the immediate and direct environment of the embryo until birth. We know but little of the interaction between the developing life of the embryo and the life of the mother in the higher animals except that the embryo must share the blood of the mother, and we know now that the blood is an enormously complex system. But under normal conditions of interaction the results, as might be expected, are fairly stereotyped. Our limited experiments seem to indicate roughly the same reflexes and the same instincts (if such they can be called) in the newborn human babe. With the exception of such rudimentary organic responses as grasping, sucking, crying, shrinking from pain and loud noises, the so-called instincts are due to interaction between the individual and the outer physical and social environment.

We may illustrate this process of integration by the so-called social instincts. The sex feeling, at first vague and inchoate, may become integrated into love for a member of the other sex through social suggestion and according to the approved pattern of social custom. Sex love in a normal human being is not just an animal instinct of reproduction. It involves idealization and socialization as integral aspects of its structure and its satisfaction. Wanting such specific integration, it may manifest itself as general restlessness and discontent, relieved by fancy and dreams. In noble natures like Plato and Spinoza, the primitive sex energies may be integrated into the higher pattern activity for abstract truth and beauty and intensify its emotional zest. In a human being, at any rate, the organic restlessness is indeterminate and may be integrated into a variety of responses to the environment. Parental restlessness may remain an aimless reminiscence of inchoate race feelings. It may under favourable conditions become integrated through the social tradition into love for family and offspring. It may in a noble bachelor like Bentham become love for human kind, especially its downtrodden portion. The vague craving for companionship may remain inchoate; it may become integrated through social contacts into loyalty to a particular herd; or it may, in rare natures, become love of an impersonal presence in nature. There is not in human nature, as in some insects, any completely organized instinct which makes it possible for a human being to realize its race destiny independent of experience. The incompleteness of man's biological heritage is its glory and opportunity. The nature of the lower animals is complete and bounded while man's nature is incomplete and plastic. We may say that the opportunity of development is in inverse ratio to the completeness of instinct. In human development the biological heritage is integrated into the social tradition, and the former is an abstraction apart from the latter. The realizing of the tendencies of a human being with the accompanying satisfaction is made possible only by his participating imaginatively in social patterns. What we call a specific "instinct" in a human being is a social integration finding its method in social habits and its value in social standards.

A psychology based upon abstract faculties is supposed to be a thing of the past. But it has returned under the guise of instincts and capacities. Psychology has treated instincts as so many ready-made faculties, existing independently of interaction with the environment. Hence the endless debate as to the number of instincts and their characteristic manifestations. No doubt there is a certain hereditary structure which in interaction with the environment shows certain instinctive traits. But these traits do not exist in isolation from the environment. They are a creative result of the interaction and show, therefore, considerable variability with the conditions of interaction. If they do not appear in a life history, that does not mean that they were ready-made but failed to be called forth. They only exist as the result of the interaction. If they emerge later in one life history than in another, this does not mean that they were delayed, but that the ensemble of creative conditions did not exist before. Nor can we say that a certain instinct in the abstract is the motive of a certain behaviour—that men do things, or refrain from doing them, because of a fear instinct, or a pugnacity instinct, etc. There is a psychological aspect as well as a biological to human behaviour and human valuation. We must take account of human nature as woven into social experience and determined by social standards. Abstracted from the network of social relations, from the pressure and valuation of the group, instinct is a fiction. The same object may call forth an entirely different response in different people and at different times. What arouses love in some people may arouse hate in others; what stimulates laughter under some conditions, may stimulate anger under others. If there is no instinct or emotion in the abstract much less is there a sentiment in the abstract. A sentiment is an emotion or group of emotions associated habitually with certain social objects.

Intellectual capacity, like instinct, must be understood in terms of interaction. The statistics of eugenists as regards the inheritance of ability are vitiated by the neglect of this fact. Children nurtured in the homes of cultured people like the Darwins have a great advantage over children bound to the customs and routine of the soil or the factory. But the children of illustrious people often fail to maintain the intellectual standard of their parents and the children of obscure people sometimes rise into eminence. We know no law by which genius can be predicted, though feeblemindedness seems to be inherited. It is impossible to say how many people fail to rise because of lack of opportunity in the form of the proper stimulus in the proper period of development. Custom counts for a tremendous deal. So far as I know I was the first college graduate in my own family, who had lived for generations as farmers in the highlands of southern Sweden, remote from city life and from institutions of higher education. There have been several college graduates in the family since I started, and I have had occasion to admire not only their ability but the ability of the older members of the family who were content to live in quiet obscurity. Who knows how many poets and philosophers there might have been among those who sleep unknown in the little country churchyard? Ability no doubt involves a certain quality of hereditary structure. But it is not an abstract quantity independent of social interaction. In any case, abilities which are the only facts we know are the result of interaction between the individual and society. Stimulus and training are essential conditions. For, after all, ability shows itself as interest; and since we cannot know interest in the abstract we cannot know ability in the abstract.

It is absurd to try to study intelligence in the abstract or to test intelligence in the abstract. What is attention in the abstract, perception in the abstract, memory in the abstract, speech in the abstract, reasoning in the abstract? They are so many fictions. The so-called intelligence tests have been vitiated by the fact that they have failed to test the capacity of the individual in terms of the problems of his unique life environment. The only way to test the ability of a farmer is in terms of the problems which he must meet as a farmer, of a mathematician in terms of the problems of mathematics, of a musician in terms of problems of music. We do not remember in the abstract, but we remember through contexts of interest. A good memory is a well-organized memory, a memory that responds effectively to the requirements of the social milieu. The prodigious memory of some scholars is due to the organization of impressions in terms of a permanent interest. Nor is thought an abstract faculty which can be tested in the abstract. It is an organization of material in terms of an interest. It involves not merely memory, but exact record. Its efficiency depends upon the mastery of a certain social technique in the way of method. Thinking about problems of thermodynamics requires a familiarity with the accumulated results in that subject, a mastery of its technique of method, of mathematical expression and record. A good thinker is one who is trained to analyze such problems as he sets himself to meet. A good scientist, as well as a good poet, "is made as well as born." Ability to think about one type of problems need not be ability to think about another type. Men trained in science may be easily duped in business. Men distinguished in the physical sciences may be easily duped in psychical research. Training and discipline enter into the capacity of the human instrument. No doubt there is a quality of each instrument. But this quality must be ascertained in the concrete interaction with the social environment. Individual genius must master the material and technique before it can become creative. It must labour in anguish to meet common problems before it can give birth to new insight, whether it be a new scientific hypothesis or a new symphony. Discoveries which seem marvellous to the layman are often the result of the mastery of technique rather than of unusual imaginative power. The dialectic of events may seemingly determine the next step to him who is prepared. While we cannot all be geniuses, each may contribute something of beauty if he has social discipline and individual earnestness. It is when soul is married to opportunity, in earnest work, in purifying pain, in the joy of beauty, that the real vintage of life is seen, be it rich or be it poor.

The study of human nature apart from the concrete situations of society and nature must therefore remain the most unreal faculty psychology. Human nature can only be understood when we consider the individual life history in the various integral situations into which it creatively enters. And here social interstimulation, social tradition, social control are for good or ill essential factors of the situation. Could we eliminate the social aspect from human behaviour, what would remain? We cannot say that animal reactions would remain, for they are responses of a different organization to a differently selected environment. The animals below man are not dependent upon society to the extent that man is. The guiding life patterns of even the highest animals are organic, however much they may be modified in execution through trial and error habit-formations, while the guiding life patterns of man are due to social interaction. To be sure, man too has organic cravings of hunger, thirst, and sex, but the pattern of their realization is prescribed by social custom and, at a higher level, by reflective ideals. It is only as nurtured by society that man can live, and he is regarded as normal only as his organic cravings take on the mental patterns of his group. He may indeed rise creatively to higher mental patterns, but when he is incapable of being guided by mental patterns as the idiot and insane he is not an animal. Nor is a mental defective—an idiot or imbecile—just a child of a certain mental age.

The idiot and imbecile do not merely lack a certain mental range of learning capacity, but they are also physiologically defective in co-ordinations and physiological tone. And this physiological defectiveness is due to the dependence in man of the lower levels of functioning upon the higher. A rift in the lute of the higher levels shows itself in a rift in the lower levels. A mental defective is not an animal because a normal animal is physiologically complete. He is not a child of a certain mental age, because a normal child of a mental age of two is dynamically or prospectively complete in that its growth span, in creative interaction with its environment, will take on the customary mental patterns which fit the child for its group activities. Its normal development includes its social integration.

The physiological method studies behaviour as stimulus-response. It conceives behaviour as a dyadic relation. It investigates the reaction of a certain physiological mechanism to the energies of the physical environment. This method is too simple for the study of human behaviour. For human behaviour is essentially triadic. To understand the conduct of a human individual we must take account not merely of an individual with certain abstract capacities, on the one hand, and of the physical environment with its stimuli, on the other, but we must also take account of the social milieu of which the individual is a part—the group pattern with its tradition. It is only in dealing with the behaviour of material things and of the lower organisms that we can state the relation as stimulus-response. To understand man we must take account not merely of the stimulus, on the one hand, and his original capacities, on the other; but we must also take account of the milieu, the social interstimulation and tradition of which he is a part. With the same stimulus and the same capacities, different individuals may respond in different ways. The French flag produces affectionate response on the part of a man brought up in the French tradition and hatred on the part of a man brought up in the German tradition, though the flag is the same and though the two men are biologically of the same family lineage.

The besetting sin of modern science has been the attempt to describe a higher level of organization in terms of a lower. The lower level has been regarded as more typical of reality, and the unique characteristics of the higher levels have been ignored. Thus science has tried to reduce the organic to the inorganic and the mental to the organic. The mechanical categories have been given undue weight and the teleological categories have been discarded. In so doing we have naturally missed the significance of those levels of reality where the teleological categories are at home. We have pressed simplification at the expense of truth. The saner way would seem to be to ascertain the characteristics of each type of organization with its milieu. Now, mind has its characteristics and its proper milieu as truly as inorganic and organic systems. The milieu of mind is threefold. There is the inner complexity—the interpenetration of systems within any one mental organization—a complexity which surpasses vastly that of the organism which is included within the higher unity. There is, further, the social milieu, the relation of mind to other minds, the intersubjective continuum. There is, finally, the milieu of nature of which mind and society are part and within which they have been evolved.

The social milieu is a new level in the evolution of our earth, a unique type of creative synthesis, and not reducible to the organic type, however many analogies there may be and though the social milieu includes the organic as part of its mechanism. We may say that mind requires the milieu of minds for its expression and life as truly as in the multicellular organism one cell needs the other cells of its characteristic milieu. The social instincts and the highly complex language mechanisms are indications of this larger integral milieu of mind. This social interdependence and intersupplementation of minds must be regarded as a new pattern relation superimposed upon the organic units. Mental living is as impossible without the social milieu as the characteristic life of the cell within the multicellular organism is impossible without the balance and mutual adjustment of the cells within its characteristic milieu; and though in each case the individual unit may survive the separation from its milieu for a time, it cannot carry on its characteristic activities in separation. By this I do not mean to imply that the organic milieu and the social milieu are alike. I am merely insisting that each is necessary for a certain type of life. They are, as a matter of fact, vastly different in the type of interdependence which they imply. Each is a unique pattern relation with its unique characteristics; and each must be understood in its own terms. In the biological organism the parts have become completely stereotyped and subordinated to the life of the whole, while in the social organism the whole should be subordinated to the freedom and realization of the parts.

To some the step of nature in passing from the unicellular to the multicellular type of organization seems the most considerable step in the course of evolution. We know that nature experimented a long time in making a multicellular organism. What led nature to pass from the unicellular to the multicellular organism? If we speak of evolution in terms of equilibrium, we must remember that the equilibrium of the multicellular organism did not exist before it had been created. The simplest multicellular organism is not a mere collection of unicellular organisms. Colonies of unicellular organisms existed before there were multicellular organisms, and still exist, but they are merely a collection of unicellular organisms. A multicellular organism involves the creation of a new life pattern as a result of trial and error adaptation to the cosmos. The unicellular organisms have for ages existed in equilibrium with the environment and do so exist at the present time. Owing to their range of adaptation and their simpler requirements they will probably long survive the multicellular organisms which they antedate. It was not natural selection which brought about the appearance of the multicellular organisms or their evolution, because natural selection can act only on life forms as they exist. It is not a constructive agency but an agency of elimination. The unique adaptation, involved in a multicellular organism, must have been prospective until the whole had been evolved with its new pattern and equilibrium. The same is true of every step forward in the evolution of multicellular organisms.

The step from the unicellular organism to the multicellular is no greater in my opinion than the step from the multicellular organism to the social organism. Here again we find a prospective construction of a new pattern. Society is a new level in evolution, a new step in the creative adaptation of our earth to the cosmos. Society is not an aggregate of multicellular organisms, any more than multicellular organisms are an aggregate of unicellular organisms. Society is not an association of organisms, but of minds. And minds exist by virtue of this new pattern relation. If we speak of society as an association of individuals, it is, at any rate, not just analogous to the association of cells in an organism, but a new step in creative synthesis. Society is no more an addition of individuals than a multicellular organism is an addition of cells. The equilibrium which is being created in social adjustment did not exist on the organic level any more than the equilibrium involved in the life of the multicellular organism existed on the unicellular level. The social equilibrium is a new creative adaptation in the history of the earth. As in the case of the evolution of the multicellular organism there are transition forms, such as the colony, which are not multicellular organisms, so, in the case of the evolution of society, there are transition forms which are not societies. If nature has experimented a long time in making the multicellular organism, so she has experimented a long time in making society. Thus on the organic plane we find the nutritive unity in the lower stages of life where several organisms have continuous cavities and thus share in the conditions of life, but they remain organisms. They do not constitute a society. There are animals which not only live together in colonies, but have a considerable specialization for a common life, such as the honey bee. But they do not constitute a society. They are rather a superorganism. A superorganism with its organic differentiation and coadaptation is not a society, however admirably adapted to the conditions of life. Some animals live in packs. But while they may show strong craving for companionship, while they may act in common defence and sometimes, as in the case of the beavers, co-operate in common maintenance, they still act as organisms. They are not social groups. They do not co-operate as minds within a common plan and with the motive of mutual aid. At any rate, the plan is not a mental plan, but rooted in organic structure.

The psychic relation implied in society is a new quality, a new pattern, which cannot be resolved into organic relations, however complex the latter may be and even though they involve a number of multicellular organisms. Just as the cells of the multicellular organism become a unity of a higher order than the unicellular organism because of a new control, and within this control constitute parts of one organic whole rather than a collection of individual cells, so individuals in society constitute parts of a new psychic whole. Individuals are destined to become members of society, rather than to stalk alone because of a new level of organization, a new type of pattern control, on the one hand, and new structural qualifications on the part of the individuals entering into the pattern, on the other. It is because the individuals are structurally constituted for a social whole that they are destined to strive creatively to discover such a whole. So far as we are mental or spiritual beings, we can realize ourselves only in a social milieu. If we were merely organisms, we should be satisfied with an organic milieu, and there are some so-called human beings that scarcely rise above the level of organic needs. But mind is evolved in the process of cosmic adaptation to respond to mind. It requires a milieu of minds for its expression. This milieu is not merely a function of a number of individual minds, though it could not exist without them. The individual minds must participate in a common mental pattern with a common tradition. They become minds only through sharing in this unique experience. A brick building is not just a mass of bricks, but bricks ordered and cemented according to a pattern; and it is as building material within such patterns that bricks are evolved. So human individuals cannot be understood in the abstract, but must be understood through the pattern relations into which they are fitted creatively to enter and for which they have been creatively evolved. It is in the social milieu that the individual develops mind in the sense of significant response to the environment. It is through sharing in the common undertakings of society that he develops control and purpose; and it is through the conflicts arising in these common undertakings that he develops individual reflection and self-consciousness.

We must postulate two types of continuity with the environment. There is the interaction of the organism with the physical milieu of the environment. We have seen that there are two stages in this type of adaptation—the protopathic stage, the stage of the all-or-none reaction to the physical stimulus, and the epicritic stage, where the response is graduated to the intensity of the stimulus and implies a spatial and temporal pattern relation to the external world. But there is another type of interaction, the interaction of mind with the social milieu of the environment. This too involves two stages of adaptation, a protopathic stage of all-or-none reaction, a diffuse primary response without intelligent guidance, and an epicritic response which involves a mental pattern—a mental pattern in the individual responsive to the pattern of the social milieu. We must, I think, presuppose an immediate protopathic sense of social presence (however overlaid and difficult to disentangle) as the background of our articulate life of social relations. This furnishes the primitive continuum of mind, which is canalized and overlaid by the later epicritic cognitive functions.

We must abandon the absurd theory that we come to recognize other minds from the analogies of the bodily movements of other individuals with those of our own. This theory presupposes a looking-glass knowledge of the individual's own movements which is entirely impossible to the young child and was equally impossible to the primitive man. Science is still largely in the dark as regards the relation of mental processes to physiological processes, and what knowledge we have is of yesterday. The Greek thinkers who laid the foundations of such mental sciences as psychology, logic, and æsthetics did not know the existence of a nervous system, but they had a large knowledge of social relations. We must, I think, regard social relations as being deliverances as immediate as sense experience. Just as we are immediately sensitive to certain physical energies of the environment, so we are immediately sensitive to certain mental energies of the environment. It is true we may imagine social relations in our dreams, as a result of past experience, but so may we imagine sense perspectives. There is a development of the social sense, as there is of the sense of touch, from a protopathic stage of undifferentiated response to one another's presence in the lower animals and in the early stages of human development to the highly epicritic discrimination which is possible in later human development with its cumulative experience and system of signs. And as in the case of touch and other senses, so in social relations we have reason to believe that the protopathic level still persists, though under epicritic control, asserting itself when the higher level is in abeyance or destroyed as in pathological cases. We may, I think, see an approach to this in extreme crowd excitement when a civilized people reverts to the primitive animal plane. It does not, of course, follow that returning to the protopathic plane in mental interaction means the returning to the protopathic plane in physiological interaction. The primitive mental plane may have at its disposal the whole range of physiological mechanisms. In any case the lapse to the primitive is relative in normal human beings. We must not suppose, moreover, that mental adaptation and physiological adaptation are independent of each other. Mind overlaps. It overlaps the physiological hierarchy of control, with its reactions to the sense world, furnishing a new quality, a new guidance to our interactions with the physical world. It also overlaps with other minds. It does not function in isolation, but in communication, sympathy, co-operation, rivalry with other minds. Mind interacts in kind with other minds. It overflows and spreads over space as well as endures in time. In the interstimulation of mind with mind, where minds interchange their quanta of influence, the physical world, including the organic body, acts as vehicle and instrument, not as a separating wall. We must recognize that social relations are part of the same cosmic process of adaptation as sense perspectives, and that personal histories can be understood only as interactions within the social medium.

The relation of individuals in society is not that of arithmetic addition but a creative relation.[5] This involves not merely the creation of a new pattern, but the creation of new units, with new characters. The whole-pattern and the units must evolve together. Else the pattern would be useless. The individuals must, on the one hand, have the capacity for language and creative imagination in order to constitute society; and, on the other hand, it is in the social milieu that these capacities must be creatively realized. The brain of man, as Professor Watson has pointed out, is largely a language organ. It is an organ for social relations. Language mechanisms have been evolved for social relations. They would be absurd abstractions otherwise. The same is true of the social traits. It is absurd to suppose that the characteristics and

[5] For the nature of social relations see *A Realistic Universe,* J. E. Boodin, 1916, Chapter XI, Individual and Social Minds, pp. 191-204; also his article, "The Existence of Social Minds," *Am. Jour. of Sociol.,* 1913, vol. xix, pp. 1-47.

capacities of human individuals can be understood in the abstract. That has been the result of such false dichotomies as heredity and environment, the individual and society. The characteristics of the human individual are the results of creative adaptation to a milieu, not merely to physical and organic nature, but also to psychic nature, to social relations—not merely to actual social relations, but to society-in-the-making, to the incarnation of new social patterns, the future kingdom of heaven which a few superior souls feel in the making and help in the making. New moulds must be created through cosmic adaptation, and it is given to the servant of Jehovah, despised and rejected of men, to see creatively into the future and by sacrifice to help build a new city of God, a new equilibrium of spirits.

We must not suppose that society and individual have an invariable meaning and exist only at one level. They exist, as a matter of fact, at vastly varying levels from association which is not much above the organic to that which is prophetic of a new order. The social pattern is not less various than the organic pattern. The singular is a class term. As the evolution of the multicellular organism from the crudest beginnings to the most complex multicellular organism has required a long process of trial and error adaptation with the creation of new and more complex pattern responses, so we must expect the social organism to require a long process of trial and error adaptation before there can be the completest mutual adaptation of individuals to each other and the total cosmic environment, before, in short, the full gamut of this type of evolution shall have run its course, if indeed it ever can run its course in the history of our earth. Certain it is that evolution since the dawn of humanity has been concerned primarily with enlarging the scope of social adaptation. Organic adaptation seems to have been fairly constant during this period. This does not mean that the human individual has been constant. For the human individual must have undergone continuous adaptation in the direction of the characteristics which are essential in social relations even though the vegetative and animal characteristics have been fairly constant. Man's capacity for sympathy, expression and intelligence must have increased vastly since the organic beginnings of humanity. And this, of course, involves certain corresponding physiological changes, however difficult to determine. But, what is equally important, a new control must have developed by degrees which has kept the vegetative and animal traits subservient to the new type of spiritual unity with its demands. And with greater degrees of freedom within society, there must develop greater degrees of fitness on the part of individuals to co-operate creatively with greater freedom. For greater social complexity of institutions and groups requires corresponding intelligence and capacity for self-control.

The most urgent need of creativeness to-day lies not in the discovery of new mechanical instruments, but in the discovery of new patterns of social co-operation, more adapted to the needs of human nature and therefore truer to creative nature. Our advance along the lines of mechanical invention has outstripped our moral advance and threatens the welfare of humanity if not its existence. It is not likely that humanity can be destroyed by its newly discovered murderous weapons, but it is possible that civilization may be destroyed. It is dangerous to let a child play with dynamite. And morally man has not passed much beyond the savage. Man must discover a moral formula of co-operation as broad as humanity. He must evolve a control of mutual respect and mutual aid based upon human beings as human beings. The mechanical means of communication have brought human beings close together in space, but the pattern for adaptive living together on a large scale is yet wanting, or at best is in the trial and error stage, with enormous cost to those concerned. Perhaps under the tension of stress and suffering, man may discover gradually a better way, a new equilibrium of life. Demagogues talk about public opinion and public will, but their appeal is to prejudice and their work is to create prejudice. An intelligent public opinion and public will is yet to be created, if it can be. Only when they are created, when philosophers are kings, shall we have sane government.

We are living in a period of great contraction and tension of the earth's crust. During this period man has emerged from the primates, and in the wake of the latest ice-age, man, as we know him, appeared. It is in this period that the new type of unity—the spiritual type of unity—has been forming. While it has been making with great rapidity, especially in the last few thousand years, it is still ragged. Humanity is still imperfectly prepared by heredity and still less prepared by organization for earth-wide co-operation in purposive endeavour. Perhaps the next ice-age which science prophesies may furnish the critical test of man's capacity for sympathetic co-operation. Perhaps in the intensity of its struggle a new type of man may arise as present man arose during the recent ice-age. Future scientists may associate the feverish activity of man and the acceleration of civilization during the last three thousand years with an unusual throbbing of nature's heart. Certain it is that our evolution is part of the evolution of the earth in interaction with its cosmic environment. And the geological record shows that the periods of great contraction and tension have been the periods of the greatest creative activity. It is possible that during the long period of relaxation and levelling of the earth's crust, which is sure to follow in the rhythm of geological history, mental types, in the way of social unities and spiritual patterns, may become as rigid as are the organic types and responses now—until a new rhythm of the cosmic pulse sets forces forming for a new level which we can as little foresee as the unicellular type of organism could foresee the multicellular type of organism or the latter could foresee the mental type.

The Nature of Mind

We must now enquire more specifically into the nature of mind. But in the attempt to arrive at a concept of mind we are dogged at the very outset by the ghosts of the past, the idols of speculation which haunt psychology and retard its progress. The most fundamental of these misconceptions is that which regards the mind as a succession of events following one another with an "inconceivable rapidity"—a conception bequeathed by Hume. But mind cannot be conceived as a succession of events, whether a series of simple events as in Hume or of chunks of events, looking backward to a dead past and forward to an unborn future, as in recent psychology. The duration of mental events is relative to the structure of the mental field. In reality the different processes of experience travel at different velocities and the same processes travel at different velocities at different times. Sensations and feelings are comparatively fleeting, but meanings fixed by language have a considerable permanence. Attention is rhythmic, though by no means so fleeting as we supposed when we confused attention with eye adjustments. Our perception of immediate events, which is made the basis of the specious present, is limited to a few successive events, though when there is rhythm and grouping the events can be increased. But the limitations of attention have nothing to do with the permanence of mind as structure. The structural characteristics of sentiments, thought, character may remain constant for a large part of a lifetime. Hence the responses can be predicted in definite situations.

The fact is we cannot understand the course of nature, whether on the mental level or any other level, as a mere sequence of events. The passing events can have no meaning except in terms of energy exchange. Selective functioning within any system involves a structural field and a relation to a certain environmental situation. The physicist does not conceive the physical order of nature as a mere sequence of particular functions. The electron moves in a guiding field and its motion must be understood with reference to the structure of this field. To understand the dynamic equilibrium of the electron fully we must understand its relation not merely to particular fields, but to the cosmic field. And so we must conceive mental events as functions of energy fields with their structure and interrelations—mental fields in relation to other mental fields and to physical fields, and, in the last analysis, to the cosmic field. Mental events like physical events are retarded or accelerated by virtue of the control of the guiding field.

We should understand mind better if we compared it to a piece of iron than by comparing it to a stream. Iron is not just an event or a stream of events, but an organization, a complex pattern, with comparative stability and a definite set of characteristics in varying situations. It is a centre of exchange with its environment, radiating electrons and receiving electrons. And its functions vary with its relations. When it is connected with an electric current, it reacts differently from its manner when not so connected. But the duration of iron is comparatively stable. The internal structure of iron is not permanently modified by the effects of the past. The elements of the structure resume for our purposes their original equilibrium when the stress is over. Organic functioning, especially in the more complex organisms, would furnish a nearer parallel to mind. Here, too, we deal with energy exchange of a certain complicated structure with its environment. And this selective exchange is a function of interaction, involving both the nature of the structure and the nature of the environment. We do not try to explain the behaviour of the spinal cord as a series of functions, but we explain the series of functions with reference to the character of the selective structure and its dynamic relations to the environment. As in physics, so in physiology we conceive functions as energy exchange. But here the exchange may modify the functioning of the individual structure, giving it a new equilibrium, a new twist, with reference to future functioning in a similar situation. We have here a more plastic duration. We must likewise conceive the behaviour of mind as the functioning of an energy structure in relation to a specific environment. Mental events are a type of energy exchange. The functional relation is vastly complicated, involving as it does a new type of control of the whole organic complex of mechanisms and a new type of duration in which the functioning of the past can make the difference not merely of organic habit, but of memory; but the mental event is none the less an energy exchange between an energy structure and its energy environment.

Psychology must liberate itself from the tradition of Hume. Mind is not to be conceived as a stream of events, but as an energy structure, capable of selective interaction and exchange with other energy structures. It is a unique energy field, existing in specific relations to other energy fields, such as the instrumental bodily fields and the environing physical and mental fields and, in the last analysis, to the cosmic field. What its characteristics are must be ascertained, as in the case of physical structures, through its selective functioning in its various milieux. The passing events of mind, sometimes called states of consciousness, can have no meaning except in terms of exchange. This exchange involves, on the one hand, a certain structure of an energy field and, on the other hand, certain continuities with environing fields. This interaction is sometimes sensed, sometimes not. Being sensed is itself the function of the selective interaction of a certain structure with a differentiated environment. It implies a certain finite quantum relation. The structure of the minded organism, furthermore, is such as to be capable of cumulative adaptation. The cumulative adaptation which is embodied in the structure at the beginning of the life history of the individual we call heredity. The cumulative adaptation within individual history, we call experience, though obviously we can draw no hard and fast line between the two. Neither phylogenetic traits nor ontogenetic can be said to exist in the abstract. They emerge only in the creative interaction of the life stream with the environment. They are functions of interaction, not abstract entities. Throughout the history of life, racial and individual structure determines exchange and exchange determines structure. Events of mind must be regarded as instances of energy exchange.

The events in no wise determine their own passage. They form no linkage with each other. One event cannot form a habit with another event, nor can one event know another event, as an absurd atomistic psychology has supposed. We may speak of events as space-time perspectives within a guiding field. Ultimately the impetus to differentiation of structure must come from the cosmic environment in its action upon matter in the process of energy exchange. But the response of matter is determined not merely by the action of the environment, but also by the characteristic properties of matter in its various stages of organization—inorganic matter, organic matter, minded matter. In the case of inorganic structures, the action and reaction is direct. It is not necessary to take into account the past history of the atoms. In the selective functioning of organic structures, the response becomes more indirect, having reference to the history of the structure, the cumulative effect of habit. In the functioning of mental structures the response becomes still more indirect, having reference not merely to the history of the individual, but to the pressure of the social environment with its tradition. The relation is no longer dyadic—that of structure to stimulus, but triadic, the relation of individual structure to stimulus within a social field. Beside duration as individual history, we must take account of the duration of society, which acts as a determining field. But in neither case can the duration be understood as events, but must be understood in terms of structure. In the act of exchange, the individual structure gets a certain twist which endures in later motion and conditions further functioning. It is this twist or set which endures, not the events of experience. But the endurance of this set makes it possible to repeat, to a certain extent, the events and to recognize the events as the same when the situation is repeated, though because of the cumulative duration, the structure cannot be quite the same, and therefore there cannot be absolute repetition. Some characteristics must, however, persist or there could be no recognition.

I have so far said nothing about the compensatory transcendental conception of mind. Kant and his successors have accepted from Hume the conception of a stream of particular atomic events and then by way of compensation have added a transcendental unity in order to synthesize these atomic events. Humean associationism furnishes the beads and transcendentalism furnishes the string. But if it is absurd to suppose that successive states of consciousness know each other, it seems equally absurd that a transcendental unity should know them. It is a mere intellectual abstraction and has no functional potency. No doubt the transcendentalist is right that a mere succession of events does not account for the perception of succession and that mind therefore cannot be a mere succession of events. But one false abstraction does not compensate for another false abstraction. Both associationism and transcendentalism have followed a wrong scent. The intellectual abstractions of events do not compound themselves by some mysterious chemistry into mind, nor do they become mind by adding the verbal abstraction of unity. The energy pattern of mind must exist before it can function as mind and give rise to mental events; and mind functions as a minded organism with a new pattern control, and not as a verbal abstraction of unity which is supposed to accompany all our states of consciousness.

Psychology has ignored the transcendental abstraction of unity as useless, which it is, but unfortunately has stuck to the particularistic abstraction of atomic events. The climax of this particularism is reached in neutralism. Abstract particulars are indeed neutral. They have no meaning, nothing can be predicated of them, as Hegel so truly pointed out. But can they compound themselves into varying patterns—physical patterns and psychological patterns? That is indeed the climax of absurdity and marks the final bankruptcy of Humean particularism. One must have an astounding appetite for magic to entertain such an hypothesis. But the magic phrase, creative synthesis, seems to make anything plausible. For our materialistic age is nothing if not credulous. Lacking the capacity for critical thought, it is ready to accept any miracles so long as they are not in the Bible. But nothing in the Bible is half so incredible as the dogma of chance even when disguised as creative synthesis. There is indeed creative synthesis everywhere in nature, but it is an orderly synthesis, not a synthesis of chance. Kant is right that unless we have a sane mind we cannot see any order in the universe.

The behaviourist method of stating reactions in terms of physiological structure and ignoring the events of consciousness serves, at any rate, as a corrective of the old phenomenalistic psychology of a stream of events. The latter cannot account for the cumulative continuity of the stream of events, and the events it has dealt with have been intellectual fictions. Behaviourism has tried to understand function in terms of structure. The difficulty with behaviourism is that it tries to interpret human conduct in terms of physiological structure merely. In trying to reduce such responses as thought responses to neural habit and language mechanisms, it has ignored the real nature of the thought function. This is qualitatively different from habit and involves a corresponding qualitative structural level. Minded organism is not just organism as the physiologist takes account of it. The materialistic implications of behaviourism are mere dogmatic prejudice. If we must know structure through function, we must be fair in the classifying of functions.

And if we are fair, we shall find that there are qualitative levels in functioning. There are logical responses, beauty responses, religious responses as well as automatic reflexes and habits. Food interests and sex interests do not exhaust the interests of some human beings. Nor can I see why we are more scientific for ignoring the internal significance of responses which are significant. And some types of functioning are enjoyed (to use the language of Alexander) by some at least as significant, even though behaviourists are incapable of such enjoyment. The awareness of the significance does not account for significant behaviour, but it is a unique quality of such behaviour.

In ignoring significance, the materialistic behaviourist ignores the unique type of exchange which we call social relations, for here the exchange is not merely that of physical responses, but of meanings. It is a mental exchange. The materialist deals with an isolated organism, which he conceives in physical categories, and its relation to a physical environment. Yet even from the organic point of view this is inadequate. Throughout animal life there are relations of organisms to organisms and these are different from the relations of organisms to inorganic matter. With bisexual reproduction the individual organism has ceased to be the unit of life, and the race becomes the unit of evolution. And this means creative adaptation of the sexes to each other in the service of the race. Aside from sex, there are various animal associations which, at any rate among the more highly developed animals, involve a certain restlessness and satisfaction which cannot be stated in terms of purely material relations unless we make the definition of matter so vague as to include all interrelations and possible interrelations. But this, at any rate, is not matter as physical science understands it. When we come to social interstimulation, the conception of material interaction becomes still more inadequate. Social communication is an interaction of minds and not an interaction of material particles. We must recognize a difference in the quality of interaction and not merely a difference in degree.

We must learn to recognize mind for what it is, with its own characteristics and exercising its own type of control. We must conceive mind as having its own structure and investigate its functions in its various milieux as we do the spinal cord and other neural centres including the cerebrum itself. We find that we are confronted with a new level of organization and control. The minded organism no longer functions as a mere reflex mechanism. It is capable of responding by means of memory, judgement, and reflective thought. It can appreciate beauty, ascertain truth and recognize right. Neural mechanisms and other physiological mechanisms now function as parts of a new pattern control. If we speak in terms of behaviour, or from the spectator's point of view, we must at any rate distinguish different types of behaviour with their implications of structure; and minded behaviour must be distinguished from other types of behaviour. We cannot compound it from tropisms, reflexes, and neural habits as a confused psychology has tried to do. If we mean by mind significant reaction, meaningful response, then we find that the development of mind goes hand in hand with language, with social expression. It is essentially a social pattern.

Modern psychology has ended in a blind alley. It has been the victim of two false bifurcations—the Cartesian dualism of mind and body, which has been unable to account for the functioning of either of them; and Humean atomism, which has abstracted mental events from the mental field and left them in the air. Modern behaviourism has thrown overboard both of the dilemmas; but it has thrown away the baby with the bath. It has thrown mind overboard and therefore can no longer give a true account even of physiological behaviour. Aristotle had the true intuition when he spoke of mind as the form of the body. At any rate he recognized that mind and body must be taken as an integral whole. But his emphasis upon teleological categories and his ignorance of the physiological levels make him fail to give the latter their due. The body is not passivity, contrasted with mind as activity. It is, we know now, a hierarchy of energy levels of which we must take account if we would understand mind. But mind is more than the actuality of the body. It does not emerge from organic growth, nor is it latent in it. Rather it is a new whole-adaptation of which organic history is part—a new actuality which establishes a new control over bodily mechanisms, which in turn make their characteristic contribution to the life of mind. We may conceive the organism as charged with mind as a piece of iron may be charged with electricity. We know that the organism becomes charged with a bio-electrical pattern, a nervous system, in the course of evolution. When the organism in turn is charged with mind in the course of cosmic adaptation, it functions in new ways, not as matter or electricity. The merit of the Greeks lies in their respect for the reality of mind as potent to control and create in its own way. They discovered that mental functions, teleological causes, are not statable in terms of mechanical causes, but the latter, on the contrary, must be regarded as instrumental to mind in the human economy.

We must conceive mind as a field of energy, which in turn owes its characteristics to the interaction of the life stream with the structure of the cosmos, for it is in creative adaptation to the cosmos that the organism evolves for mind and becomes charged with mind. The characteristics of this field of energy, we must, as in the case of other fields of energy, learn through its functions in various situations of which social situations are of prime importance. The conception of a field of energy must here, as in other domains of science, replace that of abstract entities. We must conceive the living human individual as a hierarchy of such fields. The cerebrum is not a mere collection of neurones, but an energy field with its own characteristics and with definite relation to other energy fields such as those of the spinal cord. When the fair human form lies stark and still, the quantity of matter may be the same, but it has lapsed to a lower level in nature. The hierarchical energy organization of the living individual has disappeared. We can dissect the material cerebrum of a dead person, but we do not get the system of energy which made it function as a cerebrum in the living organism. We perceive the material vehicle of this system of energy, but no longer as charged with and controlled by the characteristic energy field. The dead cerebrum responds with no reflexes, no habit, no language mechanisms. Its responses are of the more elementary chemical and physical kinds. The hierarchy of energy fields which constitutes the actuality of the living individual cannot be weighed in balances, it cannot be observed through microscopes, it cannot be pictured in anatomy books. It is an immaterial fact which eludes the gross materialist, but reveals itself nevertheless in function, in the relations of the living individual to his environment. And the mental energy level shows itself as truly in the functional relations of the living individual as do the physiological levels. It contributes a new control to the physiological mechanisms, modifying the whole gamut of their expression. It makes speech mechanisms an intricate and subtle organization for expressing meanings, attitudes and emotions, instead of mere senseless jabber. It makes possible the relation of creative expression and appreciation of meaning-patterns and leads to new types of behaviour, new correlations of matter, and a new co-operation of individuals, impossible on the mechanical plane. An organism charged with mind and controlled by mind is a different kind of individual from an automaton of physiological reflexes and habits. This holds equally for phylogenetic and ontogenetic evolution—the race and the individual. Judged from function, mind is a new energy system supercharged upon the physiological hierarchy. And mind like material organization must be known through function and is as it functions.

There is nothing mysterious about the structure of mind and its functioning as modern psychology would lead one to believe. This mysticism is the product of its false dichotomy. The progress of the physical sciences, including physiology, since Descartes, has made it seem that we know more about body than we know about mind and therefore that we must explain mental events by stating them in terms of physiological structures and their functioning. But the fact is that we know vastly more about mental functioning than we do about cerebral functioning. It is doubtful whether we can ever really follow the transitions of nature outside mental relations. Even our explanation of the organic category of habit in terms of synaptic junctions is largely speculative; and it throws no light upon the control under which habits are forged in human behaviour. This control must be conceived as interest, and interest is a mental category. When it comes to the statement of such processes as imagination and thought in cerebral terms, our supposed cerebral schemes are merely fictions, transferring what we know about such functions in mental terms into physiological language. No doubt there is an intimate connection between mind and neural mechanisms, and, for that matter, between mind and the whole organism. We have reason to believe that in the course of the creative adaptation of the life stream to its cosmic environment, the cerebrum in particular has become adapted to the carrying on of mental functioning. The great preponderance of language mechanisms in the cerebrum shows such an adaptation. This does not mean that mind is a neural centre, but rather that neural organization has been prospectively evolved for mind in the highest animals. And if we must understand mind in integral relation to the body mechanisms, it is also true that in minded organisms we must understand the functioning of the body mechanisms in their integral relation to mind. Plato is quite right that the causal explanation of Socrates' choosing to remain in prison and to drink the hemlock is not to be found in organic impulses and mechanisms. The body for the time being was under the dominance of "the Idea of the good." Thought was not a mere spectator of the body, but a potent control. The best evidence that our knowledge of mental functioning is not intrinsically dependent upon a knowledge of physiology is that furnished by the great Greek thinkers who laid masterly foundations of the mental sciences—logic, ethics, and æsthetics—in spite of their ridiculous ignorance of physiology.

The "unity of consciousness" now comes to have real significance. Mind is not a mere verbal abstraction accompanying all our "states of consciousness," but is an energy pattern manifesting itself in a unique control of the reflexes and habits of the biological organism. The minded body acts as a purposive whole, using the physiological mechanisms for its maintenance and expression. It perceives as a whole, it feels as a whole, it thinks as a whole, it acts as a whole. This unity cannot be accounted for by the external relation of parts, whether material atoms or psychological atoms. It responds by parts but not as parts. It is not the product of the association of ideas, for in order to have association of ideas or objects, these must be compresent within a field of interest and their sequence is controlled by the structure of this field. It is a meaningful teleological control which in the stress of social interaction becomes conscious of itself as personality.

Pragmatism has indeed emphasized the teleological character of mind.[5] For pragmatism, mind is no longer

[5] The most brilliant statement of the teleological character of mental processes is that by William James in *The Principles of Psychology*, 1890 See especially the chapters on Conception and Reasoning.

I am using pragmatism in its earlier form, before it started to clear away "misunderstandings." In its later phase it is difficult to distinguish it from classical empiricism. It has become merely an exaltation of scientific method, of which it has no particular monopoly. It is doubtful whether pragmatism has made any contribution to scientific method. Its contribution which is considerable to its generation has been more inspirational than critical, with the exception of Dr. F. C. S. Schiller, whose work has been consistently sceptical even to the extent of denying the possibility of truth in the fashion of the Platonic Protagoras But this cannot be said to be the method of science. For a critical analysis of pragmatism see the articles of Professor A. O. Lovejoy in the *Journal of Philosophy, Psychology and Scientific Method.*

merely a complex mechanism of ideas as in the old intellectualistic psychology; nor can the significance of thought be expressed in the formal relations of linguistic abstractions as in the old logic. Mental activity must be expressed in terms of needs and their satisfactions. The particular interest determines what we shall perceive and conceive. Mental processes—memory, imagination, thought—are instrumental to the satisfaction of the particular appetites. This is the anti-intellectualism of pragmatism. "Mind is the applying of future results to present situations" in the satisfaction of some particular tendency. Thought is valid when it is an effective instrument for procuring some particular satisfaction, as a knife is a good instrument when it cuts well. Practical value determines all mental operations. Intelligence exists for action. It is itself action, physical experimentation, in the service of a biological need and is proved true when it terminates in satisfaction.

It is a drab, bond-servant rôle that mind plays in contemporary pragmatism. When one considers its contempt for logic, it is hardly fair to apply logic to it. And it is sure to be considered irrelevant. It seems ungracious to say that pragmatism is too intellectualistic. But it conceives consequences and results in as mechanical a fashion as the old psychology conceives ideas. They happen to the hypothesis according to James. When Dewey says that mind is the applying of future results to present situations, he ignores the temporal character of the process, the creative advance of nature, for, aside from physical nature which we can take as practically uniform, the future results cannot be thus stated in advance. We cannot guarantee that the results when they shall have been lived shall be just what we project into the future as results. In fact they can never be the same, because they get a new significance from the creative interaction with the environment, and often this value is the opposite of what we intend. It is past results which by modifying our mental structure control our conduct in our attempt to satisfy our needs. Satisfactions are adaptive congruities between a conative structure and a specific environment. And therefore they are not agents in the relation. The dynamics must be expressed in terms of the selective interaction of an energy structure with other structures. The value is not an independent entity, but a quality of the selective interaction. It is true that we must understand such complicated structures as cerebral and mental structures through function. We cannot get an X-ray photograph of the structure of mind. But we must not substitute function for structure. Function must be conceived as a dynamic relation of structures. The appetite for food is a specific type of organization. Its restlessness leads to sustained search. The particular satisfaction is the result of the congruence of the object selected with the organic demand, as Dewey has so well shown.[6] The same is true in the case of the impulse to knowledge or the impulse to beauty. Knowledge and beauty are energy relations. We do not seek the satisfaction but we seek the creative relation to the objective world which shall harmonize with the structure of the impulse.

Pragmatism is particularistic in its conception of reality and values. It makes the vicious bifurcation of particular and universal, and then emphasizes the particular and treats the universal as an instrumental fiction. The cash value of truth consists in particular facts. Human nature is a collection of particular impulses; and thought is an artificial instrument, gotten from somewhere, to realize them. Pragmatists seem to be utterly lacking in a feeling for form or structure. And this vitiates all their theorizing. It prevents their seeing that particulars are not self-existent facts, whether it be particulars of value or particulars of sense. Particular events, whether falling bodies or acts of perception or satisfactions are instances of functioning of a determinate structure in determinate relations. We can never derive the structure from the mere particulars. In the process of creative discovery we mount

[6] Dewey and Tufts's *Ethics*, 1909, pp. 269-272.

by creative imagination from instances of functioning to hypothesis, *i.e.*, to a concept of structure, and then we verify the hypothesis or suggested structure with reference to functioning. Truth is not the sum of particular instances, but a conception of structure which accounts for the instances as functional relations. A law of gravitation must account for all falling bodies in terms of the space-time structure of the physical world; and the geometry of this structure did not emerge from the particular perceptions. Else a dog might have seen Newton's law or Einstein's equations. The law is the contribution of the structure of the creative imagination in its trial and error process to discover structure in things. If the knowledge of the physical world is not a sum of particulars, neither can the knowledge of mind be a sum of particulars. There too we must rise by creative imagination to structure and to such a conception of structure as will adequately account for the activities of mind.

Pragmatism has failed to furnish the rationale of mental functioning. It has failed to grasp the structure of mind and has treated it as a mere function in the realization of particular impulses. An animal organism may and does get a certain adaptedness from the trial and error process of particular impulses, working in isolation from each other, but it does not arrive at creative intelligence that way. Mind is a new type of pattern which emphasizes wholeness of functioning. It is not a collection of particular impulses with foresight added to each of them, but a creative organization of the primary impulses and habits into a new perspective. And this new level of organization has its own peculiar restlessness, its own needs, not reducible to animal satisfactions. It manifests itself in creative discovery of truth and beauty and social forms of co-operation. And the passion for such creative adaptation to the cosmic order may surpass in intensity, as it infinitely surpasses in quality, the primitive adaptations of food and sex. To one who once comes to live on the mental plane and is not just a more clever animal, the primitive functions of food, sex, and shelter, become instrumental to creative intelligence instead of this being instrumental merely to the primitive functions.

Pragmatism fails in its account of the genesis of the mental type of functioning as conspicuously as it fails in its rationale, and for the same reason, viz., its lack of conception of structure. The central idea in Dewey's account of genesis is that higher categories or types of adjustment arise from the conflict of tendencies on a lower plane. Thought arises from doubt, from conflict and failure of habitual adjustments. By some magic the higher categories are produced by friction from the lower. But this is not true in fact. A conflict of two reflexes may mean the blocking of action, if the two have equal potency, or may mean the dominance of one reflex which goes off as though the other one didn't exist. There is no evidence in the animal organism that the conflict gives rise to thought. Suspended action need not mean thinking. On the organic plane, it means just suspended action. The same is true of conflict of habits or secondary reflexes. It is a mistake to suppose that a conflict of habits by itself gives rise to thought. Titchener's experience of rising automatically from his writing to close a door which was not usually open and then seeing a pin on the floor and stooping to pick it up, but getting up and turning round to the desk without either closing the door or picking up the pin, is a beautiful illustration of the conflict of habits and their mutual inhibition, but there is no evidence of its resulting in a train of thought except as a psychological retrospect of the completed automatism. Most of us go through such automatisms daily without psychological retrospect. Nor is the problem altered if we state it in terms of group customs. Conflict of customs by itself does not give rise to thought. Not only primitive civilizations but European are full of conflicting customs. Not even when the conflict is felt, and doubt arises, does the conflict necessarily give rise to creative reconstruction. Few peoples have survived the general breaking of the crust of custom, as Bagehot truly observes. Conflict of reflexes, habits, customs, in short, of automatic adjustments, gives rise to thinking only when there is the restlessness of a thought structure seeking creative adaptation with its environment, physical or social. And the conflict to which thought is sensitive need not be practical in the bread and butter sense. It may be theoretical or æsthetic or religious. It is because mind is form and loves form that conflict or discord spurs it on to new creative organization. Conflict, in a being with mental organization, may stimulate thought, but it cannot account for the genesis or nature of thought.

Dewey's genesis of the categories looks like a veiled Hegelianism. As in Hegel's logic, it is the development of new categories by magic from the conflict of lower categories. Hegel has the advantage of having the categories manipulated by the supreme magician, the absolute, Hegel's modest name for his own insight into cosmic relations; and the absolute, with nothing apparently in his hands but the two sticks of abstract categories, manages to make a rose bush appear and bloom through resources of his own that are not obvious to the uncritical spectator. Dewey has renounced the absolute and apparently is trying to make the sticks actually generate the rose-bush by their own friction. What he does in fact is precisely what Hegel did, viz., unconsciously to play the rôle of the absolute and to dupe himself and his followers into thinking that they are empiricists. The ghost of the past walks in the shadow of the forgotten years and, even though unseen, may control the present. Dewey retains subconsciously the Hegelian faith in the dialectical unity of experience and this gives him assurance that the loose ends of conflict will be brought together in a harmonious whole. It is this which makes him certain that "the end-in-view of desire is that object which were it present would link into an organized whole activities which are now partial and competing." This gives him "a sense of the infinite reach of an act physically occurring in a small point of space and occupying a petty instant of time." Thus are "we sustained and expanded in feebleness and failure by the sense of an enveloping whole." [7] This whole is supplied neither by conflicting habits nor is it "inspired by impulse." Every noble soul is a latent idealist, whatever may be the surface play of ideas; and sooner or later (usually later) the unconscious idealism will break through, even though restrained and overlaid by empirical method. The warm and noble idealism of William James is not the product of his "radical empiricism" but the unconscious reminiscence, transformed in an intensely personal experience, of the Transcendentalism which he absorbed in his youth and which, in later life, came to his consciousness as the "higher part" within, which is "conterminous and continuous with a more of the same quality which is operative in the universe outside of him, and which he can keep in working touch with, and in a fashion get on board of, and save himself when all his lower being has gone to pieces in the wreck." [8]

Instrumentalism fails as signally to account for the genesis of structure in the evolution of the race as in the evolution of the individual. Conflict does not account for the genesis of structure in racial any more than in individual evolution. Nature does not produce sense organs or a nervous system or a mind because these are advantageous in the struggle for existence, but because these are adaptations to the structure of nature, and, attuned to its order, they prove advantageous in the struggle for existence. Intelligence does not emerge in evolution because it is useful; but because intelligence is adapted to the order of nature, it furnishes a more successful way of meeting practical situations than that of neural habit. The selective and constructive activity of mind is not accidental, but a part of the cosmos—prompted by the cosmos and therefore germane to the cosmos. This is

[7] *Human Nature and Conduct,* 1922, pp. 238-264
[8] *The Varieties of Religious Experience,* 1902, p. 508.

equally true of the process of knowledge and of the process of beauty. Mind is not a stranger in the cosmos, but is itself part of the creative activity of nature. It is useful in so far as it imitates nature, deals with reality as it is. Its passion for truth and beauty is a reflex of nature.

When creative mind has emerged in the evolutionary process, it gives rise to a new rank of satisfactions from that of the organic level. At first, it is true, mind is largely enslaved to biological needs and in many people remains so, but in some at least, mind liberates itself to commune with mind, to create in beauty and to enjoy beauty—no longer a slave of animal appetities, but their master, using the organism and its appetites to realize the life of mind. We must recognize quality and not merely quantity in the realization of life. Thought means the creative organization of impulses. It is a new level of adaptation to the universe, that of creative understanding, reconstruction, and appreciation. It presses toward a new purposive, self-directive whole of life, however stumbling and inadequate this creative striving may yet be. The formative impulse in us does not, or should not try to, impose form arbitrarily upon the universe; but because of the formative impulse in us we learn in a long trial and error process of thought to participate in the form of the universe and thus become true creators in a world of flux.

The structure of the minded organism is revealed in its integral functioning within its various milieux, physical and social. The qualitative hierarchy of functions must be accounted for in terms of a qualitative hierarchy of structure. It is because of the dynamic structure of the minded organism that experience takes on the cumulative temporal pattern of memory and the forward-looking pattern of imagination. Such responses cannot be produced in the lower animals by any amount of training, because they lack the structural qualifications. The structure of the minded organism shows itself in the projection of a temporal, spatial, and causal order into our perception of nature. That does not mean that this projection is wholly arbitrary. If mind throws its net of space, time, and causality over nature, it accommodates its meshes by a trial and error process to the meshes of nature. The determinateness of mental structure is due to the interaction of the minded organism with its environment, physical and social. But there must be the dynamic possibility for such integration in the life stream of heredity. Because the mind has structure we can discover laws of thought by becoming conscious of the implications of its procedure. The structure of mind is revealed in the creation and appreciation of beauty. It is because the mind has structure that it seeks for unity and harmony in the world of its activity—the world of knowledge, the world of action and the world of appreciation. It is true that we may not be conscious of the implications of this structure. We may proceed by a sort of intuition in our creative activity and be guided by a feeling of fitness. Man created, long before he stopped to analyze the principles implied. Even now we know little about the laws of creativeness. But all the while there is a structure which predisposes to a certain activity and guides this activity in its trial and error procedure. Else creative activity would be mere chance and its products would be incapable of intellectual analysis. But though we cannot lay down the path of creativeness, we can at least see order and discover principles after the event. Mind is order and therefore it can perceive, understand, and appreciate order. This is the immortal contribution of Kant, even though his analysis is faulty and though his lack of evolutionary sense led him to conceive this ordering activity as subjective and arbitrary.

No fixed rules can be laid down for creative intelligence. If we could reduce it to rules, we could thenceforth dispense with it, as Francis Bacon thought. The attempts to reduce thought to some one type of procedure are artificial and barren so far as real discovery is concerned. Dewey proposes the following analysis of "a complete act of thought," viz., "(1) a felt difficulty; (2) its location and definition; (3) suggestion of possible solutions; (4) development by reasoning of the bearings of the suggestion; (5) further observation and experiment leading to its acceptance or rejection." [9] But Dewey's scheme is as far from an account of the process of discovery in a creative mind as is Aristotle's syllogism, though in justice to Aristotle and the logicians of our own day, it ought to be added that they do not pretend to give an account of the psychological process of thought but merely of the formal implications of propositions. Such schemes are *a posteriori* abstractions at best; and while they may have value in clarifying the mind of the spectator and in arranging the products of thought, they do not furnish the rationale of the creative process. The real dialectic of creative thought cannot be separated into abstract moments without losing its living unity. The real understanding of the life of thought can only come by empathy, *i.e.*, living oneself into the creative process. The *post mortem* diagnosis of thought in formal analysis has, however, a negative value. If it is sterile to produce, it can point out errors. By showing us the weaknesses, formal and material, to which we are prone, it may make us more cautious in our procedure and thus save us from blind alleys.

Because of our besetting sin of formalism, we are wont to distinguish too sharply between the activity of creative intelligence in science and its operation in other fields, such as art. The difference lies not in the creative process but in the limitations which the activity recognizes. The great scientist is a poet who restrains his imagination by scientific method; and great art is thought enhanced by emotion and freed from all limitations except the appreciation by creative human nature. The only universal factor in creative reason is the feeling for form or coherence. The process may start with what the spectator regards as deduction, the implications from previous thought; and in organized activity must do so to a greater or less extent, depending upon the degree of previous

[9] John Dewey, *How We Think*, p. 72.

organization. We must bear in mind that the search for meaning, whether in science, art or social movements, is an activity with cumulative duration which not only exercises pressure over subsequent moments of an individual history but gains momentum from generation to generation. We are swept on by its logic—often more emotional than intellectual and largely unconscious to ourselves—in the creation of a philosophical system or a symphony or a social unity. What comes to us as a flash of original insight, now and then, has been long preparing, and, to the external critic who looks at creative intelligence in retrospect, may seem to follow inevitably from the implications of previous thinking. There is a nisus that operates in the progress of thought, selecting and rejecting among the alternatives which suggest themselves according to the integral drift of our meaningful experience. The deepest root of creative thought is the æsthetic feeling for harmony, bringing into unity vast masses of facts or hitherto unrelated beliefs. This feeling may come to us in rare moments as a mystical intimation of the nisus of events not yet understood. Both the inspiration and the procedure lie largely in the subconscious. The first penumbral insight is made definite in the social and physical process of expressing the meaning whether in a scientific experiment or a work of art or a social movement. The final test of thought is the creative rapport of the meaning with the selected object and in the last analysis with the cosmos. The test cannot be stated as utility though thought may prove useful, nor can such temporal qualifications, as "in the long run," enter into the test, though the test must have reference to the temporal character of the object which is intended. The test, moreover, must satisfy our whole creative nature—emotional and volitional, as well as intellectual. A theory which runs counter to our emotional and volitional nature, even if it should command a certain intellectual acquiescence or silence for the time being, is sure to prove barren of results. If it cannot be refuted, it will be ignored—or suppressed.

The Interrelation of Functions

We must understand mind as a unique energy system working through the physiological organism and contributing its pattern to its continuities with the environment. And the pattern it contributes is a pattern of meaning, of teleological control, not a mere mechanical pattern of the external relation of parts. This pattern control is an integral control and the various mental functions must be understood with reference to this integral control. We can, of course, distinguish aspects within this integral activity. But we must not make the mistake of traditional psychology, viz., of abstracting these aspects from the whole in which they figure and erect them into so many independent faculties or capacities. This is a trick that language plays upon us. We make a distinction and give it a name and forthwith it becomes an entity. In the psychology of to-day, mind is but a collective name for various classes of processes; and the name itself can just as well be dispensed with since it throws no light upon the processes. We speak of perception, memory, recognition, judgement, conception, volition, etc. But these are not really so many compartments, they are names for functions. These functions cannot be understood in isolation: they are but aspects, and closely interwoven aspects, in the integral adaptation of a minded organism to its environment.

In a complete meaningful reaction to the environment there is the selective taking account of the environment by the minded organism. But this taking account involves the duration or past history of the organism. In other words, the minded organism brings its memory organization into play. Taking account of the environment through the memory organization, is recognition. Such functioning is a significant, forward-looking adaptation. It is therefore a judgement. It is, furthermore, a purposive discriminative functioning, *i.e.*, it is a taking account of a relevant aspect, not the "shooting at a bear generally." It is therefore a conceiving of the situation. It relates this particular situation to other remembered and observed situations on the basis of the conceived aspect: this is inference. The affective organization of the minded organism is brought into play in connection with the situation: this is emotion or sentiment according to its degree of organization. The situation calls for selective action on the basis of its meaning: this is volition. But perceiving, remembering, recognizing, conceiving, judging, inferring, feeling, willing are but aspects of a complete interaction of a minded organism with its environment. They are not temporal events in the developing of the action. We don't perceive and then remember, recognize, etc. But we perceive the situation as remembered, recognized, conceived, judged, related to other situations, as satisfying a need and calling for action. One aspect develops in clearness with the others. We perceive more definitely as we conceive more definitely, etc.; and the meaning of the situation gets a reality and clearness through action that it could not otherwise have. That does not mean that action is the last term in a series, but, on the contrary, we perceive, conceive, etc., more clearly because the action is preparing, because we manipulate, experiment, etc. We cannot say that all the other factors exist for action. There has been a tendency of late to overemphasize the executive aspect. That is conceiving action too externally. It is not just action that we desire, but intelligent, harmonious, completely satisfying action. All the factors are integrated as aspects in the adaptation of a minded organism to its environment. They are separated from the whole only by linguistic abstraction. The whole transaction is a minded response as contrasted with a reflex or habitual response. When I say that the above aspects—perceiving, remembering, conceiving, etc.—are integral characters and not temporal events, I do not mean that we are aware of them all equally at the same time. There may be an indefinite period of preparation for the selected situation. In this case, we are conscious of remembering and conceiving before we are conscious of actual perceiving and recognizing. The affective factor in such a case sinks to a minimum. There is, however, incipient sensory and affective adjustment even in such a case. In the case of a surprise, on the other hand, the perceptual and emotional factors stand out for the time being. But in an actual minded reaction the factors must be considered as merely aspects of a whole-reaction; and it is not complete action of a minded organism unless all the aspects are present.

We must bear in mind, however, that, even in the case of a minded organism, there is a tendency to economy, to relegate to lower automatic levels what no longer requires significant attention in order to gain energy for the pressing situations. There is also a tendency, alas! to lapse, in our custom society, into the level of routine and to economize thinking altogether. But we should not in that case flatter ourselves that our conduct is minded conduct, conduct with soul. And we should also bear in mind the danger that the more we allow our conduct to lapse into the automatic, the more the highest level in our organization atrophies until perhaps we become incapable of minded response.

I have tried to emphasize the interrelation of aspects in the functioning of the minded organism. We have seen that we must understand minded functioning as integral functioning. I must also call attention again to the fact that minded functioning implies the integral control of the entire organism with its physiological mechanisms. This has been made clear enough in connection with such aspects of minded functioning as the perceptual, affective, and executive aspects. The perceptual aspect involves, of course, the control of the afferent channels of the nervous system, including the sense organs; the affective aspect involves the connection of the central system with the vascular and sympathetic systems and their afferent contribution; the executive aspect involves the control of the motor centres with the motor tracts and muscles. While this has been recognized, it has seemed as though such aspects of the minded reaction as memory, imagination, and thought, if not detached from the bodily organization as Bergson would have it—wedged in as in a vise in the bodily structure, and only allowed to get through by a thin edge for executive purposes—at least have to do only with the cerebral tracts, if they are not identical with the functioning of certain cerebral tracts.

We have seen that minded control is something over and above neural organization and habit. But we have also seen that it overlaps as cerebral control overlaps the levels below it. This is as true of memory and imagination, including abstract imagination or thought, as of perception, emotion and volition. Psychology has never been able to rid itself of the notion that the events of experience are stored somehow as contents in connection with the brain, whether as neural habits or as memory ideas, to be drawn on somehow in remembering or imagining. I have above insisted that duration must be stated in terms of structure. Psychological duration must be stated in terms of the mental structure of a minded organism, but not as isolated from the organic levels. Mnemic causation, then, must be understood, not as distance action of past events (which is unintelligible) but as a cumulative modification of a structure or set which when functioning in integral relation with the organism, including the sensory centrifugal tracts of the nervous system and their relation to the sense organs, makes it possible to live over in a new setting the past events.

I should not say with Bertrand Russell that "past occurrences, in addition to the present stimuli and the present ascertainable condition of the organism enter into the causation of response," [10] but that the cumulative modification of structure through its integral control of the organism with its sense organs makes it possible to re-live past occurrences in such patterns as the present control calls for, whether controlled memory for a present adjustment, such as the recall of a name, or controlled imagina-

[10] *The Analysis of Mind*, p. 78.

tion for the creation of a new pattern for action, understanding or enjoyment. The process of resurrecting past events may be compared to the action of the phonograph record in giving us back past events. No one believes that the song as a series of past events exists in the phonograph record and exercises causality in the present; but in the plate endures a modification of energy structure of such a kind that when a certain integral dynamic situation is furnished the events are repeated. Of course the analogy is halting, for mind structure is not a mere mechanical structure. It is a growing structure with a cumulative organization of modifications; and therefore mind at various moments exercises a new control. But the living over of the past is conditioned upon an integral relation of mind with the organism, including the centrifugal sensory system. Imagery is not stored away, but results from the pattern activity of the sensory centres in the cortex, which in turn send out centrifugal currents to the sensory end-organs. With such stimulation there are certain characteristic motor adjustments. There is also the stimulation of the centrifugal affective system which inhibits or furthers the process of recall, as we all know. Fluent mental functioning in recall and imagination depends upon the fluent functioning of the entire organism under the control of the mental set at the time.

If we must know mind in its functioning through the body mechanisms in relation to its environment, then the distinction between physiological and mental reactions is necessarily pragmatic and relative. We cannot say offhand that automatisms are peculiarly physiological since there are mental automatisms. Nor can we say that habit and association are the contribution solely of the physiological mechanisms, since both habit and association may be the result of purposive action. We have seen that mind contributes a meaning pattern to behaviour and this must be a characteristic which mere organic functioning lacks. But when we try to distinguish the contribution of the lower levels from that of the higher, the task is more difficult than it seems at first. In a normal human being, physiological functioning is already integrated into mental control. We have seen that the functioning of the subcortical centres is not the same when they function under the control of the cerebrum as when they function in detachment from the cerebrum. This is equally true of all submental levels, including the cerebral in their integration with the mental levels. Therefore, in order to get a pure contrast between minded functioning and physiological functioning, we must compare minded organisms with organisms that are complete without the mental level. Thus psychologists have studied instincts and emotions in animals in order to throw light upon such processes in man. But this is unsatisfactory, since physiological functioning in an organism which is complete without mind cannot be said to be the same as physiological functioning in an organism which is complete with mind. The difference in the two types is not merely the presence of significant functioning in one and its absence in the other, but there is also a difference in physiological structure. We cannot, therefore, argue with certainty from one type of organism to the other. We cannot say that because the sex instinct is a physiological pattern in certain animals it must therefore be a physiological pattern in man.

The difficulty is increased by our using the same names for mechanisms and functions at different levels. We speak of reflexes, instincts, habit, memory mechanisms, language mechanisms as though they were the same, irrespective of the evolutionary history of the organism and the integral control. But the genetic significance of such mechanisms is different when we view them as steps in the evolution of a new whole, such as mind control, or view them not as steps but as wholes. Let us illustrate by instinct. The reproductive instinct has a different genetic significance when it is a complete adaptation, as in some of the insects, from what it has when it is an incomplete structural adaptation to be eked out as regards its manner of adaptation through social experience as in man.

We are dealing with a different physiological organization in the two cases. A habit has a different genetic significance when it is a trial and error result of organic adaptation under the control of some primary impulse, from what it has when it is a lapse from a higher level of functioning which has become automatic. And if the genetic significance is different between mechanisms which function as whole-responses of the organism and those which are steps in a more advanced whole-adaptation, so is the quality different. The reproductive instinct in a developed human being does not have the same quality as that of the insect. A human being who yields unrestrainedly to the reproductive instinct does not revert to a state of animal innocence, but is an immoral being.

The difficulty with psychology in the past is that it has treated such functions as reflex, instinct, habit, perception, memory, emotion, as though they always existed on one plane. It has assumed that they have an invariable quality. It has ignored the fact that every one of these functions exists at different levels and differs in quality with different structures and their interaction with the environment. Bergson treats memory and recognition as distinctive of mind in contrast with matter. But memory and recognition exist at many levels. An organism without a mental level may possess organic memory and recognition, *i.e.*, without the capacity of living over the past as a memory image, it accomplishes a trial and error adaptation by means of organic habit. It learns to avoid certain stimuli and to seek others in its environment. But further than that, an animal on the organic plane may be capable of adherent memory, *i.e.*, it may possess the structural adaptation for recalling an event as an image, but the recall is adherent to some particular organic impulse in connection with some perceived situation. The presence of a certain object may suggest a memory picture of past experience with its pleasure-pain relation to the organism. But there may be no connection between events in memory. The association of ideas presupposes a mental structure, *i.e.*, implications of meaning between events. Recognition on the plane of organic memory or adherent memory is not controlled by a meaning pattern, and hence is not mental. Language mechanisms may figure on the organic plane as emotional calls giving rise to instinctive responses, but on this level there is nothing mental about them. It is only when language mechanisms are controlled by the intention to express meanings that they become mental. Life on the organic level includes various elementary impulses, some of them with very complex structural mechanisms for their fulfilment, but these impulses are not guided by meaning patterns. They are guided by organic patterns. In the evolution towards the whole-reaction of mind, organic mechanisms—reflexes, instincts, emotions, habits, language mechanisms—are included, but in being taken up into the new type of adaptation they come to have a new quality. Sometimes in pathological cases we have a reverting to a simpler level, as in the case, described by Huxley in his essay on "Animal Automatism," of the vaudeville singer who had lost his memory but who when placed before the footlights and given a musical score would go through with the singing of the song as of old. But such reversal is, of course, far from a return to the animal automatism of a plane without memory, since the neural centres retained a certain education from a higher plane.

It is not easy to draw the line in animal evolution where mind begins. For one thing, we are greatly handicapped in arriving at the inner life of animals; and to-day, with the materialistic bias of psychology, we are apt to discredit them too much. We must remember, too, that mind exists at various qualitative levels and manifests itself in many types. We shall not go into the analysis of the duration levels which overlap and complicate each other in various ways as shown by the new science of psychoanalysis. This science has already shown us that mind is a temporal structure of great complexity, and that confusions, obsessions, and inhibitions in one stage of development may lead to serious complications in later stages and produce serious organic as well as mental disturbances. Here we must limit ourselves to the observation that meaningful reaction has various levels and types. Meaning on the plane of revery and dreaming lacks generally a definite controlling pattern or purpose. The course of events may be determined by organic causes such as mood. Some animals, the dog, for example, seem to dream and to have meaning in this passive sense. We may regard this passive type of meaning as a transition stage in evolution, though in man it may also be a lapse of control from a higher level, as in sleep and fatigue. What we mean by mind in actuality, as Aristotle would say, or the complete mind adaptation, is creative intelligence or the control of the organism by a meaning pattern, instead of the organic condition controlling the flow of events. But here too we have different types of activity within the same individual at different times and as between different individuals. We must recognize different qualities of mind. The creative adaptation to understand our world, to enjoy its beauty and to invent patterns of action is relative to the history and quality of the individual and his relation to his environment. At best we are onesided and must supplement one another in the life of society. And we may well believe that our stage of mental development is but a step in the process of spiritual adaptation to the cosmos. There is a vast difference now in the quality of minds, and we may well believe that future creative evolution will mean still higher levels.

The Birth of a Soul

Our survey, so far, should make it clear that it is futile to try to reduce mind to material categories. The unity, duration, and forward-looking co-ordination implied in the simplest type of minded behaviour are not resolvable into the external relations of a mechanical system. Mind must be recognized as a new type of adaptation, a striving after a new equilibrium with the cosmos. If we speak in terms of levels of organization, then we must recognize mind as a new level of organization, not a function of physiological organization but a new control with a new quality added to physiological functioning. What we know in our experience as the activity of judging, of recognition and memory, of comparison and abstraction, of creative imagination and volitional selection, is a different type of fact from what we know as electrons, atoms, and molecules in mechanical relations, even though the former occur in connection with a certain organization of the latter. To understand human life, at any rate, we must recognize a determination which is spiritual, an internal bond, the unity of experience. Mental activity must be recognized as real where and when it exists. We know it as a unique way of functioning, but it is not a universal form of functioning in the finite relations which we can observe. It is not characteristic of all types of organization. It requires a certain ensemble of conditions and a certain characteristic milieu for its actuality. If we speak in terms of space-time as is the fashion now, then we must recognize mind as a unique field of control, guiding events in their space and time relations—curving them into its own structure. In this field the temporal dimension comes to have special importance, implying as it does the cumulative duration of the past in the way of memory—individual memory and social tradition—and the forward-looking control of the future through the reconstruction of the enduring past to meet new needs.

We have seen that the creative advance of evolution must be understood in terms of organization—the superimposing of new energy patterns upon the more primitive type of organization, as a result of cosmic interaction. The earlier energy systems with their lines of motion are not abrogated, but made to converge in a new direction. Thus organic patterns are superimposed upon inorganic patterns with unique results. Thus mind patterns are superimposed upon organic patterns in the creative advance of nature. We are not aided much by regarding the soul as an element—some indivisible spiritual entity or perhaps, as has been suggested recently, some type of wave impulse. We know now a large range of radiant waves, from gamma rays, at one end, to waves used in wireless communication, at the other. But the conception of the soul as an element would still leave organization to be accounted for. We have seen what enormous complexity this organization implies, involving as it does not only the relation of mind to the vast ensemble of physiological mechanisms, but also its relation to the external environment with its physical and social milieux. The evolutionary process which makes mind possible cannot be regarded as merely weather, an accidental sea drift of elements, with a mind element externally added. We must understand the appearance of mind in relation to the evolutionary process, the creative advance of nature, which prepares the conditions for mind. I am not interested in mind as an emasculated ghost. Materialistic physiology found rightly that it could dispense with such a mind. I am interested in mind in the concrete—an energy system which adds a higher level of control to the life of organic nature.

How shall we conceive the origin of such a mind? When is a soul born in the evolutionary process? When I speak of a human being as having a soul I mean the same thing as when I say that a statue or painting or symphony has a soul. I mean that matter is suffused and controlled by spirit. I mean that the human organism is alive with meaning and purpose, that it is controlled by a higher level than that found in the physiological organism. The physiological organism itself with its complicated mechanisms must now be understood with reference to a new organizing pattern. The minded organism, not the mere physiological organism, becomes the whole-pattern of evolution. A soul is born when there is an awakening to the meaning of things. In the course of the evolution of life, there is added, in the fulness of time, a new level to the evolutionary process. This holds equally from the point of view of racial evolution and of individual evolution.

The soul emerges in the evolutionary process, but it does not emerge by chance. *Ex nihilo nihil fit* holds of new types of organization as much as it holds of new elements. And soul is a new type of organization. It cannot be predicated of the elements—electrons, atoms, molecules, cells—which go to constitute the human organism. It must be conceived as energy, but to say that it is energy does not explain it. It is a new type of energy pattern. It is a new type of organization, not an abstract entity artificially added. It presupposes a certain prospective preparation, a previous organization of matter and protoplasm, before it can emerge, but the categories of matter and the categories of organic evolution do not account for it. It is not statable in terms of preceding types of organization in the evolutionary series.

This is equally true whether it be the arising of the first soul in racial evolution or the arising of a new soul in individual evolution. The mystery is the same whether we fasten our attention on phylogenetic or ontogenetic evolution. The first arising of soul in geological evolution cannot be understood in terms of the antecedents in the phylogenetic series. Neither can the arising of the individual soul be explained in terms of the antecedents in the ontogenetic series. The sperm cells and ova do not have soul, nor has the resulting germ plasm. The parents cannot contribute soul to the new life series. The new soul is not the soul of the mother or the father: it is a unique soul. It is not the fusion of the two souls of the parents. It is one integral pattern. We are not just the children of our parents and more remote ancestors, though they are factors in the creative situation. They condition to a certain extent the type of creative result through the body traits that they contribute. But these traits do not account for the origin of our life history, much less for our mind history. There must be creative synthesis, the contribution by the genius of the larger whole which furnishes the guiding field of the events of any one evolutionary history. This larger whole must co-operate creatively, not merely in the stages of geological evolution, but in the evolution of each individual life. The ancients were right that the stars preside at the origin of every human being. The whole cosmic field exerts influence in the origin of a new life history. Cosmic genius must somehow contribute the appropriate pattern in the evolutionary advance of nature. We have conceived genesis in too particularistic and materialistic a fashion. The unseen factors are more important than the seen in the conception of a new individual.

The emergence of the soul presupposes a creative contribution from the cosmos to the life stream with its heredity. But how shall we conceive this contribution? Do souls pre-exist as individual psyches, waiting to be united with a body? This does not seem plausible. For, in the first place, there is no evidence of the pre-existence of souls. And in the second place, we cannot conceive a soul as artificially added to the evolutionary process. It cannot be indifferent to the history to which it is added. Rather it emerges as a creative step in this history. But neither can we suppose that the creative synthesis which gives rise to this new type of organization and functioning is an accident. There must be a sufficient reason. This reason cannot be expressed in terms of function. The soul does not appear because it is useful. A structure is not useful before it has appeared. We must conceive the appearance of the soul as cosmic adaptation. As the structure for seeing light appears as a result of a long trial and error process to respond to light, so soul appears as the result of a long trial and error process to respond to soul, to commune with soul. In each case the creative impulse comes from the larger cosmos. The new formative pattern must interpenetrate from without to set the trial and error process going and to furnish a guiding field until at length rapport is established.

This does not mean that cosmic genius has a storehouse of an indefinite number of patterns from which it draws. This is degrading cosmic genius too much. Rather must we conceive that cosmic genius creates as the artist creates. The artist creates the variety of unique patterns in the process of creating the poems or symphonies, and is guided by the material processes with which he deals and which he controls through his creativeness. In other words, he contributes a soul appropriate to his material. He does not get his creative ideas from a book. Yet through it all there are laws of creativeness which can be analyzed and understood even by those who do not have the genius to create. The illustration from art is more than an analogy, for art is a creative adaptation of soul to the structure of the cosmos, and art consists in giving soul to material energies. Art is a type of mind organization. If the form of cosmic activity which we know as human art does not require the pre-existence of the particular patterns, but rather consists in creating new pattern-controls according to general cosmic laws, how absurd to suppose that the creativeness of cosmic genius is limited by pre-existent patterns.

We are now in a position to see the true meaning of the concepts of potentiality and actuality as applied to the evolution of the individual soul. The birth of a soul does not merely imply a creative synthesis once and for all. The soul is not a mere abstract capacity, persisting unchanged, though it is true that there is a difference in quality as between individual souls, and there is the persistence of a unique pattern in each individual history. The birth of a soul in the individual, as in the race, is the outcome of a process of creative interaction, of *wechselwirkung,* of interstimulation, and exchange. To develop a soul requires continuous exchange with soul in the cosmos. It is a trial and error process of adaptation. Heaven lies about us, not only in our infancy but throughout the life process, stimulating toward soul before the structure of soul exists, in due time contributing the appropriate soul pattern, and stimulating soul to creative activity after it exists. This we are apt to ignore because the action of the cosmic environment is constant, but it is, in the last analysis, the rationale of the evolution of soul. In a more specific sense, soul requires the interstimulation of soul in human society. It requires human intercourse with its language and tradition to articulate its meaning. For soul is evolved for a milieu of soul; and only in this milieu can it reach actuality, in the sense of self-conscious purpose. As Undine, the nature sprite, received a soul through marriage with a being with soul, so the human individual receives soul through the marriage with soul, through creative communion with soul, which is the essence of love. Thus is soul incarnated into the evolutionary process through the living breath of soul.

While there can be no doubt that the quality of heredity conditions the capacity for soul, yet neither the intensity nor the quality of soul is absolutely determined by preexistent structure, but depends in part upon stimulus and incentive within the life time of the individual. Soul is not an abstraction, not an absolute entity, but an energy field. Soul is the result of creative interaction, and we cannot understand the birth of soul unless we take account of environment as well as heredity. We cannot make a genius out of the heritage of an idiot, but neither must we neglect the cosmic and social milieu. It is possible that prenatal influences are already potent in shaping the bent of an individual—that the emotional life of the mother, especially in its intenser moments, is a predetermining factor. We know that the external social environment exercises a powerful control in the development of a human being. It is not an accident that geniuses come in clusters, that some periods have been phenomenally productive while others have been stagnant. Social conflicts and social encouragement, the inspiration of great personalities and the struggle for great causes, in short, the tension and quality of the social field within which the individual is born to consciousness and lives his life, condition not only the awakening to soul, but the amount and quality of the production. Great crises make heroes. Great epochs of civilization increase the actual genius of a people. The crisis cannot make a hero out of everybody, but furnishes nevertheless the creative situation in which the quality of heroism is tempered and born; and it is impossible to say how much of heroism is discipline and how much is endowment. The incentive furnished by such a milieu as the age of Pericles or the Elizabethan age must be taken account of as a factor in the creation of actual genius. It is not to be assumed that the biological characteristics of a people change suddenly. But while the biological quality of an individual is important, so is also the character of the social milieu in which he gets his incentive and discipline, not to speak of the more subtle cosmic rhythms of which the individual and society are part.

The emergence of soul in the sense of significant purposive expression must be regarded as a whole-adaptation, as seeing must be regarded as a whole-adaptation. Just as the various stages in the creative evolution of sight cannot function as the actuality of seeing, even though in a constructive, forward-looking sense they may be said to be potential of seeing, so the various stages in the evolution of the creative adaptation which we call soul can only be called potential soul in a constructive, forward-looking sense. Only in this constructive sense can we attribute soul to the embryo or even to the infant. The actuality of soul is no more present on a smaller scale in the early stages than there is a homunculus present in the germ plasm. Soul in the sense of significant functioning is rather the outcome of the creative adaptation to soul—cosmic soul and human society—and this outcome may not be reached by the human individual in his earthly career.

We must then regard mind—thought, constructive imagination, purposive expression—as a creative adaptation to the universe. The response to the logical character, the æsthetic character, in short, to the spiritual character of the universe is, like the response to light, due to a long constructive adjustment on the part of the stream of life to the energy structure of the cosmos. To respond to the significant form of the universe, to its higher type of creative synthesis, life requires a certain type of structural adaptation, as it requires a certain type of structural adaptation to see colour. And as in the case of sensory adaptation, so in the case of mind, the impetus to creative adaptation must come from the character of the cosmos. In the case of minding as in the case of seeing, the new type of response comes only when the structural adaptation is complete; and then, when the proper milieu is present, the characteristic response is discontinuous with the functioning of the past. The new insight comes over us suddenly as love or a summer's dream. But the creative adaptation for mind is vastly more complex than that for sight or any other sensation. It presupposes the structural adaptation to sense stimuli. It presupposes, further, the structural adaptation for duration patterns, such as habit and memory—adaptations for conserving the past. It presupposes also the organization, cerebral and bodily, for expression—the vastly complicated language mechanisms. It presupposes, finally, the evolution of the proper milieu for their use with the social coadaptation involved. But it is the divine impetus to mind from the cosmos which sets the process of adaptation going, which exercises constant pressure for its continuance, and then at length when the adaptation is complete rewards it with a new rapport with the universe.

I recognize that analogies borrowed from the physical and organic levels are halting when we try to express the creative adaptation of soul. Just because minded functioning is a unique type of functioning, it cannot be expressed in terms of any other type, least of all those of a lower type. To commune with light it is not necessary that we should be light. It is only necessary that we should have a physiological organization that can respond with proper organs to light. Since seeing, moreover, is a creative response of a higher level to a lower level of organization, we cannot attribute the experience of light and colour to physical light. Seeing is not a reaction in kind of physical light waves upon each other, but involves a new type of qualitative response on the part of the organism. As contrasted with our communion with physical nature, the communion of mind is a communion in kind. We must be mind to commune with mind. Soul is primarily a response of soul to soul and only secondarily a response to stimuli of a lower order. It is in a milieu of soul that the creative adaptation of soul arises—the actuality of soul as meaningful functioning. We see this in the genesis of our significant life in society. It is only in the social milieu of mind that minded functioning in individual history arises. The life of reason, the life of being awake to the meaning and beauty of the world, can be born only in creative interaction with mind. Through social interstimulation there is the induction, the incarnation, through a trial and error process and through the pressure of society, of the mental patterns of society into the life history of the individual, until the individual as a result of this process of adaptation comes to participate in the system of patterns of society—first automatically and later perhaps reflectively and creatively. It is only through interaction with mind that mind can arise in the growth of the individual; and when the adaptation is established, it is a communion of mind with mind and a recognition of mind by mind—the mind within recognizing the mind without, through the necessity of adaptation—the individual soul first mirroring the life of society, but in favoured instances also becoming creative of society, of a new pattern of the life of mind.

While the social milieu of mind, with its cumulative tradition, with its conflicts and demands for co-operation, is the necessary matrix of individual development, it obviously is not self-sufficient. It, too, emerges in the process of geological evolution; and it rises to new levels, it takes on new patterns in the course of evolution. It must be understood with reference to the larger cosmic matrix to which itself is an adaptation and from which it gets its stimulus and vitality. Social advance is not accounted for merely by minds taking in one another's washing. There must be a larger exchange of energy. And this exchange comes as an adaptation of the individual to the cosmos. For the individual is the centre of exchange through which creativeness arises, though this creativeness radiates in social patterns. It is through adaptation to cosmic stimulus that the geological process becomes prepared for soul; and it is through cosmic induction, the impetus from cosmic genius, and its incarnation into individual history, that soul is creatively superimposed upon the levels which are its evolutionary condition. It is through this cosmic induction that not only individual mind is created, but also the milieu of mind, intersubjective coadaptedness, without which individual mind could not develop. Through this cosmic stimulus higher and higher levels of mental adaptiveness and communion are induced, in the struggle and anguish of individual soul for larger rapport with cosmic genius. Thus arise not only superior levels of individual capacity but superior milieux, for the individual must find expression in the social milieu. And while the social milieu with its tradition gives individual genius its opportunity, it is in turn enriched by the creative expression of the individual. The whole process is the experimentation of cosmic genius to produce greater variety and greater harmony in terms of individual histories—contributing to each structure such colour and pattern as its history permits, even as the mundane artist works to realize new patterns in stone, paint, or marble. Certain it is that the stimulating genius in the evolutionary process cannot be less than mind, though it may be vastly higher than what we call mind—mind itself being one of the stages toward a more perfect adaptation, lying beyond our present conception of mind, as mind is higher than organic adaptation.

It is clear that mind is not just an external relation of a life history with its environment. It is a through-and-through relation, a relation of creative participation. The individual pattern of mind is not impressed arbitrarily from without, but is creatively induced in the trial and error process of adaptation when the conditions for the induction are complete. And the same holds for every new level of soul. The soul of the cosmic artist comes to pervade the individual structure with its presence. Just as mediæval painters of the marvellous stained windows in the Gothic cathedrals did not attain their effects by painting the glass externally, but built the glass, crystal by crystal, staining each bit in the precious fluid and thus staining their genius into the wonderful rose patterns, so the cosmic artist stains the material elements of our evolution with soul, his life blood, and builds them into appropriate patterns bit by bit, even as this composition is stained with the colour and pattern of my soul. Only in thoroughness, in pure devotion, through sustained meditation, infiltrates new soul, the life blood of divinity, into our individual history, producing the life of genuine philosophy which is also the life of genuine piety.

Is the process of creating a soul now complete as the process of seeing colour is complete? We naturally think of the actuality of mind in terms of the achievement of our own mind. For us our insight is final. But we are brought face to face with relativity in the scrutiny of even human development. We have seen that human development, whether in the race or in the individual, is not of one level. What we call mind in the primitive stages of man is not mind of the same quality as what we call mind now. What we call mind in the child is not the same quality as what we call mind in the adult. And between different individuals at any one time there is a vast difference in quality. The actuality attainable by an imbecile is not the same actuality as that of an individual whom we regard as normal. And the actuality of mediocrity is not the same quality as that of a Plato or Newton or Beethoven. We cannot ignore the difference in the quality of men. And what about the future? Is the actuality of our soul, even at its best, final? Should we not rather look forward in pious expectancy, as the ancient Hebrews looked forward to the coming of the Messiah, to a new and higher actuality, a more adequate adaptation to the structure of the cosmos—its divine actuality—, a completer incarnation of the divine pattern in the life stream of our earth? And should we not use our resources, physical and spiritual, so as to prepare for this higher level, the new kingdom of heaven? To this end we must ensure the continuance of the best biological stock and we must create greater freedom and incentive for the development of soul. In the birth of soul, the barren, those who devote themselves sacrificially to the increasing of the spiritual heritage, may have more children than those who biologically beget children; but we must have the biological heritage too if the process of creative adaptation is to go on in preparation for more adequate rapport with cosmic genius. Nor must we expect that the Son of Man when He comes will be received by men in the future, any more than in the past. The process of atonement, of attaining higher unity with the divine soul of things, must always be one of vicarious sacrifice. The path of progress leads over Golgotha.

The Monad and The Whole

One of the most pernicious bifurcations of reality has been that of the individual and the whole. In the history of philosophy the individual has either been regarded as adjectival to the whole or the latter has been disintegrated into independent monads. The adjectival theory finds its classical expression in Spinoza, the monadistic in Leibnitz. That neither type of theory has been consistent does more credit to the common sense than to the logic of the respective advocates. Thus Spinoza tries to save the ethical significance of the individual, and Leibnitz, the logical unity of the world. The attempts at compromise between the two types of attitude have been indifferently successful because they have assumed at the outset the bifurcation they have attempted to bridge. If we start with an abstract universal, how are we going to derive individuals from it? If, again, we start with abstract individuals, how are we going to derive a universal from them? If with Aristotle we place the responsibility for individuation upon matter, we should show how matter can furnish the basis of differentiation. This Aristotle fails to do and in the end must recognize individual forms or entelechies. Aquinas, who postulates a finite creation, places the responsibility upon God for the creation of individual souls. Only so could he save individual significance and immortality, which Averroes, taking Artistotle literally, had endangered. For Averroes had reasoned quite logically that if the universal mind is individuated only by bodies, then with the disappearance of the bodily organization the individual mind must merge in the great reservoir of mind. If matter, on the other hand, serves merely to split up the vital impulse into its inherent diversity, then unity disappears.[11] And if we postulate an inclusive individual to guarantee the objectivity of the subjective perspectives of various monads, then the monads become adjectival.[12] Spinoza triumphs over Leibnitz.

The antinomy of the monad and the whole is solved by means of the theory of cosmic interaction and creative adaptation. There are individual centres with their unique individual history and structure. But these individual histories are curved into a cosmic field to which they strive, by a creative trial and error process, to adapt themselves. This theory is able to give both mind and matter their due. We do not have to project reality on one plane, the psychological plane, as both psychological monism and psychological monadism have been obliged to do. Not all the parts of reality can be stated in subjective terms. We must recognize a qualitative hierarchy of organization and not merely differences in degree. But we have no right to deny subjective reality where it exists, as materialism does.

Both psychological monism and psychological monadism

[11] Henri Bergson, *Creative Evolution*
[12] H. Wildon Carr, *A Theory of Monads*, 1922, pp. 115-117.

are in the strict sense solipsistic when taken literally by their advocates—which they never are. In neither case can we have plurality of perspectives, *i.e.*, perspectives from different frames of reference. If Leibnitz's monad has no windows, it can know nothing but its own subjective perspective as individual history. If Spinoza's absolute is all in all, there can be only one real view-point, the perspective *sub specie æternitatis,* for the parts are merely functions of the whole. In our conception of reality there is real pluralism, though the parts move to a certain extent within cosmic control. The individual is not a mere function of the whole, but contributes a unique perspective of value, a unique centre of creative response. If he surrenders his will to a higher law, he at any rate has a will to yield. He does not move dumb and sightless within the fatality of the omnipotent order of the whole.

The bifurcation into macrocosm and microcosm is an artificial and misleading abstraction. The individual is not a complete universe within himself mirroring in himself, actually or potentially, the order of the whole, as Bruno and Leibnitz supposed. The relation of the individual to the whole is not a passive relation, but a relation of creative adaptation. And the individual part responds as it can by virtue of its history and structure to the order and levels within the whole. Comparatively few individuals are capable of responding to the higher levels of the whole in even a limited way. The creative advance of evolution has not affected all of nature equally. It is limited by the plasticity of the parts. The greater part of nature has become stereotyped within lower planes of organization. The material atoms, the bacteria, the protozoa, etc., are not potentially rational animals. The amœba does not aspire to divinity. Its growth span is complete. It has matured in another plane. The individuals in nature conform to certain types which have become relatively fixed in our geological evolution. Nature, at any rate, exists at any one time at a variety of levels. We cannot project it all on one plane, whether the plane of matter or the plane of mind. We must take account of qualitative levels, of types of adaptation.

We can now see the significance both of the conception of *a priori* synthesis and of empiricism, another bifurcation of modern thought. The responses of every individual to the stimuli of the environment are conditioned by the structure and duration of the individual. The atom responds as it does by virtue of its structure and duration. Within the organism, each level functions as it does within the control of the whole because of its structure and history. The spinal cord has its structure and history which condition the control exercised by the higher levels. The cerebrum in turn responds to spatial relations and temporal rhythms by virtue of its schema which it superimposes upon the lower centres. And the mental level of creative imagination, of significant analysis and synthesis, brings its own type of control. Our responses of truth, beauty, and right imply a dynamic constitution or structure—certain laws of synthesis which we must try to discover. Kant is right that our judgement of order in nature depends upon our sanity, the orderly functioning of our mind. The percipient individual is not a mere neutral blank, but a centre of attentive activity. The perspectives of mind are perspectives of interest. They are meaningful, enjoyed perspectives, not mere external actions and reactions, and they have their own laws. There is thus an *a priori* factor in the response of the individual to the environment.

But minds do not exist in isolation. They are evolved to act in the environment. Their present structure is the result of a long trial and error process of creative adaptation to the structure of the environment. Hence the laws of mind are not foreign to nature. While it is true that the discovery of the order of nature is a creative synthesis on the basis of the laws of our minds, it is also true that the structure of our mind is the result of a long process of creative adaptation to nature. The subjective mind and objective nature are not arbitrarily brought into juxtaposition. If so, the problem of knowledge would be hopeless. But mind is at home in nature. The empiricist is right in holding that mind discovers the laws of nature and does not arbitrarily impose them. The perspectives of mind, corrected by the trial and error process of social experience, become for us perspectives of nature. Our sense of reality, our knowledge of nature, rests upon our subjective perspectives, *i.e.*, our experience of reality. These perspectives are relative to the history of mind, racial and individual; and however much we may socialize them into impersonal systems of nature, they still remain relative to the advance of human experience at the time, and they still retain a certain subjectivity of meaning and value from the individual experience which does the generalizing. Thus there is an element of *a priori* bias, in our search for truth, from our temporal mental constitution.

To speak of the subjective contribution of mind as bias is, however, to belittle the transaction of the individual centre with the cosmos. It is because each finite centre of synthesis has to a degree a unique structure and history that the richness of reality arises. If each individual perspective were a mere function of the whole, the problem of knowledge would indeed be simple. We should all perceive the same way, feel the same way, and judge the same way. There would be no dark corners in the universe. It is this simplicity which makes monism so alluring to the theorist. But what a monotonous world we should have. Such a world is a mere artificial abstraction. It is not our world. If our actual world has a certain opaqueness and blindness, due to the individual history of its parts, it is a world of creative adventure, of give and take, of comedy and tragedy. Adaptation is not an eternal fact, made out of one pattern. But it is a pluralistic, dynamic, forward-looking process. It is a co-operative undertaking between the individual and the cosmos. Insight is won, conscience is created, appreciation is cultivated in this creative venture of living, of creatively discovering our function within the whole. We do not merely take, but give; and it is this willingness to participate in the law of the whole according to our individual genius that constitutes the true significance of life, the process of salvation—the genius of the whole eternally stimulating to higher rapport with itself and we responding by creative striving, first not knowing what we are doing and later consciously, however falteringly, entering into conspiracy with the genius of the whole to create a harmonious life. The search for truth, the love of beauty, the striving for right, are creative adaptations of the individual to the dynamic and overarching constitution of the whole. They are integral relations to the whole, not abstract and isolated faculties in us. Thus is the individual oriented to the genius of the cosmos, but moves with a motion of his own. His willingness is a condition of his sharing in the supreme life of the whole. This makes his act significant and moral.

The individual life is the great cosmic laboratory of creative synthesis where the energy pattern of the cosmos is transformed into creative intelligence. All insight, all value, is generated in this laboratory. All else is projected superstructure, symbolism. Cosmic interaction is an interaction of individual centres of various levels of organization. In this interaction matter plays a fundamental, even though instrumental part. For it is through the organization of matter that higher levels arise in the evolutionary series. It is through the medium of matter, in its progressive organization, that quanta of higher levels of energy are captured and held for the time being in the organization of individual history. Matter is the instrument of energy exchange from the cosmos to the individual and back again. It is through the organization of matter that habit and memory become possible, and even the highest level of creative thought must work through the organization of matter—the organization of the physiological organism and the tools of inorganic matter—to realize its pattern activity. Matter is not a veil that separates the individual soul from the spiritual energy of the cosmos, but rather the instrumentation through which the divine harmony of the whole becomes an effective reality in each of us—the capacity of matter to act as vehicle increasing with the creative organization.

After the extreme social emphasis of the last generation, it is time for the pendulum to swing the other way, to monadism, the respect for the individual. We must not forget that the life of the human individual is not exhausted in social relations: "However organic be the community in which we live, man is a solitary no less than a social being, and his ideal world is at bottom interstitial. However much he acts in common, he wishes also to act alone; however much he thinks as a member of the herd, he will wish also to think as a lonely wanderer." [13] Man requires not merely society but solitude, he is not merely a talking animal but a meditative, mystical creature. His inner life is not all exposed to the external observer and the world's gossip, but there is also a certain privacy. Our mutual understanding is at best partial and through a glass darkly. The life of minding has an inner intimate aspect, as well as a public aspect, an aspect of appreciation as well as of description. All but extreme behaviourists have an inner aspect as well as an outer aspect. Man is not merely an organization of language mechanisms, but also a unique centre of creativeness and enjoyment.

This does not mean that we should conceive the human individual as absolutely private and isolated, any more than that we should conceive him as a mere function of society. We must liberate ourselves from the false bifurcation of individual *and* society. Each individual must live in the matrix of society and nature, but each individual has a unique structure and a unique motion, a personal history of his own. It is true that we must take account of the continuum of social relations and the cosmic field with its curvature. But the continuum of social relations is not a Euclidian continuum. It is not indifferent which standpoint we occupy. The perspectives of

[13] Harold J. Laski, *The Problem of Sovereignty*, pp. 264, 265.

meaning and value vary with the personal history, though we must create a world of common measures for our living and acting together. But these at best are approximations, statistical averages. In fact, the subjective perspectives are qualitatively different and therefore incommensurable. But this is what gives richness and reality to life.

It is not true that the personal centres are windowless as Leibnitz, who was a victim of the false bifurcation, supposed. Monads have windows. Lines of influence are communicated in quanta from all sides and intersect in personal histories. Mind has immediate communion not only with physical nature but also with minds. But each mind responds as it can by virtue of its own structure and duration. The light breaks differently because of the structure of the crystal. For the individual mind is not a neutral medium. If it were, there could be no individuality, no creative response. In fact, there could be no reality, since reality is a system of interactions of individual centres with their structure and motion. Each individual is a centre of creative synthesis within the matrix of the whole, with its hierarchy of levels. Each centre responds creatively to the control of the whole by virtue of its individual organization and history. The whole requires the part and must respect its individuality. The part in turn requires the matrix of the whole to live its life and must learn by a trial and error process to adjust itself to the law of the whole for its survival in the whole. The great advantage of life on the rational level is that the individual can, however imperfectly, enter, consciously and creatively, into the law of the whole and the process of salvation within the whole, instead of blindly adjusting itself to the law of the whole. And the whole is not one plane, as we have seen, but an organization of qualitative levels, where the higher curves the lower within its control.

The vistas of divine beauty open up from the creative life of the individual, however important are social converse and incentive. In the depths of his soul the individual must struggle with the angel of truth until the day break.

Hence the importance of meditation. We have exalted too much Socrates the dialectician, and have neglected Socrates the dreamer with his superhuman capacity for detached meditation. We admire the beauty of the Sermon on the Mount, but we forget the withdrawal into the silence of the night. Man craves not only companionship, but to dream and to enjoy his soul apart, in communion with the depths. Man must have lived a long time in a world of dreams and fancy before his meditation took on the accompaniment of internal speech. And sometimes we recover something of the concrete inner life of an earlier epoch. There are moments when speech seems grey and bare. I have had moments when my soul has been touched by cosmic grandeur infinitely beyond speech. For what are words beside the glory of a sunset? Sometimes divinity comes over me like the surging tide of spring or the gentle melancholy of autumn or the rapture of a great symphony, but alas! my poor words cannot convey it. He must have a poor soul who can convey it all in words. In spite of my unworthiness, God has in rare moments opened vistas into the majesty of the whole which the world does not recognize, for seeing they see not, their souls being blind. Man may succeed in mapping the heavens. He may succeed in expressing external cosmic relations in universal laws. But there remains man's individual and unique relation to the genius of the whole, the creative individual gift of value to the soul, the private communion of man with God, the most vital of all relations, and this defies expression in quantitative symbols. Hence we should jealously keep alive the fire on the altar of meditation and the right of individual conscience.

Mind in the Cosmos

In a large and profound sense we must conceive mind as part of nature. Mind is not indifferent to nature nor nature to mind. If the electron must be conceived as having its world field and if its equilibrium must be understood with reference to this field, so mind must be conceived as having a world field and its equilibrium must be understood with reference to this field with its hierarchy of levels, for if the free electron lives in only one level, we live in several levels. Finite mind must be conceived as a creative adaptation to the structure of the cosmic whole. We gain in concreteness in speaking of the percipient organism or the thinking organism, because in so speaking we emphasize that mind functions within nature, and thus we are able to break through the vicious bifurcation which has so long hampered our thought. Behaviourism has done real service in emphasizing that the most complex reactions as well as the simplest must be studied in the matrix of nature. The danger is that in emphasizing that all functioning, including the process of knowing, is part of nature we may try to assimilate everything to the simplest types of behaviour in nature.

This is what materialism does; and modern science is wedded to the ideal of mechanics. It tries to atomize nature and to reduce everything to external relations. It treats nature as merely objective and ignores the subjective factor, thus making a false bifurcation at the outset. It confines itself to certain monotonous aspects of nature; and, in its onesided emphasis, it fails to understand even these, because these can be truly understood only in the wholeness of nature. In thus aligning itself with materialism, science has landed in logical bankruptcy. In its grovelling emphasis of the mechanical aspects of nature, it has missed the soul. It is as though one should limit oneself in the study of a poem to the letters, with their external relations and sequences, and ignore the meaning of the poem, forgetting that by this method one is unable to understand even the sequences of the letters, for the letters are part of a whole which has soul; and so are the physiological mechanisms of a human being part of a whole which has soul, and their behaviour can be understood only with reference to this whole. The remedy is not mysticism, the discrediting of thought, as some have supposed, but a more adequate conception of nature. We must be willing to recognize reality for what it is in its complexity and range of development, instead of forcing it into artificial models of our own making.

Now, using nature in the comprehensive sense as the total matrix of reality, we must distinguish various discontinuous types of selective functioning. Protoplasm is selective in a different way from an inorganic compound. It responds to light and other energies in ways peculiar to itself. With a differentiated nervous system new types of selection and synthesis appear. We have correlations of reflexes and habits. With the appearance of creative intelligence, we have a radically new method of selection and integration, cutting through and reconstructing the mechanical levels in various ways to serve the ends of purposive conduct. In the highest individuals we thus have a hierarchy of levels of functioning—tropism, reflex, habit, memory, abstraction, creative imagination—each evolutionary level integrated into the next higher level, with its characteristic selection and repression, and each level making its unique contribution within the control of the whole.

If we would understand nature, we must place ourselves inside of nature instead of outside of nature, we must take the whole-point-of-view instead of the part-point-of-view. If we view man as part of the cosmic whole, owing his nature to that whole, then we can no more regard his capacity to think and his impulse to create, with its characteristic satisfaction, as accidental to nature than we do his primitive tendencies which materialism has emphasized. The impulse for food and the impulse for sex are indeed adjustments to a whole larger than the individual organism. But why apotheosize the primitive adjustments and read all others out of court? Is not the logical impulse or the æsthetic impulse just as truly a result of the interaction of the part with the whole? Are they not the result of the creative pressure of the whole and the creative response by the part? And are not the characteristic types of functioning to which they lead, the creative understanding of the universe and the creative appreciation of the universe, as intrinsic to nature as the activities for food, shelter and reproduction? What fanciful dogmatism to regard the former activities as accidental and foreign to nature and to limit the scope of nature to what is real to a pig. No doubt to a pig it is thus limited. But we do not necessarily have to take the pig's satisfaction as the ultimate criterion of value. There is a rank and dignity of reality of which the pig does not dream; and, with John Stuart Mill, I would rather be a "man dissatisfied than a pig satisfied," in spite of the pig-trough philosophy of our fashionable materialism. There evidently are pigs enough to make a market for it and to enthrone it in high places.

Nor are we warranted in separating the logical and æsthetic types of functioning sharply from each other and placing the chief emphasis upon the former as some are inclined to do. The logical and æsthetic adjustments are both aspects of the functioning of creative imagination in its striving for rapport with the cosmos. Both require the whole-point-of-view of reality. In each case the analysis is for the sake of creative synthesis in harmony with the cosmos which has made us for this task, and which in the course of ages rewards our trial and error process with rapport with itself. In each case the utilitarian aspect of the activity is secondary to the striving for harmony. If we must condemn the attempt of the ancients to reduce science to æsthetic prejudice (such as that the planets must revolve in circles because circles are the most perfect figures), we must equally condemn the attempt of modern science to treat truth as though it were a drab thing, foreign to the impulse of beauty. What we call disinterested curiosity is fundamentally an æsthetic impulse for craftsmanship, a feeling for fitness, a bias for simplicity and harmony in a world which on the surface seems chaotic. The great scientific genius is spurred on to his creative discoveries by a feeling for beauty, a demand for form in the manifold of sense, however rigorous his methods and tests.

Nor can we regard the moral life as something accidental. It too must be understood as the striving for harmony of the part with the whole. And must we not hold that, in the last analysis, this striving is prompted by the whole? It is so prompted by the social milieu of which we are a part and which brings pressure to bear for our conformity. But above the social demands of the present there is the demand of the larger whole, the demand for creative adaptation to future society yet in the making, the demand for adaptation of our geological history to the more comprehensive constitution of the cosmos. Such adaptation to future levels cannot be stated in the barren terms of survival selection. People survive biologically and even socially at all sorts of stages of development. Indeed those who are farthest in advance in the creative adaptation to the future are generally deemed unfit by conventional society. It is only when this advance in turn is conventionalized that society builds tombs to the prophets. But there is always the new frontier which demands venture and sacrifice on the part of creative pioneers who are willing to go out into the silence and solitude inspired by the kingdom of heaven to be won. For these pioneers success is not estimated in terms of the preferment of rank and favour which conventional society bestows upon those who fawn and flatter, but in a sense of deeper insight and the creative birth of a larger harmony, however bitter may be the birth-throes. But if despised and rejected of men in their own day and often veiled in obscurity, in retrospect they stand out radiant amidst the sordidness of their time as silver birches stand radiant in the sunlight against the sombre forest—like brides waiting for the Son of God.

This greater moral adaptation is not something apart from intellectual and æsthetic adaptation, but on the contrary it must include them. The striving after moral harmony, greater and nobler patterns of co-operation, a larger and nobler common life, must mean greater creative thoughtfulness not only in the way of inventing instruments for social co-operation and for the mastery of matter, but still more in the way of appreciation of creative thought and of furnishing incentive to creative thought. This means the creation of a beautiful life and the encouragement of the creation of beauty. And since the profoundest moral adaptation must be creative adaptation to the future, the wholeness of life in the making, it must include religious adaptation, or rather be included in religious adaptation. For what is religious adaptation but a creative effort towards communion with the divine spirit of the whole which prompts eternally our creative striving towards wholeness, towards higher and higher levels of rapport with itself? Towards this source of love and beauty our spirit strives as the plant turns toward the sunlight and as the thirsty womb of mother earth craves for the life-giving shower; and from this source flows grace abundant into the souls of those who are devoutly disposed.

This conception of the cosmos in its wholeness includes not only human nature as part of nature, but it includes God, the supreme creative level of reality, as part of the cosmos. For it is a false bifurcation which separates God from nature as though the divine mind were only accidentally joined to nature and as though nature had a life of its own independent of God. Such a bifurcation necessarily leads to materialism, as indeed it has done in the history of thought. On the contrary, nature is what it is, it has determinate order and law, it evolves towards truth and beauty because it is under the creative control of God. Else were there no creative advance in nature. Matter would present but a chaos of random motions. It would lack organization. In such a case, we could discover no laws in nature, because there would be no laws. But the divine level must incarnate itself in matter. Because of this ordering level there is a hierarchy of advance in nature. From the point of view of the whole of the cosmos, we can see both the rationale and importance of the lower types of levels of which materialism has made so much. Matter is indispensable to the evolution and activity of a higher type of life. Matter is necessary to the exchange of energy from one system to another, and matter in its various stages of organization furnishes the basis of duration. It makes conservation of the past possible and thus is the basis of capacity for further development. The divine life must incarnate itself in matter in order to express itself and become effective in its control. The divine order is known to us, not as disembodied spirit, but as incarnate spirit.

But matter, with its plurality of motion, is also the basis of inertia. It thus accounts for the relativity in the various stages of organization. It furnishes not only the body and instruments of creative form, but it also furnishes certain limitations to creative form. The creative pattern is not realized *in vacuo*. If so, there would be no problems to solve, no failure, no evil, but neither would there be any creation. The mystics who have always made matter responsible for evil have forgotten that matter also means creative possibility. Evil is inherent not in matter as such, but in the hierarchy of organization where each level has an inertia of its own, and where its motion must be curved within a higher system of control. But were there no inertia there would be nothing to control, hence no activity.

If the cosmic point of view makes significant the levels of reality which materialism has emphasized, it also makes significant the higher levels which idealism has emphasized. The levels of life and mind and higher levels are not mere pensioners of the lower material levels. They exist eternally in their own right in the cosmos and they exercise control over the lower levels. They do not exist in separation from the lower, but use the lower as mechanisms for their own realization. And because they are intrinsic to cosmic structure, they can produce adaptive evolution toward the future in the lower levels in the course of any one life series such as our geological history. They are the *natura naturans,* or creative nature, with reference to the lower levels, the *natura naturata,* the advance already made. We must be careful, however, in using this contrast of creative nature and created nature not to project them on one plane as pantheism has done. Pantheism has treated created nature as the phenomenal manifestation of a unitary inclusive soul. Rather is the relation that of a hierarchy of levels. And this makes the distinction relative in the creative advance of nature, created nature indicating the advance already made, creative nature the advance to be made; but past and future in any one history are both relative to the law of the whole, the creative pattern of the cosmos, the genius of God.

If we transfer what we have learned of the economy of human nature with its levels of control to the cosmos as a whole with its vastly greater complexity and its greater range of levels, then we must think of cosmic control, not as an abstract system of ideas, but as a hierarchy of energy patterns, including suprahuman levels of control at the yonder end, but also including the scale of levels which we can identify in our experience—minded matter, organic matter and inorganic matter. We must conceive these levels as each functioning differently for being part of this hierarchy of levels, as the spinal cord behaves differently for being part of the cerebro-spinal hierarchy. But within this hierarchical organization we must also conceive each level as having its own life, individuality, and inertia, due to its own history and structure. And the lower levels may become functionally separated from the control of the higher levels and revert to their own primitive reactions, as we find, alas! too often to be the case, not only within the economy of physiological organization, but within the economy of the individual soul and in social groups. The greater the complexity, the greater the degrees of freedom, and therefore the greater the danger of running amuck. But it is precisely in self-surrender to the higher control and in creative co-operation with this control that our salvation lies. Our life destiny must be found within the whole. We cannot live truly as parts. True freedom is a freedom which finds its vocation in creative co-operation within the larger whole. Any other exercise of freedom is but suicide.

Broadly speaking, and with due allowance for the limitation of our insight, we may conceive of the genius of God as bearing the same relation to the hierarchy of levels in the cosmos as our mind bears to the levels of human nature. As the human organism is instinct with soul and expresses soul, so nature in its wholeness is instinct with God and expresses God. And yet nature as we know it is not God any more than the organism is soul. Each part of nature responds, through creative adaptation, to God as it is able, by virtue of its history and organization. But all nature responds to God in some fashion. Else there would be no creative advance of nature. The energy patterns of the divine life reach everywhere. Just what the nature of God's pervasiveness is we cannot say. We may speak of it as infiltration, osmosis, induction, influence. But these are metaphors. The pervasiveness must differ with the organization of nature, its dialysis, its inductive capacity for receiving God at any particular level. But somehow the energy of God radiates throughout, and energy radiates back from nature to God. There is a continual interaction and exchange. God is not a passive spectator of nature. He does not live His life in blissful and indifferent isolation, as Aristotle conceived Him. Rather He interpenetrates nature, becomes progressively incarnate in nature, and is responsive to the striving of nature. There is nothing foreign or indifferent to Him. To Him is present in sympathetic sharing the whole striving, surging life of nature with its undertone of grief like the sobbing of the sea, until nature is prepared at its higher levels to enter into creative participation with His life and in creative union with Him finds atonement. His pervasive, organizing, redeeming genius makes nature holy ground. Everywhere the devout soul can feel His presence, awesome as the silence of the primeval pinewoods and kindly as sunshine after rain. In the words of Xenophanes: He hears all over, sees all over, thinks all over, and sways all things by the power of His mind.

Yet while God is active on all the levels of nature, the lower levels cannot respond to God in kind. The dog, however loyal, cannot share the mind of a Newton in kind; he cannot enter into his meaning or understand his unique life. And so we must respond to God in loyalty as we can. We speak of God's life as mind—thought, beauty, spiritual activity—because these are the highest categories we know. But we must not suppose that mind as we know it is adequate to God. Even with us we have seen that the concept of mind covers a large range of qualitative levels, and other levels may still emerge. But whatever more God is, He is life and mind. What God is in His own quality we cannot know. There is a quality of each higher level which cannot be comprehended in terms of the levels below it. The quality of life cannot be comprehended in inorganic terms, neither can mind be comprehended in organic terms. And so with the further levels. The mystics have said: "To know God is to be God"; and this is true if we mean to know God in kind. But we can discover a nisus towards higher levels in the story of nature, and we are conscious of our own imperfection and limitation. We have seen that the whole scale of levels, including the highest, must coexist in the cosmos in order to produce a nisus in any finite history towards higher levels. Else were the higher levels chance additions. Our impulse to create harmony must be begotten in us by the harmony of the whole. The saying of the mystics that God is present everywhere in activity but not in essence, holds in the sense that nature responds to the activity of God at its various levels as it can, even as the various levels of our organism respond to mind as they can, but we cannot respond in kind to the unity of God until we are transformed in the course of creative adaptation into His likeness, if that can ever be in earthly history. Only when we live God can we truly know God as mind knows mind, but we can establish such rapport with God as our capacities permit. That is piety, and true piety is creative piety, not passive piety.

To the supermind of cosmic control, however incompetent we are to conceive its characteristic unity, we may believe that the perspectives of which we can take account and the levels which we can discover in our truncated life have their unique and complete significance. The properties of material systems have their function as the skeletal framework and instrument. Without matter the higher systems of life and mind could not develop and function. But matter does not exist in the cosmos in isolation from the higher levels. It owes its order and laws to the control by higher levels. In turn, each lower level makes its unique contribution to the next level in the forward-looking adaptation. And the level in which we live, think, appreciate, and worship makes its forward-looking adaptation also to the future, *i.e.*, to the creative genius of the whole. We may believe, too, that as there is selection and suppression in the integrating of each lower level into a higher one in the human economy, so within the highest integration there must be selection of the significant and suppression of the irrelevant aspects—only those aspects which are relevant entering into the crowning synthesis where there is no longer the confusion which exists in our part histories with their imperfect co-ordination and control. We must believe that the superintelligence of God is something far more luminous and thoroughly integrated than we can conceive, and His supergoodness and superbeauty something far more unified and harmonious than we can dream. And as in our life there may be sublimation of our refractory impulses on a higher plane of synthesis within the abandon to a more comprehensive activity, so we may believe that much that seems wreckage to us may be redeemed within the divine unity. Such sublimation is atonement as we know it in our finite experience.

And what about our individual destiny within the economy of the whole? Is the creative advance of nature limited to the race, or is there creative advance for the individual beyond this earthly career? Certain it is that if mind is the function of neural organization, if it is the mere realization of the organism, the mere consciousness of the harmony of the body, there can be no individual immortality. This Plato truly saw. On the materialistic theory, our conscious intelligence is like a shooting star, vanishing into the darkness whence it came. Even so, there is the history of the race where a few individuals have succeeded in leaving a discernible trail—some a trail of light and others a trail of blood. But human history, too, sinks into oblivion at last, for the earthly career of the race must end and the earth as a planet must eventually run its course and disappear into star-dust again. On the materialistic theory soul can have no final significance in the universe. But we do not have to accept the word of the materialist. The soul is not a function of the body, but an energy pattern, potent to control the physiological levels. Aristotle in his Psychology suggests, contrary to his own theory, that the soul as the perfect realization of the body may "stand to it in the same separable relation as a sailor to his boat." This is too artificial a conception. But if the soul is more than body it does not necessarily share the dissolution of the body. And we have seen that the soul adds a new pattern to the body levels.

If, as we have tried to show, there must be a Supermind, ever existing and guiding the cosmic process; if our minds are the creative patterns of this Supermind, incarnate in matter, then we may believe that this Supermind will conserve the significant patterns. Aquinas distinguishes between adherent forms which perish with the matter and separable forms, such as human souls, which can exist after the dissolution of the body. But in some beings, whom we call human, the interests of life seem to be largely, if not altogether, adherent to organic impulses and needs. We are in no position to dogmatize. All we can say is that even as the human creator of a pattern loves the pattern and tries to conserve the significant pattern of his creation, and as society tries within its limitations to conserve significant patterns, so the supreme creative genius must love his created patterns, and so far as they can be saved consistently with the unity of the whole, must wish to save them and if possible restore them if lost. And the supreme creative genius cannot fail in his intent as the individual fails and even society fails.

PART III

RELATIVITY AND COSMIC EVOLUTION

CHAPTER VI

Theories of Relativity

The twilight of the gods is at hand. And all man-made gods in our temporal order have their twilight. Thus relativity reigns. Galileo and Newton, the gods of the first phase of the Copernican age, have had a glorious era. They have provided the framework of modern science. They are the gods of the absolutes—absolute motion, absolute space, absolute time. Yet they are not truly Copernican, for in spite of their wide-reaching horizon they are still earth-bound. Their absolutes are but the emasculate abstractions of certain empirical facts as they observed them—a certain correlation of the motions of tides and planets from the point of view of our terrestrial experience which they generalized and then erected their abstractions into norms for the universe as a whole. There is a certain degree of persistence of matter and motion under the complex conditions of our experience. Hence classical mechanics postulates absolute persistence under abstract conditions. Certain rates of motion appear constant under the limitations of ordinary experience. Hence it postulates an absolute rate of motion. Some bodies are well-nigh rigid and their lengths can be practically trusted under standardized conditions. Hence it postulates absolute rigidity and absolute measures. Identically constructed clocks keep time together; and the earth clock within the limitation of ordinary experience seems constant. Hence it postulates an absolute flow of time. The founders of classical mechanics could not very well have derived their standards from the perception of an absolute rate of motion, since none such has been found. The Michelson experiment has dashed the hopes of the absolutists. The absolute motion of the earth relative to the ether has proved a fiction, and relativity reigns. The traditional ether has had a truly marvellous career. It has been invoked to solve a motley brood of difficulties. It has been supposed to function as a perfect fluid and as a perfect jelly. In Fizeau's experiments on the transmission of light in water tubes, it appears to be stationary with reference to the fixed stars. In the Michelson-Morley experiment, it appears to move exactly with the velocity of the earth. But now the old ether has gone to join the breed of hybrid fictions, the mermaids and centaurs, in fairyland. Since it does not make itself known to our observation under test conditions, it is, at any rate, useless.

The Michelson Experiment and the Fitzgerald Contraction

The new theories of relativity take as their starting point the Michelson and Morley experiment, which goes back to 1886. The results of this experiment are now an old story and therefore it is only necessary to recall the main features. The object of the experiment was to ascertain the ether drift with reference to the earth. Since light is supposed to be the characteristic motion of the ether on the undulatory theory, the problem resolved itself into discovering the difference which the motion of the earth makes to light signals. Since the velocity of light was assumed to be constant, it seemed possible that we might find the absolute motion of the earth in the ether and thus cap Newtonian mechanics. In general, the experiment consisted of dividing a light ray so as to send two signals along arms of equal length, one along an arm in the direction of the earth's motion, the other at right angles to it in the transverse direction, each signal being reflected back by a mirror to an interferometer. As the earth, according to the Copernican theory, is moving in its orbit at the rate of twenty miles a second, the signal sent along the arm in the direction of the earth's motion should travel a longer distance than the signal sent along the arm at right angles to the motion, on the basis of Newtonian mechanics, and the difference should be well within the limits of observation. The experiment, which has been repeated a number of times with variations, has so far yielded a paradoxical result. It matters not how the signals are sent, they arrive in the interferometer simultaneously, *i.e.*, there are no interference fringes. Everything happens as though the earth were stationary in the ether, as indeed Descartes held long ago. Yet if we take the sun as our body of reference, the earth appears to move in its orbit at the rate of twenty miles a second. The experiment thus upsets the classical mechanics which it was meant to confirm. It does not seem possible to establish the motion of the earth with reference to the ether; hence we can have no absolute reference frame for estimating motion, and our judgements in regard to motion must be relative, as they have, in fact, always been.

When our scientific house is upset, it is natural that we should try to restore it with the least rearrangement possible. This is what happened in this instance; and so we have the contraction theory suggested by Fitzgerald and Lorentz, and given classical form by the latter. This theory attempts a physical explanation of the paradoxical result of the Michelson experiment. It holds that the reason for the failure of the experiment to detect the ether drift is that the earth and everything that is part of it contracts in the direction of its motion to just the extent to compensate for the difference in the length of the paths as predicted by classical mechanics which assumes a rigid earth. The arm in the transverse direction is assumed to be constant, and there is no evidence to the contrary. The reason then that everything happens as though the earth were at rest is that the supposedly longer path has been shortened to compensate for the motion of the earth. "When the apparatus has been turned through a right angle, the experiment gives the same result. It does not matter which of the two arms we place in the direction of the earth's motion, that arm must be shorter than the other. In other words, each arm must contract automatically when it is turned from the transverse to the longitudinal position with respect to its line of motion. This is the Fitzgerald contraction of a moving rod. It is of the same amount whatever the material of the rod, and depends only on the speed of its motion. For the earth's orbital motion the contraction amounts to one part in 200 million; in fact, the earth's diameter in the direction of its motion is always shortened by 2½ inches, the transverse diameter being unaffected."

The contraction theory was invented to account for the result of the Michelson experiment. But as Professor Eddington, one of its critics, whom I have just quoted, goes on to say, the theory is "not at all disagreeable to theoretical anticipations. We have to remember that a rod consists of a large number of molecules kept in position by their mutual forces. The chief force is the force of cohesion, and there is little doubt that this is relative in nature. But when the rod is set in motion, the electrical forces inside it must change. For example, each electrical charge when set in motion becomes *an electric current;* and the currents will exert magnetic attractions on each other which did not occur in the system at rest. Under the new system of forces the molecules will have to find new positions of equilibrium, they become differently spaced; and it is therefore not surprising that the form of the rod changes. Without going beyond the classical laws of Maxwell we can anticipate theoretically what will be the new equilibrium state of the rod, and it turns out to be contracted to the exact amount required by the Michelson-Morley result."[1] The earth travels in its orbit twenty miles a second. If it travelled eight times faster, the contraction would be about one-half. But since our bodies are part of the crust of the earth and our astronomical instruments are part of the same crust, they alike would

[1] A. S. Eddington, "The Theory of Relativity and Its Influence on Scientific Thought," the *Scientific Monthly,* Vol. XVI, pp. 37, 38.

vary with it, and our senses would not be able to detect the contraction.

So long therefore as we keep our earth as our frame of reference, everything happens as though we were at rest in the ether. It is only when we select a frame of reference outside the earth and at rest with reference to it, such as the sun, that the problem arises. It is then that we come to the realization that a contraction must have taken place. We find, moreover, that the motion which has led to the contraction of our lengths has also led to a compensatory retardation of our clocks. Both the lengths and the clock intervals have different values because of the motion of the earth. Our space and time, therefore, are relative to the motion of the earth. We have local space and local time. Assuming the absolute velocity of light, and knowing the velocity of the earth, we can transform the units of our local space and time into the units of the frame of reference which is at rest with reference to the earth. Thus we have the Lorentz transformation formulæ. It should be borne in mind that the contraction theory is a relativity theory. In fact it was Lorentz who first used the expression "local space." If we assign a privileged position to the Copernican theory, the contraction theory is at any rate not arbitrary.

The Special Theory of Relativity

The theory of relativity, however, is associated at present especially with the name of Einstein, who, as a matter of fact, has given us two theories of relativity, one called the special or restricted theory of relativity, the other and later one, the general theory of relativity. The special theory of relativity starts, as does the Fitzgerald-Lorentz hypothesis, with the results of the Michelson-Morley experiment. But it gives these results a different interpretation. It abandons the conception of physical contraction and gives local space and local time a new meaning. It assumes rigid Euclidian frames of reference in uniform motion—motion in isolation or away from any disturbing field. For such motions Newton's law of persistence holds. An observer in uniform motion has no way of knowing that he is in motion or of measuring his motion so far as his own reference frame is concerned, *i.e.*, the body on which he is moving. Strictly speaking this would not hold for rotational motion, such as that of the earth, for there we can detect the motion by means of Foucault's pendulum. But an observer in non-rotational uniform motion may regard himself and his frame of reference as at rest with reference to other frames of reference in relative motion to his frame of reference and with parallel axes. Everything goes for him as though he were at rest in a Newtonian reference frame, *i.e.*, he regards his units of space and time as constant.

It is in his measurements of other motions that problems arise. Each reference frame has its proper space, proper time, proper mass, proper energy, which is that of a body at rest. Descartes is at rest in his boat from Dover to Calais, and not only that, but the boat, his frame of reference, is at rest, while the sea is moving past him and Calais is moving to meet him. If he experiences any discomfort from motion it is from watching the environment moving past, granting of course that the motion is uniform. An observer on another reference frame in relative motion to Descartes has the same privilege of regarding himself and his reference frame at rest while Descartes' boat moves past. So long as Newton takes the earth as his frame of reference he is quite right in regarding his measures of space and time as constant, but the earth has no privileged character in this respect as contrasted with other bodies in relative motion with reference to it. The Copernican and Ptolemaic theories are alike arbitrary and relative. The former has no privileged character, though it may prove more convenient in making our calculations.

The basic concept in the special theory of relativity is that of simultaneity. Simultaneity is determined in practice by light signals. When light signals, which are sent from two positions within a reference frame and reflected by properly placed mirrors, can be observed at once in a middle position, we regard the signals as simultaneous. Suppose now that we have two frames of reference, a train on the one hand and an embankment on the other, one in apparent motion with reference to the other. The observer on the embankment measures off his ground and ascertains a middle position from which he observes the signals. An observer on the train who is conscious of the experiment, likewise measures off a distance which contains the same number of feet in terms of his foot rule and finds a middle position. When the middle position of the observer on the train is opposite the middle position of the observer on the embankment, the signals are automatically set off. The observer on the embankment judges them simultaneous from his frame of reference and the observer on the train likewise judges them simultaneous from his frame of reference. Everything happens as though each frame of reference were stationary with reference to light. The velocity of light is independent, not only of its source but of the motion of the observer. If there were just one frame of reference in uniform motion, there could be no judgement of motion.

The problem of relativity arises when an observer on one frame of reference makes judgements about events on another frame of reference. When the observer on the embankment, for example, makes judgements about simultaneity on the train, he calculates that, since the train is moving, an observer in a middle position on the train receives the signal toward which he is moving earlier than the other one, and the observer on the train, who likewise regards himself and his reference frame at rest, makes the same judgement about the signals on the embankment. Simultaneity has a different meaning when it concerns events on our own frame of reference from what it has when it concerns events from another frame of reference as they appear to us in perspective, or rather are thus calculated; and the same of course is true of succession. Since light is not instantaneous, but has finite velocity, it cannot well be otherwise. The appearance of light from Sirius which is compresent with me would be compresent with an observer on Sirius eight light years ago. We have to take into account time as well as space, when we observe events from other frames of reference. By space here is meant units of space measurement, and by time is meant intervals by the clock. The phenomena of special relativity are supposed to arise when an observer on one frame of reference takes account of events in perspective on another frame of reference in relative motion to him. As such a perspective involves time as well as space, it may be called a space-time perspective.

It is assumed that all frames of reference are equivalent and that their own local time and local space are Euclidian. Any frame of reference is at rest for measurements upon it. When our frames of reference are stationary with reference to each other, we can compare our measures—superimpose our yard sticks and compare our clocks and thus make sure that our measures are the same. These measures according to the special theory of relativity do not vary intrinsically with the relative motion. It is only the appearances of measures in space-time perspective that alter. It seems to us on the embankment that the lengths on the passing train are shorter and that the clock intervals are correspondingly longer; and in this way we account for the fact that the observer on the train is unable to detect that he is moving with reference to light, *i.e.*, absolutely, and so regards his frame of reference as stationary. And the observer on the train who observes the embankment as moving in his perspective makes the same judgement about the seemingly stationary character of the embankment to the observer on the embankment.

The results are just the same as those of the contraction theory. In fact, Einstein took over the equations of Lorentz bodily. This is natural enough when it is the same facts, those of the Michelson-Morley experiment, which are to be accounted for, viz., why the apparent motion of the earth makes no difference to light signals.

But the interpretation is vastly different. On the Lorentz theory a real physical contraction takes place; and therefore it is not indifferent which frame of reference you occupy. The special theory of relativity holds, on the contrary, that there is no intrinsic contraction and that relativity concerns only appearances in space-time perspective when two frames of reference are in relative motion to each other. It is indifferent which frame of reference you occupy, the appearances are the same. The apparent shortening of lengths and lengthening of time intervals when we take account of events on another frame of reference are not intrinsic changes but external appearances and reversible.

Let us use a somewhat different illustration to bring out the point of the special theory of relativity. We shall suppose that the conductor on a long train has received orders to measure the length of the train while it is in rapid relative movement. He must assume, of course, that his train is at rest but the embankment is moving, and he makes his measurements accordingly. But he cannot step off and measure, because the road-bed, rails, embankment, etc., are moving past at a rapid rate; so he has to do his measuring on the train. He decides to use a flash of light from the front end of the engine to the rear platform. He standardizes the clocks of the sending end and the receiving end by bringing them together, so as to make sure that they are synchronous. The sending instrument automatically records the time to a small fraction of a second and the receiving instrument likewise records the time. The signal is sent, the records are compared and the length of the train calculated, which is easy since we know the velocity of light—viz., about 186,000 miles a second. All is satisfactory to the conductor. It is necessary for the conductor to use a light signal as the means of measurement, because only so could an observer on the embankment join in the experiment and only so could we get the relation of optical perspective between the two frames of reference without which the point would be lost.

An observer from a balloon attached to the embankment notes the point on the rail where the signal is touched off and the point on the rail at the other end of the train and measures the distance by means of a light signal through a similar arrangement as that of the observer on the train, the clocks having been previously synchronized with the clocks used on the train. It is found to make no difference with reference to light whether the measurement is made on the train or on the embankment. But to the observer on the embankment the length of the train as measured by the conductor is foreshortened by the fact that the train appears to move to meet the signal, and his clocks must be correspondingly retarded since they fail to show the fact. Of course to the conductor on the train who regards the train as stationary and the embankment as moving, the appearances are simply reversed and he judges the length to be shortened and the clock intervals to be lengthened in the measurement on the embankment.

But you say why not use a yard stick instead of a light signal? Suppose we do. We shall standardize our yard sticks by superimposing them or even use the same yard stick and we shall find that the measurement comes out the same whether we measure the train on the train when in relative motion to the embankment or mark off the distance on the embankment and measure it. But how shall we know whether the yard stick remains the same length in each process of measurement? The reason light is used is that the velocity of light is assumed to be constant. Hence we can find a basis of comparison between the lengths and clock intervals as they appear to us on our frame of reference and as they appear to us when we take account of another frame of reference in relative motion to ourselves.

As a matter of fact, we should notice no difference so long as we deal with such slow motions as trains and embankments, but let the train be the earth and the embankment the sun, and then we have the Michelson experiment. To an observer on the sun it would appear that if we measured distances on the earth by sending light signals in the opposite direction from the earth's motion, the distance should be foreshortened by the earth moving in the direction of the flash, and that the reason this does not appear to us is that our clocks are correspondingly retarded by virtue of the earth's motion. So long as we use the earth as our frame of reference, we can treat measurements on the earth as absolute. It is only because Michelson used the sun as his frame of reference that any doubt was raised as to the validity of the Newtonian conception of absolute units of time and space. The units appear to vary with the perspective when two bodies are in relative motion to each other, and this has given rise to the theories of relativity.

Suppose the speed of the train were 161,000 miles a second, then the lengths on the train when taken account of in space-time perspective from the embankment would appear as only one-half of what they would be if the train were stationary with reference to the embankment, and the clock intervals would appear twice as long. We know now of Beta rays from uranium which move with a velocity ninety-eight per cent that of light, and therefore relativity has become of interest as a problem in our terrestrial environment. Since the velocity is the product of an arbitrarily chosen time interval and an arbitrarily chosen space length, it remains constant. It is the distribution between space and time which varies.

The common sense reader has probably become impatient by this time and perhaps says that we are merely trifling, that, of course, we know we are moving when we are on the train and that the embankment is not moving, etc. But the fact is that motion makes a difference to our judgements of even such abstract quantities as space and time. And can we be so sure that we know when we are moving? The human race for long ages regarded the earth as an absolute frame of reference, but now we find it simpler to take the earth as moving and to take the sun as our frame of reference. But while the sun may be regarded as stationary with reference to the earth, the sun too is moving and the earth is moving with it; and so far as we know there is nothing stationary. Our judgements of space and time are, therefore, necessarily relative, and it is merely a question of convenience what body we regard as reference frame. Rest and motion seem equally relative.

The special theory of relativity is startling in its simplicity and revolutionary of our common sense notions. When you are running your automobile at fifty miles an hour and you are stopped by a policeman for speeding, you can tell him that you were really at rest in your car but that he, the policeman, and the street and the houses were rushing past you at fifty miles an hour. The policeman, with his common sense bias, listens incredulously to your explanation and takes you to the police station; and there in due time you will repeat your story to the judge who will send you to the insane asylum, though according to the theory of relativity you are perfectly correct in your statements. But alas! the police authorities are equally correct in their statements, and they have the long end of the law. And they are likely to have it so long as it is necessary to protect society from speeders; for spite of theories of relativity the most convenient way to protect society seems to be to arrest speeders.

The idea of gravitation loses its mystery for the special theory of relativity. If you should fall from a high tower, you could reply, if someone should shout from below that you are falling, that so far as you are concerned, you are stationary, but that the ground below is rushing up at you. Of course there is acceleration which remains to be accounted for, but this can be attributed to a demon. The advocates of this brand of relativity seem to have an indefinite supply of demons at their disposal. The increase of mass and still greater increase of energy of particles moving with a speed approximating that of light does not bother the enthusiast of relativity. Suppose you are riding astride of a Beta particle shot out from uranium with a velocity of ninety-eight per cent that of light and a spectator on the seemingly solid ground remarks that you are going with an enormous speed and that your mass and energy are vastly increased, you can reply that all that is merely a matter of appearance, that really you are at rest and your "proper mass" and "proper energy" and "proper time" and "proper space" are constant, but that, as it appears to you, the observer on the ground and the body to which he is attached have come to have a sudden increase of mass and energy. All of which is very bewildering, but we are assured by so respectable an authority as Professor Eddington that it is really so. If Eddington were as theological as Descartes, he might fortify himself with the assertion that God makes it appear that way to us and God cannot lie. For are not our ideas mathematically clear and distinct?

According to the theory of relativity, it is indifferent which frame of reference the observer occupies. But how can we then explain the phenomena which seem due to rotation—the centrifugal forces, the deviation of the pendulum? Professor Whitehead has said that Einstein's theory explains gravitation but makes a mystery of rotation. Obviously Einstein cannot explain centrifugal force as due to the absolute rotation of the earth in the ether as Newton did. It would have to be explained by the field outside the earth. It is as though the earth were the apex of an inverted pyramid. But this seems to demand a distribution of matter which is arbitrary so far as our present knowledge is concerned. Moreover any other frame of reference which we choose to select would have to be regarded similarly as the apex of the pyramid. But here we are anticipating the general theory of relativity, for the special theory can deal only with uniform motion with parallel axes.

The only facts for the special theory of relativity, as Einstein himself says, are the apparent shortening of the lengths and lengthening of time-intervals as indicated by the Michelson experiment. It is an alternative to the contraction theory of Fitzgerald and Lorentz in accounting for the results of this experiment, though it seems to be capable of wider application. Into these we cannot go. For example, physicists like J. J. Thomson and others discovered at the beginning of the century that in the case of radio-active emanations which have a velocity which approximates light, there is a great increase of mass and a vastly greater increase of energy because of the high velocity. Einstein sides with those who have come to regard mass as identical with inertia, and inertia as a form of energy. This greatly simplifies the concepts of physics. According to the special theory of relativity, however, the increase of mass and energy in the case of the electron of high velocity is merely apparent. Since the frames of reference are reversible, we can place ourselves on the electron instead of on the embankment, and regard our electron as at rest with reference to the embankment. In that case we cannot speak of the electron as having an increase of mass or energy. The observer would abide in the local space and local time of the electron. But the lengths, time-intervals, mass, and energy of the surrounding field would appear altered.

The special theory distinguishes between the proper space, proper time, proper mass, and proper energy of a frame reference and the apparent or kinetic characters which are the appearances in perspective to an observer on another frame of reference in relative motion to it. To the imaginary observer on the Beta electron with a velocity of ninety-eight per cent that of light (as we vulgarly say) there is no local difference. His proper space, time, mass and energy remain the same, but there is a shortening of the lengths, and a lengthening of the time, and an increase of the mass and energy of the environment which appears to move past him. In general the kinetic characteristics of things are supposed to be merely apparent and are reversible with the shifting of frames of reference. Surely if Plato were living now he would insist on mathematicians like Einstein, Eddington, and Bertrand Russell being banished from the state with other fabricators of new-fangled notions.

The special theory of relativity seems simple when we take account merely of two frames in relative and parallel motion with reference to each other. In the case of the train and the embankment, visual appearance is indeed on the side of relativity. Who has not seen from the train window how the environment seems to rush to meet the train and the distortion of perspective which results from this apparent motion? But we meet with difficulties when we are to correlate the appearances of multiple apparent motions with each other. We might suppose in the simple relation of train and station that the station rushes to meet the train. But what if the trains appear to enter the station from all possible directions at the same time? The station would have to hump itself to travel in opposite directions at the same time and also in transverse directions. As a matter of convenience we assume that the station is at rest with reference to the trains entering the station. We can correlate the motions on the earth more simply by taking the earth as stationary with reference to them. For the same reason, we find the Copernican theory more acceptable than the Ptolemaic. We can correlate the motions of the planets more simply by treating the sun as stationary with reference to them, though in turn the sun is moving with reference to other stars in the galactic system. Some day we shall perhaps comprehend the law of the star-stream within our galactic world. In the meantime we shall believe that the hypothesis which affords the simpler explanation is also the truer explanation—nearer the constitution of things. To be sure our hypotheses are also involved in relativity and an hypothesis which seems to explain at one time may not explain always. Witness Newton's law of gravitation. But such an hypothesis can always be taken up into a more comprehensive formula as an approximation. While it is superseded, it is not lost. In the meantime our insight into the vast constitution of things of which we are a part is decidedly relative.

For Einstein the theory of relativity has no philosophical significance. It is a mathematical device for predicting events and like other scientific devices is in danger of being upset by the first untoward fact. It is an artificial instrument and has nothing to do with the physical significance of time or motion. But Einstein's British followers have taken the special theory of relativity more seriously. Eddington[2] regards space and time as our "parochial frames," as "subjective distortions" of reality, the absolute space-time whole. This attitude seems to be also that of Bertrand Russell.[3] The perspectives which are due to the relative motion of frames of reference, *i.e.*, the kinetic characteristics of shortened lengths, of lengthened intervals of time, increased mass and energy, are for them no intrinsic part of reality. They are mere appearances. Relativity of motion is taken to mean subjectivity of motion. Indeed if frames of reference are equivalent and any frame of reference can be regarded as at rest or in motion at will, the subjectivity of motion seems to be implied. Motion can in that case make no physical or intrinsic difference to any frame of reference. But is the subjective interpretation inevitable?

It seems to me that the subjectivists have started from the wrong end of the problem. What is real is what Whitehead calls the passing of nature. The Michelson experiment did not establish the relativity of motion, but the relativity of our judgements of motion. There are for us no absolute standards of space and time. Even the velocity of light, which the special theory of relativity has erected into an absolute, must be measured in terms of our empirical standards, our local space and time, whether it has an absolute rate or not. And the general

[2] Article quoted above. Also his books, *Space, Time and Gravitation* and *The Mathematical Theory of Relativity*.
[3] *The A, B, C of Atoms*, Chapter XIII.

theory of relativity shows that there is no such absolute rate. Our perspectives are indeed relative to motion, but this does not mean that motion is relative. Motion is an absolute fact, in any case, whether it is our frame of reference which is moving or the frame of reference which we are observing in space-time perspective. The so-called "distortion" of perspective could not take place if it were not for motion. This is basic in the theory of relativity. The degree of "distortion" is dependent upon the velocity of motion, and therefore this velocity cannot be subjective. If velocity is objective, the increase of mass and the increase of energy, which are functions of the velocity of motion, must be objective.

Motion is more fundamental than our judgements of relativity, because the latter depend upon the former. Our relative perspectives of motion presuppose plurality of frames of reference in motion with reference to each other. We cannot get rid of motion by shifting our point of view. Simultaneity and succession as physical facts are not created by our judgements of them. The passing of nature is an absolute fact. Velocity, kinetic mass, kinetic energy cannot be made less real by our space-time perspectives, though it is in perspective relations that we know them. The velocity of a moving body is not altered by our perspective relation to it, but the distribution between space and time is altered by our perspective. The train arrives at its destination on schedule whether we regard the train as moving to the station or the station as moving to meet the train. There is the passing of nature in either case, and this is real. The projectile hits the target with the same energy whether we conceive the projectile moving to hit the target or the target moving to meet the projectile. Whether a body is conceived to fall to the earth or the earth is conceived as rushing up to the body, the crash is the same. Our description of motion may be a matter of convenience, but not the passing of nature. We try to determine by the correlation of perspectives of motion what is moving with reference to something else. This correlation is empirical and relative—subject to revision with further experience of motion. But everything in our world is moving. The passing of nature is an ultimate fact.

The special theory of relativity suggests to Eddington Kant's ideality of space and time. For Kant, space and time are forms of sensibility. They have no relevance to the real world. They are human perspectives, human ways of ordering the data of perception. In that sense they are subjective. But the relativity of Kant has nothing in common with the special theory of relativity. The space-time perspectives of the special theory of relativity are not relative to human nature but to bodies in motion with reference to each other. Presumably the camera would show the same "distortion" of perspective of events on other bodies moving with reference to the body upon which the camera is located. Local space and local time are not subjective, whatever their significance may be. On the other hand, the Kantian perspectives of space and time are not local; they do not vary with relative motion; they are universal, *i.e.*, the same for all observers. The partitioning of velocity into space and time is absolute. In other words, Kant is a thorough-going Newtonian in his conception of space and time, even though he holds that they are relative to human nature.

Finally the distinction which writers like Eddington and Russell make between intrinsic and extrinsic qualities—between proper time, space, mass, and energy on the one hand, and apparent time, space, mass, and energy, on the other—is itself a relative and arbitrary distinction. Why suppose that appearances of events taken account of on our local frame of reference are more real than the appearances of those events as taken account of from another frame of reference—the sun for example? At most the special theory would lead us to hold that all frames of reference are equivalent. But if we take the passing of nature as an absolute fact and if there is nothing stationary, then the appearances resulting from motion are the real appearances, and those resulting from apparent rest are illusory. For nothing exists in isolation and nothing is at rest with reference to anything else. Everything from star to electron has a duration of its own. All our perceptions are due to motion in fact, even if we do not perceive the motions. Hence all appearances are appearances of motion and all qualify reality. There are no privileged appearances. All we can do and need to do is to state the conditions of the appearances. This is a more complex affair than the special theory with its assumption of isolated motions can account for, since the special theory ignores the medium in which the appearances occur.

The special theory of relativity is a half-way house at best. We cannot stop there. It is presumably based on the Michelson-Morley experiment. This experiment shows that we cannot measure the motion of the earth with reference to the ether and therefore that our measures are relative to the frame of reference of the observer. There is no privileged frame of reference: all frames of reference are equally valid for purposes of measurement. This is a different matter from holding that motion is relative to the observer. Our space-time perspectives are relative, but they are not subjective. So far we must agree with the special theory of relativity. But the constancy of light assumed in the special theory is fictitious. Light varies in the neighbourhood of matter and, therefore, in the neighbourhood of our earth, even though our instruments as yet cannot detect this variation. The variation in the neighbourhood of the sun has been established by observation as well as mathematics. The earth itself is a rotational field and therefore non-Euclidian. This fact can be established by Foucault's pendulum and other means, independently of our knowledge of other moving bodies. The special theory therefore is not merely paradoxical, but it is an abstraction, a fiction which cannot be shown to have relevance to the actual world of motion. As Einstein himself puts it:

> Space-time regions of finite extent are in general not Newtonian so that a gravitational field cannot be done away with by any choice of co-ordinates in a finite region. There is, therefore, no choice of co-ordinates for which the metrical relations of the special theory of relativity hold in a finite region. But this invariant, *ds*, always exists for the neighbouring points (events) of the continuum. This invariant *ds* may be expressed in arbitrary co-ordinates.[4]

This, however, is merely an artificial device. We know of an increasing number of events which follow the finite quanta type, but we have no evidence that any events are of the infinitesimal order.

The General Theory of Relativity

In dealing with uniformly moving fields and their relation to each other, we have been able to make use of Euclidian geometry with its straight lines and straight co-ordinates. By using the velocity of light as a constant we have been able to translate the quantities of relatively moving fields into terms of our own frame of reference. But when we have non-uniform motion, as in the neighbourhood of a large body of matter, or in a rotational field, or in a field of unequal distribution of heat, we cannot use our Euclidian geometry. Light rays bend in the neighbourhood of large bodies like the sun. Their velocity is thus retarded and we can no longer use light as a constant for our comparisons. We have launched on the sea of general relativity where our compass itself is subject to variation in relation to the field in which we travel. It is hazardous to try to make Einstein's theory of general relativity clear in ordinary language. And after our best efforts we have no doubt that many will say with the countryman who was looking at the giraffe at the circus: "There ain't no such animal." We can at any rate sympathize with the perplexity of the students of Cambridge as expressed in their doggerel:

[4] *The Meaning of Relativity*, p. 71.

> We thought that lines were straight and Euclid true.
> God said: "Let Einstein be," and all's askew.

But this may not be the fault of Einstein.

The general theory of relativity deals with more concrete conditions of motion than the special theory. Things, including light, do not, within our ordinary observation, move in a vacuum. They move through media and amongst interfering energies. We cannot, therefore, determine motion purely in terms of perspectives of space and time or their combination. We have to take into account empirical fields with their determinants. The determinants are veiled by Einstein in the geometrical structure. We therefore have to abandon our images of fields of force and other material aids and substitute geometrical fields. If this is geometrizing reality, we must remember that, after all, what counts in Newtonian science is differential equations. And we are as ignorant of gravitation and fields of force as Newton was. It would be a mistake, however, to suppose that Einstein's theory is purely mathematics. It is with the physical structure of the world that he is concerned. The question is merely of the simplest way of predicting events. In spite of our ignorance of the internal relations of nature, of the real transitions between events, we can group our observations mathematically and make them useful.

For mathematical purposes we can simplify our terms. We can treat gravitational mass as inertia, since all bodies fall with the same velocity in a vacuum, irrespective of their texture, size, etc. Gravitation can be treated as acceleration, since that is the pragmatic significance of gravitation. When we are riding on a train and are suddenly jerked forward we *can* attribute the effect to our entering a gravitational field. Moreover, quasi-gravitational fields can be artificially produced by rotation. Mathematically the equations are the same. To be sure that doesn't explain gravitation; but at any rate our ignorance has been effectively exposed. Since all variation in space position is variation in time position—*i.e.*, in our clocks—motion is really four dimensional. "Every physical description resolves itself into a number of statements, each of which refers to the space-time coincidence of two events, A and B." [5] What we do when we try to describe the motion of a material particle relative to a body of reference is to state the encounter of this particle with particular points of a reference body, including the corresponding values of the time, the encounters with our clocks. For this purpose we must make the assumption that "the two lines which represent the motions of the points in question have a particular system of co-ordinate values in common." [6] Otherwise our values would not be measurable in terms of each other.

As in the special form of relativity, or the geometry of uniform motion, so here we presuppose plurality of motions. On either theory, our judgements of motion are relative. We select our reference frame to which the perspective appearances of any motion must be correlated. But we no longer assume a constant, independent of our reference frame and the motions observed. We cannot assume the constancy of light, for the velocity of light varies in the neighbourhood of matter. In the absence of an absolute measure we must get along with relative measures, taken from a selected frame of reference. Einstein expresses the variations of nature in terms of a geometrical structure. But to this end he needs a new type of geometry. Rectilinear Newtonian reference frames with their implications of rigid units of length and constant units of time are no longer available. The geometry employed is that of Gauss, which enables him to deal with fields of non-uniform structure such as that of gravitation. This is spoken of as the geometry of curved space. This means merely that the variations are no longer statable in Euclidian terms.

In order to get a Gaussian field of geometry we resort to the device of dividing our field by two sets of lines which

[5] Einstein, *Relativity,* p. 95.
[6] *Ibid.*

are so drawn that the lines within each set do not meet. but the two sets intersect each other, like the lines of latitude and longitude on a map. What concerns us, however, are not the lines but their intersection points. We assign to every intersection four numbers, one for each of the co-ordinates of space and one for the co-ordinate of time. These numbers have "not the least direct physical significance, but only serve the purpose of numbering the points of the continuum in a definite but arbitrary manner." [7] Since time is assigned a numerical value, there is no need of distinguishing the time-co-ordinate from the space-co-ordinates. The appearance of a material point-particle or a flash of light at one of these junctions of space and time is an event. Were nature timeless, *i.e.*, without duration, the perspective at an instant, with its numerical values, would be sufficient.[8] But since a particle has duration, its existence, according to the theory of relativity,

> must be characterized by an infinitely large number of systems of values, the co-ordinate values of which are so close as to give continuity. Corresponding to the material point, we have thus a (unidimensional) line in the four-dimensional continuum. In the same way, any such lines in our continuum correspond to many points in motion. The only statements having regard to these points which can claim a physical existence are in reality the statements about their encounters. In our mathematical treatment, such an encounter is expressed in the fact that the lines which represent the motions of the points in question have a particular system of co-ordinate values, x_1, x_2, x_3, x_4, in common.[9]

[7] A. Einstein, *Relativity*, p 94.

[8] That time is the characteristic of reality which makes it necessary for us to make new judgements or statements in order to define the real was emphasized by the present writer as far back as his unpublished doctor's thesis at Harvard in 1899 on *The Concept of Time*. It is expressed in *Time and Reality*, 1904, and *A Realistic Universe*, 1916, Part IV.

[9] Einstein, *ibid.*, pp. 94, 95.

We do not have to worry about any absolute standard of measurement. The important thing is that our space measures and our clock intervals can be taken as the same within our frame of reference. We can then make our statements about the space-time coincidence of any two events under consideration, which is what physical description means.

Einstein assumes that indefinitely small distances in our non-Euclidian field can be treated as Euclidian. That means that if two motions effect a junction in a certain intersection they will also be coincident at a point indefinitely near. Different moving particles appearing at different points within the uniform block can have their position indicated by adding an indefinitely small numerical index to the co-ordinate values. Any space-time chunk is equally available as a frame of reference. Treating an indefinitely small non-Euclidian distance as uniform is of course a pragmatic device, like treating a circle as if it were made up of an infinite number of straight lines. Such an indefinitely small chunk of space-time values, Einstein calls, picturesquely, a mollusc. Within such a mollusc we have Euclidian congruence.

From mollusc to mollusc the values of the space-time co-ordinates change. We can only add and subtract values within the uniform space-time block, because we can only add and subtract the same type values. As we cannot add red and blue, so we cannot add different types of geometrical structure. They are non-integrable.

Let us try now to understand the meaning of the theory of relativity in the concrete. It is not correct to speak of motion in space-time though we can speak of motion in space. Motion is the appearance of a point-particle or a point-flash in an order of junctures of space-time, *i.e.*, the particle or flash appears with its four numbers—its three space numbers which give its position in space and its clock-time number or date. From mollusc to mollusc there is a difference in all the numerical values. The intersections are ordered in a definite but arbitrary manner; arbitrary because the numbering may start from any intersection of space and time. Two intersections within the same mollusc, *i.e.*, indefinitely near, have the same co-ordinates. We can treat their relation as Euclidian. The important point here is that the perspectives from different molluscs have different numerical values. The survey of motion, then, is the survey of a four-dimensional numerical order. The journey of a traveller appears as a series of junctures of space-time, with different number tags. It is as though nature at each chunk had settled into a different mould. The order is determined by the guiding field—in the case of the gravitational field, by the mass of matter, which, of course, must be ascertained for each body of matter. We cannot predict the curvature of light in the immediate neighbourhood of a body of matter like the sun, unless we know its mass. It is matter or energy, then, which determines the specific geometrical structure.

But the imagination of the amateur like myself needs something more concrete in order to visualize this Gaussian geometry with its "curved space." Einstein's happy illustration of a marble slab resting on a lattice of metal rods may help us. The advantage of this illustration is that we start with Euclidian space. The metal lattice is supposed to be built up of tiny rods, each one perfectly rigid and straight and of the same length, having been standardized by the superposition of the same metal rod. These rods are built into little squares and together they support the whole Euclidian marble slab. Now suppose you heat the marble slab in the center. The heat is communicated to the metal framework unequally, so that the rods in the center are heated most and those at the circumference not at all. The result is that the form of the metal lattice is literally twisted. The figures are no longer Euclidian squares and we can no longer use our little Euclidian measuring rod by means of which all the little rods of the lattice had been standardized previous to the heating. The geometrical structure of the metal lattice has undergone a change. The factor of time has been introduced into the structure and it is now four-dimensional. While we can no longer use Euclidian geometry, we can use Gaussian geometry and proceed to give numerical values to our intersections as above described. The guiding field in this case is furnished by the constant source of heat, with its manner of distribution, which must, of course, be known. Other complications we may ignore for our purpose. The value of the marble slab in the experiment is that it may be supposed to retain practically its Euclidian structure, and thus furnishes a contrast.

An illustration often used is that of locating a house in a city by its number. It does illustrate the idea of numerical relations. The intersections would, of course, have to be increased indefinitely. Each house with its relations would constitute an event and to conform to the previous Gaussian scheme would have to be shrunk to the proper proportions in order to be described by means of an infinitesimal calculus, though this is a matter of method, since we might use a finite calculus with any size entities. But this is not the serious defect in the illustration. Our city plot is a Euclidian scheme like our original metal lattice. How can we convert this into a Gaussian scheme which, of course, it really is to an observer from a frame of reference outside the earth? We must conceive our city in motion. This must not be uniform motion, because in that case our Newtonian conception of units could still be supposed to hold and we should still have Euclidian geometry, as in the special theory of relativity where everything on the reference frame is supposed to persist according to Newton's first law of motion. We must, therefore, have non-uniform motion or change in velocity. We will suppose that our city is moving for some unknown reason through a medium of increasing density. The structure of the city will no longer be Euclidian. But we can locate the intersections with reference to each other on the basis of their numbers according to the Gaussian scheme of four number co-ordinates, and you will see the houses at various intersections with their space and time tags. To an observer in the sun our actual city plots would be Gaussian, since to him our earth is a rotational system in motion round the sun.

But we do not have to go so far afield. We can get an illustration of Gaussian relativity in the domain of economic values. It is well to remember that the actual world has a Gaussian structure. It is the Euclidian or Newtonian conception which is artificial. In Germany, Einstein's theory is sometimes referred to as the merchant theory, perhaps with a squint at the Hebrew origin of the author. In buying and selling, the merchant has no absolute frame of reference. No one supposes any longer that there is an absolute cost price. The purpose of the merchant is to buy goods as he can; and, whatever the buying price, he adds a certain percentage for profit and thus determines the selling price. There may be certain finite periodicities of varying length in the fluctuations of prices. The economist tries with more or less success to discover certain factors which constitute the guiding field in the fluctuations, and which, if he could define them, would enable him from his arbitrary vantage point to establish a certain order in the fluctuations. But this ordering is relative. Economics knows of no absolute values. In the economic world we strive as best we can to make our readjustment from finite chunk to finite chunk. There are certain complications for the merchant, for example, in having goods left over from chunk to chunk in the readjustment of the economic co-ordinates. If the merchant has a stock left over and cost prices in the market rise, the merchant gains because he marks up his goods. If prices fall, he sells as he can and may go under in the readjustment. But we shall leave the merchant to sink or swim, as he can, in the fluctuations.

The problem of a monetary standard of exchange illustrates the theory of relativity in a concrete form. The Occidental nations for the most part have a monetary standard based upon gold, the unit of exchange being arbitrarily fixed in the various states. But gold itself does not have an absolute economic value: it fluctuates in value with reference to the commodities it will buy. Gold is itself a commodity depending upon the law of supply and demand, though the value of gold is in part due to the demand for it as a standard of exchange which implies a circle. At best, gold is a relative standard. But, so far, the great commercial nations have found it convenient to use gold as the basis of exchange. The difficulty, however, following the European war, 1914-1918, is not so much the fluctuation of the gold basis of currencies, though this is fluctuating, as the fluctuation of the currencies of various countries with reference to gold. At the present time (1924) the currency of most of the European countries is far below par as compared with the pre-war ratios. The rate of depreciation, moreover, varies greatly in different states, complicating very much the problem of exchange. The question is what can be done to establish a practical basis of exchange? Some insist that this can be done only when the pre-war ratio of currencies of the various countries with reference to gold is re-established. This is patently impossible at present. The sanest solution is to stabilize, if possible, the present relative values of currencies in terms of gold. These ratios would then become the norm for the period of stability which, of course, is very finite. This would give exchange an opportunity to adjust itself and business could be done in a normal way. It is not the particular ratio of a certain currency to a gold basis that is important for business, but the stability of the ratio. Once the ratio is stable, international prices can be adjusted in terms of common economic co-ordinates with reference to gold, even though the basis itself fluctuates from time to time. Within certain finite chunks of life, it must be possible for us to have common co-ordinates, *i.e.*, a common numerical unit of value, if we are not to have utter confusion in the exchange of values. We can see now in terms of economics what Einstein means when he says that motions, to be calculated in terms of each other, must be within a certain chunk or mollusc where the co-ordinates are the same. Otherwise we have no basis of comparison. The values change from chunk to chunk but within each chunk there are common ratios. We are fortunate if we can discover a guiding field like gravitation which gives us an order of chunks.

Professor A. N. Whitehead's statement of the theory of relativity is more philosophical than that of Einstein. He is careful first of all to define his terms and in this has performed an invaluable service to science and philosophy alike. He starts with the continuous duration of nature. This continuous duration has the characteristic of extension in space and time, *i.e.,* spaces include spaces and times include times in the universal flow. Extension in time we call duration. For purposes of knowledge we must discriminate within the continuous duration of nature. For ordinary purposes we select concrete finite chunks within this duration, such as iron and other common-sense things. Such chunks have extension in space and duration in time. To such chunks Whitehead applies the term events. But science cannot be satisfied with such gross units. Hence the method of extensive abstraction. We conceive the chunks of extension, whether spatial or temporal, as made up of smaller units like boxes within boxes. We proceed with this process of abstraction until we reach a zero of extension or a point and a zero of duration or an instant. Since motion implies both space and time we have point-instants.

But events are not resolvable into space-time. They are physical events; and we must take account of their physical characteristics as well as their space-time relations. We can single out or abstract from events such characters as the sense quality blue, when we speak of a blue star. But while this description in terms of characters may serve ordinary practical purposes, it is not adequate for the purposes of science which requires such non-sensuous objects as molecules, atoms, and electrons.

The electron is the simplest unit known to science. Hence it would seem that the simplest event must be an electron at a point-instant. But here there is difficulty.

The extensive abstraction of matter must keep pace with the abstractions of space and time. Now a point is not even an infinitesimal extension and an instant is not even an infinitesimal duration. A point is zero extension and an instant is zero duration. But how can an electron which is a finite quantum occupy a zero point and a zero instant? If an electron were a Leibnitzian monad, *i.e.*, a soul, it could occupy zero space, but even then it could not occupy zero duration, since a monad is a historic continuum. Hence in order to satisfy Professor Whitehead's requirements of extensive abstraction, matter must be treated as infinitely divisible and we arrive at a physical point. Such a point with its space and time relations is an event-particle.

> Each event particle is as much an instant of time as it is a point in space. I have called it an instantaneous point-flash. Thus in the structure of this space-time manifold space is not finally discriminated from time, and the possibility remains open for diverse modes of discrimination according to the diverse circumstances of observers. It is this possibility which makes the fundamental distinction between the new way of conceiving the universe and the old way.[10]

Professor Whitehead does not mask the physical in the geometric structure to the extent that Einstein does. A variation in the geometric structure of the field of gravitation implies to him a variation in gravitational impetus. The practical congruence of motions over indefinitely small distances, or in other words the Euclidian character of an infinitesimal mollusc, can be translated into more familiar physical terminology by saying that "the integral impetus is stationary for an infinitesimal displacement,"[11] which amounts to the same thing; and as we know nothing about the physical impetus of gravitation, it is merely a question of terminology whether we speak of a change of

[10] *The Concept of Nature*, p. 173.
[11] *Ibid.*, p. 183. See also his *The Principles of Natural Knowledge*

impetus or a change of geometrical structure. It is, in any case, the latter, so far as our measurements are concerned. Since congruence presupposes motion in a world where everything is moving, we must take care that the coincidence implied in measurement is a coincidence not merely in the dimensions of space, but in the dimension of time. Our quantitative units apparently vary with space-time perspectives. Therefore we must be sure that the time is the same as well as the lengths. It is, therefore, that the measurements of science have been based upon the conception of nature at an instant.

It is no indictment of the new theory of relativity to say that it is abstract and artificial. It aims as a matter of fact to come nearer to the constitution of things than the Newtonian conception of nature, of which, as Einstein modestly puts it, it is a "correction." Uniform motion, with its constant units, may be treated as a limiting conception to a world of varying physical curvature. Thus the Newtonian conception has its place in the general mathematical frame into which Einstein and Whitehead would fit nature. For practical purposes we may regard the Newtonian conception as a first approximation which has only needed correction because of recently discovered facts. It is quite possible that, in spite of the logical elegance and generality of the new theory, science may continue to use the simple Newtonian formulæ where they are applicable and introduce corrections for practical purposes only in the few cases where the older conception fails to work. This would make the general theory of relativity largely a theoretical ideal of science, but none the less important for the truer understanding of nature. Even though for certain abstract physical purposes we may be able to proceed in our measurement on the basis of the conception of nature at an instant, *i.e.*, to disregard the temporal aspect, we now know that this arbitrary method has owed its apparent validity only to the fact that the motions we have dealt with have been too slow to make any observable difference to our measurements.

Only recently have we been able to demonstrate the effect of matter on the geometry of motion in the case of light. The revolution which has come with the discovery that time is an essential characteristic of this our seemingly so solid world, and that there can be no true measurement of physical quantities which does not take account of motion, is a permanent and momentous step in our approximation to reality. Hereafter our conception of even the most stereotyped portion of reality, that of physics and astronomy, must be that of a space-time four-dimensional manifold, whose apparent rigidity is due to the limitation of our faculties. The crust of dogmatism has been broken where it seemed impenetrable.

But, when all is said, the method of approach is still highly artificial. The theory of relativity was invented for a certain limited purpose. It is essentially an instrument of prediction in the physical realm of nature. Its metaphysical import has been no business of its early promoters. Einstein expressly disclaims any competence to deal with real space, real time, or the real world. He is dealing with certain quantitative measurements—with lengths and time intervals. And his interest lies in showing that we cannot ignore time in making our measurements, for these vary with space-time perspectives. For his abstract purposes of mathematical calculation, he admits that he is obliged to ignore "the physical significance of time." For the purposes of mathematical order, time becomes only one of four geometrical dimensions, interchangeable with the others. The real significance of past, present, and future disappears. Instead we have a four dimensional frame-work of order series. The empirical constants which determine the specific order of curvature would, of course, vary with different fields of human experience. But some empirical constant, whether matter or some other constant, we must have if we are to make predictions in the empirical world. No theory enables us to make predictions *a priori* about empirical facts. The tendency of Einstein and his followers has been to mask the empirical constants by treating them as part of the geometrical structure instead of as determinants of this structure. But it is physical relations, and not space, with which we are directly concerned in the theory of relativity.

Mathematics and Reality

The theory of relativity raises the whole question of the relation of mathematics to the real world. Einstein and Whitehead both assume the validity of the mathematical concepts of continuity and infinity, which have played such a large part in modern physical description ever since the invention of the differential calculus. They belong to the scientific method of the Newtonian era to which we owe the foundations of the physical sciences. But like the Newtonian concepts of time and space, they are purely artificial concepts. We have no evidence that nature ever has the constitution symbolized by the concepts of continuity and infinity. That nature makes no leaps is one of those *a priori* dicta, like nature abhors a vacuum, which we have come to distrust. So long as there was no evidence to the contrary, the Newtonian framework of science naturally compelled conviction. But we have seen how the conception of absolute space-units and time-units was shattered by the Michelson-Morley experiment. The evidence against the physical validity of the concepts of infinite divisibility and continuity is conclusive in increasing domains of science; and it is possible that, as our knowledge of the constitution of the real world increases, we may have to substitute a finite calculus for the infinitesimal calculus throughout the domain of science. At any rate, the infinitesimal calculus has a purely instrumental significance at the present time.

The first definite establishing of the quantum theory was in the relation of stimulus to sense perception. According to the theory of Leibnitz the law of continuity holds for this relation: infinitely small stimuli are supposed to give rise to infinitely small perceptions which, however, are conceived as unconscious. Our perception of the roar of the sea is due to the fusion of an infinite number of these "small perceptions." But Weber showed that a stimulus must reach a finite amount to be perceived at all. Below this amount there is no perception. The amount must be ascertained for each sense domain. It varies with interference and with motion. For each sense—pressure, temperature, sound, etc., there is a *minimum sensible*. That is what Fechner calls the law of the threshold. Furthermore, in order to perceive a difference in the stimulus, *i.e.*, a more intense sensation, there must be an increase by a definite finite fraction of the stimulus with which the comparison is made. This again must be ascertained for each type of sensation, and it also varies with the range of the stimulus. Fechner has stated this relation in a formula to the effect that the stimulus increases according to geometrical progression, while the sensation increases in arithmetical progression. This formula has, in view of the facts, only limited significance. What is significant for us is that in the interaction of the organism with the energies of the environment, these energies must increase by a certain finite amount for the inertia of the organism to be overcome and the stimulus sensed.

The theory of quanta has been carried by Planck into the domain of physics with revolutionary effect. It was first demonstrated, in the case of the radiation of heat, that the pulses are of a definite finite amount. The theory has since been proved for all radiant energies. When matter is acted upon by radiant energy it must either take "a whole gulp" (as Eddington puts it) or none at all. The theory has recently been confirmed in the field of spectral analysis. The brilliant investigations by J. J. Thomson, Rutherford, Millikan, Bohr, etc., into the constitution of matter have destroyed the assumption of the infinite divisibility of matter. They show that the constitution of matter is granular. The theory that matter is atomic goes back to Leucippus and Democritus, but modern chemistry dates it back to Dalton. It is fundamental in modern physical theory. At the end of the nineteenth century there was a tendency to regard the atom as a convenient fiction. But the twentieth century has furnished indubitable experimental proof of the existence of the atom. The atom of Dalton is no longer, however, regarded as the ultimate unit of matter. It is rather a holding company, an organization of tremendous complexity. The atom is at present regarded as a planetary system with its positive nucleus and its satellites, the negative electrons, moving within definite orbits. There has come into being an astronomy of the atom as a counterpart to the astronomy of the heavens. Some of these orbits are circular and some are elliptic. By introducing suitable corrections, based upon Einstein's theory that mass increases with velocity, Millikan has been able to predict with accuracy the eclipses within this miniature planetary system. The centre of interest in the new theory is the orbits rather than the moving particles. The relations of these orbits have been found to follow a finite quantum law. We are in the morning of a revolution in scientific theory, more radical even than the theory of relativity, for this still retains the methods of Newtonian mathematics.

There are two branches of mathematics, counting and measuring—numbers and geometry. The incommensurability of these two branches was the scandal of the Pythagoreans, though modern mathematics has made an heroic effort to bridge the gap through its conception of dense series, introducing grades of infinities of irrational numbers to close the gaps of the rational numbers and thus attempting to efface the distinction between arithmetic and geometry. But we shall use the distinction between numbers and geometry in the original sense, for it is with rational numbers that the quantum theory is concerned. Geometry with its kindred science, the calculus, is based upon the theory of the mathematical continuum, and this has furnished the model for modern science. The present revolution is toward the substitution of finite numbers for the continuity of the differential calculus. "We have been taught that an integration of the infinitesimal elements of a continuum may be approximately replaced by a summation of finite terms, but that the former method is exact and absolute, while the second gives but an approximation. Are we not going to be obliged to reverse this decision and to recognize that the branch of mathematics which will come nearest to meeting the needs of science will be the theory of numbers, rather than the theory of extension, and that measuring must be replaced by counting?" [12]

This does not mean that as a matter of method the description in terms of the infinitesimal calculus will be superseded all at once. Its pragmatic usefulness in many fields is undoubted, and the scientific results of generations are embodied in this method. But it means, at any rate, that the metaphysical interpretation will be different. The infinitesimal calculus has, as a matter of fact, been used successfully in many fields which we know to be discrete. To quote Lewis' brilliant statement:

> The mathematics of hydrodynamics is based on the theory of the continuum. It is admirably suited to express the behaviour of substances like water and air. Nevertheless the method is entirely an approximate one, for water and air are not continuous but are composed of discrete molecules. Hydrodynamics could not account for such a phenomenon as the Brownian movement.
>
> The methods of hydrodynamics were taken over into the field equations of electromagnetics. An electrostatic field, regarded as a continuum, is defined by the force exerted upon an infinitesimal test charge placed within it. But an infinitesimal test charge is a concept which we can no longer hold. The smallest charge is the charge upon a single electron, and if we use the electron as a test charge to determine the properties of the simplest possible electric field, namely, the field about a hydrogen nucleus, we

[12] *Valence and the Structure of Atoms,* G. N. Lewis, p. 163. The following quotations from Lewis are from the same work, pp. 163-165.

appear to find that this field is not a continuum but is strikingly discontinuous. As far as we are aware, the electron cannot exist except in one of a series of levels. . . . As far as we can see, it disappears from one level and appears at another.

We state the relations of these levels in integral numbers. We say that the distance between the first and third levels is 2, and the difference between the first and the seventh levels is 6.

Granting that the "field" about a positive particle has at least some elements of discontinuity, and that perhaps this may be true also of the field about the electron (provided that these two ideas are distinguishable), then since every electric field is a resultant of the fields of these elementary particles, every electric field must have properties of discontinuity. Instead of thinking then of an electric field as a continuum, we should regard it rather as an intensely complicated mesh composed of all the discontinuous elements due to the single elementary particles. Even if this view is correct we need not for ordinary purposes hesitate to use the equations of Maxwell any more than we hesitate to employ the inexact methods of hydrodynamics in ordinary problems.

An observer, moving rapidly past an electrostatic field, finds that it is also a magnetic field, and if the electric field is discontinuous, so is the magnetic. We need not abandon the brilliant idea of Maxwell that light is an electromagnetic phenomenon, nor need we doubt the approximate validity of his equations of propagation of electromagnetic waves, provided that we consider them to have merely statistical value. But when we consider the light emitted not from a great aggregate of atoms but from a single atom, we may be sure that this is something very different from that which is assumed in the undulatory or electromagnetic theory. It probably bears to the electromagnetic wave a similar relation to that between a molecule of water and a quart of water.[12]

We know that when an electron shifts its orbit with reference to the nucleus it shifts by a finite quantum. It may under outer bombardment or inner stress shift from an inner orbit to an orbit farther from the nucleus. In this case the atom gains or absorbs energy. Or the shift may be from an outer orbit to an orbit nearer the nucleus. In this case the atom loses energy and the radiations are produced which give us our spectral bands, whether from atoms in our laboratories or in distant stars. The shifts in either case are determined by a law of equilibrium and happen in finite quanta.

> A fundamental postulate of modern atomic theory is that an electron may not permanently revolve at any distance it pleases from the nucleus, but that there are certain prescribed distances called energy levels, any one of which it may occupy, while the intervening spaces are zones of instability. In them no electron may remain; through them it may pass, but as rapidly as possible and without a stopover.[13]

It does not seem possible that the shift from one orbit to another can be instantaneous if the electron is a real entity as experimental evidence confirms. So minute, however, are the distances in the atom to our gross senses that they are practically instantaneous.

If we could find the same phenomenon within the slow-moving pictures of the macrocosm with which astronomy deals, it would both aid our imagination and confirm further the results established in the microcosm. Astronomy seems to have an analogue to the energy levels of the atom in our solar system, viz., in the rings of Saturn and in the distribution of asteroids.

> The rings of Saturn are known to consist of a multitude of discrete particles, each revolving like a

[13] "The Master Key," by Dr. Paul R. Heyl, the *Scientific Monthly*, Vol. XIX, p. 9.

> miniature satellite in the periodic time proper for its distance from Saturn. This ring system contains several divisions, or blank spaces, in which no particles are visible. Also, the inner portion of the ring system, known as the crêpe ring is much fainter and more shadowy than the outer portion. In it the particles are evidently much more sparsely distributed. It has been known for a long time that these divisions occur at approximately those distances at which a particle would have a time of revolution commensurable with that of one or another of Saturn's satellites, all of which lie outside the ring system. . . . The same condition obtains in the system of asteroids which is found in the region between Mars and Jupiter. There are known something like 900 of these bodies, a number large enough to allow the law of probability free play in their distribution; yet it is a fact that in those regions where the periodic time of an asteroid would be commensurable with that of Jupiter few or no asteroids are found.[14]

In the planetary system of the atom we must look primarily inward to the nucleus for "the cause of the zones of instability," while in the solar system we must look outward for the cause (though in each case we must doubtless look to the total distribution of matter and energy in the neighbourhood). But may not the cause for the instability of certain zones be the same in the two cases? Dr. Heyl offers this suggestion:

> If there is something about the nucleus which produces a field of force which is slightly asymmetric or directive, and if this asymmetry rotates with a certain period, then we may expect a cumulative perturbation to be exerted upon such electrons as possess a periodic time commensurable with the nuclear period.[15]

Whatever be the cause of the instability of certain zones,

[14] *Ibid.*, pp. 10 and 11.
[15] *Ibid.*, p. 11.

the fact is that the energy field in each case has a finite quantum structure. The physical space in each case is not Euclidian but asymmetrical and directive. Nor does it conform to the theory of general relativity, since there is an actual stratification in finite quanta. It may yet be true that the passing from one finite zone to another is continuous, but the emphasis in present theory is on the orbits and their numerical relations, which are finite. This is all we can assert at present.

You may ask why I devote so much space to certain physical facts that seem indeed far enough removed from metaphysics as traditionally conceived. My answer is that metaphysics as I understand it deals with the constitution of the real world as revealed in human experience. And recent discoveries in science affect our general conceptions of events in nature, including ourselves as parts of nature. Events in nature have the attributes of energy, time, and space. If the events in nature happen in finite chunks, then we must readjust our conceptions of energy, time, and space. As Lewis says:

> The recognition that electric and magnetic fields are essentially discontinuous leads us to suspect that there is no such thing as a continuous field of force; that a gradual acceleration accompanied by a gradual increase in kinetic energy is something which does not exist in nature. Rather we should consider that every system passes by steps, which may be small but are nevertheless finite, from one energy state to another.

But if energy comes in finite throbs then the space-time intervals of events must also be finite, for they are determined by the structure of the field in which they recur. The passing of nature must be represented by finite integral numbers, in a definite order determined by nature. The structure of space as a whole must be regarded as determined by matter or energy concentration. "General space," as Lewis says,

> might be regarded as the composite of all the spaces of all the atoms, and in this space we could employ the ideas of extension, of distance, and the like, which are used in Euclidian geometry, with the same sort of approximate validity as we employ the principles of hydrodynamics to a system containing a large number of molecules, or the principles of electro-magnetics to a field generated by many elementary charges.

Einstein's general theory of relativity emphasizes that the geometric structure of physical space is determined by matter. In this respect he is in sympathy with Mach:

> Mach's ether not only *conditions* the behaviour of inert masses, but *is also conditioned* in its state by them. Mach's idea finds its full development in the ether of the general relativity. According to this theory the metrical qualities of the continuum of space-time differ in the environment of different points of space-time, and are partly conditioned by the matter existing outside of the territory under consideration. . . . Empty space in its physical relation is neither homogeneous nor isotropic.[16]

Light rays and other energies follow the curvature of physical space or the ether as a river follows its bed, or, better still, as a split in the wood follows a warp in the grain. Einstein's prediction of the curvature of light in the neighbourhood of the sun is now an established fact. But Einstein's general theory is founded on an assumption as regards matter which has no basis in fact, viz., point-particles. The smallest units of matter that we know are finite quanta—the negative and positive electrons. The "molluscs" of the real field are not indefinitely small, nor can they be chosen arbitrarily. The interlacing meshes of the web of space are definitely determined by matter, and they are determined as finite intervals, statable as integral numbers. The order is likewise definitely determined. The

[16] A. Einstein, *Sidelights on Relativity,* p. 18.

whole material world determines an absolute cosmic field and absolute geodesic lines, which are the course of motion. But the real structure of physical space-time is neither that of Newton nor that of Einstein. Successful as Einstein's theory has been, it is at best a statistical approximation to the real constitution of nature as empirically verifiable. Eventually a finite calculus based upon the empirical constitution of nature—its matter and space-time—will supplant the theory of Einstein as this has supplanted the theory of Newton. But in the meantime the method of Einstein is serviceable as the next step, and a revolutionary step, in science.

The challenge of mathematical method is more serious for Whitehead than for Einstein. While Einstein frankly admits the artificial and arbitrary character of his description and disclaims any physical significance for his space-time, Whitehead sets himself to give an account of nature. His abstractions are conceived as extensive abstractions. Even event-particles with their point-instants are conceived as contained in nature. But it is hard to see how points, instants, and physical point-particles can be conceived as abstractions from events which possess spatial extension, temporal duration, and physical thickness. They are only limiting concepts of extensive series and the limits lie outside the series. The spatial, temporal, and physical points do not possess the character of extension and inclusion. Whitehead admits that "the creative advance of nature," which is his expressive characterization of concrete reality, is "not serial." [17] But it is easy to see that Whitehead has left himself no other locus for such entities, so he had to include them within nature. He had set himself to deal with nature as closed to mind. There is to be no bifurcation into subjective and objective. Nature is to be self-contained to a theory of nature. He did not leave the least hole through which he could chuck embarrassing entities. The percipient organism is indeed part of nature, but it is to be conceived as a strictly phys-

[17] *The Concept of Nature*, p. 178.

ical thing. If he had admitted mental perspectives as a part of nature, then he might have had a locus for such creative additions as points and Newtonian uniformities and other abstract and sometimes misplaced limits. In any case, I cannot see how, in any real sense, points, instants, and point-particles can be said to be contained within nature, or how such entities can be said to have a real complexity. There is, it seems to me, an unbridgeable chasm in the argument. I can see that common sense events, such as iron, can be abstracted from the total flow of nature. I can see, too, how we can abstract space-properties and time-properties from any empirical event. For certain purposes and under certain conditions we can shrink the extension of any one event. We can also select within an event of nature certain physical characteristics and use these for purposes of description; and finally by further abstraction and inference we can arrive at the objects of science—molecules, atoms, and electrons. But points, instants, and point-particles are not contained in the same sense as adjectives or as the objects of science. They can only be considered as part of nature if we regard the instrumental function of mind as part of nature.

But there is a more fundamental objection to Whitehead's concept of nature. He assumes at the outset the continuous duration of nature, which is only another way of phrasing the Newtonian flow. But is such an assumption warranted? Nature, it is true, furnishes us with a great variety of geometric extensions and a great variety of durations in its complexity of events. But the concept we are entitled to form in each case is a class concept like that of colour. We cannot say that colour is inclusive in the quantitative sense, viz., that we can arrive at the various colours by taking chunks out of a general extension of colour. And so there is no general space extension or duration extension. We have a large variety of geometrical spaces and durations in the empirical world. But they are qualitatively different and therefore not integrable any more than red and blue are integrable. It is just because of this fact that the general theory of relativity is forced upon us by experience. Our values of time and space are different from mollusc to mollusc, whether the mollusc be finite or indefinitely small. One geometric curvature cannot be included in another. They are not commensurate, though we may, if we succeed in discovering an empirical constant, like the mass of a body of matter, be able to read our molluscs in a certain order.

We are obliged to conclude that the conception of a general duration and a general extension, each of which has the character of inclusion and therefore can be divided *ad infinitum,* is fictitious, whatever instrumental value it may possess. Extension in the concrete and duration in the concrete are properties of events which vary in the variety of perspectives. It would be merely a matter of accident if we should find that two events have the same extension or the same duration as it is a matter of accident that they are blue. Such events would, of course, be integrable in the sense that they possess the same property. They may be regarded as cases of the same property. For descriptive purposes we may find it convenient to substitute constants for the curvature of the empirical field, and to quantify nature in terms of abstract units of extension; but it remains true, nevertheless, that the empirical field varies qualitatively in structure and that therefore the chunks of the real passage of nature, be they finite or infinitesimal, are non-integrable.

It is, of course, highly artificial to treat duration as linear extension and to make it a fourth dimension, indistinguishable from the dimensions of geometric space. Duration is, in fact, incommensurable with space extension. It is a unique character or rather a class of characters, since various durations have their own unique curvature. Let us use duration, as we know it in our own life history, as an illustration. Every chunk of that history has its three dimensions of rising, climax, and waning. It is absurd, however, to treat the psychological present as one block of a definite duration. The specious present, with its dromedary curve, is one of those picturesque fictions which take hold of the imagination and remain unchallenged for a long time. To psychological analysis, however, the duration of a life history is far from a uniform flow. We must not confuse the clock intervals in terms of which we mark off our life, with the duration of the life stream and its events. Different processes of different durations are compresent within any chunk of this history. Psychological duration is not a simple affair but a sheaf of motions, having each its velocity or duration. They are accelerated or retarded in the structural fields in which they pass. Some events, such as sensations and feelings, may endure only for a brief fraction of a second, while attitudes, schemes of meaning, patterns of character may endure for years. In the human individual, moreover, there is a hierarchy of guiding fields, each imposing its control on those below. Thus the events of one level may be inhibited, retarded, or accelerated through the control of the higher level. Stimuli, such as light vibrations, travel with their own velocity but are retarded or curved in the energy fields of the sense organs. Sense impulses in turn have their own velocity but are retarded in the hierarchy of neural structure where they are sorted into kinds. The perception of sense-data has its own duration, dependent upon the structure of the dominant field of interest. Some sense impulses receive no attention, others only passing attention, others prolonged attention. Attention again is the function of the field and accelerated or retarded by this field. In turn this field is changing at different rates, sometimes being constant in the main structural features for a long time, while minor features change rapidly. Sometimes there is a sudden change in the whole structural field and therefore a change in all the interests and values. The character of the field is determined by the interacting of a certain structure—the enduring history, partly racial, partly individual—with the environment.

What we call the self is a system of exchanges in the maintenance of the life of the individual. Some motions are slowed up by hereditary pattern fields into neural reflexes, some are slowed up by the curvature of the more complicated individual history into neural habits, while others involve more complicated structures and are slowed up as memory and imagination, which in turn may be slowed up as habits. But while slowed up and curved into potential energy within the higher levels, they continue to move within the dynamic field of the total life of the individual in his interaction with his environment. Habits decay or are reinforced. Memory is never a mere living over of past events with their duration, but a living them over in a new system with a duration of its own. Hence the change in values as well as in details. At best we are poor judges of the passing of our own events. In the course of life, memories are taken up into larger symbolic patterns of meaning, emotions are condensed into sentiments, habits are co-ordinated into character in which new values and durations are imposed upon them; and the whole creative passage takes place within the field of a life interest which we call personality, which in turn has its own rhythm and duration of passage. The curvature, again, of the field of individual history, with its more or less integrated patterns of events, is controlled by the dominant field of social interest which determines in large part the emphasis, duration, and structure of our individual interests; and, finally, including it all, is the creative passage of nature of which we and society are parts, and this in turn has its own structure and determines the curvature of the life of the race, eliminating, retarding, accelerating in accordance with its own structure and duration. Thus the geometry of the duration of the individual life is exceedingly complex; and compared with it the geometry of a gravitational field is simplicity itself.

There would be still greater difficulty in treating the institutional fields of human experience as four-dimensional space-time manifolds. Here duration plays an even more significant part, since here we must take account not merely of the individual duration, but duration as cumulative tradition, furnishing a field within which individuals move. Take, for example, the field of matrimony. When people marry they constitute a new field of relations. A spectator in Mars or a too earthly behaviourist might try to treat the field in terms of geometry. He would see two bodies moving with reference to each other in a new way, with retardation and acceleration of movements as a consequence. It would be a curved geometry of a very complicated kind. There are empirical constants in the way of temperaments and past habits with their inertia. There are two life histories, each with its unique perspective. Even when they are actually curved within the guiding field of common affection and common obligations, consolidated into custom, it is not easy to find a frame of reference from which to read the events of the common life. Each one may try to treat the events of the other life as having the same co-ordinates of value as his or her own, with disastrous conflicts. They may strike a rough average and each forego certain values for the sake of the common direction. This direction is a creative advance of nature and unique. They may find a new frame of reference in the life of a child in whose interest you can read the convergence of their lives. If the motions of both bodies in marriage could be treated merely as functions of a common bond, a common field of motion, as the transcendentalists would have it, the reading of the events with their space-time would be comparatively simple. You would then have a Euclidian field of uniform motion, though even then each such field would be unique and would have to be investigated empirically. But the real field of matrimony involves the curving of lines of motion, of life histories, at any rate in part. In reading the behaviour of either life in reference to the other, we find, if the field holds together for a considerable time, that there is determination by adjustment. The values are different from what they would be within each history in isolation. Beside the adjustment to the common bond, there are adjustments to the world of outer relations with all its independent variables, including mothers-in-law. Within this larger field of relations the field of matrimony must move, and is subject to various curvatures accordingly. Truly the field of matrimony is too complex for the calculus of Einstein. In a relative world even method is a matter of adjustment. Each field of matrimony requires a method all its own. And yet perhaps nowhere is the relativity of adjustment with its space-time implications more patent—at least to a bachelor occupying an independent frame of reference. One thing is certain, the conception of relativity applies, wherever there is time and motion; and the more concrete the relations, the more vital it is to take account of it.

The theory of relativity, it is clear, will have to be adapted to the empirical facts. The differential calculus has in the past been a useful instrument in certain abstract fields. But the mere fact that it has worked tolerably well is not sufficient proof that nature has the constitution indicated. Points and instants are artificial cross sections of the temporal stream of nature. By no magic of synthesis can they be made to constitute this stream. Nature has real duration. We know now that in certain fields of physical science nature passes in finite quanta and therefore demands a finite calculus. This is even more apparent in the field of experience which we know most intimately, viz., the psychological passing of nature. The passage of nature, so far as we can verify it, is by finite throbs, not by infinitesimals. The degree of duration of nature must be ascertained empirically. Functionally human organisms may be the same for relatively long spans. A man after maturity of body and mind may react the same for many years. Wood and stone have a still longer span of duration. Chemical elements seem well-nigh eternal. They can be identified in spectra of all stages, though the radioactive elements indicate that at least some elements have their seasons. But while the theory of relativity is itself relative to the passing of nature and must be revised to meet the needs of human experience, the intuition which it embodies is fundamental. Time is of the essence of reality, and no theory of reality can stand which fails to recognize its temporal aspect. And where there is time and change there is relativity.

In examining the theory of relativity we have emphasized only those features which seem to us significant for philosophy. We are not concerned with any special mathematical framework, nor with certain assumptions of Einstein's school. The assumption, for example, that there can be no velocity greater than that of light, and that anything which should reach this limit would have an infinite mass and energy, follows from the unique place assigned to the velocity of light as the limiting value of certain equations. Of course, if we select the velocity of light as our limiting value, it could not be exceeded—in the equations. This device, no doubt, has its convenience in the restricted form of the theory of relativity; but it is not a law of nature. It is true that at present we know of no velocity greater than that of light, but this does not entitle us to say that there can be no velocity greater than that of light. All we can say is that the Einstein-Lorentz formula has been verified for the Beta electrons from uranium, which have a velocity of about 98% that of light. The pyrotechnic deduction from the special theory that a man travelling with the velocity of a light wave would not grow older is of course the result of the same assumption, viz., that light travels with an absolute velocity, independent of the source and of the motion of any frame of reference and that no velocity can exceed that of light. If the basic assumption were true, such a fast traveller would have no way of *knowing* that he is getting older, but that is no evidence that the cycle of life would not run its course unless that cycle is a function of light, which no one has asserted. But light does not enjoy the absolute distinction which the special theory has conferred upon it, as Einstein himself has shown in the general theory. Its velocity and direction vary with the character of the energy fields which it traverses.

It is supposed by some that the theory of relativity works into the hands of epistemological idealism. This seems to me a mistaken interpretation. It is true that since the events of nature and their relations are relative, our knowledge must be relative. But the relativity of events and properties in their space-time relations is not a relativity to mind, unless the properties be mental properties. The bending of stellar rays in the neighbourhood of the sun is not due to mind. Scientists merely took account of it as a fact. Local space and local time are not relative to mind, but to motion. Mind merely calculates the result. Some perspectives are indeed mental perspectives. Such are the perspectives of knowledge and value. These perspectives, too, are moving perspectives. Mind is part of the creative passing of nature. Our view-points and valuations vary from life history to life history and in different chunks of our life-duration. Human experience furnishes no absolute measure. But we ignore individual differences and for certain groups and periods enforce our Euclidian geometry—our rough social standards.

It is true that we have no data except as furnished by experience, directly or by implication. The baby responds to certain organic sensations and certain objective stimuli with certain random movements and reflexes. The reflexes of grasping lead to the reflexes of putting the object into its mouth; this stimulates the reflexes of sucking, etc. There are a few vague instincts and emotions at birth which lead to equally vague reactions. By means of trial and error these vague responses are canalized into habit and memory. Later the selective responses become more discriminative. By means of language and social interaction we learn to respond to the more abstract aspects of things. But all our responses are concerned with energy relations to our environment. Through these selective responses we come to classify the stimuli—the events and characteristics to which we respond—into material stimuli, light stimuli, social stimuli, etc.; and thus we build up the types and levels of the objective world. Through these integral responses in space-time, reality is known; but while we must be conscious of these responses in the knowledge relation, they are not "states of consciousness." They are energy relations. The knowledge relation itself is an energy relation, involving a minded organism as one terminus of the relation. What the other termini are must be ascertained through the quality of the responses. In social relations the interaction is of mind with mind. The termini are minds with their relative movements or various histories, curved within the field of a common tradition. But other parts of reality do not respond as minds. And no metaphysical theory can alter these qualitative differences in our finite relations. It may still be maintained that the quality of the whole-control is mental or supermental. With this attitude, we have no quarrel. But we must still conceive this whole-control in terms of energy and not in terms of such intellectualistic abstractions as the unity of consciousness. And we must remember that this whole-control involves a hierarchy of levels with their complexity, inertia, and relativity of motions. The quality of this whole-control may lie beyond our experience, yet within it we live and move and have our being.

CHAPTER VII

Reality and Space-Time Perspectives

Our little life, with its rainbow glory is a junction of world-streams travelling in diverse directions and with diverse velocities, but held up for a moment within the field of mind and ordered by the pattern of human experience. The substantial fabric of the world of sense dissolves into the passing show of space-time perspectives. Now and then it is given to some genius to rise by imaginative contemplation to the law of the whole. But all our knowledge is relative to the perspectives of human experience, and human experience is itself part of the passing of nature. When we try to reduce our motley world to order and measure, it is, after all, order as we conceive it and the measures are our measures. But with undying faith we shall continue to piece out the riddle of the whole from our fragmentary evidence. If the light of our reason is but a feeble and reflected light, it suffices to pierce the darkness a little way ahead. And if we are loyal to the light we have, we shall prepare for a greater light. For when we have passed from the scene and the golden sun shall look upon us no more, other pilgrims shall follow in the selfsame yet new path; and shall ask the selfsame yet new questions; and shall struggle in anguish of soul as we have struggled to make the light shine farther into the unknown.

The relativity of human experience and human measures is not a new insight. It goes back to the ancient Protagoras. Nor is the effort new to discover a law of relativity. The genius of the divine Plato tried to rise to the order of the whole beyond the flux of perception. But the new theory of relativity has thrown fresh light upon the nature of the qualitative and quantitative perspectives which furnish the basis of our knowledge, and has also projected a mathematical formula by means of which we may order our perceptions. The emphasis has been upon the relativity of our quantitative measures of space and time. But quantitative measurement depends upon the comparison of qualitative perspectives so far as these can be treated as having extension. Our quantitative units are pragmatic devices by means of which we try to measure the passing perspectives of nature from our plural frames of reference. If qualitative perspectives are relative to the passing of nature, quantitative perspectives are relative to qualitative and therefore secondary.

For purposes of prediction we quantify qualitative perspectives belonging to one type. We treat space extension as a continuous quantity, ignoring the uniqueness of geometric extensive qualities. In this way we are able to use yardsticks and other extensive measures. In the same way we may quantify the passing of nature by abstracting the duration aspect from the variety of concrete durations and treating it as a continuous quantity which can be measured by clocks. In the same manner philosophers have spoken of consciousness in general, which is merely an abstraction from the variety of primary awarenesses. But this practical device of grouping characters into classes and treating these classes as purely extensive should not blind us to the reality of the primary differences. A mediæval realist in like manner regarded colour as essentially an extensive genus out of which colours are differentiated, and man as an extensive universal of which men are instances.

The Order of Nature

One of the most persistent bifurcations of reality is that into particulars and universals. There could be no more striking illustration of the bias of human interest. Half-minds see half-truths. Only whole-minds see whole-truths, and such minds are extremely rare. The earliest emphasis on particulars as contrasted with patterns comes down to us from the atomists of ancient Greece. If the atoms and their mechanical motions in space are the only ultimate facts, then the order or pattern of events must be the work of chance. Lucretius, the Roman poet, furnishes us the classical explanation of how this might happen.

> For verily not by design did the first-beginnings of things station themselves each in its right place by keen intelligence, nor did they bargain sooth to say what motions each should assume, but because the first-beginnings of things, many in number in many ways impelled by blows for infinite ages back and kept in motion by their own weights, have been wont to be carried along and to unite in all manner of ways and thoroughly to test every kind of production possible by their mutual combinations, therefore it is that, spread along through great time after trying unions and motions of every kind, they at length meet together in those masses which suddenly brought together become often the rudiments of great things, of earth, sea, and heaven and the race of living things.[1]

This is an honest attempt, at any rate, to evolve the universal from the particular, order from chance, and has not been improved upon. The miracle would have to be repeated an indefinite number of times and in an indefinite number of places. While Lucretius here envisages reality as one history, from chaos to an accidentally evolved order, he shows at times an intuition of a law of compensation and reciprocal exchange; for in spite of the fact that everything appears to wane and ebb by length of time,

> yet the sum is seen to remain unimpaired by reason that the bodies which quit each thing, lessen the things from which they go, gift with increase those to which they have come, compel the former to grow old, the latter to come to their prime, and yet abide not with these. Thus the sum of things is ever renewed

[1] Munro's translation, p. 126.

> and mortals live by reciprocal dependency. Some nations wax, others wane, and in a brief space the races of living things are changed and like runners hand over the lamp of life.[2]

Had Lucretius worked out this intuition of reciprocal dependency he might have dispensed with the doctrine of chance, for why should not the pattern as well as the matter be communicated, as indeed is the case in human life?

The problem of the universal and the particular, the class and its instances, becomes central in the Middle Ages. Here we have a clear bifurcation. Roscellinus, if we may believe his enemies, declares that the individual only is real and the universal is a mere name, *flatus vocis,* while William of Champeaux in his extremest statement maintains that only the universal is real and the individual is *flatus vocis.* But common sense prevailed over extreme nominalism and extreme realism, and in Abelard and Thomas Aquinas mediæval thought returns to the Aristotelian position—the universal in the individual, the instances in the class, though from the point of view of human discovery the universals appear *post rem.* For a brief period the whole-point-of-view triumphs over the part-point-of-view, though the abstractions are rather added together than envisaged as abstractions.

Modern nominalism takes its cue from the sophisticated psychological atomism of Hume rather than from the naturalistic atomism of Leucippus. Kant's attempt to mediate between psychological atomism and rationalistic realism proved futile, for with Kant the order of nature is imposed arbitrarily by the human mind upon the manifold of sensation, the facts of nature. The human mind does not discover order in nature but creates that order. The artificial gulf between the abstract particulars and the abstract categories remains. In the German idealistic movement, realism triumphs and the world of sense

[2] *Ibid.,* p. 32.

becomes a function of the pattern-creative activity of mind, while in Anglo-American empiricism nominalism triumphs and the world of fact dissolves into chaotic particulars. Nominalism has had a recent revival in William James and Bertrand Russell. In the brilliant language of William James:

> The world *per se* may be likened to a cast of beans on a table. By themselves they spell nothing. An onlooker may group them as he likes. He may select groups and name them capriciously, or name them to suit certain extrinsic purposes of his. Whatever he does, so long as he takes account of them, his account is neither false nor irrelevant. If neither, why not call it true? It *fits* the beans-minus-him, and expresses the total fact, of the beans-plus-him. Truth in this total sense is partially ambiguous then. If he simply counts or maps, he obeys a subjective interest as much as if he traces figures. Let that stand for pure "intellectual" treatment of the beans, while grouping them variously stands for non-intellectual interests.[8]

The facts, then, are neutral so far as any order is concerned. There are no objective patterns in reality.

It is but a short step from objective neutralism to complete neutralism. Hume had already shown that if we dissociate the object into particular impressions, we must also dissociate the subject into particulars. He can find no ego but "a bundle of perceptions." The initial mistake lies, of course, in hypostasizing experience as stuff, forgetting that in reality experience is *experiencing* and that experiencing is a selective relation of a percipient energy system to the specific energy systems with which it interacts. Once we forget this and treat the functions of this relation as substantive bits by help of the fixation of words, psychological atomism follows. We come to speak of particular sensations, feelings, ideas, etc., and we can

[8] *The Letters of William James,* Vol. II, pp. 295, 296.

find no pattern because we have already abstracted from the concrete pattern interaction. Such an intellectualistic introspection is bound to find that the self is as much the product of external association as are the equally fictitious external objects. The "I think" becomes identical with the "I breathe." Now all abstractions are neutral. Only energy systems have efficiency. Therefore, the intellectualistic introspectionist argues that reality is compounded of neutrals and that mind and body are only different names which we give to certain external collocations of neutrals. Those that are more permanent we call body, and those that are more transient we call mind, but both are made of the stuff of pure experience! What a comedy of errors, once we launch on this intellectualistic procedure of false abstraction. It is the irony of fate that the amiable William James, the sworn foe of all intellectualism, should thus have become its victim. It is to his moral credit that he ignored the practical consequences and remained true to his ethical idealism, with its emphasis on the efficacy of faith and the momentousness of spiritual attitudes. It was left to his lesser imitators, who had nothing to lose, to follow out his "pure empiricism" to its limits.

It is an illusion of linguistic abstraction to suppose that particulars exist. A brute fact is not a fact at all. Nor can we say that these isolated particulars subsist, *i.e.*, are aspects of reality. Particular sensations do not subsist as the substantive, atomic entities which we find in traditional psychology. (But for our purpose we shall ignore the technical distinction between the terms exist and subsist, since in reality all facts are dependent upon contexts and only the whole has absolute existence.) Particular sensations do not enter into compounds. It is not true that sensations are the raw-material out of which all the furniture of heaven and earth is made. They are "inert," as Berkeley held, because they are abstractions. We do not sense sensations, we sense aspects of energy relations. Sense facts can only be understood as functions of energy systems, involving complicated relations. The nominalists have been right in denying that abstract universals exist, but they have only fallen on the other horn of the dilemma when they have insisted that particulars exist. The antithesis itself is due to a false abstraction from the concrete matrix of reality. There is the passing in nature from one energy system to another. But there exists nothing which is not a part of some energy organization unless it be the lowest conceivable limit of diffuse heat; but from a cosmic point of view this limit of the downward trend is a turning point in the rhythm of the downward and upward path.

The theory of relativity emphasizes that everything must be understood as part of fields of energy with their space-time structure. The relations in nature are not relations between abstract entities. This is as true in the physical world as in the human world. Our gravitational and electromagnetic laws hold for neighbourhoods: they have no applicability to entities in the abstract. And they must be understood dynamically, not statically. This is even more apparent when we deal with the evolution and functioning of living forms. The abstracting of the individual from his environment vitiates our formulæ alike in the living and physical world. It makes the properties of things which are functions of energy perspectives unreal abstractions. Active space-time functioning is the aspect of which our particulars of sense are abstract substantiations. And this functional relation is a varying relation. Even in our abstract mathematical world the particulars such as points, instants, numbers, exist only as constituted and defined by unique systems with their postulates. Only particulars in systems are real; and then they are no longer mere particulars. They lose their hard shell and become fluid in the varying relations of the system of which they are functions.

There has been an attempt to simplify the problem by substituting abstract essences for abstract particulars. There is supposed to be a universal whiteness or a universal redness in which the particulars participate. It is by redness that things are red, by goodness that things are good, and by beauty that things are beautiful. The doctrine of course goes back to Plato, but it has had an interesting rehabilitation recently.[4] And the old confusion has also been rehabilitated. In the first place, the concepts of sense qualities are confused with sense qualities. The verbal concepts seem immutable and universal, once their meaning has been fixed by tradition. On the contrary, the sense qualities undergo change owing to the variation of the perspectives of which they are aspects. And the sense qualities are specific, non-integrable aspects, though they are repeated when the conditions are repeated. There may be one concept of redness, but the sense qualities of red are various and one is as real as another. Owing to repetition in nature, including our organism, we can identify a sense quality as the same, and so we can have a concept of it. We can conceive a world such that no quality could be experienced more than once, but in such a world there could be no concepts, no memory, nor thought. Constancy in our world, however, is pragmatic and relative to the space-time conditions of nature. We must not mistake verbal identity for identity in nature. Qualities are not eternal essences but variable functions. The abstract essences, moreover, are not simple entities. So far from being simple entities or even aspects, they are in fact class concepts. There does not exist an essence of whiteness nor of redness nor of humanity, but there is a class of whitenesses or rednesses or human beings, consisting of aspects of nature which are themselves non-integrable even if within limits repeatable. Surely it is the limit of absurdity to regard nature as participating in essences which are themselves classes of aspects of nature. Essences, then, are merely hypostasized abstractions of the second order and therefore even more remote from reality than the abstract particulars from which they are derived, though there is a true sense in which there are classes of aspects in

[4] G. Santayana in *Essays in Critical Realism,* pp. 178-183.

nature when we take account of the creative activity of the human mind.

We have seen that particulars are linguistic abstractions and as abstractions cannot be said to exist. We must recover the innocence of the senses before we can perceive sense facts. But what about universals? Can they be said to exist? It must be borne in mind that the traditional concept of the universal includes both the concept of class and the concept of order, and this has caused no small confusion from Plato down. Can we say that a class exists? Does a class exist in external nature or merely in the human mind? It must be clear that a class as an abstraction, a set of linguistic labels, does not exist in nature, though it has a certain existence in the human mind. But in fact we do not thus separate between a class as a linguistic abstraction and what is classified. What the class means is a collection of aspects of nature as included within a defining relation. And the class includes all the relevant facts. The class of colour includes all colours within a defining relation which excludes all facts that are not colours. The class of humanity includes all human beings within the defining characteristics which exclude all but human beings. The class concept must be relevant to the aspects of nature intended, and the aspects of nature must lend themselves to classification. Thus colours can be distinguished in experience from facts which are not colours; and they also contain distinctions amongst themselves so that we can arrange them in different series. There is the element of discovery which is subjective and of course the particular labelling is subjective in the sense that it belongs to mind. But the class of colours is not a fiction. It exists in nature as a group of aspects which our mind selects and abstracts as the class of colours. The discrimination and labelling makes the class clear and distinct for us, it does not create the group of aspects and their relations. Quantitative classes, our measurements of the aspects of nature, are secondary in that they involve the conventional process of measuring with its conventional units, but while the method is arbitrary it is still true that so far as the measuring is consistent with nature, such classes are implied in nature. Of course the concept of classes, whether qualitative or quantitative, is bound up with the human mind. But we must remember that mind is part of nature in a larger sense, part of its history and interaction, and that therefore the selective and synthesizing activity of the mind is not arbitrarily imposed upon nature. Mind is a process of adjustment within nature, and since the human mind has grown out of nature, it is no miracle that nature lends itself to the selective action of mind.

But classification is not explanation. A class is an artificial selection at best. We explain nature when we take account of the aspects of nature in the order of nature. The concept of order is more fundamental than the concept of class, and order in the concrete at any rate includes class. In mathematics order is defined by the concept of betweenness. But mathematical betweenness is "the same for right and left as in the case of before and after." [5] In other words, it takes no account of the real significance of time. In the real world, we mean by order dynamic order. It has reference to time as well as space. It looks backward and forward. In the creative advance of nature, the temporal order includes the spatial order and gives it real significance. As the theory of relativity would state it, the order of nature is a space-time order, though the mathematical theory of relativity ignores "the physical significance of time" and makes the dimension of time indistinguishable from the dimensions of space.

The old question arises: Can we discover order in nature? Or is order a human addition to nature? Is man the measure of all things, as Protagoras held? No one will dispute that we can find an intrinsic order in the works of mind. The mind constructs systems—logical,

[5] J. Laird, *A Study in Realism*, p. 116.

æsthetic, social, etc.—with their implications of meaning. Such systems, once embodied in symbols, have a certain eternity and universality as systems, though they may fail as empirical adjustments. Since mind is part of nature, we must recognize order as intrinsic in part of nature. The bias of mind for order in nature is also part of nature. Is there relevance in assuming order in nature, inorganic and organic nature, as well as in the activity of mind? Our hypotheses as regards order must be tested, like our assumptions of properties, through the results of experience. Is there a pattern in the atom, in the living organism and in nature as a whole? Scientific discovery has made it certain that there is an energy pattern in the atom which is mathematically statable, however inadequate our efforts may be. Nor can there be any doubt that there is a pattern control within the organism which would explain the life history of the organism in its interaction with the environment could we clearly define it. As in the case of the atom, we have made progress, though much remains to be done. The fact, however, seems indubitable. The faith in a cosmic order is a stupendous venture of creative imagination to make intelligible the fragments of reality which we can seize upon in our experience, including the ordering activity of mind and its partial success in demonstrating order in the world beyond. We must account for the emergence of the ordering activity of mind. It is reasonable to suppose that the cosmic process furnishes a sufficient cause for the ordering genius of man. The structure of our finite mind must be somehow a reflex of nature. It is not intelligible that we are washed up on the shore of time by the accidental sea drift of heredity and circumstance—born by the cosmos to be eternally mocked in the most fundamental quest of our being. Form is ultimately due to control by the whole. The discovery of order is a co-operative enterprise between the finite mind and the cosmos. Knowledge is a conspiracy between the part and the whole. Nature prompts to creativeness and then acts as the test of our efforts. We must strive to view reality from the point of view of the whole, and our faith in the orderly character of nature is ever rewarded by new discoveries. And we are but lately of the jungle.

We may abstract the structure aspect of events from its concrete matrix in nature, and for scientific purposes we are obliged to practise abstraction. We are aided in this abstraction by the fact that the pattern or type has a considerable permanency in the passing events of nature. The atomic patterns seem to be eternal in nature even though some atoms at least, such as the radioactive, pass through a cycle of dissolution and synthesis in the changes of cosmic weather. Wherever the spectroscope reveals atoms they appear to have the same essential structure. On the higher levels of synthesis such as the organic and mental, we cannot predicate any such eternity of recurrence, but within the history of our earth, organic types have a permanency which dwarfs the fleetingness of individual lives; and even mental types show a remarkable duration in the passing generations. We need only mention Hebrew culture, Greek culture, Roman culture. And the general laws of mind endure through the passing epochs of culture. But while we can thus discriminate the aspect of structure and observe its relation to other aspects of nature, we must not hypostasize structure as Plato did and as the abstract realists after him have been prone to do. Structure as an abstraction does not exist. It exists only as an aspect in the advance of nature. There exist organizations and these are dynamic organizations. It is these organizations of energy which are efficient causes and which communicate energy patterns in time and space.

This must be said, however: Universals tend to overlap, whether they have to do with classes or order. The history of thought shows that it is more difficult to maintain universals in isolation than particulars. The nominalists seem as dogmatic as ever in their emphasis on brute fact, abstract particulars. But the universal in any honest dialectic tends to take on concreteness. Plato's Ideas forsake their isolation in the *Timæus* and become creative world forces. The universals of the Mediæval realists manage to incarnate themselves in individuals somehow, whether by emanation or inherence. And the abstraction, the Hegelian absolute, must somehow in the dialectic process concrete itself into a semblance of the empirical world. Surely it is the irony of comedy that in the history of thought the radical empiricists should have proven to be the most extreme dogmatists and that absolute fact, as they have emphasized it, should have turned out the most extreme fiction.

Mathematics furnishes the domain of the most abstract employment of the constructive activity of mind. When such concepts as classes and order are completely separated from the matrix of things, they furnish a realm of adventure of their own. To the outsider the revelling of the mathematical imagination in infinities of infinities may seem a veritable debauch. But the mathematician is entitled to his sport; and one can never know when and how free imagination may be wedded to fact. If, however, he mistakes the realm of his abstract entities and relations for the real world, he lives in a cave more closed than that of the empirical naturalist, for he is not forced to accommodate himself to the stern dialectic of events. Mathematical realism, therefore, is the most ghastly realism. It seems incredible that any one should mistake such shadowy fictions as points and instants—the unreal limits of mathematical reason—for ingredients in the real world. Even in dealing with such abstract aspects as classes and order, it conduces to sanity to remember their derivative character. Thought is originally a process of trial and error adjustment within the real world. It is from the real world that the aspects with which the mathematician deals are derived; and however much they may be manipulated by the logical imagination, their derivative character furnishes the ragged edges without which they lose their meaning. It seems far from clear "that two and two would be equal to four if no couples existed in the world." We may agree that "pure mathematics is logically independent of its applications to existence, and so is the pure logic on which pure mathematics is based." But if "logical principles are *a priori*," what guarantee have we that they "apply to any thinkable being whether such a being could exist or not"? Is it a "matter of course, that *a priori* principles, like those of logic and number, do in fact apply to existence" and that "all existing things have logical structure"? [6] We cannot thus separate thought from existence and understand the significance of thought. How simple just to assume that "all existing things have logical structure!" But at any rate it is only through the trial and error adaptation of thought to reality that we discover order in nature. Thought must first of all operate upon the aspects of existence. It is of course true that once thought has made the abstraction of logical principles, it can manipulate the aspects of nature in new ways. It can even create new entities, such as mathematical limits, which have no existence in objective nature, taken as closed to mind, but are creative additions resulting from mind operating on nature. But though mind is not bound to the routine of nature and though such aspects as order and magnitude can be abstracted from their real nexus and can be independently manipulated in thought, surely there is no sense in saying that they have any existence except in energy structures—the mind itself being such an energy structure. They are derived in the first instance, at any rate, from experimenting upon the real matrix of things.

What lends force to the nominalist's contention that such concepts as class, order, and law are conventions—mere man-made, arbitrary selections from an alogical world—is that thought is a trial and error adaptation in which mind must contribute its tentative guesses which at

[6] The quotations in this paragraph are from *A Study in Realism*, J. Laird, p. 116.

best are approximations. The duration and order of nature are not immediately intuited by the mind. They must be learned; and they must be supplied largely by inference from the implications of the facts of sense experience. Immediate perception supplies us with but a crude matrix of sense aspects with their immediate spatial and temporal togetherness and their instinctive causal implications. The objective order and duration of events must be spelled out by the creative activity of the imagination, restrained by scientific method. There is thus necessarily a large subjective element in our reading of the order of nature, even though the order of nature is not dependent upon our reading of it. In our reading of the order of nature we have indeed been guilty of "accommodating by violence the nature of the other to that of the same," [7] to use a saying of Plato's. Modern science, according to M. Meyerson, proceeds from certain concepts of limits, like a perfect gas, a weightless lever, a body moving under no external forces, an absolute space, an absolute time, etc., and then proceeds to accommodate the variety of motions in nature to these limits. Identity is the aspect emphasized by science.

> Reason has never been able to comprehend transitive action. Atomism is rational, we see, only to the extent to which it satisfies the demand of the mind for that which remains identical without changing; its irrationality is due to the fact that it involves a diversity which cannot be rationalized.[8]

The two fundamental concepts of science—law and causality—emphasize different aspects of reality, according to M. Meyerson. Law, which is another name for invariable sequence, emphasizes diversity, while cause emphasizes identity: *Causa æquat effectum.*

[7] This quotation from Plato is used by M Emile Meyerson as the motto of his work, *De l'explication dans les sciences,* and expresses his philosophy of science

[8] From Leonard Russell's review of the above-mentioned book, in *Mind,* Oct., 1922.

There is no denying that the procedure of science has been artificial. And we must also grant that the abstract conventions of science have been pragmatically useful in the advance of man's knowledge of nature and control over nature. But we cannot agree that the procedure has been purely arbitrary. It could not have succeeded to the extent it has if it had been merely convention. While there has, no doubt, been too much of a tendency to accommodate nature to scientific abstractions, there has been brilliant progress in accommodating man's abstractions to the order of nature. There has been approximation towards the order of nature in the advance of science. The more adequate our approximation, the less cramped is nature in our formulæ; or, what is more to the point, the more successful are we in adjusting ourselves to nature. Thus Einstein's theory of relativity has proved a closer approximation to reality than the theory of Newton; and the quantum theory involves a still more radical adjustment of our mathematical concepts to the empirical aspects of nature. While there is a large subjective element in our knowledge, it means to adjust itself to an objective order of nature and is increasingly successful in so doing. If there is noticeable approximation to such an order, and if the success of knowledge depends upon such approximation, knowledge is not entirely arbitrary. One of the most important aspects of this advance is the taking account of time as well as space in the reading of nature, which is evidenced in the dominant rôle of evolution in the conception of nature. And however abstract may be the conception of space-time in the theory of relativity, it is testimony to the fact that time cannot be ignored even in the abstractest fields of knowledge. This makes possible a more adequate account of law and causality in nature than the old conventional concepts.

When, moreover, we say that reason can know certain aspects such as identity, but cannot know other aspects such as diversity and change, are we not setting an arbitrary limitation to reason? What is it that knows the aspects which reason cannot know and how can we be so sure of this other knowledge which reason presumably cannot possess? Evidently we must know about these other aspects, or we could not know that reason cannot know them. Why identify reason thus with a certain unreal type of knowledge and not give it credit for the more real kind? Evidently we have concepts of diversity and change. Why not enlarge our conception of knowledge to include these? It is precisely this diversity and change in nature which makes it necessary to revise our old formulæ and suggest more adequate ones, though, of course, we could not have knowledge if there were no recurrence, no constancy in nature. Reason for me is the whole conscious creative effort at adaptation to reality as we become conscious of it in human experience. In this trial and error process, reason discovers its failure or partial failure and, with an undying faith in order, strives to accomplish a more successful adaptation. This creative adaptation involves not merely such intellectual functions as comparison, abstraction and naming, but it involves the whole personality, including the volitional attitude—the willingness to know—and the emotional factor of feeling for order and faith in order.

Qualities and the Perspectives of Nature

Two other bifurcations, in the history of thought, have blocked the true understanding of relations in nature, viz.: the bifurcation into things and qualities, on the one hand, and the bifurcation into the percipient individual and the environment, on the other. Both bifurcations are tricks of language. It is by a trick of language that we convert qualitative functions into entities and proceed to compound things out of qualities, forgetting that qualities are but aspects of energy perspectives and relative to these. Things and qualities, as thus contrasted, are creatures of abstract thought and do not exist in the real world. It is names—not things or qualities—which exist apart and give plausibility to the bifurcation.

Equally unreal is the hard and fast division of nature into an external environment and a percipient organism. This has led the victims of this bifurcation to regard the characteristics of the integral situation, in which the organism and the external energies interact, as belonging to one or the other factor in the situation. Thus the psychological idealist has insisted that sense qualities are the contribution exclusively of the percipient individual, while the naïve realist has argued that they are the contribution exclusively of external nature, isolated from the percipient organism. Since each partisan bases his theory on a false abstraction, one is as far from the truth as the other. The history of philosophy consists largely of such false and futile antitheses. We are now awakening to the fact that sense qualities are the functions of specific space-time perspectives, and have no existence except as such functions. They do not exist as abstract entities either in external things or in the mind. The quality of continuous extension can no more than colour be attributed to physical things in the abstract, neither is it a contribution by the human mind. Physical nature, we have seen, has a discrete quantum constitution. It is in the energy relation of our organism to external nature that the quality of continuous extension is sensed, just as it is in such relation that colour is sensed. Both are aspects of space-time perspectives and vary with such perspectives.

Stated in terms of evolution, sense qualities are functions of the process of adaptive interaction between a system of organic energies and the energies of the environment in certain space and time relations. If we take a concrete instance, such as our sensing of a certain quality of red, we find that this involves the character of a certain energy source in certain space-time relations to the observer. This source sends forth different radiations of so many billions per second, which travel through certain media and set up certain photochemical changes in an organ of specific structure, the retina, these changes being in turn communicated through a selective nervous system to the cortex of an organism which in turn is in a certain relative motion with reference to the event perceived. The specific quality of red, which we perceive in a certain finite fraction of duration, is the function of this total situation. What the physicist calls red is merely a type of radiation of a certain wave-length. What we sense as a certain red is a function not only of the wave-length of physical light radiation, but also of photochemical and physiological changes of a specific character. If the eye fails to function, we are blind. The light rays still strike our organism and are responded to in certain ways, but we do not sense them as light. If the photochemical structure of the retina is functionally defective, we may be colour-blind or may be red-green blind or yellow-blue blind. The specific response to a certain colour with its differences in wave-length and intensity seems, according to recent evidence, to involve not merely the end-organs but also the selective action of the hierarchy of nerve centres with its cortical pattern control. When this integral relation is broken in certain cerebral disorders, we may have a confused all-or-none response to certain kinds of light, but it is not the determinate perceptual response which we ordinarily mean by light and colour. We cannot say, therefore, that physical light-waves are bright or coloured, nor can we say that colour sensations are contributions by the individual organism. In one sense the position of realism is true: the sense quality of colour and every other sense quality is independent of the psychological history of the observer, in other words of the individual's mental perspectives.

The sense quality of colour depends upon the intensity or amplitude of the physical light-wave as well as its wave-length, while a physical colour means just a specific wave-length. Some physical light-waves are too weak to be sensed at all. Our sensitiveness differs for different wave-lengths, *i.e.*, at the same physical intensity some colours look brighter than others. In ordinary daylight, the brightest colour in the spectrum is yellow and violet is the darkest. At a low intensity, green is the brightest. But the sense quality also varies with variation in intensity. Thus with greater intensity of light, spectral red becomes various tints of pink until finally it is lost in dazzling white. With lower intensities, spectral red becomes various tints of brown until it is indistinguishable from dark grey. This qualitative variation of sense perspectives of colour with the intensity of light is contrary to the physicist's concept of colour. It is due to the specific character of the physiological response. Yet one sense perspective is just as real as another. All are functions of interaction. Colour contrast and negative after-images show even more strikingly the importance of the physiological factor in the interaction. By stimulating for red we may see green, if we place a grey patch on a red background. In the case of prolonged stimulation by one colour-stimulus, we get a negative after-sensation of the complementary colour.

These interactions involve the character of the medium between the percipient organism and the source of the light waves. The retardation of the waves in the medium means the crowding of the spectrum towards red and infra-red. We know now that there is such retardation of light near large masses of matter. The character of the medium must account for the phenomena of interference which is itself a striking confirmation of the wave character of light. The medium may curve the light rays as has been proved in connection with light rays travelling near the sun. It may refract light as in our atmosphere. It may absorb certain light rays. The medium, then, must be taken account of as a determinant within sense perspectives. So must the space-time relations which in turn affect the intensity.

It has proved impossible to show any effect of the relative motion of a terrestrial observer with reference to the velocity of light. But we can illustrate the effect of relative motion in the case of sound. I quote from Professor Nunn:

> Imagine a number of persons spread along the circumference of a large semicircle while a motor car from which a whistle of constant pitch is sounded moves rapidly along the road which forms the diameter. Then, as is well known, not only will each person at a given moment hear a note different from the notes heard by his companions, but the note heard by each is different for different positions of the car. Moreover, the occupants of the car will hear all the time a steady note which, except momentarily, is heard by none of the bystanders. Are we to maintain that all these diverse notes are being simultaneously emitted by the whistle? [9]

The answer is, of course, that the listener on the moving car and the various listeners in their geometric distribution in the semi-circle on the relatively stationary ground are all equally right in taking their sense report as the true quality of the whistle of the moving car in their various space and time relations. The quality of the sound is a function of the total situation, involving the relative movement and the space distribution of the listeners. The variation of the quality of the sound with the direction of the listener is, as a matter of fact, one of the important aids in telling the direction of the object producing the sound. Nothing could better illustrate that there is no absolute quality, but that the quality is a function of a specific perspective. This involves, in the case just stated, the frame of reference of the source of the stimulus, the character of the medium, the vibration rate and undulation span of the air motions, the varying space position of the listeners to each other and to

[9] T. Percy Nunn, *Proceedings of the Aristotelian Society,* 1909-'10, pp. 203, 204 The article is a masterpiece of scientific analysis and has had a large influence on the realistic movement.

the air-waves, and the complicated physiological conditions including ear, nerves, intermediate neural centres and the discriminating function of the cerebrum.

The conception of a local space-time on different frames of reference solves another problem which Professor Nunn raises:

> Thus, if I identify the note of an engine as upper C when the note "really" emitted is C sharp, my "error" may be due either to my ignorance that the engine was moving away from me at the rate of 44 miles per hour, or to my ignorance that this circumstance would make any difference to the sound heard.[10]

The answer is that there is no error, that the engine as "really" emits the note of upper C to the listener on the frame of reference, taken as stationary with reference to the moving engine, as it emits C sharp to the listener moving with the engine. If the whistle were set off on the embankment instead of on the engine, the listener on the engine would perceive the note as upper C and the observer on the ground would hear it as C sharp. On Einsteinian principles the man on the engine, if he knew the difference of quality, *could* account for it by the embankment moving away from him at the rate of 44 miles per hour.

But does not the sense of touch give us absolute qualities? It seems strange that the testimony of the sense of touch should have had such prestige in human thought.[11] It tells us nothing about sound, light, heat, electricity and other pervasive energies. It responds only to gross matter, yet matter itself on which the sense of touch is moulded is now conceived to be electrical. Could touch ever have informed us of the electrical constitution of matter? Touch tells us very little about the temporal order of events and what it tells, as in the touch rhythms of walking and danc-

[10] *Ibid.*, p. 207.

[11] There has been a revival of this emphasis in philosophy recently, notably in Professor C. D. Broad's book, *Perception, Physics and Reality*.

ing, is confined mostly to our own organism. As regards space relations, we know that people congenitally blind are largely wanting in a sense of the third dimension. They move in an auditory world. Even in discriminating positions in two dimensions, touch is far inferior to sight. In the experiment with the compass points, touch identifies two points as one when sight shows that they are some distance apart. As regards the discrimination of form, touch is very rudimentary and does not compare with sight and hearing. Only the shape of very small objects, such as pennies, can be perceived by active touch. And the definiteness which touch seems to contribute in space contours as well as in space relations, it borrows largely from visual perception. The perception of the shape of large objects, such as a house, would not be possible by touch alone except as eked out by memory. Nor is the testimony of the sense of touch as regards form indubitable within its limits. Suppose you draw a pair of compass points over the mouth so as to enclose the lips. The sense of touch will tell you that the figure described is that of an ellipse while sight shows that the lines are parallel. There remains the quality of solidity which Descartes refused to place among the qualities which are clear and distinct. It surely is a very relative quality. The continuity and impenetrability of gross matter as reported by touch are creative physiological responses—real only within the conditions of the touch perspective. They are not evidence of the objective constitution of matter as ascertained in other perspectives. We may shoot an electron through a bar of iron without its colliding with anything. So far from being solid, matter has spaces within it out of all proportion to the filling. Even the most solid matter such as steel is compressible. An X-ray photograph gives us infinitely better evidence of the structure of matter than touch can do. Touch does furnish us evidence of the inertia of matter, and perhaps we must concede that our conception of inertia is ultimately derived from active touch. But, by itself, touch can tell us nothing of the relation of inertia to motion. In general we may say that touch with its vagueness of discrimination is a sort of rough first approximation in the adjustment of the organism to its environment.

The emphasis on touch is founded on common sense and common sense deals with the integral result in perception. It does not analyze the factors which condition this result. In this result the sensations from muscles, joints and tendons are fused with the pressure sensations and the integral product is called touch. Moreover, the space-time of the normal person is dominated by sight. He locates other sensations in the space-time of sight. It is true, as Berkeley pointed out, that visual perception borrows from the motor sensations of the larger musculature, especially the arms and legs, but the result is a visual perspective in which other sensations are located. The human brain is dominantly organized for vision and, as Titchener points out, the congenitally blind lack a great deal more than the use of the eyes: they lack the use of a large part of the brain. The normal person, who is not a psychologist, attributes to the sense of touch what he has learned from visual perception which is fused with the tactual in the integral reaction. The use of words gives a fixity and definiteness to our perception of qualities and space-time relations which an animal incapable of social communication could never attain; and this fixation of meaning through language is attributed by the untrained observer to the senses. This is natural, inasmuch as perception is the integral functioning of the whole individual in the service of his interests.

To the psychologist the sense of touch itself is not such a simple affair as it appears to common sense. There are as a matter of fact several senses of touch, as Dr. Head and his collaborators have shown. There is the vague, non-discriminative protopathic sense; there is the epicritic sense, with its discrimination of relations in two dimensions; and there is the deeper sensibility which makes possible orientation in three dimensions, the sense of posture. The latter two senses are the contributions of cerebral organization with its complex mechanisms for adjustment to the environment. The same hierarchy of levels has been verified in visual perception. If we take touch, however, as an integral response, there are still problems to be faced. If we are to rely on the sense of touch as evidence, is it successive touch or simultaneous touch that we shall rely on? It is a well known fact that the two do not agree. A coarse comb is sensed as longer, both spatially and temporally, when the teeth are applied successively than when they are applied simultaneously. Which is to be the standard? Furthermore a filled interval—for example, a comb where there is a row of teeth between the end-teeth—is sensed as longer, spatially and temporally, than an empty interval, *i.e.,* where there are no teeth between the end-teeth. In other words, the theory of relativity applies in the field of touch as well as in the field of sight. What we do in practice is to compare the intervals-as-sensed with artificial standards of measuring rods and clocks within the frame of reference of an observer who is not himself the subject of the experiment. The sense of touch is no more absolute than the sense of sight, and touch has the disadvantage that the filled and the empty intervals cannot be experienced together by the same organ of sense but must be experienced successively. We must, therefore, make an additional assumption, viz.: the constancy of nature during the finite intervals of the experiments. And we know that however constant may be the objective aspect of nature, the character of the subject who makes the judgements is not constant.

Common sense assumes that the sense of touch is the same over the whole body. The psychologist knows that this is not true. Different parts of the body differ in their tactual discrimination. The intervals which can be discriminated—whether simultaneous or successive—differ for the tips of the fingers, the tips of the tongue, the back of the hand, the back of the body, etc. Which part of the body is to be the frame of reference? The common sense observer seems to have absolute faith in the finger tips and no doubt they are the parts most useful for exploration. But theoretically they have no more claim to absoluteness than the other parts. Professor G. F. Stout well sums up the case:

> The constancy of tactual sensation as compared with visual is not a superiority but a defect. It is to be noted that they are not constant except for the same part of the skin; and even with this restriction, constancy is only due to the fact that the conditions under which the tactual experience is gained are strictly fixed and limited instead of being widely variable as they are for sight. . . . The tactual sensum is constant only in the way in which anyone of the alternative visual presentations is constant so long as the eyes are turned in the same direction, and the thing is seen at the same distance. The difference is that tactual experience is limited to one set of conditions and does not occur at all without them.[12]

It has been said that the theory of relativity is limited to the sense of sight because sight is the only sense which can be said to be perspective. It is true that the special theory of relativity is optical. It is based upon the assumption of the absolute velocity of light, and its conceptions of simultaneity and succession involve optical signals. But, in fact, light does not have this absolute character and the special theory has been supplanted by the general theory. The significance of the general theory of relativity is that we must view reality everywhere as events, that we cannot describe events without taking account of time as well as space, that reality everywhere appears in space-time perspectives, none of which has a privileged character. Perspective, then, is not used especially in an optical sense, though the word is borrowed from the vocabulary of sight

[12] *Mind*, October, 1922, pp. 403, 404.

and though our data of nature are mostly obtained from sight. Wherever we deal with the integral response of sensing, whatever the sense may be, we must take account of space-time perspective directly or indirectly. Sensations as isolated particulars have no existence. They are the fictions of traditional psychology. Actual sense responses exist only as causal perspectives, involving time as well as space. (We call them sense data when we emphasize their cognitive significance as aspects of reality.) No unsophisticated animal or human being regards sense facts as existing merely inside his skin. They are perspective relations calling for a certain response to the environment. The amœba moves away from a noxious stimulus and towards a satisfying stimulus. It lives in objective relations and so does every other animal. The distance senses of sight and smell have a peculiar value as signs to the other senses of the satisfaction to be sought or the danger to be avoided. Thus sight or smell may act as a distance sign to the satisfaction of the taste sensations and these again are signs to digestion and assimilation. Such sign relations between the senses are established by a long trial and error process in the race and in the individual. What concerns us here is that sense continuities are aspects of the adjustment of the organism to its environment. Sensing is part of the arc of acting, whether the arc be simple or complex, direct or indirect. And action, from the simplest to the most complex, is projective, which means that it is perspective. It has to do with the causal relation of the environment to the individual, on the one hand, and the causal relation of the individual to the environment, on the other. The lowest animals respond perspectively to an external world in space-time. So do plants and inorganic elements. Sensation as we know it is only a special organization of such perspective responsiveness throughout nature.

It is absurd to suppose that any of the senses give us an immediate, intuitive copy of external reality. All sense responses are causally mediated. Their character is what it is because of the specific energy relations. In each sense there is the medium through which the external energies affect the nervous system. The external energies do not act directly upon the nerve endings. Matter does not touch the nerve endings of touch. It acts by some sort of induction through the superficial skin, which has no sensibility, and sets up chemical changes in the proper end-organs of touch, and these changes are communicated to the nerve-endings and then go through the elaborate mill of selection, integration, and projective redirection in the hierarchy of the nerve centres. This integral process is what we are aware of as sensing, which is itself an aspect of acting. The response is to the velocity and duration of the stimulus as well as to its extent and location. It is a space-time response. Though the process is mediated in our own organism, we are under the necessity of discovering its nature just as much as though we had to do with energy systems in the outside environment. It is only recently that Dr. Head and others have unravelled the hierarchy of factors which enter into seemingly so simple a sense perspective as that of touch.

In all the senses the original organic perspective relation to the proper stimulus is modified through experience or secondary signs. This can be illustrated in touch as well as in sight. The blind learn to estimate distance by habit and association. To a certain extent they learn to take account of the difference in the external medium. They know when they approach a wall by the difference in the resistance of the medium. But the secondary aids in touch are, of course, meagre beside those available in the perspective of sight where apparent size, light and shadow, the number of intervening objects, the clearness of the object, etc., all help to make definite the crude physiological perspective. This does not mean that the sense response in touch is not perspective, but that the perspective of sight is different and vastly superior by virtue both of its complex distance receptors and because of superior cerebral organization.

But it is not my purpose to discredit any of the senses. Rather would I emphasize with Empedocles that we should despise none of them. They all contribute their evidence. And the evidence of the senses, with the instruments by means of which we eke them out (touch being notably incapable of such aids), and the implications which their evidence carries with it are our only door to physical nature. Some philosophers seem to think that if we could only be independent of the senses we should perceive the world as it is. But a disembodied ghost would have no way of knowing the properties of the physical world. All qualities are reactions and therefore relative. There are no perspectives in the abstract and therefore no properties in the abstract. Nor can we say that all perspectives involve mind as an active factor. The camera records perspectives. There are numerous properties of nature which have only lately been discovered. There are spectroscopic, geological, and palæontological perspectives of which we are only beginning to become conscious. But it is true nevertheless that the data for such properties and perspectives must come through sense perception.

Science has in the past recognized the importance of taking account of the actions, reactions, and interactions of various fields of energy with their specific structures and their relative position in space. But we have been in the habit in the past of treating this interrelation of fields, with the consequent perspectives, as though these fields were stationary with reference to each other. We have failed to take account of the variations of perspectives, and the consequent variation of their qualitative characteristics and their quantitative units, owing to the relative motion of the frames of reference. Hence the prejudice of unvarying qualities and unvarying units. The chief contribution of the special theory of relativity is to call our attention to the difference which our relative movement makes to our perspectives. It has emphasized primarily the variation of our quantitative units of space and time, but, since these are derived from the qualitative perspectives, we must seek the real reason for the variations there. In short, all the characteristics with which geometry deals are in question, not to speak of other characteristics. A stone dropped from a moving train to the ground will appear to the observer on the train to move in a straight line, but to the onlooker on the embankment it will appear to describe a curve. An observer stationed on a frame of reference outside the earth and stationary with reference to its motion would see our square buildings as distorted. These phenomena of relative movement are still further complicated when lines of motion which intersect with our frame of reference are curved in passing through a certain physical medium, as light rays are bent in passing near the sun. But that is not a problem of relative motion but of the geometry of the medium.

The question naturally arises: Are not these variations in tone, in colour, in geometric and other qualities, which are due to relative motion, mere appearances? Can they be conceived as real in the sense that properties appearing in our local space-time are perceived as real? Does not a body travel either in a curve or a straight line? Shall we take the appearance in our local space-time frame as real and discard the appearances from other frames of reference as illusions? Such has been our conventional prejudice. But we are now awakening to the fact that it is merely prejudice. All perspectives are equally real, though pragmatically, or for executive reasons, we may find it convenient to standardize certain appearances—to treat things as square if they appear square in certain perspectives. But we should bear in mind that this is an arbitrary emphasis due to our practical interest, not a metaphysical account of reality. Why discriminate in favour of the stationary type of relation when this relation itself is an arbitrary selection and everything is in relative motion with reference to an indefinite number of frames of reference? Our earth cannot boast of an absolute position as man so long thought. Hence all perspectives on it are at any rate relative to frames of reference outside the earth.

Perspectives, then, vary with the structure of the interacting fields, with their intervening medium, and with their space-time relations. Qualities are dependent upon perspectives in the sense of being functions or aspects of them. They depend in a sense upon the above factors in that these determine perspectives and therefore qualities. We cannot say that they depend upon the factors in the sense that they are "part of" them, as Russell uses the word dependent. Dependent does not necessarily mean part of, and part of does not necessarily mean dependent. Touch qualities and sight qualities may be said to be part of the same perceptual thing in the sense that they are aspects of it, but they are not dependent upon each other. Again, qualities may be dependent upon certain factors without being part of them. Colour is not part of the physical light vibrations or the medium or the physiological organ of vision. It is a function of the integral situation involving all the factors. These factors are merely abstractions from the integral situation. This situation implies creative synthesis. We cannot arithmetically add the factors and get the qualitative perspective. But taking the integral situation as a fact we can for the purposes of prediction analyze it into certain factors.

It appears that we must regard the sense data of nature as determined in part by variables independent of the structure and motion of the percipient organism. The stimuli, the things sensed, have a structure and motion of their own. They are not merely functions of the percipient organism. Even organic qualities are not created by the percipient; they are not functions merely of the subject. Some organic qualities have only recently been discovered and others await discovery. It is true that we *know* nature only as sense perspectives or implications from them, but that is a different assertion from saying that nature exists only in our sense perspectives. It is not the percipient organism which makes light rays curve in the vicinity of the sun, but the presence of a large body of matter which alters the structure of the field through which light travels and so alters our perspective. It is not the percipient organism which makes the magnet move in adjustment to the position of the loadstone, but the percipient perspective is altered by that fact. Iron and gold have a different structure and a different density. It is not perceiving them which makes them different, but we perceive them as different. With a certain amount of pressure iron can be reduced in volume; with a certain temperature it can be poured like water, under certain conditions it rusts away. But it is not our perceiving iron that makes the difference, but certain conditions which vary independently of the percipient organism, and which make a difference in our sense perspectives. The elephant has a life span of more than a hundred years, while some insects live their life cycle within a day. But neither the character nor the duration of the life cycle depends upon its being perceived. Again the celestial bodies are situated at various space-time distances from us from 1.2 light seconds to the moon to thousands of light years to the spiral nebulæ. It is not our perception which makes the distance, but our sense perspective differs with the distance. While the specific structure of the organism is an essential condition in sense perspectives, no physiologist would be deceived by his prejudice into conceiving it as the sole determinant. It does not matter if in turn we express the external variables as sense-aspects. Even if we conceive matter as a class of sense aspects, it still holds that light rays curve in relation to the group of sense-aspects which we call matter and independently of the group of sense-aspects we call the percipient organism, and that our perspective of light varies accordingly. But matter for us is more than a group of sense-aspects.

We may say that our knowledge of reality, in the chunk of duration which we call the present, consists in the system of perspectives of which we can take account. But we must enquire more closely into the nature of perspectives. Our immediate data of physical nature consist of sense perspectives, including the various senses. Nature is what it appears to be in our sense perspectives. But all actual and possible sense perspectives would not give us all the perspectives of nature. For sense perspectives are only one class of perspectives where an organism of a certain complexity is the receptor reagent. We must recognize perspectives which are independent, at any rate of our experience. The earth rotates while we are asleep and brings the periodicities of day and night. The vast perspectives with which the geologist and palæontologist deal are discovered, not created by them. The processes of growth and decay take place in nature whether we watch them or not. Even though we do watch them, we cannot follow their transitions. We perceive end-terms and interpolate the transitions. In other words the chunks of duration in which we perceive the external perspectives of nature are not the chunks in which they happen in nature. We, therefore, must eke out our sense perspectives with other actual perspectives. Since these are not directly sensed we may speak of them as *implied perspectives.* We must infer these perspectives in order to give a coherent account of the perspectives of sense.

The scientist has the advantage in two respects over the ordinary man in watching nature. In the first place, he equips himself with instruments which can respond to minute differences in nature in a way our senses cannot. He can provide himself with certain physical media such as lenses. He can construct interferometers that will measure the intensity and frequency of light-waves. In other words, he can arrange certain physical perspectives of nature to eke out his limited sense perspectives. But this arrangement would not be possible except for another advantage, the scientist's intellectual equipment, his cumulative preparation in the way of concepts, his systematic guessing at nature's perspectives and his checking up of these guesses in terms of the differences that nature's perspectives make to sense perception. If he succeeds in verifying his sketch of the course of events in nature, then his anticipation, however artificial, must be at any rate an approximation to the implied perspectives of nature. Astronomers did not actually perceive the curvature of light in the vicinity of the sun, but they photographed stars in the vicinity of the sun during an eclipse, then compared their apparent position during the eclipse with photographs taken when the sun was not in the neighbourhood, and found that the former implied the predicted curvature. In order to account for certain end-terms in his sense perspectives of nature, the scientist has conceived movements of molecules, atoms, and electrons which lie far beyond the range of his senses, even when equipped with microscopes. Yet the course of nature seems to imply some such constitution.

The properties in the implied perspectives of nature are not sense properties, even when the external energies are the same as those that figure in sense perspectives. The effects of light on inorganic matter or on plant life are not the same as on our differentiated sensory system, though the various wave-lengths have their characteristic effect in either case. Light and gravity are important factors in the symmetrical growth of our own organism, but we do not sense these effects. The pressure on iron does not give rise to pressure sensations, though if it is of sufficient amount it will restrain the atoms of iron within a smaller volume and thus alter our sense perspectives. Furthermore, the implied perspectives in nature indicate energies for which we have no corresponding sense receptors—infra-red, ultra violet, X-rays, to use illustrations from the domain of light. It is because of the implied properties of these in the perspectives of nature that we have been able to discover them and make use of them. We must take account, therefore, of the properties of nature in the variety of nature's implied perspectives, as well as in our sense perspectives. The perspectives implied in the combustion of coal are incommensurable with the perspectives of our organism in the sensing of heat, though in certain chunks the changes of combustion may act on a percipient organism and be sensed as heat. But the changes of combustion will go on whether there is a percipient organism or not and produce characteristic physical changes, as they did in geologic ages before man appeared and still do. The house may be struck by lightning and burn down while you are absent. It is not a question of reality as between our sense perspectives and implied perspectives in nature. They are equally actual, equally real, but they are different and hence their properties are different.

We sometimes speak of the perspectives of nature as conditional perspectives. By this we emphasize that they do not occur unless all the factors which mediate them are present. There is a knee-reflex, but it does not occur unless there is the proper stimulus, such as a sharp blow or an electric current. I do not now sense red or sweet, but I can establish relations with certain stimuli which will bring about the perspectives of red and sweet. In this general sense all perspectives are conditional. It is true of implied perspectives as well as of sense perspectives. Sometimes the conditions for implied perspectives are within our control. We can vary them at will and observe the results of the variation. This is the great advantage of experimental science. Sometimes the processes of nature are on too vast a scale in complexity, space or time for our human control, and we must watch nature's experimentation and try to decipher its factors as best we can. We can arrange the conditions for combining hydrogen and oxygen into water, but we cannot do so with protoplasm, and we must be spectators of eclipses and earthquakes.

The above use of conditional is not to be confused with the special sense in which the physiologist uses the term "conditioned response," as for example the "conditioned reflex." This has to do with the substitution of stimuli where a stimulus which is associated with the primary stimulation becomes a sign of the primary stimulation. Thus if, when we stimulate the secretion of the salivary glands of a dog by putting food into his mouth, we ring a bell at the same time, we find that afterwards the mere sound of the bell becomes an adequate stimulus to produce the flow of saliva. The secondary stimulus comes to imply the presence of the primary stimulus. But in either case we deal with sense-perspectives. This principle of substitution can be extended indefinitely in the learning process of a human being where words come to figure largely as secondary stimuli. But we have here to do, not with primary perspectives, but with secondary perspectives.

We speak of some conditional perspectives as possible perspectives and say that nature is what it appears in the system of actual and possible perspectives. But the term possible is ambiguous. Certainly some conditional perspectives are not now possible. Some conditional perspectives are only possible when we take account of time. I saw a large elm when it was a tiny seedling, but the perspective of it as a tiny seedling is not possible in my present chunk of experience. It now functions actually as a large elm whether in the perspective of my sense perception or in the physical environment. The perspective of the tiny seedling is indeed implied in the present elm, for this exists only in a history of perspectives. But the perspective of twenty years ago is not possible in the present chunk of duration, at any rate as our experience measures duration. It is conditional upon our placing ourselves and nature in the perspective of twenty years ago. The perspectives of geological and palæontological history while temporally implied and part of the definition of our earth are not now possible to our sense perception. They are inferences from the record which we do perceive.

The case is even more difficult when we deal with future perspectives—perspectives conditioned upon the creative passage of nature. I cannot agree with Bertrand Russell that "it is a mere accident that we have no memory of the future" and that "the apparent indeterminateness of the future . . . is merely the result of our ignorance."[13] A fundamental difficulty with Russell's conception of reality is that it ignores what Whitehead so aptly calls the creative passage of nature. Russell seems bound to the conception of "nature at an instant" from the structure of which we are supposed to be able to read the past and future alike. This is the classical conception of nature, before the theory of relativity. But now we have learned that we must take account of time as well as space, that one system of perspectives of nature is not sufficient to characterize nature, but that we require an indefinite number of versions of nature. Russell recognizes that "we cannot define a perspective as all the data of one percipient at one time, because we wish to allow for possibility of perspectives which are not perceived by anyone."[14] But he seems to think that we can state the relation of any particular with reference to nature by means of the conception of simultaneity. He would define the perspective to which a given particular belongs as "all particulars simultaneous with the given particular."[15] In other words, he seems to think that nature can be defined as a system of perspectives at an instant of time. Of course in that case our inability to remember the future would be an accident of our ignorance, since the future would exist in the present instant. But does a certain aspect of nature belong with simultaneous any more than with successive aspects?

The theory of relativity has brought home to us that perspectives of nature are space-time perspectives. In other words history must enter into our definition of reality. Russell's statement that "complete knowledge would embrace the future as well as the past"[16] is still formally true, but it is materially impossible. Past, present, and

[13] *Scientific Method in Philosophy,* p. 234.
[14] *Mysticism and Logic,* p. 140.
[15] *Ibid.,* p. 141.
[16] *Scientific Method in Philosophy,* p. 234.

future cannot be projected on one plane. An event happening now in a distant star may be thousands of years in the future to man's perceptual perspective. The fact is that, in the actual world, the interaction of various histories in the cosmos, and therefore the correlation of these histories in our system of knowledge, requires time as well as space. They do not interact instantaneously and therefore cannot be correlated in an instant. And in each history the quality of the creative advance cannot be ascertained except by waiting. Furthermore the span of duration in different histories varies and we must take account of these chunks of duration in order to understand nature. The laws of nature hold for such chunks. The laws of physical nature have a considerable span, but they are not eternal. The abstract characteristics of system may be eternal as Willard Gibbs holds. But the concrete characteristics of systems depend upon the constancy of certain conditions of temperature, pressure, electromagnetic field, etc., as W. K. Clifford clearly pointed out. For the brief span of human science they may be constant. Ten thousand years in the life of a star may make no perceptible difference. The anatomy of man may not have varied in ten thousand years, though the history of human civilization has varied enormously. Of course the seeming stability of physical nature may be due primarily to the coarseness of our perception. We know it varies over long periods and sometimes it varies catastrophically. The catastrophical character of such variations may be due to our dulness in following nature's transitions. We know this is often true in human evolution. But be the chunks of duration larger or smaller, the temporal character of all perspectives is an empirical fact. The structure of reality is a space-time structure and cannot be truly understood without taking its temporal character into account. It is true that we may ignore the temporal character for certain purposes. The user of coal, and even the experimenter with the properties of coal, may take coal as it is.

But the geologist knows that the present perspective of coal with its properties is a chunk of a long history and that the end of the history is not yet.

We may conceive the span of consciousness as varying in different individuals and under different conditions. We know, as a matter of fact, that it expands and contracts within our experience. It has been maintained that consciousness under certain conditions is vastly lengthened, as in so-called clairvoyant states, and that in such a span the future can be perceived as present, but the evidence for such states cannot be said to be conclusive. At any rate, the chunk of duration of such states would presumably be limited though it excels the average. It was suggested by Josiah Royce that the Absolute has an infinite span of consciousness and that to such a being the past, present and future would exist at once. He did not, however, deny the temporal values within such a consciousness. There would still be unique order and novelty within that order as in the movement of the symphony or, better still, as in the number order. For us finites there would be, as now, the creative passing of nature and an indeterminate future. But we may dismiss the clairvoyant and the Absolute for lack of evidence. It is true, however, that the future somehow is an outgrowth of the past and therefore the order of the past cannot be indifferent to it. The order of the past, moreover, must get its significance from its relation to the future. It appears that there is a nisus, a drift in space-time. To use the inspired words of Alexander: "There is a nisus in Space-Time which, as it has borne its creatures forward through matter and life to mind will bear them forward to some higher level of existence."[17] If there is such a nisus, then some minds under certain conditions may be sensitive to this nisus as others are not. We know that some poets and prophets feel the drift of events when the mass are locked in the crust of custom. But while we may thus feel the nisus, the dynamic intersection of lines of motion, it is still true

[17] *Space, Time and Deity,* Vol. II, p. 346.

that it is felt as future. At any rate the actuality when it comes has a quality of its own which cannot be foreseen. It involves a creative synthesis which, while conditioned by the past duration, is not a mere arithmetical sum of the characteristics of the determining conditions. Even when histories seem to repeat cycles, as when the child lives over the life cycle of its parent or when different cosmic histories repeat corresponding cycles, so that what seems future to a world like Alexander's may seem past to a world of greater range of development, it is still true, as we know, that the repetition in the concrete is a repetition with variations, the correspondence is in generic features. Hence perspectives from more advanced histories cannot read the concrete future, the real quality of the passage of nature in other histories. Even an overarching system of perspectives which surveys the various histories from the climax of cosmic evolution would still have to take account of novelties in the concrete, however complete its provision in the abstract. So it seems from our moving part perspective. In other words, so far as we can comprehend, there is no complete definition of reality in the concrete.

The perspectives of sense are finite perspectives. Their local space-time is finite and their variations of qualities and intensities are by finite quanta. Throughout the domain of sense Weber's law holds, not Leibnitz's conception of infinitesimal correspondence between stimulus and sense perception. Sense perspectives have their threshold below which we have no sense perception, and above this threshold the stimulus must increase by a quantum, which is finite and relative to the standard of comparison. It is not empirically true, either within any one experience or as between individuals, that "between two perspectives which are similar, we can imagine a whole series of other perspectives, some at least unperceived, and such that between any two, however similar, there are others still more similar." [18] There are not an infinite number of

[18] Bertrand Russell, *Scientific Method in Philosophy*, p. 88.

sense perspectives of light, for example, as would follow from this theory. A colour as sensed does not, necessarily, correspond to even a single vibration rate. It may correspond to a span of different wave-lengths. For instance, red is practically the same in appearance from 440 trillion to 460 trillion vibrations a second. The correspondence in any case is finite. We do not in fact have an infinite number of colour perspectives. We must here adopt the principle of Leibnitz that what is indistinguishable is the same. Now between any two hues of blue we cannot distinguish an infinite number of hues of blue. If we select the hues in a certain way, we cannot distinguish any intermediary hues. The gradations of just distinguishable hues can be so arranged as to seem a continuous series, and yet they are very finite. It seems the human organism can distinguish from 150 to 160 different daylight hues. It can also distinguish about 700 different greys from white to black. As colour perspectives vary also with the intensity of the stimulus, we must add these perspectives. The number of distinguishable visual perspectives, including the variations in brightness and the various hues and tints of colour, has been estimated from 33,000 upward. But this is far from infinity. It is dangerous to let the mathematician loose in psychology.

The perspectives of light are not, of course, limited to sense perspectives. We must also take account of the interactions of light with the various structures outside our sense perspectives. These are implied perspectives. Light and radiant heat have been important agencies in fashioning the history of the earth from the beginning. We know from the researches of Planck that the radiations of light and all other radiant energies come in finite quanta. Electron radiation is also of the quantum type; and the relation between the two types of radiant energy follows the quantum law. Atomic matter exists in definite quanta. While it is too soon, perhaps, to generalize, we may say that an increasing number of the perspectives of physical nature are found to be of the quantum type, while we do not know that any relations in nature are of the type required by the mathematical concepts of continuity and infinity. Hence we should be cautious about introducing our mathematical concepts into nature. The spaces and durations of nature seem to be finite chunks. They are not perspectives from mathematical points and instants any more than they are perspectives of mathematical points and instants.

It should further be borne in mind that local space and local time are not subjective. They are relations in nature. It may be possible for more than one observer to occupy a specific local space-time in nature, *i.e.*, to occupy the same frame of reference. Two or more observers may perceive the same phenomenon in nature. They may watch the same experiment by one looking over another's shoulder. They may take account of the same eclipse, *i.e.*, the perspective may be indistinguishable as shown, for example, by photographs. Of course, in the case of touch we cannot actually occupy one another's space, *i.e.*, we cannot touch the same thing at the same time. But we can, even here, occupy the same frame of reference in nature successively. We can exchange spaces and we can exchange durations. This means merely that, within certain finite chunks, the structure of nature can be taken as uniform. Else we could have no science. In order to have science, it must be possible, within the duration of nature, to repeat our experiments and for different observers to check up one another's observations and experiments. We demand in natural science that the relevant conditions shall be repeatable, and that, if these conditions are the same, the perceptual perspectives shall be the same. Within what chunks of nature our perspectives can be taken as the same must be ascertained empirically, following the principle that what is indistinguishable is the same. Two observers have the same colour when they point to the same colour. Two listeners hear the same note when they can repeat the same note. Our comparison of similarities is possible because we can occupy the same chunks of duration in nature. Of course if the observations are successive they cannot be the same by clock time, but the chunks of duration of nature are not controlled by the movements of our clocks. So far as the laws of the physical processes of nature are concerned, their span of duration is so large that we can take it to be constant for the purposes of our observation, provided we specify our frame of reference. Our quantitative units are practically stable within the same frame of reference. The earth-clock varies perhaps 1/1000 of a second in a century owing to tidal retardation, but this does not matter so long as our clocks agree.

Primary Perspectives and Secondary Perspectives

We have so far been concerned with primary perspectives—sense perspectives and perspectives which these imply as conditions of their existence and character. But we must also take account of another type of perspectives—those which have to do with substitution of stimuli and responses, with signs which owe their implication to the psychological history of the responding individual, which in turn implies the relation of the individual to the social group with its traditions, since it is only in social relations that words originate. We may lay it down as a principle that the rate of motion and the characteristics of the secondary perspectives do not as such directly affect the primary perspectives of nature, including the sense perspectives. Our taking account of nature does not alter nature, though we may alter nature through our executive relation to it and by so doing indirectly alter the perspectives of nature. Our faith may affect the circulation of the blood and the secretion of glands, and thus alter our organic sense perspectives, but our awareness of the organic stimuli does not alter them. We may by our executive control over nature change its physical contour, but our perceiving it does not alter it. The primary perspectives are events in nature, while the secondary perspectives, our judgements and interpretations of nature, are events in our personal history. The secondary perspectives do not affect the qualities of nature, but they affect the significance and value of nature. Our sense perspectives may indeed be affected by the history of our organism. Our senses become dull in old age. But this is not due to the psychological history of the observer, but to the physical history of the observer. A man's judgement has not necessarily deteriorated because he must wear spectacles.

Secondary perspectives involve a type of duration which we do not recognize in physical nature, viz. "mnemic causation," *i.e.*, cumulative duration in the sense of habit and memory. Secondary perspectives are not independent of the primary perspectives in the sense that the latter are independent of the former. Secondary perspectives presuppose sense perspectives as data for interpretation. Secondary perspectives also presuppose, within the present personal existence, the organic cycle of nature with its complicated structure and its specific span of duration. But they have in turn a certain independence of the primary perspectives. They are not mere functions of the course of physical nature, tied to its routine. Secondary perspectives are creative relations to nature, and so are the artificial sections into which we divide nature the better to observe and control it. Secondary perspectives are suggestions to nature, even though they may err in these suggestions. They single out the relevant aspects from the mass of primary perspectives. They, in short, enable us to see meaning and appreciate value in nature. The secondary perspectives, therefore, add a realm of great richness to the life of nature. We may call this the realm of mind. We cannot give a complete account of the perspectives of reality without including mental perspectives. They are, in a broad sense, part of the functioning of nature. It is misleading to speak of nature as closed to mind. What this means, presumably, is that the primary perspectives of nature are not functions of our psychological history. Their existence and character are independent of our interpretation. If this were not so, we should have no science of nature. But in the matrix of reality, nature is not closed to mind, nor mind to nature. Nature is open to mind in the cognitive sense that nature must appear in mental perspectives—the perspectives of meaning and value. Nature is also open to mind on the executive side, since mental patterns are energies, effective not only in adapting the organism to nature, but to a certain extent in making over nature, redistributing its energies into new ensembles, whether in the realm of subjective systems of value or in the realm of objective reconstruction, as in mechanics and art.

A great deal has been written about the privacy of individual experience. This point of view finds its extreme statement in Leibnitz's windowless monads. Bertrand Russell seems to follow Leibnitz in this respect:

> What we call the different appearances of the same thing to different observers are each in a space private to the observer concerned. No place in the private world of one observer is identical with the private world of another observer. There is therefore no question of combining different appearances in the one place.[19]

There seems to be here first of all a confusion between primary perspectives and secondary perspectives. We have seen as regards primary perspectives, viz., sense perspectives and implied perspectives, that we can occupy one another's frame of reference or space-time. We can observe the same perspectives simultaneously or successively in nature. Otherwise we could have no description. We can also occupy different frames of reference. We must, then, take account of the difference in the characteristics of perspectives when observed from another frame of reference. If our perspectives of nature were absolutely private there would be no way of comparing the similarities of simultaneous or successive perspectives of different

[19] *Mysticism and Logic*, pp. 153, 154.

observers and hence no way of correlating these perspectives into a common order of nature. Yet Russell assumes the possibility of such comparison and correlation.

> Two men are sometimes found to perceive very similar perspectives, so similar that they can use the same words to describe them. In case the similarity is very great we say the points of view of the two perspectives are near together in space; but this space in which they are near together is totally different from the spaces inside the two perspectives. It is a relation between the perspectives and is not in either of them; no one can perceive it, and if it is to be known it can be known only by inference.[20]

But how could two such solipsistic observers communicate by language and inference? Communication is possible because we find that our responses are the same to the same situations. We are able to use the same measures within the same frame of reference. If we are given a series of colour cards we arrange them in the same order. If we do not so arrange them, our difference is noted, and we are classed as some type of colour blind. We ascertain the aberrations of sense instruments in the same way that we ascertain the aberrations in other physical instruments. It is because we respond the same way within nature that we can conceive an order as common to us.

We live objectively and socially. It is an after-thought—and a rather modern after-thought—to differentiate our personal history from our interactions with one another and with physical nature. When we do make this differentiation we find that the sense perspectives and the implied perspectives of nature are independent of our personal histories. Or rather, it is the discovery that the situations in which we interact do not vary with our personal histories, which leads us to distinguish between primary and secondary perspectives. Secondary per-

[20] *Scientific Method in Philosophy,* p. 88.

spectives are abstractions from our integral relations to nature. We start with the objective interactions, and later, if ever, we become abstract psychologists. If we started with absolutely private spaces and times, we should never be able to ascertain similarities and differences in one another's perspectives unless we had some power of clairvoyance peculiar to such people as Leibnitz and Russell. It is true of course that we cannot live inside one another's skin, but neither do other interacting entities in nature. The important thing is that we can occupy the same objective spaces and times, *i.e.,* that we can live in the same frames of reference in nature. Our sense perspectives are physiologically projected with reference to an order of nature in which we must interact, and afterwards we come to recognize these relations in a halting way in our secondary perspectives of meaning.

We have tried to make clear that the supposed privacy of perspectives does not hold in regard to the primary perspectives of nature. Our sense perspectives can be investigated by the objective methods that we use in the physical sciences. It is not necessary to bring in the conception of a private consciousness in investigating sense facts. It is when we come to deal with secondary perspectives, with signs and their meaning, that the personal history of the individual becomes important. Are these personal histories absolutely closed to one another? Or are they only relatively closed, in the sense that physical things have properties which are not revealed in a specific perspective? There is more to the individual organization than can appear in any one perspective. There is also something unique in the response of the individual organization which must be taken into account as a fact of experience and cannot be predicted *a priori;* but this can be said also of the reactions of physical compounds. What seems peculiar to personal histories is that they are capable of a cumulative realization and of selective reaction on the basis of this cumulative individual history. But the character of this individual history appears in reactions to the common situations in the environment and, therefore, is not absolutely private. Our responses to common situations are integral responses, involving the whole history of the individual, mental as well as physiological. The mind of the individual is not outside these responses, but gives them their unique quality. Just as life is not something back of living behaviour and isolated from it, but is a unique quality of living behaviour, so mind is not something isolated from minded behaviour but is a unique quality of such behaviour, and known as such.

The privacy of mind is a fiction of an abstract psychology. Abstract thought created the false dichotomy of mind and nature; and, once having isolated mind from nature, made it more and more ghostlike and unreal, until finally mind has disappeared from psychology. Behaviourism consistently confines its description to physiological reactions and consigns the unreal sideshow which it inherited from the past to limbo where it belongs. But behaviourism has ignored the mental level of control and reaction. We cannot state human behaviour, at any rate, in merely physiological terms. It is only when we come to recognize through the dialectic of events that intersubjective relations are real interactions which must be included if we would give a complete account of behaviour that psychology will have a real place among the sciences of nature. This dialectic is working itself out by the necessity of giving an account of expression. Language is the dominating form of expression, though it is not the only one. We have also the more primitive types of physiological expression—the reactions involving the large musculature. We have the expressive media of art and technical construction. We can, as a matter of fact, give a very considerable account of human history before any language records are available through the technical products of man, such as tools, pottery and architecture. We can establish a serial order, with distinct epochs of development, in primitive civilizations where no language records exist; and we can trace the intercrossings of races and cultures. But language vastly increases our knowledge of human perspectives and their interrelations. All forms of social co-operation depend largely upon language. The cumulative control of the environment has been made possible by tradition; and tradition without language as we observe it in the higher animals must remain rudimentary. Man's personal perspectives have been largely controlled by social perspectives. The solipsistic man is a figment of philosophers. Could a man know that he had blue spectacles if he did not touch them? Perhaps not in a solipsistic world. But in our real world of interactions, we become aware of our idiosyncrasies, including blue spectacles, through our social relations. In fact, it is only in social relations that mental perspectives are possible. Social relations, including language, are as truly the medium of mental perspectives as air is the medium of sound.

It is because we can share the secondary or mental perspectives that we can have such co-operative enterprises as art and industry, not to speak of other co-operative enterprises. We can understand one another's plans and meanings from our behaviour to the common situations in nature. We can do this to some degree even without language, as some of us have learned who have travelled in countries where we did not understand the language. But we cannot establish any large co-operation without the use of descriptive language. We learn, moreover, to recognize that there is a difference in our secondary perspectives even when we act on common situations, and therefore we cannot say that the same stimulus will have the same effect on one individual as on another or on one individual at different times, though the organic characteristics of the individuals may seem constant. Hence the conduct of animals is more easily predicted than that of man. This difference in predictability is due to our ignorance of the personal history of the human individual. In animals, secondary perspectives play little part. Hence their conduct is comparatively easy to predict. But human behaviour is also predictable to a considerable extent. Meanings which relate to objective situations can be shared in the objective reference of signs. And on the structural side, the perspectives of thought are not so different but that we can discover a common procedure. These universal characteristics in the procedure of thought we abstract as logic. In the case of valuation the emphasis is more on the subjective organization or the personal history. Yet feelings and emotions as primary levels are highly contagious: they tend to arouse similar feelings and emotions in others. And even on the level of secondary perspectives there is some agreement in our valuations or we could have neither economic exchange nor art. Of course the correspondence of our personal histories both as regards meanings and values is due to our being part of a group with its controlling tradition. What we must not forget is that subjective perspectives do not exist in isolation from nature, but are creative adaptations of man to the cosmos. The trial and error process involved in creative imagination is different from that of inorganic and mere organic adaptation, but it is as genuinely a type of adaptation as they. Secondary perspectives are the result of social interaction, and therefore cannot be absolutely private, though we all recognize that they have a certain relative privacy. The reason that they seem more private than the primary perspectives is that they vary not only with the primary perspectives, but with the personal and variant history of the participants. We cannot, therefore, predict with the same certainty that an individual under given conditions will have a specific secondary perspective as we can predict that he will have a specific primary perspective.

It is through social relations that we are able to establish any considerable degree of correlation of perspectives within our experience. The correlation of the senses with each other is indeed effected for us on the primary level by means of habit. When we begin to reflect, the order of impressions in the sense of touch has already been correlated or identified with the order of the sense of sight, and the other sensations have been located in the space of touch and sight, or rather, in a normal person, in the space of sight. This correlation is functional, *i.e.*, through our acting upon the external world on the basis of our sense perspectives. That our sense perspectives imply an external order of events is a conviction, which is presupposed in secondary perspectives. Seeing is believing and so is all presence to the senses. The lowest animal has no doubt that the sense adjustments guide it to its food or away from a noxious external stimulus. The projection implied here may therefore be treated as organic. But outside of the correlations which we share with the humblest animals there are large classes of correlations involving judgement, thought and valuation. These are secondary or mental correlations of perspectives and these involve social relations. It is through social relations that we come to have the concept of a common objective order, with its correlation of perceptual perspectives and implied perspectives, in which we live and act. It must be noted that it is not the existence of the order of nature, but the recognition of it, the concept of it, which depends upon social interaction. It is the existence of it which forces the recognition of it. The order of nature is not a function of social participation, as Durkheim seems to think. But our knowledge of the order of nature is the result of social co-operation. We live in the order of nature and society before we become conscious of the significance of the fact. Then by the pressure of events in our common life we come to recognize this order. If we were really isolated in our living, we should never dream of establishing a common order in thought. The fact is, of course, we should not think if it were not for the problems arising from our interactions with fellowman and nature. And if it were not for language, which is the product of our need for communication, thought would remain at best rudimentary.

Mental perspectives are adjustments, or attempted adjustments, of man first of all to his fellowman and in co-operation with him to physical nature. We attempt to discover the meaning of our environment. We do not desire merely to live in interaction with it—the physical things and the animals below us do that—but we strive to retrace the perspectives of nature in our perspectives of meaning. We strive to discover significant relations—relations which we can employ as signs of other relations and thus anticipate and to a certain extent control nature, or at any rate our conduct within nature, on the basis of our experience. In so doing we are ever discovering new implications in the perspectives of nature, which enable us to correlate more of the facts of nature within our schemes of signs. Our secondary perspectives are at best abstract compared to the wealth of nature, but in this abstractness lies their convenience. For the most part they are but rough approximations to the order of nature, but they can only prove useful in so far as they are to some extent approximations. And in the process of creative adaptation we strive to make our secondary perspectives more adequate signs of the primary. We arrive at truth in so far as we conceive the relations in the situation of nature which our interest selects as they are in nature. Even though our purpose may be to reconstruct nature, we must first learn nature's ways. And pure knowledge has its own value, aside from practical ends. It is hardly necessary to add that many of our guesses at connections in nature prove to be spurious additions to nature and fail to survive. At best, truth is a trial and error process with only gradual and partial approximation.

We have seen that on the physiological and unconscious plane, the organism, as a result of the trial and error process of biological adaptation, responds by a native cerebral schema to the world of energies in space and time. But on the plane of creative thought we try to recreate in the world of social concepts the common order of nature. It is thus that we build up the constructs of a common space order and a common time order. This we substitute for the world of primary perspectives and forget perhaps that it is derivative, until some genius comes along who points out to us that our abstractions are only approximations. In our adjustments we learn that there are various personal perspectives which have their own sequence and their own characteristics, even though for some purposes they converge with our own perspectives upon common objectives. We learn, too, that in nature there are multiple structures, each with its characteristic complexity and its space-time pattern. A star figures not only in the perspectives, primary and secondary, of our experience. But it has a structure and history of its own, with its own perspective relations of parts and aspects to one another and to the cosmos. Or, to take a nearer illustration: a tree figures not only in our perspectives of sense and our perspectives of meaning, but it implies also a history of its own with perspective relations of the parts and aspects to each other within this history and its relations to the environment. By thus following the perspectives of nature and their interrelations in ever more comprehensive histories, we are able to extend the correlation of signs in our conceptual scheme.

Truth, error, and illusion alike have their ground in the use of certain aspects as signs of other aspects. Errors and illusions, as well as true judgements, are events in nature in the sense that they happen. They are efforts at adaptation just as are true judgements. The error or illusion in our meaning does not lie in the aspects that are present in our primary perspectives, but in their supposed implications in our secondary perspectives. Illusions are not confined to the supposed implications of sense perspectives. They may also have to do with implied primary perspectives. If a physician takes the temperature of the body as a sign of health, he may find that while the thermometer responds normally, the patient fails to recover. In illusions of recognition the appearance of a certain group of aspects is in accordance with nature. The association of these aspects with certain other aspects of a thing or a person is also in accordance with nature, for habit is part of nature. It is in the taking of certain aspects as signs of certain other aspects in our present relation to nature that we are sometimes mistaken and consequently have illusions. Such mistaken implication may vary all the way from ordinary cases of misplaced recognition at a distance, to mistaking a disturbance in the ear for the voice of a supernatural being. Illusions are due, therefore, to secondary perspectives. There is nothing illusory in the crooked visual appearance of the stick as seen in the water. The illusion lies in any one's taking this appearance as a sign of a crooked touch-aspect in the water. Touch and sight are different perspectives subject to different conditions, including the medium in each case, and there is no reason *a priori* why they should coincide. It has sometimes been said that touch is not a perspective sense, while sight is. This is not physiologically true. Physiologically the qualities of touch with their superficial and deeper strata are complex perspectives. As figuring in our perception they imply successive selection and discrimination on the part of the hierarchical central nervous system as well as the specific changes in the end-organs. They also imply projection to the space-time stimuli which act upon the organism. But the perspectives of sight and touch are governed by different laws. They never hold in the same respect, since an object which should touch the retina could not be seen. In visual perspectives, moreover, we must take account of the properties of the various media through which light passes, while the medium in touch—the intervening cells through which the end organs are stimulated—is normally constant in any one part of the surface layer. In the case of the stick which is seen as bent in the water, the perspective must be different because of the medium which refracts the light. In the end, the only way we have of arriving at truth in regard to the complex relations of nature is by the correlation of perspectives and of properties as aspects of perspectives.

Science and philosophy are both concerned with the correlation of aspects, the saving of appearances, to use a phrase of Plato's.[21] But the sciences, owing to the necessity for division of labour, divide the appearances into types, and each science investigates a specific class of appearances. The danger is that the scientist, owing to the limitations of his interest, often treats the class of appearances which he investigates as isolated, and not only neglects but, perhaps, denies the claim of other aspects of nature. The scientist who is preoccupied with physical perspectives may neglect mental perspectives. Philosophy should be an attempt to correlate perspectives into a whole of reality. It should attempt not only to save the appearances of nature but to show their relation to each other. Philosophy should be indeed, as Plato defined it, the love of the wholeness of things both human and divine. And, as Plato so truly recognized, this is sanity, whether in science or statesmanship. For it is not sane to emphasize certain aspects in isolation as though they were the whole. So long as we do this we live in a cave of self-deception. We cannot see the real implication even of the aspects which we do recognize. To see sanely and live sanely is indeed a difficult matter and beyond the possibility of attainment in our limited span of life. But it is the striving for sanity which must shed meaning, however fragmentarily, upon our task.

It is true that if we arbitrarily limited philosophy to certain abstract aspects of reality we might make a better showing at being scientific. There has been a tendency of late to identify philosophy with formal logic and formal mathematics. Philosophy on this view becomes a sort of abstract lexicography. Not that I mean to minimize the

[21] The conception of philosophy as the saving of appearances has been well set forth by Professor R. F. A. Hoernle in *Studies in Contemporary Metaphysics*, 1920.

importance of formal definitions. But the fact is that if we limit our mind to such formal interests we shall be living in a cave far more closed than that of the natural sciences, where the human mind is at present breaking through age long prejudices, with a new respect for appearances and a conscientious effort to find schemes of correlation more adequate to the order of nature. Philosophy must become what it aimed to be, in the great Greek period, an enormous induction of reality. In its effort to envisage reality as a cosmic whole, it is both the correction and poetry of science. It cannot afford to neglect the aspects emphasized by the natural sciences, but it must also recognize aspects which these neglect—the aspects of value and their correlation with one another and with the whole. The option of trying to create such a philosophy, if we want to think and live truly, is not only a momentous but a forced option, for a rational life implies some sort of philosophy. The philosophy which boasts of its one-sidedness is the dupe of its own egotistic illusion, whether it be logical formalism or materialistic naturalism. A thorough-going naturalism is bound to conserve all the perspectives. From the point of view of reality in its wholeness, the mental and spiritual perspectives are as natural as the material, which is only another way of saying that they exist as efficient aspects of the cosmos.

Whatever our partial emphasis may be, it shows lack of sanity. There can be no true understanding or salvation except in the wholeness of things. We may try to reduce everything to the matter-type of pattern, based especially upon the touch reactions. Again, we may try to reduce everything to the mental type of pattern, as we become conscious of it in our social relations and as we strive to find meaning in the world. But he that knows only matter does not know matter. He that knows only mind does not know mind. Only by doing justice to the claims of matter and the claims of mind within the whole of reality, shall we arrive at the truth of either of them. We may in our conceit suppose that there is no order in the universe except as our mind carves it out of the chaos of our sensations, forgetting that the pattern creative activity in us is but a trial and error response to the order of which we are a part, in which we interact, and by which our evolution is controlled. The æsthetic and spiritual pattern responses are adjustments to the environment as truly as the food and sex impulses. The emphasis at different levels of development and from different perspectives in a moving world will of course be different. Sometimes the emphasis will be on the unities and constancies, sometimes on the changing and individual events with their unique setting. At best, our selections are partial and relative. But all go to make up the whole and are functions within the selective activity of the whole. We start with a vague restlessness and with sensations changing and spread out. Then comes gradually a sense of discrimination and order, even as on a misty morning all is blended and confused, but with the rising sun details and perspectives appear.

I would not deny its due claim to any perspective of reality. The material perspectives have their basis in sense-experience, and in the implications of sense-experience. Their reality is confirmed by our practical adjustments. They are based upon real properties in space-time and a real order in space-time. While the properties vary in the diverse space-time perspectives and the diverse intervening media, they are independent of our personal histories. Both the properties and their order are truly objective. It is this fact that makes it possible for us to co-operate in our observations of nature and in our conduct within nature. If the properties and their order were the contribution of the individual percipient, such co-operation would be impossible. Nor can we say that they depend upon "consciousness in general," a sort of standardized social mind, for we have discovered space-time perspectives in nature—in geological evolution for example—before mind or even life can be predicated of our earth. The material perspectives have a reality of their own, and we cannot give a complete account of reality if we ignore them nor can we act effectively. The material world is just as real as it appears to be—and just as variable.

But while we have no right to deny reality to material properties and the perspectives in which they appear, we have no more right to deny reality to other properties and other types of perspectives which are not material. Since touch seems bounded by the skin, we have been prone to bound reality that way. But we must recognize the reality of social relations as truly as that of gravitational or electromagnetic relations, and social relations cannot be truly stated in material terms. There are mental perspectives as well as material perspectives—perspectives of active interpretation, of complicated adjustments to the future on the basis of the past duration. The mental motion from past to future is different from material motion. There is in the former case significant implication from the past to the future. Sections are made of the stream of duration, properties and relations are abstracted from the concrete flow, the better to observe the tendency of this flow. Abstract perspectives of this flow, such as space and time and abstract sections of the space-time flow, have their empirical constants too—the interests and laws of mind which set the postulates for our ideal construction. They are part of the trial and error procedure of mind to know its world and to act upon it. And mind is part of the creative advance of nature. We must recognize such perspectives as truth, beauty, and justice as well as material perspectives. Nor should we slight the material perspectives. A deeper insight will show that soul needs body as much as body needs soul.

Since reality is energy, it can be known only in interaction and interaction implies space-time. It is futile to ask about substance in the abstract or qualities in the abstract. Substance is but a name for the recurrence of qualities—for the enduring of an energy structure and its types of reactions. But energy systems never exist *in* *vacuo*. Motion in isolation is an intellectual abstraction. Energy is what it does and we can discover what it does only in integral situations. All the perspectives of nature are equally real, though for executive purposes we may emphasize certain aspects as more important. The distinction of primary and secondary qualities has relevance only from the practical point of view of prediction. There is no rank of qualities in reality. In reality we must note the properties within integral situations. The implied perspectives, *i.e.*, the properties in integral situations where there is no percipient agent are as real as those where there is a percipient agent. We must interpolate the former in order to understand the latter. The wood burns to ashes whether we watch or not, but in our cognitive schemes we weave the implied perspectives into a common world with our perceptual perspectives in order to give a consistent account of the world. We supplement our fragmentary experience with hypothesis and inference.

Entities, whether physical or mental, are known as constants in perspectives and possible perspectives. They do not exist in isolation. They are never neutral in reality. Of course entities which are mere fictions of our constructive imagination are neutral so far as the perspectives of nature are concerned, but even then they exist as constants in the perspectives of imagination. All perspectives must have their relative constants. Else there can be no prediction, no reading of events. Entities are what they appear to be in perspectives. They are but groups of aspects. Matter is what it appears to be in sense perspectives and in other perspectives. Mind is what it appears to be in mental perspectives of meaning and value. The latter presupposes mnemic causation, *i.e.*, the enduring of past functioning as memory into the present. They also presuppose social relations, of which language is an instrument, for their elaboration. Mental perspectives have been called secondary perspectives in contrast with sense perspectives and implied perspectives of nature, not because they are less real as perspectives than the primary, but because they presuppose these and make creative additions to these in the way of artificial constructions in order to interpret them. So far as these mean primary perspectives and aim to construe and predict them, they must be verified in terms of the primary perspectives. They may, however, be free constructions of the creative activity of mind. They then involve no control except that set by the constitution of the mind. Mental perspectives have their own characteristics and history. They do not belong within the class of perspectives to which we give the generic name of matter. But the diverse classes of perspectives, while distinct in kind, are not closed to each other. They intersect under conditions which can be established by scientific evidence. We thus get rid of the cumbersome theories of parallelism and of divine intervention as regards the relations of different types of perspectives. Of these theories, the former is a mere confession of ignorance; the latter attempts to explain by bringing in another assumption. All perspectives must intersect mental perspectives if knowledge is to be possible. So far as the perspectives of nature are closed to our knowledge, we have no evidence of their existence. But their relation to knowledge is for us at any rate a relative matter. Large fields of nature which have been isolated from our knowledge are being opened to it and vast fields await discovery, and some relations of nature may lie permanently outside the possible perspectives of human nature. The relation of nature to knowledge is not a relation of absolute dependence.[22]

Reality is what it appears to be in space-time perspectives. We must hold with Hegel that the real appears, and with him we must find the ground of appearances in reciprocal activity. In the past we have been prone to ignore time and to treat reality, including our own opinion, as eternal and absolute. Now we have found that we can-

[22] For a masterly statement of the Hegelian hypothesis see Lord Haldane's *The Reign of Relativity*.

not define reality without taking time into account, even for purposes of astronomy and mechanics. We must not mistake the seeming immediacy of facts to introspection for immediacy in causal perspective. The causal relation is a space-time relation. We do not see stars immediately but we see stars of a certain distance and a certain date. Time figures as a factor in all real perspectives. We live from perspective to perspective, and all our reality is relative to perspectives. He who asks for things in the abstract and properties in the abstract asks for an empty fiction. Such entities would indeed be neutral, since they would be nothing at all. We can sometimes vary the perspective. We can make it larger or smaller, nearer or farther, but we cannot get rid of it. All facts, whether properties, lengths, time-intervals, or values are facts of adjustment. They are what they are because of the guiding field with its space-time perspective and empirical determinants. Our personal perspectives though not isolated are in fact unique, non-integrable, but for practical purposes we can treat them as Euclidian, *i.e.*, we can apply common measures and co-operate for common ends, since they are adaptations to the common world of action. By thus applying common yard-sticks to one another's perspectives, we gain no doubt in efficiency for action, but we may miss the concrete significance. And as we generally strive to enforce our measures upon others, we fail of the enrichment from other peoples' point of view. But above our finite varying perspectives with their kaleidoscopic effects, there is the form of the whole, the law of equilibrium, the guiding field in which our perspectives exist. This is largely an article of faith, but every consideration, material and spiritual, points to it.

Consciousness and Perspectives

In speaking of primary perspectives and secondary perspectives, I have said nothing about consciousness. The fact is, that so long as we are dealing with integral reactions, we do not find it necessary to say anything about consciousness, for consciousness must be included somehow within the concrete interactions if these constitute reality. If consciousness is included within the perspectives of reality, either as the whole of which the various perspectives are parts, or as an aspect of perspectives, then it is misleading to say that the perspectives of nature are independent of consciousness. But we cannot say what is the relation of consciousness to the perspectives of nature until we have defined consciousness. It is a striking and discouraging fact that while philosophers have had a great deal to say about consciousness, they have not stopped to make clear just what difference consciousness makes to the perspectives of nature. Is it an entity or is it a relation? If it is an entity, does it figure in complexes with other entities? Or does it exist in isolation? Is it a type of energy? Or does it belong to another class of entities? Is it "another general name for the acts of mind, which in their relation to other existences are said to be conscious of them as their objects"? [23] Or is it something distinct from mind, so that we can say that the mind may be conscious or unconscious? Is it an indefinable quality like blue? Or is it a quantitative relation of which there can be more or less? But even if it is a quality like blue, we can at any rate distinguish blue in relation to other qualities and we can make distinctions within blue by arranging the hues of blue in schemes, and we can define the kind of perspective in which blue appears. Can we do so with consciousness?

The trouble with definitions of consciousness is that they are vague and circular. Consciousness is sometimes defined as awareness, and awareness is said to be neutral. But awareness is only another name for consciousness. The term awareness implies a relation. It implies something that is aware and something of which this is aware. If awareness is a relation of mind to something else, awareness cannot be identical with mind. Can we be sure that minds are the only things which sustain the relation of

[23] S. Alexander, *Space, Time and Deity,* Vol. I, p. 12.

awareness to other things? Or can things which are not minds sustain the relation of awareness to one another? If we mean by awareness significant awareness—judgements, conceptions, inferences, appreciations, volitions—then we must limit awareness to mental or secondary perspectives. But are we not arbitrary in thus limiting the term? We cannot say until we know what we mean by the term awareness.

Consciousness seems at best a confused concept, yet somehow we do not seem able to eliminate it from the discussion of reality. In her brilliant and suggestive book, *The New Idealism,* May Sinclair makes an advance in the definition of consciousness by distinguishing between primary consciousness and secondary consciousness: "Primary consciousness is the whole block immediately present in consciousness, before reflection, or any sort of secondary awareness, has got to work on it." [24] We cannot, according to Miss Sinclair, distinguish consciousness from this primary immediacy of sensa or primary acts of will or involuntary association: "Until the secondary act of reflection has taken place it is impossible to shave off the thinnest slice of pure consciousness from the primary block, so entirely is it one with its object. Object and consciousness are given whole in one indivisible act or state." [25] The more intense consciousness is, the more convincing is the absorption of consciousness in the object. In the case of the primary facts of experience, then, consciousness seems to be an inseparable aspect of the facts: "The razor blade of analytic thought can only get in between it and the secondary act. It can, that is to say, only distinguish between consciousness and consciousness." [26] We can only distinguish secondary awareness from primary awareness. It is impossible to regard the awareness as independent of the sensa of which we are aware. In this I am inclined to go a considerable distance

[24] *The New Idealism,* p. 275.
[25] *Ibid.,* p. 275.
[26] *Ibid.,* pp. 276, 277.

with Miss Sinclair. But before we can get anywhere, we must make clear what we mean by consciousness.

When we try to discover, in the mass of verbiage concerning consciousness, some defining characteristic, there is only one aspect that stands out, and that is the aspect of selection. Consciousness in psychological analysis is bound up somehow with emphasis and corresponding inhibition; with clearness and distinctness; with attention and orientation in relation to certain events. It is an aspect of adjustment and therefore varies with the field of adjustment. To be sure, psychology has been concerned with secondary consciousness primarily, *i.e.*, with the judgements and attitudes of the mature man. Hence it presupposes a certain kind of duration in the way of habit and memory; and adjustment comes to mean a definite type of implication from the past to the future. But even the old psychology recognizes limiting cases of pure perception where the secondary structures which have to do with meaning are kept in abeyance and where the awareness at least approximates to Miss Sinclair's primary type. In any case, since the individual who is to discriminate between the primary and secondary consciousness necessarily functions in so doing as a secondary consciousness, it is not so easy to get a razor blade between the secondary and primary consciousness as Miss Sinclair seems to think. It is only in some cases of transition as in waking up from a shock or swoon or deep sleep that we seem to be able to catch the transition from the primary to the secondary types of consciousness. And here we cannot have the primary consciousness quite pure, since the primary consciousness does not judge and the secondary consciousness cannot judge until it is superimposed upon the primary.

The problem becomes simpler when we study behaviour objectively, though in studies of this kind the term consciousness has generally been avoided. In objective terms, as in the study of the behaviour of animals of various grades, including the protozoa, we can determine whether the selective reactions are strictly physical, such as tropisms, whether they imply habit, whether they also imply reproductive association, and whether in the highest animals they imply some rudimentary form of judgement and inference. But in judging human beings as well as in judging animals, we must understand consciousness in terms of adjustment; and we are notably more successful in judging others than in judging ourselves. The stimulus-response method, if taken in its broadest sense so as to include social interstimulation, is the only scientific method in psychology as in other sciences, though we may gather interesting collateral evidence in the former case from the introspective interpretation which the subject makes of the stimulus-response relation, even if this is often mistaken.

It may be noted that Miss Sinclair's primary consciousness coincides largely with the primary perspectives in the previous pages except that she does not recognize the existence of implied perspectives which are not perceptual perspectives. Her secondary consciousness corresponds in the main to the class of secondary or mental perspectives. This correspondence has more than passing interest. If we are able to give an account of reality in terms of perspectives without using the term consciousness, it seems that consciousness, if it has any place in an account of reality at all, must be an aspect of perspectives. It may, I think, be conceived as a universal and inseparable aspect of perspectives, namely, the selective aspect which is implied in all perspectives. All perspectives imply, as we have seen, a space-time structure from which and a space-time structure to which a selective response is made, with due allowance for the medium in which the transaction takes place. Miss Sinclair recognizes that in some sense there are perspectives in the past and in the present which are not human perceptual perspectives. These must, however, on her principle be regarded as conscious perspectives since consciousness is inseparable from reality. Selectiveness seems the only function or character which is inseparable from perspectives of all kinds.

If we identify consciousness with the selective aspect of perspectives, then consciousness is indeed universal. We may say that the magnet is aware of the entering of the lodestone into its field and takes account of the direction and distance of the lodestone. Physical things "take note" of one another's presence. Chemical elements, entering into compounds, take account of one another's quantitative and qualitative characters and the temperature, electrolysis, and other conditions of their synthesis. We have indeed the high authority of Lotze for using consciousness in this generic sense, though we must guard against the animistic implications of Lotze's philosophy. In order to have interaction in nature of any sort, whether inorganic, organic, or mental, it is not sufficient that certain factors are compresent in time and space; they must be sensitive to one another's presence, take account of one another's presence, be different somehow for the compresence of the other factors. Else the other factors might just as well not be compresent. As Lotze says:

> If things are to take a different course according to different conditions, they must take note whether those conditions exist or no. That difference of conditions, consisting in the fact that at one time *a* is, at another is not, must make a difference for *b* itself, not merely for an observer reflecting on the two; *b* must be in a different state, must be otherwise affected, must experience something different in itself when *a* is and when *a* is not.[27]

This holds wherever we have causal determination, for here we must account for how *a* becomes α and *b* becomes β by virtue of this relation. And this cannot be accounted for unless the compresent factors take account of one another, and not only take account of one another in general but of one another's qualitative and quantitative characters in space-time.

Such discriminative, determinate reaction is character-

[27] *Metaphysics,* Vol. I, p. 45.

istic of nature throughout; and this is what makes it possible to predict nature. If we treat the selective compresence of fields of energy in nature as awareness—the adjustment of the magnetic needle in a magnetic field, the adjustment of a body in a gravitational field, the selective responses of neurones in the spinal cord to sense impulses, the selective cerebral schema, the selective responses of meaning and volition—we shall have a tremendous methodological advantage. We shall no longer have the cleavage between consciousness, on the one hand, and the unconscious, on the other. Nor shall we be confronted with the paradox of deriving consciousness from non-consciousness which confronts us otherwise in every genetic series, not only in geological history but in every individual history and in the transitions within individual history from sleeping to waking. We can then account for secondary consciousness as what it is, viz., significant awareness which is made possible by superimposing, upon the primary physiological perspectives, a new type of structure with a new type of duration and new methods of creative synthesis and differential response. This type of structure, in turn, implies social organization with its symbolic signs, its tradition, its tensions and necessities for adjustment. The degrees of freedom vary with the complexity and so does the character of the duration. For it is only in connection with the most complex structures that we can perceive cumulative duration. In inorganic matter the duration is practically static for us creatures of a day, while in the more complex organic and mental structures we have cumulative functional adjustment, with corresponding complexity of behaviour.

Consciousness, as we conceive it, takes its place with space, time, energy, and structure as one of the universal categories.[28] These are abstractions which we make from the concrete history of nature in order to describe it. In order to describe its flow, we require the metric conceptions

[28] See *A Realistic Universe,* Macmillan, 1916, for an account of these categories.

of space, we require the concept of duration or passing which we quantify into clock-units and combine with space units, we require energy constants, and we require structural levels. But where does consciousness come in? Consciousness is the aspect of sensitiveness, of taking note, and is implied in all action. This taking note is preparatory to action. For in every action there is the sensitiveness to outside stimulus, there is the unique structure which determines what sort of action shall take place, and there is the response itself. The stimulus-response conception of action emphasizes the end-terms of the action. But the same stimulus may give rise to vastly different responses and different stimuli may give rise to the same responses, according to the structure of the interacting factors. The complete relation, therefore, implies stimulus-structure-response. It is true that in inorganic nature awareness and response are in fact indistinguishable. They are only logically separable. But even in the inorganic realm, while the reaction begins with the awareness, the full action requires time. There is the inertia of the structure of the reagent to be overcome. In simple organisms there is an observable slowing up of the action between stimulus and response, owing to the complexity of organic compounds. It is, however, in complex organisms that the retardation between the awareness of the stimulus and the overt response becomes striking. With the development of a nervous system with its complicated structure and its new types of duration in the way of reflexes, habits, and memory, there arise conflicts of responses and a reintegration is necessary before the response can take place. The conflict may be of various levels. It may be a conflict of hereditary impulses, such as the hesitation we notice in a child between the tendency to stroke a dog and the tendency to move away, excited by the dog's growl. It may be a conflict between custom and hereditary tendency, as in the child's impulse to satisfy its hunger and the delay required by table manners. It may be a conflict between memory tendencies with their emotional colouring, as in the blocking of a name we are trying to recall. It is only on the mental level of organized meaning and creative experimentation that the delay takes the form of significant analysis and reconstruction. But throughout the various levels of action, from inorganic to reflective action, awareness is an essential aspect of action. The complete action, in any case, includes both awareness and response, though it is only where there is noticeable delay between the first awareness and the overt response that we usually discriminate between the awareness and the response.

Perhaps I ought to say a word further about the relation between consciousness and energy. Does not the concept of energy include consciousness as we have defined the latter? That depends, of course, on how much we make the word energy mean. If we mean by energy all activity, kinetic and potential, it would include not only consciousness but all reality. For activity in the concrete is reality. But for the understanding of reality it is necessary to analyze the concrete action and to abstract certain aspects such as the spatial aspect, the temporal aspect, and the energy aspect. When we use energy in the strict scientific sense, it is no longer synonymous with action as in popular parlance, for then it would include time and space, etc. For science energy is only an aspect of action. It emphasizes not change but constancy. It figures as an empirical constant in our equations. It finds its general statement in the law of conservation of energy. According to Einstein's conception of energy it includes inertia, which also figures as an empirical constant. Energy and inertia are only two ways of looking at the same aspect of reality—the same aspect with different signs. We speak of energy as inertia when we are interested in the superimposing of a new motion or a new direction of motion. As a matter of fact, everything is in motion and is part of fields of motion. Everything has its energy character. With the new conception of energy, we can reduce matter to energy, for by matter we mean certain constants in the empirical exchanges of nature. It is clear, then, that while action in the complete sense includes consciousness as well as space, time, etc., we cannot say that energy includes consciousness. Consciousness is an aspect of an activity system. It belongs to reality, wherever there is exchange, reciprocity. And as every part of reality exists in some bond with other parts, there is always consciousness. But not every part of reality is sensitive to every other part. The opposite of consciousness is inertia. Some atoms are spoken of as inert because they have not, so far, been stimulated to chemical exchanges with other atoms. But no part is wholly irresponsive. Matter at least responds to gravitational fields if it does not respond chemically. In a sense we can say with the ancient poet-philosopher, Xenophanes, that reality sees all over and hears all over. It is sensitive everywhere to some relations, even though it does not except in parts have differentiated organs for specific responses.

Consciousness, like the categories of space, time, energy, and structure is a class concept. Just as there is no extension in general or duration in general or energy in general or structure in general, so there is no consciousness in general. As we give up the Newtonian conceptions of a uniform extension and a uniform duration, so we must give up the Newtonian conception of a uniform sensorium of nature, co-extensive with infinite space. Consciousness, like extension and duration, must be described in terms of a Gaussian geometry. The real nature of awareness varies with the structure and motion of the fields where it appears. Consciousness, like length and duration, is a character determined by adjustment. Its curvature varies with the character and motion of the interacting fields. It is retarded or accelerated and its quality is altered in the creative passing of nature. It is fundamentally non-integrable. Consciousness is then relative, varying with the interacting factors and fields and their relative motion. It is a different consciousness with every variation of the perspective of which it is an aspect. How various in quality and value! How it shifts and trembles like evening shadows!

If we start with consciousness in general as an extensive abstraction, then we may, of course, think of the particular unique awarenesses or instances of selective adjustment, with their unique taking note, as staining the general consciousness. We may even from the point of view of such an abstract realism regard the various perspectives as facts of consciousness. We may speak with Miss Sinclair of a "tree of consciousness," regarding consciousness as a universal container from which the concrete world is carved out. But this is inverting the true order of nature. There is no more a consciousness in general than there is a colour in general. And the similarities of consciousness must be determined in the same way as we determine the groupings of colours. There are, as a matter of fact, not a colour, blue, and consciousness, but a selective response which we call blue, and so with every other quality of reality. The awareness is an aspect of the selective response and inseparable from it. And as the selective response is non-integrable, so is the awareness. We are too prone to ignore the difference in quality in individual relations and to reduce them to quantitative collections. To a certain extent we must do this, and when we deal with the simpler orders of reality it is, aside from questions of beauty, a question of convenience. But in the realm of human relations this ignoring of quality and reducing individual facts to quantity becomes the very essence of immorality. And distinctions in beauty have their claim too as well as distinctions of morality.

I cannot conceive how the sense qualities could be transmitted from some great reservoir of consciousness and merely canalized by our sense organs and nervous system. In social communication it is not other peoples' sensa that are transmitted from one mind to another. But the sensa are correlated with common situations. This correlation may be instinctive or it may involve inference. The sense-qualities are in any case functions within perspectives. They are canalized, not in the sense that they pre-exist, but in the sense that they are characteristics of determinate perspectives of nature, implying specific space-time stimuli, sense organs, and nervous system. If we regard the sense organs as mere vehicles for canalizing pre-existent sense qualities, what is to canalize the sense-organs? We cannot escape reference to matter in some way. Have we any reason, moreover, to suppose that for a superconsciousness qualities are not functions of the various perspectives of nature in which we know them—that colour does not involve the reaction of a photo-chemical film in or outside the eye, that the curvature of light in the neighbourhood of matter is not what it is for us but is a curvature of thought? From what we know within our own experience of nature, there is no reason to believe that the primary perspectives, whether sense perspectives or implied perspectives, are altered as regards their character and order in cognitive perspectives. Blue does not alter its colour by our thinking about it or analyzing it in thought. The idiot and Newton probably have the same sense perspectives, though they are almost an infinite distance apart in the range and comprehensiveness of their secondary perspectives. In the last analysis the primary perspectives owe their character to adjustment to the cosmic field of control in which they eternally move. This field of cosmic control is not something externally superadded to reality, though it may be superadded to our consciousness of reality. Within this ultimate field of control all perspectives have their definite function determined—in part by their own nature, in part by the cosmic control within which they move.

The concept of mind now becomes an intelligible concept. Mind must be conceived as a certain type of structure, known by its interaction with other structures, mental or physical. We are justified in speaking of perspectives as mental, whenever we find significant interfunctioning, actual or potential. The mental perspectives are no more constituted by consciousness than the gravitational or electromagnetic. But, in any case, consciousness is an inseparable and essential aspect of the perspective relation. That consciousness is different in the secondary perspectives from what it is in the primary perspectives of nature is due to the structural character and unique duration of mental structures.

If we define mental perspectives as perspectives which involve the psychological history of the individual, in contrast with primary perspectives which vary independently of this history, it is clear that mental perspectives are vastly more variable and more difficult to predict than the primary, for they vary not only with the primary but with the personal history of the interpreter. They do not constitute a simple type, but rather a class concept, including various types and grades of significance. They include both the intellectual and the æsthetic types of valuation, and both types have various degrees of clearness. The introspective attitude towards the process of valuation still further complicates the process, but is, after all, only one type of secondary perspective and not the only type as some have erroneously supposed. We do not take the introspective attitude in analyzing other individuals' significant responses nor in analyzing the products of mind, those of our own mind or other minds. We may call introspective attitudes mental perspectives of the second order. The critical evaluation, again, of these introspective judgements we may call mental perspectives of the third order and so forth. If we speak of the process of judging as being awake, as Bosanquet does, there are evidently different degrees of being awake. These degrees have reference to the organization of our judgements. The ideal of valuation is that of wholeness, in which our various judgements shall be correlated into a complete interpretation of reality. The ideal of wholeness is relative, however, to our human point of view which is itself part of the creative passing of nature and relative to this passing. We must not mistake our dogmatism for the absolute. There is nothing absolute but the law of the whole, and this we can only realize in human perspective.

Since we cannot reduce mental fields to gravitational fields or electromagnetic fields, any more than we can reduce gravitational fields and electromagnetic fields to each other, therefore we are justified in speaking of a cosmic mental field as we speak of a cosmic gravitational field. As we conceive matter as moving within a gravitational field and within an electromagnetic field, so we may conceive it as moving within a mental field. It seems that matter plays the important part of the mediator, both in the availability of electromagnetic energy and in the availability of mental energy. But the differentiation of media and types of energy is after all a classification of functions and our human experience is too truncated to make dogmatic assertions of the upper levels of energy.

Do not suppose that mind is made less real because we must approach it from the side of function. We have no knowledge of anything except through function. Matter and electromagnetism are merely class names for functions. Neither must we be deceived by language into supposing that mind is one generic affair. We have now learned that events in gravitational fields are uniquely determined and non-integrable. The same is true in the electromagnetic field. In each case, to be sure, we must assume a cosmic guiding field, a world curvature. But this in no wise abrogates the reality of the individual fields and the individual events within these fields. On the contrary, we can see in the case of matter that the total curvature is dependent upon the functioning of the individual fields and their relative distribution. The cosmic control must operate upon individual motions with their inertia, and these do not lose their individuality when curved within the larger control. This holds equally for the significant mental fields with their unique duration. Mind is exchange, interaction, not an abstract absolute, though there must exist a higher level of mind than our mind to account for the evolution of our minds and our sense of limitation. Certainly it is not our mind which makes the objective order of nature which we interpret in knowledge and appreciate in beauty.

Nor must we suppose that mental perspectives are less real because they presuppose a highly complex organization of matter and electromagnetic energy. The fact that we presuppose a certain organization and motion of matter and electricity to make mental interactions apparent is no more an argument against the reality of mind than the fact that we are dependent upon the organization of matter to make light apparent is an argument against the reality of light. It is because light, and radiant heat, etc., reveal themselves as having unique properties in their action upon matter that we believe in the reality of these types of energy. And so, for the same reason, we must believe in mental energy as a unique type, since we cannot reduce it to matter and electricity. In the meantime we must remember that the cosmos is eternally the interrelation of these and other types, little as we know about this interrelation. One thing is certain—they are plural and they effect energy exchanges with one another, without one type being changed into another. Their quality is constant.

If we make experience, *i.e.*, the relation of experiencing, so general as to cover all taking account of one fact by another, then we may well say that there is no fact which is not experienced since there is no fact or aspect of the real world which is not part of a field and in energy relations to other facts in space-time. In this broad sense to be is to be perceived. But this is broader than the sense we usually have in mind. Berkeley humanizes reality. To him things must exist for minds such as the human mind. By experience he means human experiencing. He humanizes God as well as nature, as the epistemological idealists have always done. But if we attribute the compresence of experiencing to nature in all its stages, we must strip it of anthropomorphic implications. The quality of the experience relation depends upon the organization of the factors which enter into the relation. We must not ascribe mental experiencing to those parts of nature which lack the structural qualifications for such experiencing. But all are part somehow of the control of the whole.

Reality as History

History is the fundamental type of reality. All other types are abstractions in various degrees from it. Physical science in the past has carried on its measurements on the basis of nature-at-an-instant, but now it turns out that even for the abstract purposes of physics and astronomy we cannot ignore time in our measurements. Our measurements and laws of nature are empirical. They hold only for certain conditions of motion, pressure, temperature, electromagnetic field, etc. We know now that these conditions are relative to the passage of nature. The laws of science are valid only for certain chunks of the duration of nature, and these chunks must be ascertained empirically and differ for various types of duration. The theory of relativity shows the necessity of taking account of time as well as space. Our statements of reality must be four-dimensional.

It must be clear now that time is the crux of the problem of relativity. If it were not for time, there would be no problem of relativity, for there would be no variation of perspectives. In a timeless world there would be no motion, no prediction, no adjustment. We should have still life, minus the life. But in fact our perspectives vary with time. Time is an ingredient in reality. It affects our qualities and our measures. We live from chunk to chunk. The varying perspectives are non-integrable, as Weyl has shown. Our transformations from one space-time perspective to another are therefore pragmatic in the real passing of nature. The real path is the result of adjustment in a four-dimensional world. We discover empirical constants which make it possible for us to read some order from next to next, and so we have a certain degree of prediction for practical purposes. But we have no reason to suppose that these empirical constants are absolute.

Time is the passage of nature. If reality were nature at an instant, a statement concerning nature would be eternal. Of course an instant is itself a limiting abstraction from our temporal world. The conception of nature at an instant could have meaning only in a temporal world. It is because reality is temporal that we can establish such limits as instants; but because reality is temporal the description of nature at an instant is insufficient. We require, even for the abstract purposes of the physicist, an indefinite number of descriptions. When we speak of the passage of nature we refer to the intuition of time. The significance of time may be stated in intellectual terms as follows: Time is that character of reality which makes necessary an indefinite number of descriptions in order to define reality.[20] It matters not for our purpose whether the passage of nature is primarily physical or primarily psychological, or both physical and psychological; in any case it makes necessary a new statement of reality. We have here nothing to do with the device for quantifying the passage of nature into clock intervals and giving time a numerical value, though this device has its convenience for purposes of description. We are dealing here with what Einstein calls "the physical significance of time" or what we should call its metaphysical significance, since it holds for all domains of reality. This has reference to the instability of the structure of reality or what Professor Whitehead calls the creative passage of nature.

In real history, as contrasted with the abstraction with which physical science deals, the past endures. It is not true, as in the abstract view of chemistry, that any number of step-compounds make no difference to the new synthesis. Where we have real duration, structure carries a twist from the past and this affects future behaviour. We have some indication of the enduring of the past in the different

[20] See *Time and Reality*, 1904, Chapter I, and *A Realistic Universe*, 1916, Part IV.

reaction of steel, when it is magnetized, but it is in the organic and psychological passage of nature that the persistence of the past as a condition of new synthesis is most potent to our limited observation. We see it in the realm of biological heredity in the cumulative duration of variations and in the inertia which this duration offers to interbreeding. We cannot cross species; or if we can cross kindred species, as in the case of the horse and the ass, the result is sterile. We see it in the social realm in the cumulative structure of civilization and the inertia which tradition offers to new social syntheses or assimilations. But if this is inertia from the point of view of a new synthesis, it is also a condition of advance, for without this cumulative duration there could be no progress. This duration in physical nature generally has such a large span that it is apt to escape the observation of us creatures of a day.

The phrase, the creative passage of nature, needs definition. While all nature is passing, all the passage of nature is not creative, at any rate if we view it piecemeal as we must in human experience. There is a great deal of passage to and fro in the Brownian movement—the passage of molecules in dispersion. But it cannot be said to be creative passage. A great deal of the motion in our own lives is restless hurrying to and fro without creative result. The mere passing over space does not mean creative duration in time. The theory of relativity deals with nature in a purely quantitative manner. It spatializes time, as Bergson would say. We have a four-dimensional ordering of events in which time is interchangeable with the dimensions of space. Motion is lost in numerical relations, as it must be if we deal with motion as an intellectual abstraction. But there is no passing of nature in the abstract. It is always a concrete passing, a real duration, determined by empirical conditions and canalized by the curvature of the whole. The abstract limit of the passing of nature is symbolized by Newton's first law—the law of persistence. Here we have pure passing, with no intrinsic alteration. But, as Einstein has shown, and Newton and Hegel long before Einstein, such pure passing is indistinguishable from rest or no passing. In the real passing of nature there is no absolute relation between translation over space and creative duration. The two are not functions of each other. Our translation in space with the earth, which is the basis of our time measurements, does not necessarily make any difference to our psychological duration—our habits, meanings, and purposes. The concrete throbs of our psychological existence are not functions of the divisions of clock time. We must keep in mind, too, that real space is not our quantitative units of measurement which we abstract from the extensive qualities of things, but the medium which conditions the motions of our extensive things; and real time is not the conventional intervals of clocks, but the real passing of nature, of which our clocks serve but as artificial measures, though useful for social co-operation. Real space is not divided by our yardsticks. The real passing of nature is not divided by our clocks. It has its own rhythm, its own blocks of duration, its own retrospect and prospect which we must learn to respect. The actual passing of nature involves interaction and creative synthesis. It runs its cycle in obedience to the law of the whole. It has various qualities of duration—inorganic, organic, psychological—which we must discover empirically and cannot deduce from quantitative space-time.

The passage of nature is not a simple affair. It is not a one-way process. The downward path in nature and the upward path exist together. The passage of nature means dissolution as well as creative synthesis, as Professor A. Lalande has so well shown in his work, *La Dissolution*. In reality dissolution and creative synthesis must go on together. They are complementary aspects in fact, though separated in our attention. For in nature creative synthesis is made possible by the dissolution of the existing structures. Sometimes we may regard the existing structures as step-compounds, in the language of chemistry, but a new creative synthesis involves in any case the dissolution of the bond of the past. The rearrangement must be thorough. The new synthesis is a new pattern-distribution of the components. Nature always passes from synthesis to synthesis through dissolution. One must die to be born again, is a fundamental law of nature. Therefore we must take account of the dissolution of nature as well as the synthesis of nature. Sometimes the dissolution is the dominant phase and the synthesis is hidden for us in the future. So far as our circumscribed human interests are concerned the dissolution may seem final. But in the large, and from the cosmic perspective, the dissolution is a phase of the creative advance.

The reality of history implies plurality of structure as well as motion. For if reality consisted of only one block, one system, whether it be material or psychological, even though we conceive it as in motion, we cannot conceive it as knowing that it is in motion. Such an isolated system would presumably move uniformly according to Newton's first law. And for that reason it would have no way of knowing whether it were moving or stationary. It would remain self-identical. It would cumulate nothing. There could be no development, no creative advance. Even if such a block were conceived as complex, no part could contrast itself with the whole, for the part would move with the impulse of the whole, in a uniform relation to the whole, and therefore could not possibly distinguish itself from the whole. For if it should move independently of the whole, this would mean that it has an impetus of its own which is not communicated by the whole. A single field of motion could, of course, notice its motion if it were accelerated. But it could not accelerate itself. An impetus must be encountered from another field of motion. In physics we might say that the motion enters a gravitational field.

One thing is certain, there can be no distinction of parts, no cumulation of structure, no creative passing of nature unless we have a pluralistic world. Nature, as we know it, whether in the abstract realm of physics, or within the more concrete realms of biology and sociology, is an interaction of multiple fields of motion. It is because of this plurality that we have a conflict of motions, acceleration or retardation of motions, relativity of perspectives, hence the necessity of adjustment, hence thought. Thought implies relativity and conflict. A uniform world would be a dead, unconscious world. This necessity for plurality and conflict was clearly seen by the great ancient seer, Heraclitus:[80] "Homer was wrong in saying: 'Would that strife might perish from among gods and men!' He did not see that he was praying for the destruction of the universe; for, if his prayer were heard, all things would pass away." For progress there must be selective competition, as Heraclitus also saw: "War is the father of all and the king of all: and some he has made gods and some men, some bond and some free." Such harmony as we know is a harmony of tension; and this must be true in the large as well as in the small. As Heraclitus says: "The harmonious structure of the world depends upon opposite tension like that of the bow and the lyre." This implies a cosmic law of adjustment.

If history is the fundamental type of reality, human history is the only history which we know intimately. All else is for us projection and interpretation from human perspectives. Human history is the history of values in the concrete, though because of the limitations of our interest, we divide it up into abstract histories or histories of certain types of value, and the tendency is for the particular historian to regard the values with which he deals as paramount. The student of economics subordinates everything to his special interest; so does the student of science, of art, of morality, or of religion. This is a natural limitation of human nature, but we shall ignore it here. We here refer to history in the concrete, which is an interplay of an indefinite number of motives. It is here that relativity reigns *par excellence*. The difficulty is that while we know a small block of human history intimately

[80] Fragments 43, 44, 45, in Burnet's Translation.

we lack the large perspective that we have in geology, for example. It is difficult to find a frame of reference outside the mollusc in which we live (to use Einstein's ugly but expressive word). We live too much in local space and local time. When we take account of another frame of reference we treat our own frame of reference as absolute and read the values of the other frame of reference in terms of our own. The mathematician may say that one frame of reference is as valid as another, and so it is—for the mathematician. But as real human beings our own frame of reference has the reality of conviction. We always feel that the universe of values within which we live is absolute. We are satisfied with things as we are. Those who live on the Common Street of custom and prejudice do not know that they live on Common Street in the sense that a person who has a perspective from another centre with an independent history sees it. And is it so certain that his perspective and his standards are ultimate?

We are no better judges as regards the successive molluscs in our own history than we are of other histories. We live from block to block in our personal history as though the block in which we live were absolute until, through the pressure of events in the advance of nature, we find ourselves in the next block. In each case we use the co-ordinates of the system within which we live as the basis of measurement. We assign values on the basis of our present standards to other perspectives, successive and contemporaneous. But our measures are after all relative, as we can see in retrospect. From block to block the values vary because the co-ordinates, the standards, are new. The plus values may become minus values and the minus values plus values, but all have to be revalued in the passage of nature. There is nothing absolute in our experience except our conviction, our will that our present standards of value shall be acted on as final. Else action would be paralyzed in the pale cast of thought. Hence a certain blindness is an inevitable part of human life. But if we live our truest insight and if we live deeply, something of the eternal order, we may hope, is reflected in our life. For through it all there runs the silver thread of the law of the whole, and to some it seems to be given to see more of it than others, but all see it in the perspective of their own motion.

There is no better illustration of the complexity of history than human history. We speak of history in the singular, but it is well to remember that history is a class concept. In fact, there are histories—parallel histories, intersecting histories, successive histories. Every individual has his own history and his own series of perspectives of value, conditioned by heredity on the one hand and the interactions with the environment on the other. Individual history, again, is a succession of chunks of duration. Within each chunk the measures of value are fairly constant. But even individual history in any one chunk is far from simple. It consists of a sheaf of tendencies or activities. Some of these motions, potential or actual, conflict. Others converge and may be understood in terms of a guiding field or direction. Some are parallel as in cases where we do not let the left hand know what the right hand doeth. The degree of integration varies in different individual histories and in different epochs of the same history. In early life the motions are parallel; each impulse runs its own course except as accidentally it may conflict with some motion from without. As life advances there is an increasing tendency to integration within a hierarchial control. But the physiological reflexes preserve a great deal of independence; and even on the mental plane there may be co-consciousness between different co-existent self-systems or alternation between different self-systems. An extreme instance of this is multiple personalities, but perhaps no human life is fully integrated.

It is a marvel how individual histories with their various perspectives ever became integrated into group control. It must have meant considerable reflection and discipline by events before a crust of custom could be formed which would make possible group control. The pressure for co-operation in order to sustain life and the necessity for curbing the reproductive instinct are dominant factors in primitive society. Some geniuses, brighter and braver than the rest, saw the economy of submitting disputes to a third party instead of deciding them by force. The desire to live life without interference led gradually to the recognition of a common order. Once the integration had begun, it became consolidated more and more, partly by conflict with the forces of nature, but more especially with individuals and groups who threatened the community interest. Once the consolidation had taken place, the conflict became a conflict between groups rather than individuals. But the original motive which led to the formation of groups has led to further consolidation of groups with the same ruthlessness as against individuals and groups which have resisted assimilation. We thus have the national histories of modern times, with their enormous complexity of motives or lines of motion within a nation and the continuous rivalry and conflict amongst nations. What concerns us here is the integration of individual histories and their perspectives into group histories with a common perspective, a common line of motion. This does not mean that the integration even within the group is complete. Only those motions which are regarded as important for the life of the group are curved within a common control. The same holds in the further integration of groups. As between groups which are not integrated under a common control, self-interest or fear may still restrain them from conflict for the time being.

Group histories like individual histories move from mollusc to mollusc. The crust of custom within the group comes to seem absolute and resists change. Institutions may be begotten by geniuses in pain and travail; but, once they mature into custom, they are carried on by high grade morons for morons of various grades. Within the crust thinking ceases, until in the stress of events the crust breaks. The institution is hostile to genius, for genius means individual motion and the group can tolerate nothing which it cannot curb. There is no jealousy so bitter as the jealousy of mediocrity. Mediocrity elevates the ass to be the arbiter of values, for the ass knows his master's crib and his judgement is sure to be satisfactory—to his kind. While the crust maintains itself there is a certain unanimity in the basis of valuation. We have common measures, a common perspective. But groups are proverbially blind to the scales of value of other groups as well as of individuals that have a different frame of reference. Every group history has its own tradition and its own measures, it arranges the values of the past and present in its own perspective. This relativity of valuation may be illustrated in the attitude to prominent personalities of history. A personality who is a hero from the point of view of one group perspective may be a criminal from another group perspective. Witness the case of Napoleon in Europe. And what holds as between different group perspectives holds also between different molluscs in the same history. Here too the values change and sometimes in a revolutionary way. Witness the change of perspectives in France from the Bourbons to the great Revolution and from the Revolution to the return of the Bourbons. It is plain that the co-ordinates, the measures of value, are different in different perspectives. Therefore we cannot integrate values of different perspectives.

What has been said of personalities holds equally of ideals. In fact the two cannot be separated, since personalities are valued as exponents of ideals. Perspectives of aristocracy and democracy, saintliness and worldliness, beauty and utility are incommensurable. One age or group believes in aristocracy and all its values are determined by this ideal. The whole field of values is assigned its numbers on that basis. Another age believes in democracy and all the values change. The whole structure of values becomes different. We have a new geometry of value. The geometry of values is indeed a Gaussian geometry. We cannot correlate the perspectives of aristocracy and democracy nor can we correlate perspectives of spiritual and of material values. Every molluse is characterized by conviction. It is to itself an absolute frame of reference. When two conflicting perspectives co-exist with their will to live and to prevail, there is war until the death or sullen surrender of one of them. At any rate it must now be clear that what we have empirically is not history, but histories with their various perspectives, claims, and ambitions. The valuations of history are transient. There is no absolute frame of reference available. And our pretences at absoluteness are soon made ridiculous by the creative passing of nature. This does not mean that all judgements of history are equally valid. Within the perspective in which we live we must aim at the largest possible correlation of values. This involves creative imagination and sympathy as well as painstaking labour. The more thorough-going our correlation is, the greater its instrumental value within the mollusc and the better the way is prepared for a new valuation.

So far, we have had no continuous development in human histories; and therefore we have no way of telling of the possibilities of human advance. Theoretically, groups may live on indefinitely. They are not limited by the span of individuals. They grow old and ossified, to be sure, in their customs; but as there are always new generations of men, a group may become young again. In fact, the history of groups has been foreshortened by internal and external conflicts. Owing to the lack of communication, some groups and races have lived parallel histories. Others have intersected with critical result to their historical development. Few peoples, as Bagehot truly remarks, have survived the breaking of the crust of custom. Since man attained his present physiological development, various races and peoples have supplanted one another. Of the early history of man we have but fragments. The Cro-magnon race attained a very considerable development in art and tools, but for some unknown reason disappeared from the scene and was supplanted by physically inferior races. In the use of tools there has been a fairly steady advance, but this is after all only one measure of civilization. In art the cave-dwelling Cromagnon, spite of his disadvantages, attained an excellence in certain lines that we must still admire. As for the most prominent historic peoples, the characteristics in which they have excelled have been for the most part different and there can be no common measure. Their span of life, moreover, has been comparatively brief and so we cannot tell what they might have done.

If we take into account only the more recent historic peoples, we are struck by the incommensurability of their qualities, on the one hand, and the lack of continuity in the general human stream, on the other. The Greeks had a brilliant development in art, science, and politics for a short span and then went into decadence. Their history was intersected by that of the Romans, a more primitive people, who stamped their own practical genius upon the civilizations which they found, as they reinterpreted them from their own frame of reference. Rome in turn went into decadence and was supplanted by the barbarous races to the north, who while they went to school to Rome transformed Roman civilization into their own traits and tradition. Held together in an external way by the authority of the mediæval church, the new peoples mastered the rudiments of the old civilization, until the centrifugal motion of their own histories broke the old bond and we have the complex life of modern Europe with its many streams and conflicting perspectives. It is an illusion to suppose that these histories, as they supplant each other in turn, inherit the culture of the groups they supplant. Roman history takes over from Greek history only what it can assimilate, and so with the histories that fall heir to Rome. Roman history in its comparatively long span falls into two sharply distinct epochs. The gulf is greater between pagan Rome and Christian Rome than between pagan Rome and Athens.

When Rome fell, the Arabs took over in their own way the ancient treasure only to be overwhelmed by the Turks, who, in their blindness, destroyed what they could not assimilate. But if the Turks burned the library of Alexandria, the Christianized barbarians burned the library of Cordova. In the various intersections of histories, great treasures of civilization have thus been destroyed which can never be replaced. Until recently the peoples of the far Orient had enjoyed a long continuity of history with an undisturbed development, paralleling that of Europe in an interesting way. But Europe has now thoroughly intersected Asia and the rest of the earth. Lest we wax conceited over our own tolerance, we may remind ourselves that in burning the Summer Palace of the ancient rulers of China the Western armies were faithful followers of the Huns and destroyed treasures of art which neither Europe nor China can replace.

To-day we patronize the "backward" races—all races but our own being "backward." Is it certain that we are as superior to them as we feel? If a yellow peril or a black peril confront us because these races from their own historic perspective do not see things as we do, should we be surprised? May it not be that they have qualities which the enterprising European lacks and which he might well admire? It is true that the Western world has made great material strides owing to the developments of science in the last three hundred years. But this advantage is largely an historical accident. The foundations of modern science were laid by a few geniuses who, inspired by the love of truth, braved the contumely and prejudices of the day. No particular people or race has a monopoly of genius. Organized groups have made use of the results of science and have come to subsidize science because they have been able to use it; but the Western nations did not as nations contribute science. The methods of Galileo, Newton, and others were an accident so far as the history of the Western nations is concerned. And can we be so sure that material achievement is the supreme standard of value? There are those who are doubtful. They recognize that "science alone may destroy this world instead of saving it" and "that science in itself is not the most important thing in this world, but that the salvation of the world is to be found in the cultivation of science together with the cultivation of a belief in the reality of moral and spiritual values."[31] Our own nation, U. S. A., has perhaps made greater advance than any other in the use of science for material welfare. And we are prone to feel that we are the advance guard of civilization. But is our boasting justified? Have we solved more of the real human problems than any other nation? Are we contributing more to the advancement of art, literature, and truth? Certainly no other nation would concede that we are.

Is the struggle for dominance to continue until the nations of the earth have in their blind hatred destroyed the fruits of the civilization that the ages have accumulated? One thing is certain, that there is no hope for the nations of the earth unless some creative genius or geniuses can discover a common frame of reference which, while permitting the characteristic development of individuals and groups, allowing each to make the contribution of its own genius, shall still make it possible for them to live together. But this requires more than intellectual development. There must be the creating of some degree of mutual respect and of mutual sympathy before there can be mutual understanding. There must be brought about a new moral attitude before a successful formula can appear. This—or the twilight of man.

How can we estimate what we are pleased to call the progress of mankind amidst these divergent currents of history, each with a structure and perspective of its own? How can we measure the Greek genius for beauty and science in terms of the practical achievements of Rome in law and social organization? How can we measure the values of either beauty or utility in terms of the ideal of holiness and salvation in the Middle Ages? And how can

[31] The quotations are from the Address of Acceptance of the Norman Bridge Laboratory of Physics, by the distinguished scientist, R. A. Millikan, 1922. Printed in *Science*.

we measure the respective merits of the outstanding European nations of to-day—the genius of France in terms of Germany, and vice versa; or the genius of Britain, Italy, or Russia in terms of either of these or of one another? What impresses one is that each of the prominent nations is travelling with its own motion, has its own structure and that each interprets the other from its own frame of reference, each having sublime confidence in the genius of its own history. The big nations feel very superior to the small nations and bully them. But is the sense of power an adequate measure of superiority? May it not be that some of the small nations are actually outstripping the big nations in the real values of civilization? We must not mistake our blindness to other perspectives for evidence of superiority. The passions engendered by war have arrested the development of civilization in the same measure that they have increased the blindness of peoples. For the development of civilization is accelerated by exchange. Again, new currents of history have been liberated and who can tell the outcome for civilization?

When we consider progress we are apt to fasten our attention on the collective instruments of civilization of which we make use. And here our advantage appears enormous when we contrast our own age with other ages. But individual culture is not to be measured in the things a man can use, but in the things he can create. An American moron can make use of telephones, telegraphs, trains and automobiles. Is he therefore superior to the Eskimo who is creatively the master of his civilization? There are those who find our civilization cheap and superficial when compared with the greatest creative periods in human art and literature. Galton finds the modern European as inferior to Greece in its glory as he is superior to the African negro. Gladstone finds present thought slovenly compared to the masters of the thirteenth century. The literature and art of our age of hurry and bustle seem to many thoughtful critics to fall far short of the great masters of ancient Greece, the later Middle Ages, or the Renaissance.

We no longer have the confidence of the eighteenth century in the speedy attainment of utopia. And to some honest critics the idea of progress seems an illusion of man's will-to-believe.

If we consider only the present chaos of values, the selfishness of nations and the stupidity of politicians, it is easy to give way to pessimism and to deny that the idea of progress has any relevancy to human history. But if we take the long view of human history that biology and palæontology are opening up to us, can we deny that there has been advance since the first apelike ancestors of man appeared? For while man did not descend from the present apes, the evidence shows that man and ape were closely related in their origin. They had a nearly equal start. The distance from Pithecanthropus to Newton is vastly greater than that which separates Pithecanthropus from his ape kin; and we need not suppose that Pithecanthropus is the first in the human series. If we view man as the palæontologist views him, we can hardly deny advance. And if we view man as the anthropologist views him, the advance is even more striking. We need only arrange the tools of man from the earliest known implements which show but little if any change from crude nature to the inventions of modern man. While the study of the evolution of tools opens up the longest vista into the development of human civilization with its various cross-currents, the evolution of language and institutions from the simplest beginnings is no less striking even though less known. Human history in the large is not a mere succession of events, even though our limited data make it rash to state any general law. By selecting a certain aspect at any rate, we can discover cumulative reference over periods of history. Ages before written records are available, we can arrange human events into periods and show the cumulation of culture and the interrelation of cultures as has been illustrated strikingly in recent years in the case of the history of Egypt.

If we consider the brief part of human history of which we have written records, the most fundamental and continuous aspect is not the advance in knowledge which has been sporadic for the most part and only cumulative in a scientific sense during the last three hundred years, but the advance in human freedom, the enlargement and deepening of moral values. The remarkable expansion in knowledge for a fitful though brilliant period in ancient Greece and in a more cumulative way since the Renaissance may itself be viewed as an aspect of moral emancipation. The ancient Greeks made the first historical experiments in democracy, in community government, albeit on a foundation of slavery. While slavery was recognized in Roman law, it was not congenial to Roman character. The practice of manumission grew rapidly and, to the conservatives alarmingly, during the empire. This is all the more remarkable since the slaves were for the most part captives from the conquests of Rome and belonged to other peoples and races. In general the respect for human rights broadened vastly in the thousand years of pagan Rome; and Roman law and institutions furnished the background and school of the new Europe that rose on the ruins of Rome. Christianity marks an epoch in the emphasis on human freedom and human dignity, though the practical fruits have been slow in maturing. But the idea of the fatherhood of God and brotherhood of man was at any rate a leaven for a new order during the political chaos of the Middle Ages. In the church men did rise from the lowliest station in society to the very highest office. Work became in some vocations a craft and conscious of its dignity and power; and even the feudal tenant was a step higher than the slave, however hard his lot. It is well to remember that if the Middle Ages created the feudal lord, they also made the first beginnings in representative government, without which our larger modern self-government would be impossible.

With the advent of modern science and industrial inventions, the struggle for human freedom has been greatly accelerated, and the end is not yet. Indeed what we have attained seems superficial enough when contrasted with what is yet to be won before every man, woman, and child shall have the opportunity to realize their capacities in a just social order. But dark as the picture of human wrong seems to-day, we must remember that the darkness would not seem so dark if we did not contrast it with the light of a new conscience. Slavery constituted no problem in the moral philosophy of the Greeks. We no longer believe that class distinctions are fixed in nature, however thorny the road to real democracy. We have broken through the horrible pessimism of St. Augustine and the Middle Ages as regards the nature of man. And though we cannot share the optimism of the eighteenth century as to the perfectibility of man and the dramatic realization of liberty, equality and fraternity, we are perhaps doing more in our prosy way to accomplish those ideals. At any rate the instruments of political democracy and education can win for us these ideals when we learn to use these instruments wisely; and we, like our predecessors, must learn through suffering. There is no other way. It is true that the interpretation of this struggle for freedom has not as yet found adequate expression in art and poetry. Modern democracy is still waiting for a Homer or Shakespere. But artistic expression is not wanting, and when our purposes are clearer, the expression will come—richer, if not more beautiful, than the expressions of earlier civilizations. When the great interpreter comes he shall do for our complex, struggling life what Homer did for Greece, what Dante did for the Middle Ages, what Shakespere did for the buoyant life of the Renaissance. But shall we know him when he comes? The Son of Man comes to His own and His own receive Him not. It was ever thus. The group is only wise in retrospect.

The long view of history encourages us to believe that man is part of the creative advance of nature, dark though the facts may seem at times. Because man must discover the way through trial and error, we must expect many failures and many irregularities in the advance. Since history is a real adventure and not a puppet show of logical categories, we may fail of the highest possible realization on this earth. At best we must work in faith following the light as God gives us to see the light. For we can see but a fragment of the vast order of which we are a part. Yet we must strive to break through our narrow centrism and try to view reality as a whole, for we may be sure that, in the large, human history is a process of adaptation to a cosmic order. This makes the idea of progress vastly more complicated than when man was made the centre of the universe, whether in the old theological theory of salvation or in the philosophy of the monistic idealists who apotheosized human reason. But we must believe that somehow there is a nisus in the creative advance of nature which will carry us the next step if we strive creatively and loyally to prepare ourselves for it.

History, in the sense we are using it, is more complex and empirical than in the monistic theories of Hegel and Croce. It is not just the staging of thought, the making explicit of the implications of one logical perspective. It involves real time and real pluralism, with the empirical relativity consequent upon such a world structure. The categories of valuation are themselves relative to historic advance, however dogmatic such thinkers as Hegel may be in asserting them and in forcing the facts of history into their artificial schemes. We may say that Hegel and Croce stand in the same relation to history as we conceive it as Newton stands to Einstein. Instead of interpreting history *a priori* in accordance with abstract models of our invention, we must learn to take account of its empirical nuances. The neat schemes of nineteenth-century philosophers for reading the events of history have all proved mythological since scientific anthropology applied itself to studying the facts in the concrete. There is not just one set way in which social institutions or art or industry develop, but the steps and forms vary with the concrete conditions—with the local traditions, with social interchange, with geographical conditions, but most of all with individual inventiveness and its fructifying of tradition.

Finally, if we are to understand the curvature of the small fragment of history with which we are acquainted we must strive to know something of its relation to the structure of the cosmos. Human history with its valuations is itself part of the creative advance of nature and relative to this advance. And how little we know of this advance!

The Hegelian conception of history is fundamentally anthropocentric. The mind of the philosopher (under the euphonious name of the absolute) is conceived as constitutive of reality. The interpretation of history becomes identical with history. All history, therefore, is contemporaneous. The mind not merely makes the significance of history for us, in interpreting it, but creates history. This is supposed to hold of all history—the history of nature as well as human nature. In fact, nature is but the product of the activity of mind. To quote Croce:

> In the philosophy which I have sketched, Reality is affirmed as Mind, not a mind which stands above the world or runs through the world, but a mind which coincides with the world. Nature is shown to be a moment and product of the mind itself. Dualism, therefore, (at least that form of dualism which has tormented thought from Thales to Herbert Spencer), is surmounted with its transcendence whether of a materialistic or theological principle. Mind, which is the world, is the mind which is evolving, and therefore it is both one and diverse at the same time, an eternal solution and eternal problem. The self- consciousness of this mind is the philosophy which is its history or its history which is its philosophy, both substantially one and identical. And the consciousness is identical with the self-consciousness, that is, they are distinct and yet one, like life and thought.[22]

But Mind written with a capital M is after all our human mind. And history becomes a human construction in

[22] *Storiographia*, p. 286, quoted by H. Wildon Carr in his excellent work, *The Philosophy of Benedetto Croce*, p. 205.

which the creative passing of nature is evaporated into verbal abstractions which are no less empty because they are put in the mouth of the absolute.

History is not the staging of a scheme of abstract categories—not even if we give it the euphonious name of the absolute—but a pluralistic process of adaptation in which the earth in its history and complexity strives to get into rapport with the larger whole. Instead of construing history anthropocentrically and reducing it to categories of our artificial logic, we must recognize that human history is part of cosmic history and must be understood with reference to cosmic history. It is part of the history of the earth, an integration of its crust, in its interaction with the structure of the universe. It involves interaction not only among human histories but also with other histories and levels of the cosmos. Human history is part of the creative passing of nature with its cycles and determined, in the last analysis, by adjustment to the whole. Only so can we understand the creative advance in geological history, including human history. If we would see the full significance of our ephemeral existence, we should have to understand the law of the whole. If we would understand our immortality, we should have to know the law of conservation within the whole and our significance for the whole. We have seen that the effective conservation of energy in the cosmos implies the conservation of structural levels. Else energy would run down to a dead level of dissipated heat. The fact is that energy without structure is an abstraction. We must postulate the conservation of organization as well as the conservation of the quantity of energy. We can no more conceive the pattern of energy than the quantity as coming from nothing or disappearing into nothing. As the quantity of energy must be conserved within the whole, so must the structure be conserved in the whole. But structure must exist as individual. It cannot exist in the abstract. The conservation of structure must, therefore, mean the conservation of the individual as well as the species, for species without individuals are abstractions. We do not know the complete cycle of human life within the whole. But in some way it depends upon adjustment to the genius of the whole. In general we may say that immortality is not a state, but a quality of structure. The significance of life will be conserved, whether it be individual significance or group significance, if it can be taken up into the creative advance of reality, *i.e.*, if it proves to be an aspect of cosmic structure and not an error of our partial temporal adaptation. If we take the geocentric point of view of evolution, then indeed human history with its values and ideals is an exotic glory. For humanity, with the higher levels of thought and beauty, seems to be doomed, so far as our earth is concerned, to disappear after its brief day of strife into the flux from whence it came, as the evening sun sinks blood-red into the storm-swept sea, colouring the waves for a moment with its crimson—and then the enveloping night. It is only from the point of view of cosmic exchange that history and value can have ultimate significance, for then what disappears here is conserved yonder to participate in the creative advance of nature towards God, the supreme actuality.

CHAPTER VIII

Relativity and the Law of the Whole

As I stand enwrapt in the mystic silence of the night, looking up into the star-strewn immensities of cosmic space, I find myself in imagination a grain of besouled dust on the extreme wing tip of Cygnus,[1] reflecting like a diamond the colour and movement of the whole. Even as I gaze in wonder, imagination transforms the world of stars into flocks of giant wild swans, sailing high in stately procession—swans of many colours, red, yellow, green, blue, white, and black, wheeling about in the vast expanse, shifting positions, re-forming their ranks, yet preserving withal the spiral pattern of their galaxy. Perhaps future generations with improved artificial senses may yet hear the harmonious, rhythmic swish of their wings. Their path is prescribed by the genius of the whole. They shall not miss their way in the transparent ether sea, and in due time, with the turn of the cosmic year, their homing instinct shall drive them to seek the same familiar scenes again. They live their life cycle in vast æons, but they are not eternal. They too are born and die. In the throes of birth they shine with a crimson glory; and blood-red they are when they sing their swan-song in the throes of death, but in the prime of life their radiance is purest white. Their real life secret of love and hate and glorious adventure, we know only in human experience. But our lives, too, are part of the star stream, an integration of its energy, eddies in its movement. Their course is determined by cosmic adjustment. They find their significance in the law of the whole.

[1] According to astronomers, our solar system is on the edge of the constellation, Cygnus, the Swan. H. Shapley, the *Scientific Monthly*, Vol. XVIII, p. 429.

Cosmic Adjustment

It is the cosmic implications of the theory of relativity which appeal to my imagination—the law of cosmic adjustment, cosmic equilibrium, cosmic curvature. This I count the most significant contribution of the theory of relativity to cosmic philosophy, though this aspect of the movement has been largely neglected. Just as in the theory of Heraclitus, the dark genius of antiquity, his contemporaries and successors seized upon the aspect of flux, but neglected the complementary aspect—the cosmic path, the law of exchange and equilibrium—so, in the case of the modern theory of relativity, the small minds of critics and imitators have seized upon the protean variation of perspectives, but have failed to see the significance of the other aspect—the curvature of the world, the law of dynamic equilibrium—without which relativity means chaos.

In the grasp of the cosmic implications of the theory of relativity it appears to me that Weyl passes Einstein. The difference between the two may be illustrated in their conception of the congruence of time intervals and lengths. According to Einstein,

> If two ideal clocks are going at the same rate at any time and at any place (being then in immediate proximity to each other), they will always go at the same rate, no matter where and when they are again compared with each other at one place. If this law were not valid for real clocks, the proper frequencies for the separate atoms of the same chemical elements would not be in such exact agreement as experience demonstrates. The existence of sharp spectral lines is a convincing proof of the above-mentioned principle of practical geometry.[3]

The same generalization is made for lengths: "If two

[3] *Sidelights of Relativity,* p. 38.

tracts are found to be equal once and anywhere, they are equal always and everywhere,"[3] *i.e.*, whenever they can be brought together for comparison. (Both the lengths and time intervals may be different in the meantime.) But this generalization is made to rest on pragmatic grounds. It lacks the support of a comprehensive theory. Weyl rightly objects, I think, that we have no guaranty that lengths and clocks which coincide at one point will coincide at another point unless we can deduce such coincidence from a law of world-curvature. Only thus can we be assured of congruence whether over indefinitely small areas or astronomically large areas.

Weyl distinguishes in a lucid way between two kinds of determination in nature—the determination of a magnitude by "persistence" and by "adjustment." I can do no better than use his illustrations:

> We can give to the axis of a rotating top any arbitrary direction in space. This arbitrary original direction then determines for all time the direction of the axis of the top when left to itself, by means of a tendency of persistence which operates from moment to moment; the axis experiences at every point a parallel displacement. The exact opposite is the case for a magnetic needle in a magnetic field. Its direction is determined at each instant independently of the condition of the system at other instants by the fact that, in virtue of its constitution, the system adjusts itself in an unequivocally determined manner to the field in which it is situated. *A priori* we have no ground for assuming as integrable a transfer which results purely from the tendency of persistence.[4]

The Newtonian law of persistence is, of course, artificial, since it assumes an isolated motion. We have no evidence of any such motions, though light rays away from large masses of matter seem to move practically in a straight line

[3] *Ibid.*, p. 37.
[4] *Nature*, Vol. CVI, p. 802.

and with constant velocity. In our empirical world, persistence itself is determined by adjustment. It was the fact that we could not in our experience trust to absolute persistence; that even light is affected by adjustment, which led to the general theory of relativity.

In approaching the problem of relativity in terms of the electromagnetic field, Weyl has the advantage in the generality of his formulation. For here science has discovered a universal law of equilibrium, a genuine "world-curvature," internal to the system. Hence it is possible to state the law of determination by adjustment with exactness. Only on the basis of such a law can we understand

> why an electron, even after an indefinitely long time, always possesses an unaltered charge, and why the same charge e is associated with all electrons. This circumstance shows that the charge is not determined by persistence, but by adjustment and that there can exist only one state of equilibrium of the negative electricity, to which the corpuscle adjusts itself at every instant. For the same reason we can conclude the same thing for the spectral lines of atoms. The one thing common to atoms emitting the same frequency is their constitution, and not the agreement of their frequencies on the occasion of an encounter in the distant past. Similarly, the length of measuring rods is obviously determined by adjustment, for I could not give this measuring-rod in this field-position any other length arbitrarily (say double or treble length) in place of the length which it now possesses, in the manner in which I can at will predetermine its direction. The theoretical possibility of a determination of length by adjustment is given as the consequence of the *world-curvature,* which arises from the metrical field according to a complicated mathematical law. As a result of its constitution, the measuring-rod assumes a length which possesses this or that

> value, *in relation to the radius of curvature of the field.*[5]

A stupendous conception in which relativity is outrelatived. We must admit that the conception of adjustment is the only fruitful way of considering values in our empirical world. It is in this way that we must understand the path of motion, not by an *a priori* conception of a natural path.

The fundamental difference between the special theory of relativity and the general theory is not that light loses its privileged character in the latter theory and becomes curved and retarded in the neighbourhood of aggregations of matter. This is rather a consequence than a determining factor. The essential difference is that we no longer deal with reality as isolated perspectives of space-time, but recognize that the character of these perspectives is determined by adjustment within the dynamic equilibrium of the whole. Nothing exists in isolation. The world in which we live and in which our earth floats is not a world where things are eternally what they are by persistence in the isolation of empty space, but it is a world of interaction where things are what they are and move as they move by adjustment. This adjustment is not a Newtonian adjustment—not the instantaneous action of bodies at a distance over a homogeneous, isotropic space. But the concentrations and organizations of energy which we call bodies affect the character of the medium, the curvature of the field. The geometrical properties of physical space are dependent upon the aggregations of matter and their distances. In predicting motion, therefore, we must take account not merely of the motion of isolated bodies or light rays but also of the curvature of the medium in which the motion takes place. This curvature determines the path of the motion. The geometric qualities of the cosmic medium vary with the dynamic distribution of the bodies as shadows vary with the light. No part of the medium

[5] *Ibid.*, p. 802.

has a constant curvature. Therefore we must have a space-time geometry.

Not only do the properties of the cosmic medium vary with the dynamic energy distribution, but the geometric properties of bodies also depend upon this distribution. Properties can no longer be conceived as belonging to things in isolation. Lengths and durations are determined by adjustment. Gravitational mass is not a mysterious property inherent in things. Since all things fall in the same way in free space, irrespective of their size or texture, gravitation is equivalent to inertia. But inertia is not an absolute property which things possess in isolation. It has been the custom to distinguish two kinds of inertia or mass—potential or gravitational mass, sometimes called proper mass, and kinetic mass, sometimes called apparent mass. It is now recognized that the mass of matter increases with motion and takes a sudden leap when velocities approximate that of light. One is not likely to consider this mass as an absolute property of the body. It is different with gravitational or potential mass. This has been conceived by classical mechanics as an intrinsic and absolute property of things in isolation. Mach first conjectured that "inertia depends upon the mutual action of bodies." [6] This conjecture is supported by the theory of relativity. According to Einstein (1) "the inertia of a body must increase when ponderable masses are piled in its neighbourhood"; (2) "a body must experience an accelerating force when neighbouring masses are accelerated and, in fact, the force must be in the same direction as the acceleration"; (3) "a rotating hollow body must generate inside of itself a 'Coriolis field' which deflects moving bodies in the sense of the rotation, and a radial centrifugal field as well." [7]

What counts for our purpose is that gravitational mass is a function of energy interaction, of dynamic adjustment. Both gravitational mass and kinetic mass are statable in

[6] *The Meaning of Relativity*, A. Einstein, p. 110 and p. 119.
[7] *Ibid.*, p. 110.

terms of energy to the great simplification of science. As Einstein puts it: "Mass and energy are equivalent." [8] "The momentum per unit volume and the flow of energy are equal to each other." [9] Mass and energy therefore "are only different expressions for the same thing. The mass of a body is not constant; it varies with changes in its energy." [10] Within the atom, the mass of the negative electrons is practically kinetic, while the gravitational mass is contributed almost entirely by the nucleus. Light, too, is material and follows the lines of gravitational curvature as has now been clearly proved. It has mechanical mass as is evidenced in the bombardment of comets away from the engulfing gravitational field of the sun, as well as through experiments in the physical laboratory. There remain then energy and space-time; and the gravitational field—the field constituted by matter—"determines the metrical laws of the space-time continuum." [11] The properties of matter and the geometric properties of physical space are alike determined by adjustment. As matter must be conceived as an organization of energy, the concepts of science are enormously simplified. Instead of space, time, matter, mass and energy, we have the trinity of space, time and energy or rather energy in space-time perspectives. Of the three concepts, energy tends to overlap, for, in the concrete, energy becomes action with its equivalent effects. In action or an energy system all three concepts are involved.

Determination by adjustment is the master key of the universe. Everything is determined by adjustment—the small as well as the large. The electron has a constant charge, a constant size, by adjustment. "An electron," says Eddington, "could never decide how large it ought to be unless there existed some length independent of itself for it to compare itself with." [12] The size of the electron

[8] *Ibid.*, p. 57.
[9] *Ibid.*, p. 54.
[10] *Ibid.*, p. 51.
[11] *Ibid.*, p. 67.
[12] Quoted by Bertrand Russell, *The A, B, C of Atoms*, pp. 168, 169.

is determined by the radius of the world curvature, which is constant. What is true of the size of electrons is true of the size of stars. The size of stars varies about a mean in a way that could not be accounted for by chance. Stars are not indefinitely large or indefinitely small. If we consider spiral nebulæ as universes comparable to our galactic system, we may well believe that they are determined as regards size and shape by adjustment within the whole. What is true of the size of the energy units is true of their orbits. These too are determined by adjustment and, in the last analysis, by cosmic curvature. The units, large or small, find their path in the equilibrium of the whole. There is a boundary assigned to them.

The course of events in time as well as in space is determined by adjustment. This does not seem to be clear to Eddington:

> We have said that an electron would not know how large it ought to be unless there existed independent lengths in space for it to measure itself against. Similarly it would not know how long it ought to be unless there existed a length in time for it to measure itself against. But there is no radius in curvature in a time-like direction; so the electron does not know how long it ought to exist. Therefore it just goes on existing indefinitely.[13]

But we cannot thus separate time from space in the real world. The electron persists because of the space-time curvature of the cosmos. And not only that but it enters as an element into certain space-time patterns, by virtue of the space-time structure of the whole. Only the structure of the whole is constant and this structure is dynamic. Space relations are included within the forward and backward looking temporal order. Space-time events are determined by interaction within the cosmic order. They

[13] *The Mathematical Theory of Relativity*, p. 155. Quoted by Russell, *Ibid.*, p. 169.

enter into new creative synthesis or into dissolution, they are uniform, accelerated or retarded, they have the quality or pattern which they have by virtue of adjustment within the dynamic equilibrium of the whole. Their degrees of freedom and their stability, their rhythmic periodicities, whether it be periodicities of the breaking up of atoms into electrons and the recombination of electrons into atoms, or the periodicities of social revolutions and the encrusting of individuals anew into customs and institutions, are determined in the last analysis by cosmic curvature. I do not mean that this is a passive falling into line. All adjustment is a trial and error process. The parts are energies with a motion of their own and offer resistance to a change of direction. They must find the cosmic path through interaction and eventually fall into line because with reference to the future it proves to be the line of least resistance.

The course of the creative passing of nature is thus determined by the dynamic equilibrium of the whole and this equilibrium is determined by cosmic interaction. This is true of the entire course of history with its complexity of patterns and levels, and not merely of the quantitative passing of nature with which the physical sciences deal. The dynamic organization of any part-history in the cosmos is no less due to the dynamic structure of the whole than is the size of the elementary constituents. The nisus or direction in any part history is determined by adjustment within the dynamic structure of the whole with its eternally co-existent levels. Here *nisus* comes to have definite significance and is not a postulate left in the air and arbitrarily assumed. This is a world of pluralism—plural energy systems held in subordination for the time being within the control of the whole—until they have completed their rhythm and are released for future service. The history of our earth, moving as an integral unit, is thus conditioned in its development—its emergence of types and levels—by its interaction with the space-time structure of the whole. There is only one unconditioned reality and that is the dynamic whole. All part-histories are determined by adjustment within this whole.

Cosmic Space

There has been a twofold emphasis in recent science—the emphasis on space, on the one hand, and on matter, on the other; on fields and on quanta; on geometry and on number. The theory of relativity emphasizes space, geometry, fields rather than entities. Motions take place according to the geometrical set of space-time. But, on the other hand, the geometrical structure of space is determined by the dynamic action of matter, and matter exists in quanta and acts in quanta, therefore the abstract continuum of space is checkered into varying geometrical quanta. All interaction involves, on the one hand, a medium of communication—space or ether—and, on the other hand, quanta to be communicated. Both the structure of the medium and the size of the quanta are determined by world-curvature, and world-curvature is determined by the reciprocal action of energies, existing at various levels.

The conception of cosmic space is fundamental in the theory of relativity and in any cosmic philosophy. Space is the universal medium in which the interaction of energies is staged. Without space we can have no metric conceptions such as distance, size and shape. Einstein is right that space is not a nonentity. It has physical reality. Leucippus and Democritus, who first distinguished space as non-being from being, insisted that non-being is as real as being. Since by being they meant material atoms, what they did was to contrast space and matter. But if space is an empirical reality, its properties, like those of matter, must be ascertained through experience, *i.e.*, space must be for us the sort of medium that we require for the description of the interaction of energies in the cosmos.

Certain it is that we cannot rule out the concept of ontological space from our account of reality as the subjectivists try to do. The process of interaction and exchange implies space. This may not be so clear in qualitative change. But qualities, immediate though they seem to introspection, are functions of energy relations. The sense quality, red, is a characteristic of the interaction between a certain physical energy of the cosmos and a certain organization of energies in our retina. The change of the red to a dark brown and finally into a dark grey with the coming of twilight is again due to energy relations—the decreasing intensity of light and the specific reaction of our retina. We always find that qualitative change involves a definite change in energy relations, which, in turn, imply space as well as time. Nor can we get along without space in describing mental relations. It is implied in social exchange, social interstimulation, as well as in physical. We cannot live inside one another's skins, nor can we live within our own skins, though the skin as the boundary of an organism plays its part in marking off the relative perspectives of our perception. We live within fields of interaction, and within this intercommunication distance plays its part. We cannot have the same concrete relations within long distances as we can within the face to face distances, spite of all the modern aids. It is not just a difference in the intensity of the particular type of interstimulation. But it is a difference in quality—in that type of creative complexity, that synthetic compresence of various factors, which constitutes reality.

After having discarded the old concept of the ether, whatever that may have been, Einstein identifies ether and space. "The conception of the ether has again acquired an intelligible content, although this content differs widely from that of the ether of the mechanical undulatory theory of light. The ether of the general theory of relativity is a medium which is itself devoid of all mechanical and kinematical qualities, but helps to determine mechanical and electromagnetic events. What is fundamentally new in the ether of the general theory of relativity as opposed to the ether of Lorentz consists in this, that the state of the former is at every place determined by connections with the matter and the state of the ether in neighbouring places, which are amenable to law in the form of differential equations, whereas the state of the Lorentzian ether in the absence of electromagnetic fields is conditioned by nothing outside itself, and is everywhere the same. The ether of the general theory of relativity is transmuted conceptually into the ether of Lorentz if we substitute constants for the functions of space which describe the former, disregarding the causes which condition its state. Thus we may also say, I think, that the ether of the general theory of relativity is the outcome of the Lorentzian ether through relativation." [14]

It is clear, then, that space according to the theory of relativity is endowed with physical qualities, it is identical with ether, it is the medium for the propagation of light, it furnishes the possibility of space-time measurements (measuring rods and clocks), "but this ether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts that may be tracked through time. The idea of motion may not be applied to it." [15] While, however, it is absolutely continuous in that it has no parts, yet the geometric determination of it has a certain discreteness. There is no electromagnetic or gravitational field within a particle or in its immediate vicinity. Hence there is a certain quantum determination, though Einstein conceives his molluscs as indefinitely small. Within these, as we have seen, Euclidian geometry applies.

While Einstein's ether-space is conceived in general as curved, the curvature is not intrinsic to the ether. If so, it would be constant and we should not require time and matter to define it. But curvature varies with the masses of matter and the space-time distribution of matter. It

[14] A. Einstein, *Sidelights on Relativity,* pp. 19 and 20.
[15] *Ibid.,* pp. 19 and 20.

can be defined only when we know the aggregations of matter and their space-time distances. It decreases rapidly away from matter and is nearly neutral at vast distances from aggregations of matter. It is not therefore impossible to imagine space without gravitational potentials as Einstein holds.[16] In his special theory he conceives bodies as moving uniformly in empty space; and even in the general theory of relativity he succeeds in imagining small areas of a Euclidian character. He is constantly employing the conception of empty space as a contrast to his gravitational space, and he conceives the world as finite in order that energy may not escape into empty space. He is certainly inconsistent in saying that he cannot conceive empty space. If it is a ghost for Einstein, the ghost is not laid!

The really novel aspect of Einstein's conception of space is that the geometrical properties of space can be determined by matter. But that after all is an empirical question. Einstein's conception of space curvature has met with brilliant success so far. The three tests, set by Einstein, may be regarded as fairly met. There is no question about two of those—the bending of star rays in the immediate vicinity of the sun and the explanation of the perihelion of Mercury; and Professor St. John, on the basis of a revised estimate of the pressure in the interior of stars, has recently come to the conclusion that the retardation of light in gravitational fields—or, more precisely, the shifting of the spectrum towards red in the case of light emitted from substances in the sun as compared to emissions from the same substances on the earth—agrees, within the probability of error, with Einstein's prediction.

The ether-space of Einstein must be capable, on the one hand, of being determined by matter into a rigid geometrical structure in order to function as the gravitational field of our world and guide the course of the motions within it; on the other hand, it must function as the medium for the transmission of light and other radiant

[16] *Ibid.*, p. 21.

energies. It seems to have succeeded in meeting the first requirement. But we must wait for a satisfactory theory of light before we can say whether it can meet the latter requirement. Einstein rejects the mechanical undulatory theory of light with the old concept of the ether. If the quantum theory of light prevails, there would seem to be no need for any medium except space for the communication of light. The main obstacle are the phenomena of interference which are apparently explained on the undulatory theory of light, but have not yet been successfully met on the quantum theory. It is difficult to imagine how a medium without parts and without mechanical or kinematical properties could communicate vibrations in the manner required by the undulatory theory. If, on the other hand, the phenomena of interference can be accounted for in terms of quanta of energy, this difficulty disappears. It may be that the interference which appears to our sense perception is due, not to the cancellation of the energy pulses of light, but to the filling up of the gaps between the light pulses with other pulses of light, so as to produce a continuous instead of an intermittent stimulation on our organism. We know in the case of sound that the stimulus must be intermittent and that a steady pressure produces no sensation of sound. If this is true in the case of light, then mutual cancellation of energy pulses would not be necessary. But in that case there should still be mechanical pressure which could be measured. In the meantime we must wait for the further advance of science.

Because he is impressed with the danger of matter and energy being dissipated into empty space, Einstein postulates a curved universe, unbounded like a sphere or an ellipse, but finite. No doubt the conception of curvature is fundamental to Einstein's theory, but it does not imply necessarily either the finitude of space or the finitude of the cosmos. Einstein presents the following arguments against the conception of a space-infinite, and for the con-

> (1) From the standpoint of the theory of relativity, the condition for a closed surface is very much simpler than the corresponding boundary condition at infinity of the quasi-Euclidian structure of the universe. (2) The idea that Mach expressed, that inertia depends upon the mutual action of bodies, is contained, to a first approximation in the equations of the theory of relativity; it follows from these equations that inertia depends, at least in part, upon mutual action between masses. As it is unsatisfactory to make the assumption that inertia depends in part upon mutual actions and in part upon an independent property of space, Mach's idea gains in probability. But this idea of Mach's corresponds only to a finite universe, bounded in space, and not to a quasi-Euclidian, infinite universe. From the standpoint of epistemology it is more satisfying to have the mechanical properties of space completely determined by matter, and this is the case only in a space-bounded universe. (3) An infinite universe is possible only if the mean density of matter in the universe vanishes. Although such an assumption is logically possible, it is less probable than the assumption that there is a finite mean density of matter in the universe.[17]

Thus Einstein, like Parmenides of old, envisages a finite world in the form of a sphere; and, like Parmenides, he denies the existence of empty space outside, on the ground that it is inconceivable. The dogmatism of Einstein is likely to give rise to objections similar to those raised against Parmenides. For there will be those who can imagine empty space outside such a finite universe. But let us now examine his proofs. The argument from simplicity is not convincing, for a theory must in any case be complex enough to meet the facts. A theory may be too simple. In the second place, the idea that gravitational inertia depends upon the mutual action of bodies

[17] A. Einstein, *The Meaning of Relativity*, p. 110.

does not require that space shall be finite. It only requires that there shall be such a distribution of matter in any one gravitational world, that there is a large nucleus and a thinning out of bodies towards the margin. Such a distribution we find in our galactic system. Since matter, according to Einstein, determines the curvature of space in its vicinity, in accordance with the quantity and dynamic distribution of the aggregates of matter, we are not concerned with the finitude of space, but with the closed character of the gravitational field within the space medium. Space might be infinite and yet the world might be finite in the manner in which Einstein pictures it. Such a universe would be an island in infinite space.

Einstein himself has pointed out the independent character of the electromagnetic field.

> The existence of the gravitational field is inseparably bound up with space. On the other hand a part of space may very well be imagined without an electromagnetic field; thus in contrast with the gravitational field, the electromagnetic field seems to be only secondarily linked to the ether, the formal nature of the electromagnetic field being in no way determined by that of gravitational ether.[18]

Matter and space are, at any rate, conceptually separable:

> Since, according to our present conception, the elementary particles of matter are also, in their essence, nothing else than condensations of the electromagnetic field, our present view of the universe presents two realities which are completely separated from each other conceptually, although connected causally, namely gravitational ether and electromagnetic field, or—as they might also be called—space and matter.[19]

But if matter determines the gravitational field of space and we can imagine space without an electromagnetic

[18] A. Einstein, *Sidelights on Relativity*, p. 21.
[19] *Ibid.*, p. 22.

field, we certainly can conceive an empty or non-gravitational space. For each island universe it would still hold that

> it must of necessity be spatially unbounded and of finite magnitude, its magnitude being determined by that mean density, . . . if there exists a mean density, no matter how small, of the matter in the universe.[20]

We might conceive an infinite number of closed island universes such as Einstein's universe, with no connecting energy field—huge, windowless monads, without any communication with one another. There is no theoretical difficulty in conceiving an infinite number of such monads. The island universes would correspond to the rational numbers and space would furnish the continuum—curved in the neighbourhood of the islands of matter, but for the most part neutral like Euclidian space. That there is no logical impossibility in an infinite collection, even if we cannot count it, has been abundantly proved by modern mathematics. Such collections have properties of their own which are quite distinct from those of finite collections; for example, that a part of an infinite collection can be put into a one to one correspondence with the whole. Such properties lead to paradoxes only when confused with those of finite collections. It is not necessary, however, nor is it congenial to reason, to conceive such an arbitrary distribution of energy. It is possible, I think, to conceive the island universes as closed gravitationally so far as the space-time distribution of bodies is concerned, and yet to regard cosmic space as curved by the distribution of universes *ad infinitum*. It is not necessary to assume the finitude of the cosmos to safeguard the escaping of energy into empty space. The cosmic field of energy may be closed and yet be infinite, *i.e.*, if there is an infinite number of universes. The combined effect of the total number of

[20] *Ibid.*, p. 20.

universes might be sufficient to canalize streams of radiant energy such as light from world to world, even though not sufficient to disturb the gravitational nexus constituted by the immense aggregations of matter concentrated within any one world. Moreover, the pressure exerted by such energies as light would contribute to make the spacing between worlds definite by driving in the outlying fringes of electronic matter into the main nexus. Such outlying fringes would have practically no mass and therefore would furnish but insignificant resistance.

It is plausible that light and other radiant energies of enormous velocities can escape from the gravitational field of any one world and thus establish communication between worlds, bridging the gaps of material fields. If they can break through the gravitational field of enormous stars with almost insignificant retardation and pass within grazing distance of stars with barely perceptible effect of curvature, they can escape the more attenuated fields. Einstein seems to think that light is curved within our material world, though he admits that we must wait for the investigation of the masses of the large fixed stars before we can have any adequate evidence. If his supposition were correct our material universe would be blind to anything outside itself. This assumption, however, does not seem to agree with astronomical evidence. Astronomy to-day inclines to the view that the star stream of the galactic system, of which our sun is a somewhat mediocre part, must be thought of as one of a vast number of independent star streams. We may picture our galactic system as a flattened disc, a watch-shaped aggregation of stars having, according to Shapley, a diameter of 300,000 light-years and a thickness of 37,500 light-years. But the spiral nebulæ, more than a million of which, according to some estimates, can be photographed with the largest telescopes, should, according to recent evidence, be regarded as outside our galactic system. They are conceived as "island universes," materially isolated in the depths of space, comparable in size with our galactic system; and with distances from us ranging from 500,000 to 10,000,000 light years. And even our modern telescopes do not reach far into space. According to this conception, the light-field is inclusive of various isolated material worlds. The "island universes" are open to light; and quanta of radiant energy can be communicated from one material world to another. Space, in other words, is not bounded by our galactic system and our experience is not closed within the latter. Our material world, with its gravitational nexus, is not the boundary of reality. The early Greek naturalists, more endowed with creative imagination than the modern, though poorer in facts, envisaged a cosmos consisting of plural worlds. And modern astronomy with its superior technique seems to be veering towards a similar conclusion.

Cosmic Cycles

The direction in which the theory of relativity points is that the reality which we know on the hither side, the side of our sense perception, as relative motions, as space-time perspectives with their empirical constants, must, on the yonder side, from the point of view of the whole, be conceived as having a definite structure—a law of equilibrium, determining the character of our finite perspectives. As we must conceive a law of curvature for the electromagnetic field and for the gravitational field and for the relation between those two fundamental types, little though we know of this relation as yet, so we must conceive a cosmic curvature, a guiding field of reality as a whole with its complexity of fields and levels. Only thus can we account for its eternal movement. To know reality truly we must needs know the cosmic path, the law of the whole, of its moving equilibrium. From the point of view of the cosmic whole, the plural worlds are quanta determined by the curvature of the whole.

Besides space and energy we must take account of time, the passing of nature, to understand the real world. It has been the fashion since Parmenides and Plato to regard the moving and relative as unreal, and to attribute reality only to the eternal. But it is only in movement and interaction that we live at all. Rest means stagnation and death. It is true that the creative passing of nature cannot be conceived as mere chaotic chance as Heraclitus in one of his dark sayings intimates: "Time is a child playing drafts. The kingly power is a child's." There must be structure as well as motion. But the real structure must be the structure of a moving world. It is a structure where the part-motions are determined by adjustment to the whole. The parts are sensitive to the presence of other parts. They are not like the self-contained monads of Leibnitz. Their path is determined by interaction. It is a dynamic equilibrium looking backward and forward. The universe repeats certain themes with variations. The themes and their succession are controlled by the whole. The variations are due to the unique motions and accidents of the parts. The equilibrium, moreover, is an equilibrium not merely of parts, but of phases and levels. In the cosmos as a whole all phases and levels coexist. A law of compensation operates within the whole. Energy is not lost, but its points of concentration shift. The cosmos consists of a plurality of compresent cycles, not a single cycle, and there is an equilibrium amongst the phases of these cycles controlling the redistribution and reorganization of energy. The ascending and descending phases are compensatory in the rhythm of the whole. This law of compensatory rhythm is illustrated in the life of the race. Just as in human generations, the point of maximum life shifts from generation to generation, all the ages of man coexisting so long as human life is a self-sustaining equilibrium, so in the cosmos, which is ever self-sustaining, all the phases coexist, from the youngest nebulæ to dark stars which have run their span of life. Life ascends from childhood to youth and maturity and descends to old age and the grave. And the ascending and descending phases are compresent. If there continue to be children because there are parents, there continue to be parents because a new generation rises to take the place of the old. Flowers come from seeds and seeds from flowers. Solar systems come from nebulæ and nebulæ from solar systems; and there are always nebulæ and always solar systems. Reality as a whole exists equally at the top and at the bottom in obedience to the equilibrium of the whole. Worlds as they mature and die yield up their soul to the universe as the ripe flower sends the pollen on the wings of the wind. Is this poetry? Yes, but only so can there exist a self-sustaining reality.

The law of compensatory rhythm must hold for all the types of energy and for all the levels of energy in the multiple histories of the cosmos. It must account for the waxing and waning of energies in the part-systems of the cosmos—such as our earth—and for the succession of levels in these systems. To account for the series of levels in the finite histories, the cosmos must be eternally stratified in its structure. The law of dynamic equilibrium does not suffice to account for the compensatory rhythm unless we have the conception of a stratified structure of levels eternally coexisting in the universe.

We can now see the cosmic signifiance of the second law of thermodynamics, *i.e.*, the constant tendency in any part-history for energy to flow downward from a higher to a lower potential—towards the level of dispersed motion. The downward trend—the dissipation of energy, the breaking down of the radioactive elements—is open to our observation. But what about the synthetic aspect, the running up process? Clerk Maxwell attacked the problem by postulating intelligent selection at the heart of things. And in some sense his insight must be right. Arrhenius thinks that in the interior laboratories of the bright stars, with their enormous heat and pressure, radioactive elements may be regenerated from their own débris. It is clear that the radioactive elements must be synthesized as well as expended or they would not now exist. But how could mere heat and pressure generate atoms with just such patterns and identical with those of the past and those now existing throughout the cosmos? If it is true that matter evolves, it is also true that the constitution of matter is eternal. The spectroscope shows that matter everywhere has the same patterns. The repetition of these patterns in space and time throughout the cosmos cannot be accounted for by mere chance. In some way the existing energy patterns must interact with matter in-the-making and furnish a guiding field. The synthesis must be determined by adjustment to the dynamic structure of the whole with its creative genius.

The mere conservation of energy within a closed universe, finite or infinite, would not save the universe from the consequences of the second law of thermodynamics. It would not prevent energy from running down to a dead level. For this there must be a compensatory dynamic stratification of levels in such a way that what is running down in one history may be run up in another, even as life runs up inorganic energy to a higher level. If we conceive the universe as one series, whether dramatically created as in the first chapter of Genesis or gradually evolving as in the theory of modern science, it must eventually run down and must be wound up again in some artificial way if it is to continue to run. In order to have a self-sustaining cosmos it must not merely be closed, but there must operate within it a law of compensation. This is possible through the rhythmic coexistence of a hierarchy of levels in the cosmos as a whole. Higher levels in one history thus operate to control the movement of another history from lower to higher levels, each eventually handing over its complexity of life to another and in turn going into its descending phase. The equilibrium is thus not only quantitative but qualitative, sustaining the coexistence of levels and phases. There is no abstract, timeless structure existing in the pure Empyrean, beyond the movement and struggle of the world, as Plato, weary of strife, fain would think. The real structure is the structure of a world of process where the pure Euclidian limits are warped and distorted, and where there is the appearance of chance in the conflict of plural motions, as Plato so keenly realized. But in the moving equilibrium and under the control of the guiding field of the whole, the plural motions with their inertia, their centrifugal tendency, swing into place, at any rate, over long periods and continue to swing into place.

We must not suppose that the characteristic motion of the parts is abrogated in the whole. We know from observation and experiment that in complex systems of motions under the control of a guiding field, the characteristic motions of the individual components are not lost, though for the time being they are under the control of the guiding field. Thus hydrogen and oxygen, when the compound, water, is dissociated, resume their characteristic reactions. Thus in the human nervous system, if a lesion disconnects functionally the centres of the spinal cord from the upper centres, we find that the lower centres resume their characteristic protopathic, all-or-none reaction, instead of reacting differentially to the locality and intensity of the stimulus, as they do while under the control of the cerebrum. Every system of energy has a motion of its own and offers resistance to the superimposed control of another system. Thus the thermal motion of the electrons offers inertia to magnetism and this inertia increases with the motion. In the complex economy of the human organism where we have a vast number of energy systems, each level in the hierarchical control offers inertia to the superimposed higher levels, and though these various systems are held in subordination for a season within the control of the whole, their centrifugal tendency remains. This means strain and consequently the equilibrium is unstable. The heart may fail while the other organs are still sound, but with the failure of this vital organ to respond to the control of the whole, the organism dissolves into its constituent elements with their characteristic motions. All part-systems are thus unstable and have a limited span. There is always the inertia of the component motions. When the common control dissolves, the constituent parts, held in leash for a period, resume their characteristic motions. There is only one equilibrium which is absolutely stable and that is the dynamic equilibrium of the whole.

Death is the price nature pays for complexity. Only the rhythm of the whole is eternally compensatory. In the equilibrium of the whole there are a variety of systems in different stages of evolution and each as it dies gives up its life to the others. There can be cumulative orderly duration in any one history because the different systems give and take. Within the economy of the whole there is immortality, for nothing is lost, be it individuals or phases. If we mourn because of the conflict, pain, and death involved in such a moving cosmos, we should consider that only through conflict and pain was there ever any advance in the world which we know best. Uniform motion is the stagnation of values, the degeneration of structure and function. And when the death of dear ones pains us or the thought of our own little life casts its shadow ahead, we should find consolation in the fact that in the cosmic economy nothing is lost. Not only the end phase of a life history is conserved, but all the phases are conserved somehow in the yonder to share in the motion of the cosmos, perchance to share elsewhere in the creative advance of nature towards a unity higher than anything of which we have been able to dream. In the meantime it is well for us to remember that cosmic genius is conditioned in a measure by the inertia of the parts; and while in the long run the parts must fall into step for a season in the varying figures of the great cosmic dance, yet our individual willingness may affect the rate of movement of the whole, even though in an indefinitely small way. Certain it is that it affects our individual destiny in a momentous way.

The mechanism of the creative advance of the cosmos, the efficient causes by means of which this stupendous whole can act as a unit under the formative influence of cosmic genius, awaits further investigation. But within the small world, the human organism, we are familiar with two types of messengers which travel from part to part and which effect unity of control. We know that certain ductless glands such as the thyroid, parathyroid, pituitary, and pineal glands transmit through the blood chemical messengers, the hormones—energy patterns by means of which they influence the tone, proportion, and growth of the organism. And there are the neural, bioelectrical messengers which seem to be formative agencies in the growth of the organism as well as stimuli to action. In each case what is transmitted is not merely energy but an energy pattern, potent to control the development and behaviour of the organism.

But how can energy patterns be transmitted over the vast spaces of the cosmos? On the undulatory theory of transmission they must be too far spent to affect matter upon the earth. But here new discoveries into the relation of energies may help us to make the interrelation of the parts of the cosmos more intelligible. A definite and simple relation has been discovered between the waves of radiant energy and the movement of the electrons. Radiant energy can be converted into electronic motion through the agency of atomic matter. By acting upon atomic matter, wave radiation can produce electron radiation, and *vice versa.* Wave motion is defined by two qualities—the wave-length and the amplitude. Electron radiation also has two characteristics—number and speed.

> In what way then are the characteristics of the waves related to the characteristics of the electron movements which are excited by them? The answer is simple but surely unexpected. The velocity of the electron depends on the wave-length; the number of electrons depends on the intensity, but not on the wave-length.[21]

The decrease of the intensity of the total wave would nat-

[21] The Robert Boyle lecture by Sir William Bragg, "Electrons and Ether Waves," the *Scientific Monthly,* Vol. XIV, p. 155.

urally follow from the diffusion of the quanta components over long distances. "The essential point is that wave radiation falling on matter of any kind whatever and in any physical condition, liquid, solid or gaseous, hot or cold, causes the ejection of electrons." [21] And the velocity of the electron which is started by a certain wave-length is the same, even though the wave has apparently spent itself in the length of its journey. "The effects are as if the energy were conveyed from place to place in entities, such as Newton's old corpuscular theory of light provides." [22] The radiant wave somehow yields up the original quantum of energy when it acts upon matter and sends forth electrons. As the action of electrons determines the behaviour of matter we can see how the behaviour of matter may be controlled at a distance. This stupendous discovery bids fair to revolutionize our conception of cosmic interaction. The enormous distances no longer divide in the sense that influences from one part of the cosmos may not be potent in forming the development and behaviour of another through the mediating agency of matter. Thus cosmic interaction and cosmic control at length seem a scientific possibility.

In the cosmos there must be higher orders of interaction and adjustment than gravitational and electromagnetic, for we know of higher orders of interaction within our experience—the interaction of living things with living things and the interaction of minds with minds. To these higher orders of interaction, the lower orders become instrumental. They act as bearers, vehicles, conducting agencies. Every level of reality establishes its own continuum over space and its response in kind wherever the conditions are present—the higher levels riding on the lower and using them as instruments in their space-time expression. The higher levels are more concrete than the lower, for they include the lower, to which they give a characteristic impulse and organization. This we see exemplified in human expression and communication.

[22] *Ibid.*, p. 158.

The mental level controls the complicated physiological levels. It uses the complicated language mechanisms in the service of the meaning to be expressed, and through them it communicates its characteristic pattern to the medium. In speech the air-waves which transmit the idea do not constitute the pattern which they communicate. The whole integral situation with its unique control enters into the expression and communication of the meaning. The air-waves become the body which carries the meaning pattern to the listener. In writing, the ink and paper become the body, and in sculpture, the marble. But the meaning pattern is incarnate in the medium or it could not be communicated.

Just as we speak of a thermodynamic continuum and an electromagnetic continuum, so we should speak of an intersubjective continuum. In each case the continuum is an interpolation to account for the end effects in space-time. Mind patterns are transmitted in quanta in our social relations, irrespective of the decrease of the intensity of the waves that carry these quanta. The news of misfortune or good fortune produces the same characteristic effect whether the voice that communicates it over the long distance telephone sounds faint or loud. The quality and potency of the news are not affected by the intensity of the waves that bring it. The communication in higher orders of interaction, as in lower, is in kind, and so is the response in kind wherever the proper receptor organization exists for receiving the impulses. Living matter has a quality of its own, different from inorganic matter and responds to the quality of living matter as it does not respond to inorganic matter. So minded matter has a quality of its own and responds to minded matter as it does not respond to non-minded matter. Not only do the energy pulses exist within a different organization and control in organic matter from inorganic, and in minded matter from either of these, but the total impetus communicated is different. Else how could there be a characteristic response? For the response must be to the impulse as communicated. When we have an exchange of ideas in conversation, it is not just mechanical air-waves that are communicated, but the integral mind, the whole personality is communicated. This is true whether we are capable of sympathetic participation or not, though of course we do not perceive it or respond properly to it unless we are capable of sympathetic response. Not merely the organization of energy into material atoms, but also its organization into higher patterns, such as organic and mental patterns, must produce characteristic radiations which communicate the energy in kind.

If every atom emits a characteristic energy pattern, so that it can be identified in the space-time of distant stars, we must also believe that larger and more complex organizations radiate characteristic energy patterns. We know that the compresence of levels in human personality is not merely a collection of parts, but constitutes a unique organization with unity of control and with characteristic expression through which the personality as a whole can be identified in distant parts of space-time. The earth moves as one history under a unit control and the various levels that we know are integral parts of the history of the earth in its interaction with the cosmos. We must believe that impulses communicated from a cosmic history such as the earth are integral expressions of its character and are communicated as integral impulses to other parts of the cosmos. They may elsewhere be analyzed where the proper receptor organization exists, as we succeed in part in analyzing the complex impulses of the medium in which we move. The integral action of such impulses contributes towards constituting cosmic curvature, the space-time mould, the geodesic path of creative advance in the cosmos. And such interaction is effective in the total steering even if the parts do not have the organization to respond differentially to the complexity of the impulses—as light is effective before there are differential organs to respond to its complexity—steering towards life and mind, before life and mind in a particular history exist, and furnishing the guiding field towards the development of proper organs in the trial and error adaptation of the parts. Yet the quality of a particular history is not the mere repetition of the pattern communicated, but is the unique result of interaction of the special history with the impulses from the cosmos.

The law of cosmic adjustment must be conceived as including all the levels of interaction and must include them within an integral control. The various energy pulses from various parts of the cosmos both enter as ingredients and are curved within the total control. And as in the microcosm of human personality the higher levels overlap and exercise control over the lower—selecting or inhibiting the impulses from the lower levels in accordance with the set of the highest level, so cosmic genius must exercise control of the streams of energy of various levels in the cosmos. But in the cosmos this selection and integration is eternally going on and does not lapse as in our limited human economy.

But you say: Is not this eternal recurrence of cycles futile? What inspiration can there be in such a conception of reality? If there is no gain in the process, is it worth while? If there is gain, how account for it? In the first place, if evolution meant exact recurrence as the Stoics conceived it, it would not necessarily be futile. The idea of indefinite progress is a comparatively recent idea; and if we examine it we find that it is at best a vague sentiment. No law of progress can be laid down. It is rather a wish projected out of our present feelings. The idea of progress grows out of our feeling of imperfection. The perfect does not progress. Perfection is its own excuse. We do not want a perfect thing to be different. It is only the imperfect that we want to be different. No one would want a perfect symphony, a perfect personality, altered. On the contrary, the feeling for its perfection constitutes a demand that it shall be eternal. "A thing of beauty is a joy forever." We want it repeated as the satisfactory thing that it is, as expressing an idea, a phase of experience in a perfect way. Of course there must be complexity in the movement of reality. We want repetition with variation from part to part of the symphony. But that does not mean that the symphony as a whole is not eternally complete or that there need be any apology for the repetition of the symphony. It is, at any rate, conceivable that there might exist a reality where all types exist at a maximum of perfection. Such a reality we should wish to imitate and own. We should not want to alter it. Such was indeed the Greek idea—the idea of Plato and Aristotle—of ultimate reality. Plato's perfect pattern of beauty and goodness exists beyond the world of chance and mutation. The activity of Aristotle's God is circular. The Christian City of God is eternal in the heavens.

But in our temporal conception of reality, it is not necessary to suppose that the recurrence of cycles means automatic repetition. In the cosmic exchange from history to history, whether the history of worlds, of civilizations or of individuals, one history appropriates the energy patterns of another by creative adaptation; and the significance of the pattern depends upon the history and structure of the individual part which appropriates the pattern. When one world takes up the cycle of another, one group the civilization of another, one individual the pattern of another individual or group, there is not just repetition, but repetition with variation. This would probably be admitted without argument. But suppose a world with its constituent parts lives through a second cycle in the course of the cosmic year. Would this have to be mere repetition, as the Stoics indeed conceived it? I do not believe so. For, in the first place, the process of creative adaptation must take place through individual centres of energy. We have no reason to believe that such effort at adaptation would be just the same in successive cycles. Speaking in terms of human experience, we need not assume that individual willingness or effort is mechanically determined. If we might do more or less in the way of attending, if we might try to meet the problem differently, life history might be different and the ensemble of realization might be different. The cycle would be repetition with variation and its whole significance might be altered. The cosmic cycles then might be looked upon as creative experimentations to approximate the ideal order, "the pattern laid up in heaven," to use the language of Plato. Success or failure might have an entirely different quality in various cycles. Our individual trial and error response, our willingness and earnestness do count in the realization of the group and its preparing for the future. And if there is a difference in the creative individual factor, then the cosmic cycles may be different in the concrete realization, whatever be the eternal themes.

But, in the second place, there may be differences in the cosmic environment from cycle to cycle. The process of cosmic adjustment must now be conceived in terms of universes, each with its individual control and life but in interaction with other universes. It has been suggested by Moulton that we must conceive the cosmos as a hierarchy or hierarchies of universes. At any rate, there is some sort of interdependence which we do not understand as yet. We cannot place any limit to the number of such universes. There may be an infinite number moving about in cosmic space in accordance with a law and rhythm of the whole. This cosmic control we know dimly in the higher reaches of our experience as a spiritual control. What if we could look at reality from the yonder side, the control of the whole! In the rearrangement in such a cosmos, there may be infinite variation in the external influences that bear upon the cycles of any one world. And realization may have to be conceived in terms of infinite variations on a few eternal cosmic themes with universes furnishing the instrumentation of the harmony. O vastnesses, O sublimity! How can we pretend to grasp the Genius of such a cosmos. How different from a university professor sitting down and spinning a web of categories from his own consciousness as the German idealists conceived God.

The concept of a universal law of equilibrium, of a cosmic control, is a momentous one. What a stupendous thought thus to outrelative relativity. The grandeur of standing as it were even in imagination on the very top, in a qualitative sense, of the cosmos—at the centre of exchange, of cosmic redirecting of the multiple streams upward and downward, of the interflashing of cosmic genius from part to part—fills me with a dizzy rapture such as I have felt when I have surveyed mountains and plains from some isolated granite peak, towering towards the sky. I must not forget, however, that it is, after all, my finite and relative perspective of divinity from my finite moving frame of reference. And this should keep me humble. But even from our human Pisgah to try to rise above the passing show and to view things *sub specie æternitatis,* to envisage a cosmic path, a law of the whole, of its moving equilibrium, fills me with an emotion of reverence, a sense of sublimity which passes the moral law within and the starry heavens above, for these, in the last analysis, are but finite perspectives of the cosmic order. This order we can but adumbrate fragmentarily in our little life. In the meantime we must carry on as best we can from moment to moment of our multiple moving world with its transitive and asymmetrical relations, and try through the ages to piece out the curvature of our bits of experience, striving all the while to create plans for better living and for larger correlation of the facts of life. The finding of the cosmic path, the straight and narrow way that leads to salvation, must be one of trial and error experimentation, of creative discovery through the ages. Salvation is a co-operative undertaking. Divine genius furnishes the impulse of higher orientation, but the finite individual must respond creatively to this impulse. He who fails to find the path, merely oscillates and beats out his life in vain. And oh, the tragedy of it! He who finds the way, finds life, development, divinity. And oh, the glory of it! But this insight must be bought with anguish and blood. No advance is made without paying the price. Sometimes in a moment of beauty, sometimes in a fleeting mystic sense of unity, we may feel the order, the way, which our intellect is so inadequate to trace. And be the moment ever so brief, it will shed its radiance over a life—a radiance from the divine source of beauty, gentle and constructive in its influence, enveloping like love, creative like genius, tender as the soft kiss of a child.

CHAPTER IX

FINALE

Cosmic Religion

The Awakening of Mother Earth

We are told in ancient story of a mighty giant who received fresh energy every time he touched mother earth. But Hercules conquered him by strangling him in the air. The human soul likewise receives fresh energy from contact with the world of concrete reality, but it has long been well-nigh strangled by the abstract intellect which holds it in the air, away from the source of our being. For we are children of mother earth more truly than we are children of our biological parents. We never leave her womb. We are always part of her circulation. We are sustained by her substance. We breathe her energy. We are old as she because in us are the traces, the Karma, of her entire past. We are young as she, for in us she opens her eyes in wonder to gaze upon a novel world. We are the architecture of her genius and experimentation through countless ages. In us she would fain lift her head above the stream of passing change and come to the realization of the beauty and meaning of the world. In us she strives to maintain herself at the high vantage-point of conscious self-direction against the forces that would level all into primeval chaos. For ages she prepared herself unconsciously, controlled by a cosmic order which we can see only dimly and in retrospect, for this nobler vocation. She captured the necessary elements and brought them within her control. Under cosmic guidance she stored the sunbeams in her recesses, she prepared the proper proportion of elements and the proper conditions that she might in due time, nurtured and fecundated by cosmic energies, give birth to life. With life as a magic agent she was able to remake herself and to carry on the experimentation for higher forms of life until she could mirror herself in consciousness, see the creative bent of her genius and create, if not more intelligently, at least more economically. After striving for ages to establish, first, types of physical environments, then types of organic structures, she has more lately striven to express herself in types of ideas; and the survival conditions have become no longer merely those of brute might, but of spiritual selection—sometimes rank, sometimes more expressive, but working by vastly more economic tools and more rapid experiments than organic creativeness. Thus she has been able to objectify in us—compounded of dust and wind and sunshine—the futile strife and blindness of the past, and to seek a better way. This and much more mother earth has accomplished, and in this we share as her offspring.

The human mind in its attempt to understand its world has invented strange dualisms and then become the victim of its own abstractions. In its childhood it was prone to ascribe a life like its own to things about it. Later it invented a world of doubles, a ghost world, which seemed to dominate the seen world. How it came to create this ghost world is a problem lost in the hoary past. Whatever its origin, the ghost conception has haunted man for ages and haunts us still. It is at the basis of a great deal of our religious and philosophic thinking. It has led to a strange separation between this world and the fairyland of imagination. It has made this world seem mechanical and dead, and has made us seek our values in some remote realm created by fancy to suit our wishes. In fervent mystical moods it has led to a derealizing of this world as at best a veil or sign of some other reality. By our abstraction we have thus made two worlds, and separated them the whole distance of earth and heaven. But while our imagination has created another world for the values which we seek, we have degraded the earth more and more, little recking that all the while we have our roots in the soil and that the values which we have abstracted and transposed to an imaginary world of their own are the florescence of our own humble earth. In its creative process we must find God and heaven, if we find them anywhere. Both the materialists and the theologians talk as if soul and intelligence blew in somehow by accident into this world. They do not realize that human nature is the expression of nature; and that whatever is noble and beautiful in us is nature's recreating herself in us.

Man's bondage to the ghosts of the past is a subtle one and not easily broken. It is not merely the popular idea of doubles which are just like our bodily self, which flit away at death and live somewhere else in the land of fulfilled wishes; but the ghost idea may be magnified and purified into an ideal being, still like ourselves, but infinitely enlarged in power and wisdom. It may take on the transcendental form of personifying the universe into one vast inclusive ego, the fulfilled wish of its maker. This flatters man. In his egotistical conceit he would fain worship himself, especially when he can do so in the guise of himself infinitely enlarged. But, after all, it is our conceit which makes us think of the supreme reality as a double of ourselves, even though it be our complete and satisfied self. We are still moving in a ghost world, even though it is more refined and abstract than that of our more honest and simple forbears. The most blighting ghost of all is that of materialism. For proud though the materialist is of his idol of mechanism, it is, after all, but the ghost, the double of its maker. It is but the reading of his mechanical habits of mind, his callousness to all finer values, his philistinism, in short, into the objective universe. In his consummate egotism the materialist assumes that the only order of the universe comes from his little brain! And where did his brain come from? But we cannot atomize the universe into dead abstractions and make a living whole out of it. And our ideals, our striving, our creativeness, are part of the universe even more truly than our routine and mechanism, though the latter have their place.

It is a horrible tragedy that man should have accepted the theory of blind chance and of might as the philosophy of the universe. But this fits the tiger nature in man. We hug the illusion of self-preservation, forgetting that only by losing ourselves can we find ourselves. Our blindness and warfare are part indeed of the eternal struggle of forces in their externality. It is the path nature has travelled; but while a necessary discipline for the development of a hardy race, it is a wasteful process. And so mother earth developed the altruistic instincts—love for others, care for others, co-operation with others. Instead of the old order in which individual might prevails, it is an order in which the bond of love and loyalty prevails. And since this bond can exist only where there is fair play and helpfulness, it means that love and justice are more powerful than hate and brute might. There is an order in things which strives dimly and painfully for expression—the order of atonement. And only in this direction is life. We live such a little while. What a pity to waste this life in strife. Mother earth is caught in the net of struggle, in internecine competition, but what she craves deep in her unconscious heart, and especially when she awakens, is harmony, redemption from her blindness, union. And so she begets man. But mother earth, when she wakens at times to consciousness of herself in man, cannot be said to be altogether pleased with her offspring—man, the most predatory of all animals, who has robbed the earth of so much beautiful life to satisfy his rapacity and vanity, and who even preys upon his own kind. Now and then, however, in choice individuals the earth realizes in a prophetic way the longing for harmony, in the forgiveness and sacrifice of Jesus of Nazareth—not in a Nietzsche who would maintain the illusion of egoism and strife, but in the true saints, those who have a passion for charity and atonement, who give themselves, all their riches of heart and genius, that life may become more harmonious, who feel the order in the universe and strive earnestly in thought and deed to make it conscious and real. It is they who must be the leaven of a new society, if a new society there is to be—a fairer earth. For the meek shall inherit the earth. To them we must build the temples, not to the rapacious tiger-men whom the world deems successful. Worldly success is bought at such infinite cost—the cost of soul. There must be the spirit of sacrifice, of help-live—a spirit which the world cannot understand—if the earth is to attain to its truer life. So long as the victor despoils the vanquished, and the vanquished hates the victor, it matters not so much who is the prey or who is the tiger. The vicious circle goes on. We need the courage, not so much of fighting—that is easy—but of forgiveness. In this direction, in the end, lies the law of economy as well as of happiness. No longer in division and strife but in union, in creative synthesis, must our salvation be sought.

The dualism which has made a fairyland out of our ideals and left this earth dead and godless must be broken down. The material and spiritual are not two separate worlds. The spiritual is the re-creation of the material into new unities, wider and higher syntheses. The seeming deadness of much of our earth is due to the separation of forces. A material element is but energy hide-bound with habit, pent up for future liberation. What mighty stores of energy are condensed in the humblest portion of matter can be seen in the light and heat of radium. How wonderful is the solvency of life compounds! And what shall we say of the spiritual relations of friendship and love? They disclose the potency of our earth in the choicest and purest ways. Spirituality is the distilled, purified union of nature's energies in the most complex relations. Materiality is but inertia, particularity, separateness, isolation, externality. And so a materialistic man is a man with few and narrow wants, self-interested, self-centred. The spiritual man responds to myriad tones. His windows are open to the light in all directions. He is social and universal in his interests. Deadness is abstraction, separation. It is in creative union that there is life and spirituality. It is the striving of our mother earth and the universe to accomplish such union. Thus nature creates life as a new fact—a miracle even in its lowliest form. The humblest bit of life is infinitely superior in workmanship to gold and diamonds. We must learn to value life more and brute things less. And life is communion, not isolation. Isolation, whether in the inorganic, organic, or spiritual stage, is barren. It is in communion that there is fruitfulness. Hence we must strive for larger and more complex communion. In rare moments nature becomes conscious of this striving for union—in the warm kiss of love, where dust, wonderfully fashioned dust, meets dust and lingers in fond embrace; in the chaste bond of friendship; in the communion of saints. It is the attraction of spirit for spirit, for spirit is earth divinely organized and realizing its own richness. Not earth and spirit, but earth realizing itself as spirit in the creative communion of choice souls with one another and the Genius of the universe. It is the striving of nature, the push of its order, to reach spiritual creativeness, to liberate itself from the limitations of next to next in space and time and to attain unity of life. This can be reached only in spiritual appreciation and communion —in love, in friendship, in art. And art is but the architect of nature working with more delicate tools, conscious of the drift of nature.

If we are dust, dust looking into the eyes of dust for a moment in seeming separateness, only to blend soon in the common melting-pot again, why not make the brief moments as significant and beautiful as possible—bringing to life in each other the hidden resources of love and appreciation? Dust is beautiful in its creative synthesis—beautiful in the sunset, beautiful in the glory of spring, but most beautiful in the divine communion of human souls. It is then that we feel most truly the creative potentiality of dust, our kinship with the harmony and tragedy of the universe. We must learn to realize life in common, not ourselves, in order to live ourselves. We must learn to live as part of a whole if we would be individuals. Individuality must be precipitated and purified in social emotion, social thought, social co-operation and sacrifice in order to redeem itself, even as the servant of Jehovah gives his life as a ransom for many. There is ample room for asceticism in any life worth while—the denial of the present for the wholeness of the future, of the individual for the wholeness of the group, of the group for the wholeness of humanity. Only through self-denial can the higher values of life win fruition. Flesh has its claims too, but it is part of a larger whole—which flesh cannot see. At best life is partial in our imperfect world. We must strive to realize the higher partiality as against the lower when the two conflict, as they often do in this imperfect existence. But we must not forget that the end of life is not partiality but atonement, union, communion.

We must turn from the ghost religion of the past, with its anthropomorphic background, to a more real basis, the basis in the evolution of our earth. We must know the tree by its fruits and the creative potency of nature by what it produces. We cannot discover the secret of life in the slime of the sea. We must discover it in creative synthesis; and the more complex synthesis is more truly expressive of the Genius of the whole and its incarnation in the finite than the simpler. True religion is such a creative synthesis. If we had a living religion, a vital faith, instead of a ghost of the past, what a difference it would make. We repeat words, but the life, if they ever had life, has passed out of them. The old paradises and infernos have moved to limbo. It would be well to begin all over again. A sincere nature-worship were better than no worship, and thus we might liberate ourselves from the slavery to words. If we should worship the incarnation of divinity in the life of mother earth genuinely, we should get hold of reality, at any rate. And we might through her ascend to the Genius of the whole, rising from the perishing beauties of earth to the enveloping beauty and goodness. Yet not despising our mother. For the earth is our mother. We are dust of its dust. In the spring, after the long northern winter, the earth clothes herself in a garment of green grass and leaves and flowers—a garment of wondrous beauty. Just so, in the ages, the earth clothes herself with human society, with institutions and science and art—in short, with civilization. For we and our civilization are but the development of the earth's crust in creative response to the forces of the universe. The earth is not dead. In its creative union with the cosmos it glows like the Holy Grail. It is mother earth that looks with myriad eyes at myriad stars, that produces symphonies and listens to them with myriad ears. It is mother earth that spins the invisible threads of human relations and weaves them into various patterns. It is mother earth that wakens in us to reflection and creative construction. We remain part of her throughout. It is not nature and man, but man the last experiment of nature. She holds us up in the sunlight for a moment and then reclaims us to her bosom. We are motes in the sun, walking flowers whispering joys and sorrows to each other, ants crawling at the bottom of the atmosphere, building our miniature abodes. All the while we are part of the earth's control, of the law of her evolution, drawing our life-blood from her until our little span is complete.

We should love mother earth, for it is but a fragment of her that loves in us. It is she that reveals her nature in the bond of love, in friendship, in all striving for truth and beauty. The family with its parental instinct and filial response is her creation. So is the bond of the community, the bond of nationality, the striving for larger human unity. We fight each other in our blindness, not realizing that we partake in one creative essence. Oh, how the earth has struggled to attain this moment of living in us, looking at herself through us, waking in us, creating in us. And why should we fear death? It is but the earth reclaiming its own. It is but being clasped closer to her mother heart. We are of her. We are earth. I that speak am earth, and you that listen are earth—earth in myriad unique creations, but we are children of the same mother. If she claims us, if she undoes the work of her brief blossoming in us, it is because she has her race to run. She cannot tarry. She is impelled by a still larger destiny. Truly the virgin earth is pregnant with divinity, and in her travail and birth is revealed a glimpse of the larger life.

The Song of Mother Earth

If mother earth might speak through us its parts and organs, she might say: "It is my genius that reveals itself in the story of evolution. I create species. I press on to life in myriad individuals. Love's sweet mystery is my mystery. I strive for union and atonement. The holy bond of friendship is my bond. I love in myriad hearts. Mother love is my love. The romance of youth is my romance. When love mourns the death of dear ones, it is I that mourn. I clothe myself in flowers. I fill the world with my fragrance and I shape organs to enjoy the fragrance. I love beauty and I create organs to contemplate and create beauty. I sing in the song of birds, expressing my joy and anxiety, calling to my mate to fulfill love's obligations that the bird song may go on. I am the waving corn-fields and the cattle on a thousand hills. Mine is the music of flowing waters, the hush at dawn, the low drowsy hum at eventide, mine is the majesty of the mountains and the tranquillity of the plains, the sweet fragrance of lilacs after rain, the pulsing days of spring-tide and the sad beauty of autumn. The floating clouds and the rainbow are mine. I gaze at the vast immensities of the starry spaces and feel humble in my lowliness. I gaze into my own being and am overawed by the dimly felt law of my own destiny. I carry the yesterdays in my frame, the striving and hurry of to-day, and the promise of the future. And I am man, to profit and to enjoy, to praise and to condemn. His conscience is my awakening. His sense of beauty is my harmony with myself and the universe. I created his sense organs and his mind, in unconsciousness, not knowing my own genius, that I might enjoy sunset and evening star.

"But I am more than myself. My genius is but the expression of the Genius of the cosmos. I am sun-dust, part of the energy of the sun, evolved from the same nebula, life of its life. It is the sun which impregnates me in his shower of golden light. I was incubated by his energies in the vast ages. I am held safely in his embracing arms in my perilous journey among the stars. I grow and develop because of the nurturing energy of the sun. Therefore I thank and praise the benignant author of life and beauty. But the sun too is star-dust, part of the drift of the cosmos, part of the starry heaven that inspires me with its sublimity. And I am akin to these larger energies. The history of cosmic dust lives in me. I have been present in the rise and decadence of worlds, in the everlasting harmony and tragedy of the spheres. When the glorious father sun is a burned-out cinder, moving sightless in the dark spaces, waiting to be recharged with new energy, I shall follow him somehow in his death and resurrection. I am not self-sufficient. I am part of the larger destiny. I live only as a part of the rhythm of a still larger order. I have my flowering period, and then I too must die, at least for a season. In my conscious moments I sometimes mourn my death, for I too would fain live. But I submit in confidence to the larger Providence. I am the vessel of the great Potter. I am more, I am His child. I am the work of the Genius of the whole expressing Himself in every part. And He loves me with an infinite love, of which the love I show is but a fragment. To this love I trust myself and mine, as I travel the unknown spaces in the infinite flight of the æons.

"My soul is at peace at length, and my restless, throbbing heart aches no more, for in the cycles of change I have caught the music of the whole. I shall sing my song to the harmony of the whole, to the overarching and all-pervasive cosmic Genius which furnishes the goal of my striving and the field within which I move, though sometimes tardily and in parts perversely. Of myself I am a barren virgin, but I share in the life of all the worlds; and, lowly though I am, I am yet the bride of the Highest. Through the Divinity that envelopes me, I shall conceive, in the fulness of time, yet greater and nobler soul. I shall bring my gift to the whole, to the immensities where stars are lit and fade in the depths of space as a candle burns out in the night, though not without lighting new worlds in the reciprocal exchange of the whole. Every part, however humble and however great, lives its life within the guidance of the whole and is fructified by the Spirit of the whole. May I become attuned to respond to this creative Spirit with still nobler gifts. This shall be my prayer and my religion—feeling what I cannot see and reaching forward to what I cannot comprehend—as I wait in pious preparation for the new incarnation of Divinity."

The Aspiration to Divinity

We do not understand, but somehow we are part of a creative destiny, reaching backward and forward to infinity—a destiny that reveals itself, though dimly, in our striving, in our love, our thought, our appreciation. We are the fruition of a process that stretches back to star-dust. We are material in the hands of the Genius of the universe for a still larger destiny that we cannot see in the everlasting rhythm of worlds. Nothing happens but what somehow counts in the creative architecture of things. We fail and fall by the way, yet redeeming grace fashions us anew and eliminates our failures in the larger pattern. The pangs of pain, of failure, in this mortal lot, are the birth-throes of transition to better things. We are separated for a time by the indifference of space and by our blindness which particularizes and isolates us. But in us is the longing for unity. We are impelled by a hidden instinct to reunion with the parts of the larger heart of the universe. We are hurrying to the consummation of the drama—tragedy, because we cannot see beyond our failures; comedy, when our little systems are revealed in a new and wider plot which in turn is but a curtain-raiser to a new drama.

This is not a religion of nature in the sense of levelling all to the less-developed stages of nature—brute and matter. It is in the upper creative reaches that the meaning and goal of the universe, the genius of divine creativeness, is foreshadowed. When the earth becomes conscious in us of its order and law, of the cosmic trend, there is much to criticize, much to eliminate from the jungle of life and the elements as they are thrown together by the sea drift. We cannot worship the whole of things as a mere collection. We must discern and feel the Genius of the whole. There must be ideal direction and synthesis. And so we have art and morality and religion—earth's noblest creations. We must eliminate sin which is isolation, blindness to the larger whole. We must select in our appreciation, our striving. And so we worship the finite. Not all is good or beautiful, at least to usward.

Realism and idealism both have their place. Idealism is the flowering of the pain and stress of life. It is the compensation for our sense of failure. To us the completer union is something beyond, in the creative bosom of the future. We must build our air-castles to keep the spirit of effort and hope alive. There is ever the beckoning of the unknown, the spires rising heavenward out of the tragedy of the soul. The mistake of idealism has been that it has erected an artificial heaven of values, apart from this world, while it has made this world sordid and mean. Hence the eternal hiatus, the failure to bring the two worlds together, and the consequent tragedy of life. So we must have realism to balance our idealism. We must learn that the true air-castles of the spirit, of our nobler striving, are the manifestation of nature, the adumbration of its meaning, produced by the cosmos even as the sunset and the rainbow—not something apart from it. They are the artesian pressure of the Genius of the whole in human nature, behind even as before, seeking realization in the finite process and in finite centres. Mourn not because the moments of this constellation of dust are brief. Say not that it is all in vain because we must die and the earth too must die, for some æons at least until she is resurrected again from her slumber in the larger Providence of the universe. Flowers too have a brief time to bloom. Is it in vain that flowers bloom, because they must die? We were not brought here in vain. The Genius of the universe will see to it that nothing perishes which has permanent worth. And to stand for a moment on Pisgah, to see and feel the beauty of the world, is this not worth while?

There is in us the impulse for immortality. There is the consciousness of the unfinished task, of the larger creative destiny. We cannot see our place in the infinite future. But we must work in faith for the promise. We must have faith that the creative Providence which has led us hitherto with infinite care and pain is not playing an idle game, cannot be permanently defeated in its striving. We do not know our place in the structure of the whole, but we must pray and have confidence that what is best shall come to pass. A great deal of our hope for immortality has had its roots in our vanity and egotism. We have built our future upon our pride in personality, our pride in class and race. We have erected false distinctions of values. We create the gulf of separation between the sinner and the saint. We erect our measure of value, based upon our limitations, and expect the universe to respect it. We egotistically pride ourselves on our saintliness or welter in our sins, forgetting that in the struggle for life it is often our self-satisfied saints who make sinners out of the rest. But we are all miserable sinners and potential saints—imperfect beings, half-men. Man in his vanity personifies what seems to him good and calls it God. And in like manner he personifies what seems to him evil and calls it devil. He completes his wishes in imagination and calls the result heaven. He objectifies his pain and frustration and calls the result hell. But our measure of values is relative to our ignorance and imperfection. In the democracy of dust, sinner and saint lie down together—the sinner often more sinned against than sinning, the true saint more conscious of failure than consummation. But mother earth heals the scars and starts the experiment anew. The real measure of achievement in this life is the capacity for forgiveness. Salvation is an infinite process. And we shall share in this process constructively in the measure that we share in the infinite love. It is not for us, creatures of a moment, to prejudge the outcome of an infinite experiment, but it is for us to help as we may in the process of atonement. If we so do, our errors and conceits, our blindness of race, our false centrism of self and group shall be purified as by fire. We shall discover our real kinship in the life of the whole.

In the flux of human opinion, the fundamental values of life change but little. Our ancestors thought in ghost terms, we think in cosmic terms, but the Sermon on the Mount remains. Dante's world has vanished in the light of human knowledge, we must find a new home for the values he strove to express. But in the new setting the fundamental values remain, even as a diamond may be set in gold or platinum. They become only more real to us when we can see them as a part of a cosmic Providence. The forms change, but the substance, the meaning, the drift remains, though deriving new significance when seen in a new setting. Future generations must again formulate the meaning of life in their own way. It holds throughout that the new wine must have new bottles. Some people mourn over their outworn creeds and their defunct institutions as Jonah mourned over his gourd. They forget that redemption is the important thing—the seizing upon the divine life in the process of the ages and creating new forms for it, more germane and satisfying to the human spirit.

We need a religion that we can use in our complex life. The cry for salvation was never deeper than in a society which has lost touch with the past but failed to discover the future. We are nervous, and fret our lives away. We are tired and haggard, with taut nerves and drawn faces, old before our time. We need a religion that shall quiet our nerves and calm our spirit in order that we may draw fresh strength from the infinite reservoir of energy. We are absorbed in ourselves and in our narrow group interests, and miss the refreshment of companionship. We need atonement, a larger sympathy with man and the universe. We are young and ambitious, but know not the way. We need new insight and faith to reorganize a shattered society. We love—and fear lest the dream prove a nightmare. In all the conditions of life we need a new rapport with the redeeming love of the universe. We need communion with the larger life, the security of the everlasting, the hope of the ever-creative; we need the love that links men together in deeper co-operation and appreciation. We need a religion that enables us to live and not merely to get; or our doing and fretting are in vain. We need the consciousness of the creative Spirit of the ages.

Jesus remains for us the choicest incarnation of cosmic genius in the warm flesh of mother earth. His significance does not depend upon an outworn ghost conception of the world, which, on the contrary, has too often hardened men's hearts against his real spirit. That spirit is one of union, atonement, creativeness. Wherever it becomes active, it dissolves age-long distinctions between men and makes them into a community, it establishes a new rapport with the universe. It is a spirit of renunciation of our narrow centrism that the larger creative life may be realized, of renunciation of our paltry immediate interests that a larger future, a better humanity, a better earth may be created. It means the creative incarnation of divinity, not merely in individuals, but in society, in social individuals—in the small intimate unities and in the ever larger enveloping unities—though this incarnation must necessarily come in despised minorities through which the higher light must break, whether in church or industry. It makes for creative wholeness of life, as broad as humanity, yea as expansive as the cosmos.

We presumptuously make definitions of God as though He were a creature of dictionaries, as though His essence could be packed away into snug little formulas of our own making. We have too long insisted on making God in our own likeness, a magnified ghost of our own ego. God is too vast for our limited imagination, too rich for our abstract thought. His is the creative genius of the ages—the genius of an infinite cosmos. How can we presume to fathom Him? But we feel that His essence is incarnate somehow, however imperfectly, in all holy bonds, in all sincere loyalty to the best, in all regeneration toward a higher and more perfect order. If we are true to our noblest insight, if we strive creatively for larger unity, we shall in a measure live Him even if we cannot understand Him. "Live in me, create in me," says the larger life. "I am the true vine, ye are the branches. Without me, ye can do nothing. Co-operate in free and loyal creativeness for the whole, and the universe is yours."

The vision of reality which rises before my imagination is not the well-defined finite model of a Greek temple with its sharp geometric outlines and its self-contained beauty. Rather there rises the vision of a Gothic cathedral with its arches and spires pointing and guiding heavenward—towards the Beyond, the unattained, the inspiration and fulfillment of our striving, incarnate in the pulsating life of humanity, yet transcending our mundane experience, surpassing our telescopes and our imagination, sublime yet tender in its encompassing majesty. The controlling genius of such a cosmos cannot be defined in the image of man, even the mind of man. Much less can such a reality be expressed in the infra-human levels of mechanical causation which is "machinery just meant" for a higher realization. We must look for the nature of cosmic genius above and not below man, though pervading and working through all the levels of matter, life and mind. Its presence comes to us as an unsatisfied longing—more to be prized than attainment—as an intuition of a reality which we can only dimly grasp and still less describe, as a love which outreaches knowledge, as a peace which passes understanding.

In the stillness of the night I had a dream, and in my dream a spirit radiant with an unearthly light stood over me. And the spirit said: "Thou shalt pass light." I answered in amazement: "How can I pass light? Nothing can pass light." But the spirit affirmed with emphasis like thunder: "Thou must leave light behind. The light must shine upon your back." I awoke in perplexity and wonder, and I recorded the strange dream. For I could not understand and my soul was filled with misgiving and anxiety. But as I meditated on the spirit's words, the meaning began to dawn upon my soul. The spirit was speaking of human life with its finite perspective. I must pass the light that now is, the light of man's experience, and this light must shine upon my back, while I move in faith, guided by a destiny through which "I am more than I am and know more than I know," into the darkness which I call future, towards a goal which I cannot see. And I must pass the idea of god that man has created in his effort to grasp the universe and to find salvation—the god of man's philosophy, yea the god of my imagination. And I must move on toward the Beyond which eye hath not seen nor ear heard and which has not entered into the thought of man—the transcendent, yet pervasive and guiding harmony which passes infinitely what man conceives as beauty, truth, and goodness.

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