TYPICAL METHODS OF THINKING

IN

SCIENCE AND PHILOSOPHY

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BY

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QUALITIES OF THEORIES

CHAPTER I.

A study of modern theories in science and philosophy reveals very contrasted methods of thinking. By some of these methods conclusions have been reached which are recognized as valuable acquisitions to the store of useful knowledge, while by other methods, conclusions have been reached which have never gained wide recognition and which have remained independent of the general evolution of thought.

We may hope to benefit by our experience with thinking and by a comparative study of past efforts, may discover principles which will guide us to fruitful results in the future. The purpose of this thesis is to study a number of typical theories in science and philosophy, to compare and classify them, to analyze the method of procedure in each, to consider the simplicity, believability and usefulness of each; and thus to draw conclusions as to the comparative value of the different methods used in deriving the theories.

The theories considered will be: Darwin's—"Origin of Species," Hyslop's—"Science and a Future Life," Locke's,—"Essay Concerning Human Understanding," "The Theory of Ions," "The Theory of Inorganic Evolution," and "The Theory of Matter as Electrical."

Statement and Analysis of Darwin's Theory of the Origin of Species.

Darwin in his theory of "The Origin of Species" reasons as follows:—Under domestication, we find much individual variation in both animals and plants. The causes of the variations are many, complex, and little understood; but for the purposes of the theory the variations may be taken to be perfectly indefinite or of chance occurrence. Some are variations of structure and some of function.

Some make the creature more desirable for human purposes and some less desirable. Man, by selecting and breeding from individuals having favorable variations, has produced widely diverse breeds, adapted to his various purposes. In nature, we find individual variations of the same kind that we find under domestication indefinite or approximately chance variations. We also find in nature a selecting agency; the struggle for existence. Of the vast number of offspring born each year of animals and plants, a great percentage perish because not well enough adapted to the surroundings in which they are born. Those individuals having variations favorably adapting them to the conditions of life will more often survive than those not having such variations. The surviving individuals will, individual variations being hereditary, breed their kind; from their offspring, selection will again be made; and this process continuing from generation to generation, through long periods of time, will give rise to breeds, often quite diverse and each well adapted to live under the conditions of life in which it has been produced. It is admitted that varieties have been thus produced and Darwin concludes from his argument that this also was the manner of the origin of species.

Similarities in organic structure and vital functions, in animals of distinct species, suggested to Darwin the possibility of a common origin. This was a natural hypothesis. It perhaps would be among the first theories that would occur to a thinker, seeking an explanation of such similarities. From experience with phenomena, it has become natural to expect relationship where we find similarity. The theory then which occurred to Darwin was one which, if suggested to any other thinker having knowledge of the facts with which Darwin was acquainted, would have seemed quite possible to him.

A common origin was the natural inference from the phenomena of marked similarities, similarity being so often to our knowledge the result of relationship; but this inference raised the question, by what means came the diversity to be. For, until it was shown how the diversity came from the common origin, the theory of a common origin would not possess great certainty; but if it could be shown that there were forces operating which would produce the diversity, then the theory would gain greatly in strength.

Darwin turned to nature in quest of the forces which he believed must have worked and still were working to produce species. When he consulted his experience he found under human control a process by which diverse breeds were produced from a common stock of animals. To understand fully this process and its possibilities, Darwin experimented for many years. He then turned to nature

and found there analogous variations from which selection might take place and a selecting agency, the operations of which he carefully studied. The analogy was complete, man selecting from the offspring of a common stock, produces diverse breeds suited to his purposes; nature by the struggle for existence, selects from varying offspring and produces diverse species suited to live under diverse conditions.

Thus Darwin answered the main question raised in his thinking by performing an experiment. When the question arose: how were species derived from a common origin? Darwin answered it by producing species from a common stock. He then investigated nature and found that it imitated the processes which he had performed in his experiment.

Darwin in his thinking and in his experiment conceives the things about which he thinks and with which he deals, just as the ordinary man conceives them. Similarities in structure and function, individual variations, the struggle for existence, heredity, and all the other things and functions involved in the theory are such as could be explained to the ordinary man without his changing the character of his conceptions of the things about which he was told. In all cases the things considered are such as are presentable in experience. Pigeons, species, variations, the struggle for existence, all are such things as Darwin could identify in the world about which he was thinking. And when he identified these things, he took them to be just what he found them to be. He took pigeons to be what any man would find them to be who examined them. In no case would his conceptions be disputed, and, if they were, the dispute could be settled by reference to the thing conceived, for it was from this alone that Darwin pretended to draw his information.

Darwin went to nature as one believing that it would upon investigation reveal its own reality. When he made an inference, he made that one which experience had taught him was the most probable implication of the facts from which the inference was made. When a question arose as to what processes existed in nature and what was the consequence of their operation, he went to nature and experiment to determine. And in all his thought and experiment he conceived things to be what they discovered themselves to be in his experience.

Statement and Analysis of Hyslop's Theory of Life After Death.

Belief in a future life implies a belief in supersensible reality and a belief in survival of personal consciousness.

Scientific thought is continually dealing with supersensible realities, so the existence of the supersensible will not be doubted. If then there are occurrences which no other known theory will explain, we must for the present accept the theory of the existence of discarnate spirits.

Super-normal knowledge and personal identity exhibited by communications through Mrs. Piper as medium are occurrences explainable by no other known hypothesis. Therefore we must, until some better hypothesis is found, accept the theory of spirits.

Prof. Hyslop like Darwin experimented. But Darwin by his experiment was showing that his explanation was a true one, while Hyslop by his experiments is gathering facts to be explained. Prof. Hyslop performed no experiment to show that his explanation was a possible one.

The following facts with other similar facts furnish the foundation for Prof. Hyslop's theory. Mrs. Piper, a medium, goes into a trance state. While in this state, questions are asked of her, to which neither she in her normal state nor the questioner knows the answer. These questions are answered correctly, questions are asked, and other communications are given by or through the medium. These communications are so given as to appear to be given by some person known to be dead. And sometimes the communications are such as to make it appear that one person is conversing with another, all of whom are known to be dead. Mistakes and confusions occur as if memories had failed or as if those appearing to communicate had not adequate means of communication. These are the facts of evidence for the theory and also the facts to be explained by the theory. Everything that is said, is spoken by the mouth of Mrs. Piper; but what she says purports to be the communications of others.

No other theory adequately explains these facts; all other known theories are therefore excluded from belief. Prof. Hyslop thus advocates belief in the theory of survival after death.

Prof. Hyslop's theory implies the existence of a number of facts. These facts implied are: that in the human make-up, there is a part never yet discovered to science; that upon death this part does not die but becomes separated from the body and leads an independent existence; that, though in life there seems to be closest dependence between physical and mental functions, yet that this spirit disengaged, carries on the mental functions, little impaired, after the decay of the physical being; that these spirits, possessed neither of eyes, ears, vocal organs, nor any of the known organs of perception and communication, nevertheless do perceive things of the world and

of each other, and do communicate with each other and with living men; that either, they in communicating to us, move the entranced subject to speak what they would have her speak, or her volition being dormant, a spirit takes possession of her organs and operates them as a man would a typewriter, making her speak mechanically the thoughts of the communicating spirit.

These are the facts implied by the theory and I shall here briefly repeat the facts of evidence for them. An entranced subject speaks in answer to questions and imparts supernormal pieces of knowledge; the things which she speaks purport to be communications from persons no longer living; what she says sometimes purports to be conversation between dead persons; and there are mistakes and confusions such as we should expect from persons with failing memories or with deficient means of communication.

We note that here there is no direct evidence of the existence of such a part as the spirit in the human make-up. And all experiments relative to that question tend to indicate that if there were such a part and if it were essential to mental functioning, that it ceases to function when the physical organs are injured or destroyed Neither does Prof. Hyslop perform any experiments nor offer any evidence to show that spirits can perceive and communicate. Nor is any explanation given of how they can communicate without organs of perception and communication known to us. There is then no experimental evidence in the theory leading to an inference of the existence of spirits; and no experiments are performed to show how spirits can perceive and communicate or to lead to an inference that they can.

We have thus far exhibited the evidence offered for the theory and the conclusions and implications of the theory. We now call attention to the fact that the conclusions and implications concern things of whose nature and abilities we have no experimental evidence and no experience. And we also note that these things about which the theory is concerned are like nothing in experience. Prof. Hyslop's thinking then, reveals this peculiarity: that whereas evidence usually leads us to infer that something out of experience is like something in experience; in Hyslop's thinking we find an inference from evidence in experience of what things out of experience exist and of what they are like, when they are like nothing in experience. From certain manifestations in experience the existence of spirits and their powers are inferred. As spirits are like nothing in our experience, we cannot infer that they produced the manifestations because of their likeness to something in experience producing such manifestations; and the theory as we have found it, offers no experiments to show that

spirits can produce such manifestations or how it is possible for them to do so.

Locke's Theory of Human Understanding.

The reasoning of Locke's theory is as follows: Reality is constituted of three different kinds of things with their relationships. The three kinds of things are minds, ideas, and bodies. The mind is a receptive medium in which ideas arise by virtue of the operations of matter or body. Anything which is present to the mind is an idea.

Ideas are impressions made upon the mind and are of two kinds: those caused by the primary qualities of objects and those caused by the secondary qualities of objects. A quality of an object is the power in it to produce ideas. The primary qualities produce ideas which copy them or resemble them; the secondary qualities do not produce resembling or copying ideas in the mind. The secondary ideas are mere perceptions in the mind; the primary are modifications of matter which cause ideas in us resembling them. It results from the nature of these two kinds of ideas that secondary qualities reveal to us nothing of the real object, while knowledge of primary qualities is "real knowledge," knowledge of "real existence."

Knowledge is the perception of the connection of, and agreement or disagreement of, ideas. Thus the originals of knowledge are ideas of sensation impressed upon the mind by matter and knowledge is limited by the existence and nature of ideas.

Thus Locke concludes his task. He sought the originals, certainty, and extent of human knowledge: he found its originals in the ideas; its extent in the limits of their relationships; and its certainty dependent upon the directness with which the mind perceives those relationships.

The problem which Locke sought to solve was one of definition and origin. He asked: what is knowledge and in what manner does it come to be. As we have seen, Locke succeeds in answering both questions. We are here interested in determining by what method he reaches his conclusions.

Locke entered upon his thinking with a certain conception of mind. He conceives the mind to be an empty cabinet into which ideas get; or a plastic medium upon which they are impressed. This conception, he takes for valid without question. Such a mind is not directly revealed in experience and Locke performed no experiments in search of evidence for its existence or for its nature. He assumed both to be as he conceived them.

This conception of mind which Locke assumed, involved in it

necessarily his conception of an idea. If the mind is an empty cabinet, ideas must be of a nature to be contained in it in some way: or if the mind is a plastic medium, the idea must be a modification of it or an imprint upon it. Thus by assuming the nature of mind Locke has by implication also assumed the nature of ideas.

Also in Locke's conception of mind is bound up his conception of the real outer world. For Locke conceives the mind to be a passive medium, and ideas to be mere modifications or imprints. The modifications can then only arise, if some active principle operates upon the mind to modify it. This active principle is matter or body. Thus it appears that when Locke made his original assumption of the nature of the mind, he likewise assumed the nature of the idea and of body. These three constitute the whole of Locke's reality.

The solution of Locke's problem, the statement of the nature, certainty and extent of human knowledge is a direct logical deduction from his conceptions of mind, matter and idea. And these we have found to be bound up together in his conception of mind. The mind can, by assumption, concern itself only with ideas; knowledge is a mental function; knowledge must concern itself only with ideas. Thus, the extent of knowledge. As knowledge is not an idea nor a group of ideas, it must be of the relationship of ideas. Thus the nature of knowledge. As the mind perceives the relationships of ideas with different degrees of directness, different degrees of clearness or certainty result. Thus the explanation of the degrees of certainty of human knowledge.

The same method of assumption and deduction is revealed in Locke's theory of "real knowledge." He assumes that some ideas copy or resemble reality and some do not; and that we can know which do copy and which do not. This assumption is not grounded on experience and Locke did not investigate to determine its validity. From this assumption it follows in Locke's reasoning, that some knowledge is real or reveals to us the nature of real existence.

We conclude from this examination that Locke's method of thinking consists in making an assumption and drawing out the natural implications of that assumption. Locke assumes the mind to be a plastic medium; it follows that ideas are modifications or imprints and that some active principle operates to produce them. Knowledge being a mental function, must concern itself with ideas and be limited by the number of ideas and their relationships.

The theory thus derived, has some peculiarities to be noted. The mind which is assumed to exist is like no thing in experience which we can examine and determine the qualities of. Therefore we can infer nothing as to its nature. Neither was such a mind discovered

by Locke and investigated so as to reveal its properties. Being like nothing in experience, a modification of the mind or an impression upon it, is like no modification or impression of which we know. Therefore the nature of the idea and the manner of its origin are unintelligible to us. Neither is the manner in which the ideas resemble or copy objects like any resembling or copying of which we know. Therefore the manner in which ideas copy or resemble things, we cannot comprehend.

This statement of the theory, its method of procedure, and characteristics will serve as a basis for study and comparison in connection with the other theories here dealt with.

The Theory of Ions.

Another type of thinking is represented by the theories presented in Duncan's "The New Knowledge." The theories are as follows. Upon examination, the atomic weights of many of the elements are found to be approximately whole numbers. The elements can be arranged in groups having closely resembling qualities and having constant relations between their atomic weights. In short, it is found that, "the properties of an element are a periodic function of its atomic weight." This law has been many times confirmed in different ways.

Now the scientist reasons thus: either the elements were created (or are) each unique in substance and structure and the relations between them, expressed by the periodic law, are chance relations; or the atoms of elements are complex, and uniformities in their structures will explain uniformities in their properties. Only if this latter hypothesis is true, can we explain the periodic law.

But, because the assumption that the atom is complex in structure is the only one upon which the periodic law can be explained, the scientist does not take this assumption to be established theory, but begins to investigate to determine the validity of the assumption.

He finds that groups of atoms unite together to form bodies with related properties and group relationships, and he finds that groups of atoms unite and act like elements. Thus the scientist reasons, that if combinations of atoms may act like elements and may form, by variation in number and arrangement, compounds related as the elements are related, is it not probable that sub-atoms form elements and by their number and arrangements furnish an explanation of the periodic law?

But more direct evidence of the complexity of the atom is demanded and obtained by the scientist. He finds that gases under certain conditions have an increased conductivity. When the gas is

filtered, it loses this increased conductivity. Thus something is filtered from the gas, which gave it conductivity. This something can also be taken from the gas by passing it through a space in which there is a current of electricity. Only particles could be caught in a filter and only electrified particles would be drawn from the gas by a current of electricity. As the gas, as a whole, does not change, the particles must be both positive and negative. Once having discovered these particles, the scientist experiments with them. He subjects them to electrical forces and by their motions determines their charge, velocity and weight by the familiar formulae of Physics. He finds them one-thousand times smaller than the smallest atom; alike in nature and size and that they constitute an actual part of the matter from which they fly. He controls them so as to produce chemical, heating and mechanical effects and thus arrives at a more intimate knowledge of them. He finds that they give rise to x-rays in bodies which they strike; that they are absorbed by all bodies in direct proportion to the density of those bodies; and that they act as nuclei about which atoms and molecules collect. These corpuscles are given off by elements in their natural state, by radium, uranium, polonium, actinium, air, etc. As these different substances continually emit these particles, one-thousand times smaller than atoms, it is reasonable to believe the atoms constituted of them. This belief is strengthened when we find that, as the corpuscles are emitted by some substance as radium or thorium, their atoms continually change, forming entirely new elements. As the same atom in some cases breaks down into many different atoms, the original must have been complex.

Before proceeding with the next step in the establishment of the theory, a brief summary will be of value. The scientist on investigation finds the elements definitely related. The relations are too numerous and too extended to be explained by chance. The scientist can only hope to explain them, if the atom is complex. He finds particles existing much smaller than atoms. From the fact that atoms continually emit them and in emitting them continually change into atoms of different kinds, the scientist believes the atom complex and constituted of these smaller particles called ions or corpuscles. In his procedure thus far, the scientist has assumed nothing. He has investigated the things about which he wished information; he has found the atom to be complex and of what it is constituted by examining it by every possible means known to him. Although these atoms and corpuscles manifest themselves to none of his senses; yet he controls them by forces familiar to him and leads them to produce familiar effects, from which he can infer their nature with a certainty which no one understanding his procedure will question.

But how does the scientist proceed from the knowledge he has thus gained, to an explanation of the periodic law? He has found the atom complex; he has found it constituted of ions some positively and some negatively charged. He now makes an assumption. He assumes the positive charge to be a spherical shell surrounding the negatively charged particles. Granting this assumption, the structure of atoms containing various numbers of corpuscles can be mathematically calculated; and the variations of structure with different numbers of corpuscles in the atom are such as to explain in detail, the Periodic Law, Group relations of elements, Series Relations, Prout's Hypothesis, the Triads of Dobereiner, valency, chemical action, the zero group, Radio activity, and unstable atoms. When it is said that the variations of structure explain the variations of properties, it is meant that there are periodic recurrences of the same structure where there are periodic recurrences of the same quality. There are uniformities in structure corresponding to the uniformities in property.

It is evident that in this step in the theory, the scientist has changed his method of procedure. Up to this step, he had established all upon an experimental basis. Here he attempts to establish a step in his theory upon other grounds. That the atom is a spherical shell of positive electrification surrounding negative charges, he does not verify experimentally. He assumes that it is true and according to the established laws of physics, finds that the structural relations will be such as to explain the chemical to a remarkable degree. The validity of the assumption rests alone on its explaining power. The Atom may not be formed as assumed; it may be but accidental that if it were, all that correspondence between physical and chemical relations would result, yet such chance occurrences are so anomalous in our experience, that where we find such perfect correspondence we faithfully seek for dependency. And when in an experimental chain, we are at a loss for a link and we find one fitting perfectly, our experience has been such that we take it as very probable that such a perfect fitting is not accident, but that our assumed link is really existent and perhaps some day to be experimentally revealed.

The Theory of Inorganic Evolution.

The scientist's method of procedure is also well illustrated by the theory of inorganic evolution presented in Duncan's "New Knowledge." Some elements such as radium and uranium are found to be actually evolving into other elements. Elements at different

temperatures give different spectra, which means that they decompose into other elements. The temperature of different parts of the sun and of the same parts at different times, and of the stars, can be observed. With small changes of temperature in the sun, different forms of the same elements appear; with great changes of temperature some elements disappear and new elements appear. In the stars there is a great range of temperature. In stars, differing little in temperature, we find different forms of the same element. But in stars differing greatly in temperature, entirely different elements exist. Beginning with the hottest stars, we have elements of the smallest atomic weight and as we pass from cooler to cooler stars, the elements of heavier and heavier atomic weight appear. As the heavier atomic weight invariably appear in the cooler stars, we believe that the heavy atoms have evolved from the light atoms, which alone are found in the hottest stars.

We note that the evidence is of observed relations between the elements under different conditions. The scientist observes directly the gradual dissolution of radium and uranium into other elements. He can with the small range of temperature under his control, materially change many elements. He observes the sun and sees the heavier atoms appear as the sun spots dwindle and disappear as the sun spots approach the maximum. And in the stars, which give him the greatest range of temperature, he observes the relation between temperature and the existence of atoms of different weights. As certainly and as directly as we see a seed germinate and grow into a tree, does the scientist see the lighter atoms, as the temperature falls, change into atoms of heavier weight. To be sure, he does not view the atom change directly, but he views the lines in his spectroscope, which he has learned by experience, faithfully represent the atoms; and they tell with equal certainty the history of the evolving atom. In acquiring this knowledge, the scientist has made neither assumption nor inference. He has simply read the report of the spectroscope, the trustworthiness of which long experience has taught him.

The Theory That Matter Is Electrical.

By experiment it was found that atoms were composed partly of corpuscles, and that corpuscles were small, negatively charged bodies moving with great velocity. The mass of these corpuscles, when at rest, was experimentally compared with their mass when in motion. The supposition was then made that the corpuscles were merely electrical charges; and the mass when at rest and in motion,

was computed on this supposition. The results agreed with the actual masses as experimentally determined. That the mass of a small body electrically charged greatly increases as its velocity approaches that of light is an experimental fact. As matter is made up of such small, rapidly moving, charged, corpuscles, part at least of its mass must be electrical in origin. But the scientist infers that its mass is entirely electrical in origin; for if it were entirely electrical in nature, its mass would be just what its mass in fact is. In other words, the scientist takes mass to be the distinguishing characteristic of matter; he then finds that an electrical charge has exactly this same characteristic. It may be that matter is not electrical in nature and that this correspondence is accidental. Yet the theory that matter is electrical has strength; for in our experience such an accidental correspondence would be an anomaly. Here again the scientist has made an assumption which so strikingly fits a place in an evidential chain, that its validity seems a credible inference.

Thus far, we have attempted to state the theories which we wish to study; to reveal the important steps in the procedure by which each was derived; and to note the dominant characteristics of the resulting theories. In the succeeding chapter we shall compare and classify the theories in question.

CHAPTER II.

CLASSIFICATION AND COMPARISON OF THEORIES.

I have found in considering the theories stated that they may be conveniently classified from two points of view. When viewed from the point of view of method of procedure in deriving the theory, there are two distinct classes; and when viewed with respect to the nature of the problem solved as a basis, there are two well defined classes.

We shall first consider the classes of theories from the view-point of problem solved. The first class of theories under this head consists of those which have for their object to explain the origin or existence of things or relations between things by showing the manner in which these things or relations were produced. Darwin's theory of "The Origin of Species" falls under this class. His problem was to explain how well defined species of animals and plants came to be formed; and his solution consisted in showing that individual variations with natural selection would give rise to species in nature as similar processes do in case of domesticated animals. Hyslop's problem and solution were of the same nature. He sought to explain the origin of supernormal knowledge, and did so by inferring that spirits of departed persons, who were possessed of the knowledge in question, still existed and imparted the information through the living medium. So also the theory of ions belongs to this class. The problem there was to explain the origin or existence of the well defined relationships existing between the chemical elements, and expressed by the Periodic Law. The relationships were explained by showing the complexity of the atom and the periodic variation in the number and arrangement of the ions in the atom. And lastly, the theory of Inorganic Evolution has the same kind of problem and solution. The problem was to explain the existence of the many elements in nature and their origin. The solution consisted in showing the transformation from one element into another with varying degrees of temperature. Thus these theories illustrate a class in which the question is asked: how came certain things or relations to be? and is answered by revealing the process of origin.

Now there is from the point of view of problem and method of solution, a second class of theories. Those theories which seek to determine the essential qualities of things or relations by defining them. John Locke in his Theory of Human Knowledge, seeks to

determine the nature of knowledge, and solves the problem by defining knowledge to be the perception of the connection of and agreement or disagreement of ideas. However, Locke also sought into the origin of knowledge, and set forth the process by which it was produced. This part of his theory falls under the first class of theories in which the problem was that of origin; and solution that of revealing process. We find, that the theory that matter is electrical is also a theory of definition. The problem was to determine what matter essentially is; and the solution consisted in showing that matter is electrical in nature. Thus the theories examined reveal two distinct classes of theories from the point of view of problem and method of solution.

They also exhibit two well defined classes from the point of view of the method of procedure by which the theories were derived. The method of procedure in one class consists of observation and experiment, and inference from facts thus revealed. Some of the theories in this class make use of an occasional assumption.

I shall first treat of those theories which proceed by observation and experiment and do not make use of assumptions. Darwin's theory is such. He observed the individual variations of plants and animals in nature and under domestication. He also observed how man selects the variations which suit plants and animals to his purposes, and how nature selects those variations which fit the organism to live. He experimented to determine more fully how great individual variations were and how much change could be produced by accumulating them in the off-springs. Thus Darwin determined the existence, nature, and extent of individual variation and natural selection, by observation and experiment. Observation also revealed the nature of past organic life, the remains of which had been deposited in the Earth's crust. The inference of which this theory consists followed directly from these observed and experimental facts, without the assumption of the existence of any others or of their nature.

The theory of inorganic evolution was derived by the same method of procedure. The transformations of elements under different degrees of temperature producible by artificial means, and exhibited by solar conditions and in the stars, were observed and carefully investigated. The inference, that diversity of elements had originated by virtue of changes in temperature, was based directly upon these observed and experimental facts.

There are some theories which make use of the same method of procedure but also contain occasional assumptions. The theory that matter is electrical is such. It is not shown by a direct investiga-

tion of matter that it is electrical in nature. But by experiment, the essential characteristics of electricity are determined. By the same method the qualities of matter are revealed. The reasoning then proceeds in this manner: Assume matter to be purely electrical, and its essential qualities can be explained; therefore we infer matter to be electrical. Thus the assumption because of its explaining power becomes an inference and is no longer purely hypothetical.

So also the theory of ions though based fundamentally upon the experimental method, makes use of a similar assumption. The existence of the ion, its size, weight and properties are experimentally revealed. The theory then proceeds by assuming that the ions are arranged with a spherical positive electrical charge surrounding the negatively charged ions. There is no direct experimental evidence supporting this assumption; but grant it to be true, and from the known properties of ions, their numbers and arrangements in the atom will be such as to explain to a remarkable degree the Periodic Law. Thus this assumption because of its explaining power becomes one of the inferences constituting the theory.

Thus the examination of the theories considered in this paper reveals a class derived by the method of observation and experiment, some of the theories making no use of assumptions and others using assumptions which from their explaining power become inferences.

The theories in question exhibit a second distinct class from the point of view of method of procedure. A class from which the thinker proceeds by assuming the existence and nature of things which have not been experimentally investigated and which are like no things in experience. His further procedure consists in developing the logical implications of the assumptions made. Such a method of thinking is John Locke's in his theory concerning human understanding. Locke assumes a mind to exist and that it has a certain receptive or plastic nature. This assumption is in no way founded upon observation or experiment. And as the mind is like nothing in experience, Locke did not infer its existence by analogy. The mind and its qualities are purely hypothetical. In setting forth Locke's theory, we have already shown that the nature of the idea, the nature of matter and the nature of knowledge were all implied in the assumed nature of mind; and that Locke's further procedure consisted in developing these implications.

Hyslop's thinking shows the use of the same method. Locke had the fact of knowledge given and sought to explain its origin and nature. He did so by assuming a mind of a certain nature to exist. Similarly, Hyslop has the fact of supernormal knowledge

given and seeks to explain its origin. He does so by assuming the existence of spirits with certain powers. Like the mind of Locke's theory, these spirits are not things directly manifest in experience; and no experiments were performed yielding evidence of their existence or of their powers. The fact of the existence of spirits and of their powers is purely hypothetical, and by these hypotheses supernormal knowledge is explained.

The difference between the use of assumption in Locke's and Hyslop's theories and its use in the theory of ions and of the electrical nature of matter, a difference which will be fully considered later, should here be noted. In the theory that matter is electrical and in the theory of ions, the assumption is only of the existence of things like things in experience. Concretely in the theory that matter is electrical, it is assumed that electricity exists in the form of matter; and in the theory of ions, it is assumed that the atom consists of a certain arrangement of ions. It was not necessary to assume what the qualities of electricity are and it was not necessary to assume what would result from the certain arrangement of ions; these both were experimental facts. For this reason we found that assumptions in these theories had great explaining power and that the explaining power was evidence of the validity of the assumptions. Contrast the situation in the theories of Locke and Hyslop. Here the assumption is of the existence of things out of experience like no things in experience. Concretely, in Locke's theory minds were assumed to exist, and in Hyslop's spirits. From the fact that the assumed things were like nothing in experience, the powers of these things were not known, as they were in the case of the theory of ions, and of electrical matter. Hence it was necessary for Locke to assume that the mind had certain powers and qualities, and for Hyslop to assume that spirits had certain powers and qualities. Then, when these powers or qualities were manifested in experience, it could not be inferred that the assumed mind or spirits existed; for it was not known, but only assumed, that minds or spirits, as the case may be, could produce such manifestations. Thus the explaining power of the assumptions made in Locke's and Hyslop's theories did not lead to an inference of the validity of those assumptions; while as we have seen, in the theory of ions and the theory of matters electrical nature, it did so lead.

From the fact that the qualities and powers of minds and spirits are assumed in the theories of Locke and Hyslop, and from the fact that minds and spirits are assumed to be things unlike anything in experience, there is no limit to the powers or qualities that may be ascribed to minds or spirits, as the case may be. If by ascribing a

certain nature to mind Locke could not have given an account of the origin of human knowledge, he could have ascribed any other desired qualities to the mind necessary in order to obtain an explanation; and, if by ascribing certain powers to spirits Hyslop could not have accounted for the phenomena to be explained, he could, at will, have assumed the spirits to have other powers, and have adapted the assumed nature of spirits to the requirements of the case.

When, however, the assumption is that a thing out of experience is like something in experience, the nature of the thing in experience whose qualities we know, limits and controls our assumption. When it is assumed in the theory of ions that an atom consists of a spherical shell of electrification, surrounding a number of negatively charged particles, it cannot be or it is not assumed that an atom has any different or other qualities than such a spherical shell of electrification containing charged particles would have. Our assumption is limited and controlled by our experience with such electrically charged bodies; and if the qualities which we, by experiment, find such bodies to have, will not, when ascribed to the atom, explain the phenomena in question, the theory will be abandoned or modified by assuming the atom to be like some other thing in experience whose qualities we know. From the nature of the assumption that matter is electrical, the theory will be abandoned, if the qualities of electricity discovered by experiment fail to explain the characteristics of matter; and from the nature of the assumption that an atom is an electrically charged spherical surface containing negatively charged particles, the theory of such atoms will be abandoned, if the qualities which by experiment we know such an electrically charged surface containing such negatively charged particles would have, fail to explain the relationships described by the periodic law. But the nature of the assumption of the existence of spirits and their powers is such that the theory need never be abandoned. As spirits are assumed to be like nothing in experience, their powers must also be assumed, and any powers may be ascribed to them necessary to explain any given phenomena. When new phenomena are revealed, spirits can be assumed to have different or additional powers and the theory, therefore, need never be abandoned. The assumption of Locke's theory is of the same nature. If the mind is like nothing in experience, any powers may be ascribed to it, and any phenomena explained by it. So much for the distinction between the use of assumption in theories like the theory that matter is electrical and the theory of ions and its use in theories like the theory of discarnate spirits and the theory of mind as set forth by Locke.

The theories examined, then, divide themselves into two classes,

whether the basis of classification is the nature of the problem and solution or the method of procedure employed in deriving the theory. From the point of view of the nature of problem and solution, we have found that there is one class of theories whose problem is to explain the process of origin and a second class whose problem is to reveal the essential nature of a thing. From the point of view of method of solution, we found that there were also two classes: those which proceed by observation and experiment, a sub-class of which makes use of assumptions in completing an evidential chain; and those which proceed by making assumptions and developing the logical implications of those assumptions.

A further examination of the theories shows that either method of procedure might be used with either class of problem. Darwin's problem is one of origin and his method is that of observation and experiment; while Hyslop's problem is also one of origin but his method that of assumption and deduction. On the other hand, the problem in the theory that matter is electrical is one of definition and the procedure in solving it is that of observation and experiment. While Locke's problem in his theory of knowledge is also one of definition but his method is that of assumption and deduction. It is evident from this that whether the problem is one of origin or one of definition, the method of procedure in solving it may be either experimentation or assumption and deduction.

Having in this chapter classified the theories, and compared their problems and methods of procedure and discussed the relation existing between the two, we shall continue our study by an examination of the qualities of theories.

CHAPTER III.

QUALITIES OF THEORIES.

Believability of Theories.

An examination of the theories, here studied, reveals that some have a much greater probative force than others. This power which a theory has to gain credit for its validity may be called the believability of the theory. To the writer, the theory of inorganic evolution and Darwin's theory are the most convincing. A little less so are the theories of ions and that matter is electrical; while between these four theories and the theories of Locke and Hyslop there seems to be a considerable difference, the latter two theories being much less believable.

It is true that the confidence of our belief in a theory depends somewhat upon our familiarity with it, the nature of our education, and our general character; yet it is equally certain that there are qualities inherent in the theories themselves which play by far the largest part in determining whether the theory will be believed or not. It is our purpose here, by an examination of the theories, to reveal those qualities upon which believability depends.

We are convinced by a brief survey, that it does not depend upon the nature of the problem to be solved by the theory. Darwin's theory was one of origin, and the theory of the electrical nature of matter was one of definition. Both theories are strongly convincing. While Hyslop's theory, like Darwin's, was one of origin; and Locke's like the theory of electrical matter, was one of definition, yet neither Hyslop's nor Locke's theory is of a believable type.

Believability seems to have much more dependence upon the method of procedure by which the problem is solved. We have found two distinct methods of procedure exhibited by the theories in question, namely: the method of experiment, and that of assumption and deduction. We found in the class using the method of experimentation: Darwin's theory, the theory of ions, the theory of inorganic evolutions, and the theory that matter is electrical; while in the class using the method of assumption and deduction, we found Hyslop's theory and John Locke's. Now all the theories of the first class are of a convincing nature, while those of the second class are not. The theories based upon experimental methods are the believable ones,

while those based upon assumption and deduction are comparatively unbelievable.

A close examination may reveal whether this relationship is an accidental one, in this case, or whether it is a significant one which we may expect to hold quite generally. The concepts which constitute the essential materials for Darwin's theory are those of individual variation, inheritance and natural selection. The existence of individual variations, and their nature were experimentally investigated by Darwin: and may be by any other person. No one will doubt that there are individual variations. So, also, the existence of natural selection, and its nature, were directly investigated by Darwin, and may be by any person wishing information concerning them. Or if any one doubted either that individual variations and inheritance existed or that natural selection operated, he could determine the facts by an investigation of these forces. The conditions with regard to Locke's theory, for example, are quite in contrast. Locke did not examine the mind to determine its properties; he assumed it to have a certain nature. And upon this assumption the validity of his theory rests, as we have shown. The theory as presented by Locke offers no evidence for the validity of the assumption, and no evidence exists for it. The theory is in this peculiar position that it may sometime be shown to be false, but never can be shown to be true; for if the only objects with which the mind can be concerned were ideas, the mind itself and the real things of Locke's theory could never be investigated, nor the relationships between them. So the concepts which constitute Locke's theory have never been subjected to experimental investigation, but are purely hypothetical; and the theory is believable only when one will accept the unsupported assumptions.

The same contrast maintains between the theory of inorganic evolution, based upon the method of experimentation, and the theory of future life based upon the method of assumption and deduction. In the theory of inorganic evolution, changes of temperature are tested by instruments which experience has proved to be reliable. The presence or absence of a certain element can be certainly ascertained by investigating the light emissions: this experience has verified. When then the investigator, after a thorough examination, reports the different temperatures of the Sun at different times, and the temperature of the different stars, his results will not be doubted. Also his report that some elements disappear and others appear is the direct outcome of an experimental investigation. The concepts with which the theory deals are experimental entities which any experimenter may, if he doubts, determine the existence of. If any of the things which the theory affirms to exist, did not exist; or if the nature of any thing was not

what the theory affirmed it to be; the method by which the theory was derived makes it possible to review its procedure and correct any error in its determinations. The theory is for this reason strongly believable.

In the theory of a future life, quite different conditions maintain. We have shown that this theory was derived by the method of assumption and deduction; and that the strength of the theory depended upon the strength of the assumptions. If spirits exist with memories, power of rapid motion, power of communication between themselves and between them and human beings, then supernormal knowledge is explained. But if one doubts that a spirit survives the human body, that it can move without being substantial, that it can see, hear, and understand without eyes, ears or brain; or that it can operate the physical mechanism of voice production with all its intricate muscular combinations, in the entranced subject; doubt these assumptions and the theory will not be believed. Now from the method by which the theory was derived, these facts were not experimentally determined. They were not directly investigated by the author of the theory and no other person interested in showing their truth or falsity can at present investigate them. The method of procedure is such that its affirmations cannot be reviewed by methods which will finally determine their truth or falsity, until the theory is put upon an experimental basis, at which time it will no longer be a theory of assumption and deduction. As the method by which the theory was derived does not present its data in a believable state, the theory does not carry conviction. From this examination we conclude that there is a significant relationship between method of procedure and believability of theories; that the experimental method generally leads to believable theories, while the method of assumption and deduction from its nature does not.

We shall also attempt to show that believability depends to some extent upon the simplicity of a theory. However, before dealing with this question it will be necessary to consider this quality of a theory, called its simplicity, at length.

Simplicity of Theories.

Upon an investigation of these theories which we are here studying, we find that there are four different qualities of the theories which might be designated by the term simplicity or complexity. I shall set forth these different meanings in order.

First, simple may mean simple in structure; the quality will depend upon the number of concepts in the theory and the number of their relationships. This meaning for the word simple as applied to a

theory is, however, of little value; for the amount of data involved in a theory has no significant bearing upon its important qualities. All the theories, here examined, are simple in this respect, except, perhaps, the theory of ions. Each of the theories is made up of few concepts and of few and simple relations between them. Darwin's theory involves merely individual variations, inheritance, and natural selection. Hyslop's deals with souls, mediums, and communications through the mediums. The theory of inorganic evolution considers merely changes of temperature and corresponding changes in elemental structure. The theory that matter is electrical simply compares the essential qualities of electricity and matter. The theory of ions is a little more complex in this respect, involving a consideration of the different kinds of ions and their properties; the number and arrangement of ions in the atom; and the relationship between the structure of the atom and its chemical properties. It will be seen that different as these theories are in other important respects, they all contain but few concepts and but few relations between them, and are all in this sense comparatively simple.

Secondly, the term simple may be used to designate that quality of a theory which depends upon the directness with which its data can be presented, and the number of other theories involved in, or whose validity is implied in the theory in question. In illustration, Darwin's theory is simple in this respect: individual variation, inheritance, and natural selection are processes which can be presented directly in experience. The theory involves, however, inferences as to the length of time through which organic life has existed on the earth, and the nature of past geological conditions. In this respect the theory is in this second sense complex; it is concerned with existences which cannot be directly presented in experience. In the theory of inorganic evolution, changes of temperature on the earth, sun, and stars are inferred. Also the existence and non-existence of elements are inferred from light emissions. Its materials are not directly presented in experience, and in this sense it is complex. The theory also involves inference as to past astronomical changes.

Concerning the theory that matter is electrical: electrical qualities are manifestations in experience and so also are the qualities of matter. But this theory rests upon the theory of ions, the materials of which are inferred existences. This latter theory deals entirely with inferred existences. The ions, their properties and arrangements are all inferential facts. The theory that matter is electrical and the theory of ions are both then comparatively complex in the sense that the materials with which they deal are not facts of experience, but are inferences from it.

Locke's theory and Hyslop's also are complex in this sense; and

peculiarly so. For in Locke's theory the mind, ideas as impressions upon the mind, and matter are all not only things out of experience, but things like nothing in experience; things not to be inferred from experience. And in Hyslop's theory the existence of spirits and of the powers ascribed to them are not things which can be experienced, and not things which can be inferred from experience. The materials of Locke's and Hyslop's theories are not matters of experience and are like no things which are matters of experience. These theories are, therefore, complex in the sense that their materials are not presentable in experience, and are to be distinguished from the other theories from the fact that their materials being like nothing in experience, are not to be inferred from it. This latter peculiarity will be considered under the fourth sense of simplicity as applied to theories.

When thus applied the term may have a third meaning. It may mean only that the reasonings by which the theory is derived are difficult to follow. The reasonings may be sound, but are intricate, and thus tax the strength of the understanding. However, a consideration of this sense of simplicity could have but little value, as it is evident that the simplicity of a theory, in this sense, would have no important bearing upon its other qualities.

There is, however, a fourth meaning which simplicity may have and which we shall find of considerable importance. The term simplicity may be used to signify the intelligibility of a theory, and complexity to signify unintelligibility. A theory is unintelligible, in whole or in part, when its validity involves the existence of things which we do not know to exist, and the possibility of whose existence we cannot, in the present state of science, understand. An examination of the theories will clarify the meaning of the term simplicity as here used. Darwin's theory and the theory of inorganic evolution are simple in this fourth sense. The concepts involved in both can be clearly set forth to the understanding. Darwin can present as facts in experience all the forces which produce species, and exhibit them in operation. And the astronomer can show to any investigator the changes of temperature on the sun and in the stars; and can show the elements of low atomic weight disappearing and those of higher atomic weight appearing as the temperatures fall. Here the materials of the theories are presented as determined facts, and the understanding is not concerned with contemplating their possibility.

In the theory of ions we find the situation, in one part of the theory, somewhat different. The conclusion of the theory is that the number and mechanical arrangements of the ions in the atom explain the periodic law. But it is impossible, in the present state of science, to understand how chemical quality can be dependent upon mechan-

ical structure. If we knew that such were the fact, the theory of ions would not be concerned with explaining it. But as we do not know it to be a fact, the theory is unintelligible in that it cannot explain to us how chemical quality can be dependent on mechanical structure. This theory, however, is aided in this aspect by the fact that in other cases within our knowledge, mechanical structure and chemical quality change together. This gives grounds for the inference that a relationship exists.

Instances in which there are no grounds for inferring the existence of a fact, and the possibility of whose existence cannot be understood, are better illustrated by Hyslop's theory. This theory assumes that there is a spirit, which survives death, with all the psycho-physical functions of a living human being. From our experience during life, we know that there is an intimate relation between body and mental function. If the brain is shocked, thinking ceases; if the auditory nerve is destroyed, hearing ceases; if the optic nerve is destroyed, seeing ceases; and if our vocal organs are destroyed or certain brain cells, speaking ceases. Yet this theory assumes that after death the soul without brain, eye, ear or vocal organs performs the functions of thought, seeing, hearing and communicating. Now we do not know from our experience with spirits that they have such powers; as spirits are like nothing in our experience of which we have knowledge, we cannot infer that they have such powers; and, as we cannot comprehend how spirits can perform such functions, the theory presents an unintelligibility and is thus complex in the fourth sense above defined. The theory presents other typical instances of this kind. The spirits are assumed to be present at almost any place the medium chooses to sit, whether she has come to that place over railroads or across seas. The spirits have no organs of locomotion like any of which we know and therefore their rapid motion is unintelligible to us. Again, spirits are assumed to have power to communicate through the medium without the medium being conscious of sights, sounds or touches of spirits; and the theory assumes that perhaps there is no use of the mediums mental functions at all; that the spirit itself operates the vocal organs to produce the speech of the medium. We do not know these to be facts, we have no analogy to them; and as their possibility cannot be explained they are unintelligibilities. This theory then is found to be complex in the sense that it presents many such incomprehensible elements.

In the same sense Locke's theory is complex. His theory involves the conception of a mind which is like an empty receptacle and becomes filled with ideas, or which is a plastic medium, and ideas become impressed upon it. But when Locke speaks of the mind as

empty, he evidently does not mean spatially empty, and that ideas are space occupying things which fill it. Yet a relation between mind and ideas is involved in the theory, and Locke describes this relation by saying that the empty is filled. Yet this emptiness is like no emptiness of which we have had experience, and the filling is like no filling of which we know. The relationship is, therefore, unintelligible. The same is true of the conception that ideas are impressed upon the mind. Locke here evidently does not mean impressed in the physical sense. Yet there is no other sense of the word which we can conceive of as applicable. The theory asserts that mind and ideas are intimately related, but the relationship is like no relationship of which we have knowledge, and is, therefore, an unintelligible one.

Locke's theory also involves the conception that ideas resemble or copy objects. When it is said that one thing resembles another or copies it, it is meant that the two are alike in characteristic respects. But Locke evidently does not mean that the idea is solid and extended like the object or that it possesses any of the characteristic qualities of the object. The resembling or copying, then, which Locke refers to, is like no resembling or copying of which we know and is thus incomprehensible to us.

This element of unintelligibility which we have considered as a condition of complexity in a theory is also displayed by Locke's conception of real knowledge. The theory is that because some ideas resemble objects, that therefore knowledge concerned with these ideas, is knowledge of the objects themselves. And Locke considers that we know some knowledge to be real. The acceptance of the theory would necessitate one's believing that the mind knew of the relationship between ideas and things, although knowledge is but the perception of the relations between ideas. How the understanding reaches a knowledge of the relation between ideas and things is to one accepting the theory incomprehensible. Our examination of Locke's theory then reveals many unintelligible elements, and thus we shall agree that the theory is complex in this sense.

It may be helpful here to call attention to two conditions of unintelligibility which the theories in question reveal, one of which makes the theory more complex and the other does not. In Darwin's theory, we know that individual variations are inherited. We determine this to be a fact by observing parent and offspring. Yet we know little of the laws of inheritance; of how inheritance is accomplished. This, however, does not affect the complexity of Darwin's theory; for the theory needs for its purposes only the fact that there is inheritance. When the fact is known, the theory is not concerned with the question of how it is possible. In the theory of ions, how-

ever, we determined that the theory was complex from the fact that the relation between mechanical structure and chemical quality was unintelligible. We do not know such a relationship to be a fact; that is what the theory invites us to infer. We are required to infer a relationship, although at present the relationship can in no way be explained. If we knew that the relationship existed, we would not be concerned with showing by what means it is accomplished. But we have more difficulty in inferring the relationship to be a fact, because the relationship is at present unintelligible. Hyslop's theory illustrates this point well. If we knew that spirits existed and could communicate with each other and with us, the theory would not be concerned with showing how they do it. The existence of supernormal knowledge could be explained without such a demonstration. But the theory asks us to infer that spirits have powers of communication between themselves and human beings. This inference is the more difficult for us to make because the manner in which spirits perform these functions is unintelligible to us. A theory is only complex then, when it asks us to infer an unintelligible thing to be a fact.

Having considered the simplicity of the various theories, we shall now study the relationship between the method by which the theories were derived, and their simplicity. We have found that simplicity may mean any one of four things. It may mean that the theory has few concepts and few relations between them. Secondly, it may mean that the materials with which the theory deals are things which can be presented in experience, and not such as must be inferred from it. Thirdly, it may mean that the reasonings of the theory are easy to follow. And, fourthly, it may mean that the theory possesses few or no unintelligibilities. Now we shall find little relationship between method and simplicity in the first three senses. We have found that none of the theories here considered possesses many concepts, and that, with the exception of the theory of ions, their reasonings are easy to follow. Yet Locke's and Hyslop's theories are derived by the method of assumption and Darwin's theory, the theory of inorganic evolution, and the theory that matter is electrical are based upon the experimental method. It is very evident that the method of assumption might lead to a theory complex in structure, and containing difficult reasonings by increasing the number of assumptions and the intricacy of their implications. And so the experimental method may lead to a theory involving many concepts and difficult reasonings. The theory of ions is such a theory. The conceptions involved in it are comparatively numerous. It involves the conception that matter is made up of ions of different kinds; that

these ions, in different numbers and with different arrangements form the atom; that the difference of number and arrangement of the ions in the atom, conditions the difference of qualities expressed by the Periodic Law. The mathematical reasonings involved in the theory determining the number of ions in different atoms, and the causes of instability of certain atoms are very difficult. Thus it is evident from our examination that either method of procedure may give rise to complex theories; complex from the point of view of structure and difficulty of reasoning.

So also the experimental method may give rise either to a simple theory, simple meaning one whose materials can be directly presented in experience; or to a complex theory, a complex theory being one whose materials cannot be presented in experience. Darwin's theory we found to be simple in this respect; individual variations, inheritance, and natural selection being processes subject to direct observation: while the theory of ions, we found to be complex in this respect; the ions and their combinations being inferred existences. Both theories were derived by the experimental method.

The method of assumption and deduction, however, will always give rise to a theory complex in this respect; for the assumption is always of the existence or of the qualities of something out of experience. This is shown by both Hyslop's and Locke's theories. Hyslop's theory assumes spirits with certain powers to exist out of experience, and Locke's theory assumes minds, impressions upon minds, and "real things" to exist, although never observed. Thus a theory derived by experiment may be either simple or complex in this respect; that is, its materials may be either observed existences or inferred existences; while a theory derived by the method of assumption, will always be complex in this respect; that is, its materials will always be in whole or in part, existences beyond experience.

It remains to consider the relation between method of procedure and simplicity in the fourth sense, in which it was defined to mean free from unintelligibilities. The theory of ions, we found to be a theory based upon experimentation, while Hyslop's was found to be based upon the method of assumption and deduction. Yet both theories contain unintelligible elements. It is evident that a theory may be complex, in the sense that it contains unintelligible elements, by whichever method it is derived. This will be obvious when we consider the source of unintelligibilities. Things are unintelligible in the sense of the word as here used, only because we do not know enough about them. As knowledge is gained, primarily by observation and experiment, it may be said that unintelligibilities arise when observation and experiment are incomplete. In the theory of ions sufficient investigation

may clearly show the relation between mechanical structure and chemical quality. And in Hyslop's theory, sufficient observation and experiment may reveal the nature of death, and the powers of spirits, if such are found to exist. It is evident that such uninvestigated parts may occur in a theory developed by either method of procedure. However, our investigation has revealed that by far the most unintelligibilities of this kind occurred in the theories of Locke and Hyslop, both of which are based upon the method of assumption and deduction. A further examination of those theories may reveal the reason for this. Both theories assume the existence out of experience of something, like nothing in experience. This necessitates additional assumptions as to all the qualities of the thing assumed to exist out of experience. Being like nothing in experience, we cannot comprehend its nature, nor how it exercises the powers ascribed to it. Hence the great unintelligibility of these theories. We cannot comprehend the nature of the spirit conceived of in Hyslop's theory. Spirits communicate but have no means of communication of which we have knowledge. They move rapidly but have no means of locomotion like any with which we are familiar. Thus each of the powers ascribed to them is unintelligible to us.

So in Locke's theory, the mind is out of experience and is like nothing in experience. We cannot therefore comprehend its nature. The mind is impressed in a different way from any we have knowledge of. The idea resembles the object with a different kind of resemblance from any of which we have had experience. So the thinker in dealing with Locke's theory meets with these many incomprehensible elements and finds the theory in this sense complex. This evidently is a necessary consequence of applying the method of assumption as it is applied by Locke and Hyslop. Assumptions may be made of the existence of things out of experience without incurring incomprehensible elements. In the theory of ions, it is assumed that the atom is constituted of a spherical shell of positive electrification surrounding the negatively charged ions. Now a spherical surface of electrification is a thing producible in experience; a thing which can be investigated and whose qualities we therefore know. The assumption is not here, as in the theories of Locke and Hyslop, of a thing out of experience like nothing in experience, and further assumptions as to its qualities are not necessitated. When such an assumption is made, unintelligibilities do not arise; for the powers of the thing assumed are known from experiment. Whereas, when the method of assumption is applied as in the theories of Locke and Hyslop, and a thing is assumed to exist like nothing in our experience, then we know nothing of that thing or its qualities from experience, and must assume it to have certain qualities, although we cannot understand its possession of

them. Thus we conclude that the method of assumption, as revealed in the theories of Locke and Hyslop, will inevitably give rise to a theory complex because it possesses unintelligible elements.

Having now fully considered the question of simplicity of theories, we shall return to the question of the relation between believability of theories and their simplicity. It will need no discussion to show that simplicity has no bearing upon believability, when we mean by simplicity only that the theory has a few concepts simply related; or that the theory possesses no difficult reasonings. The theory of inorganic evolution is simple in both these respects and is a very believable theory. Hyslop's theory is also very simple in both these respects, but is not a believable theory. While the theory of ions is comparatively complex in these two respects and it is a believable theory. Darwin's theory and the theory that matter is electrical are simple in these respects and are both believable; while Locke's theory, also simple in these respects, is not convincing. It is evident that theories simple in structure and easy to understand in their reasonings, may or may not be believable; that there is no apparent relation between simplicity so understood and believability. Is there any relation between simplicity in the sense of presentable in experience as contrasted with inferred from experience, and believability? Darwin's theory is the most simple of all the theories examined in this respect and is also the most believable. In the theory of ions, the ions and their relationships are inferred existences, and although the theory is very believable, yet just because there is room to doubt the existence of ions and their relationships, the theory is less believable than Darwin's. In the theory of inorganic evolution changes of temperature on the sun and stars are inferred existences, and also the appearance and disappearance of elements in those places; yet the methods by which those conditions are discovered have been so thoroughly tested that the evidence leaves no doubt in the mind, and a theory results quite as believable as Darwin's theory, although in the theory of inorganic evolution the materials of the theory are inferred existences. It is evident that where part or all of the data with which a theory is concerned is inferred existence, that the believability of the theory will be somewhat affected by the strength of the inference of the existence. And that theory which is most simple in this respect, whose materials are for the most part experienced facts, will be the most believable, other conditions being the same.

It remains to consider the relation between believability and simplicity in the fourth sense, where it was defined to mean freedom from unintelligible elements. The most believable theories considered, the

theory of inorganic evolution and Darwin's theory, are free from unintelligible elements.

We have noted that the theory of ions had involved in its reasoning one unintelligible element; that the dependence of chemical quality upon the mechanical structure of the atom was not known to be a fact and in the present state of science is unexplainable. It is evident that this impairs the believability of the theory. In order to believe the theory, we must infer that chemical quality is dependent upon mechanical structure, and this is the more difficult to do just because we cannot explain such a relationship. However, the theories most complex in this respect, the theories possessing the most unintelligible elements, were the theories of Locke and Hyslop. These two were also the least believable of the theories examined. In dealing with the question of the relation between method of procedure and believability, we discovered that the method of assumption gave rise to unintelligible elements in these theories, and that because of these elements the theories lacked believability. It will, therefore, be unnecessary to show here that theories, complex in this respect, will lack believability. It will hardly be disputed that when a theory requires an inference to be made, that inference will be less readily made, when it is of the existence of unintelligible things. The theories possessing most such incomprehensible elements, like the theories of Locke and Hyslop, are the least believable. Therefore, we conclude that there is an intimate relationship between the believability of a theory and its complexity, when complexity refers to the existence of unintelligible elements.

The Verifiability of Theories.

To verify means to show the truth of. We shall first consider the question of how theories are verified and on what their verifiability depends. We have found that there are two distinct types of theories; those of definition and those of origin. How are theories of definition verified? The theory that matter is electrical is a theory of definition, and we shall consider how its truth may be shown. We can determine by observation and experiment the essential qualities of electricity. To demonstrate that matter is electrical, we must show that it has the same essential qualities as electricity. An investigation of matter will reveal its qualities, and they can then be compared with those of electricity. The characteristic quality of matter is found to be inertia. By experiment we show that electricity possesses this same quality. Therefore, electricity is matter, or matter is electricity. Here then, we see that verification consists in showing that the facts affirmed by the theory are true by experimentally manifesting them in experience, or gaining evidence for their existence. Once the theory

is set forth, all evidence adding to the strength of its inferences, is a verification of it; for the facts of evidence were implied to exist by the theory, they being merely the manifestations of the thing which the theory affirms to exist. The verification of a theory of definition, then, consists in revealing the facts affirmed by it in experience; or the implications of those facts.

How are theories of origin verified? Darwin's theory is a theory of origin. The conclusion drawn in the theory is that species originated by virtue of individual variations, inheritance, and natural selection. Here, we cannot directly show this to be true by reproducing the past history of organic life, as we did show matter to be electrical by having it manifest the qualities of electricity. We can, however, show by experiment that individual variations, inheritance, and selection will produce species. We can exhibit this fact in experience. But the further verification of the theory requires us to show that these forces did actually so operate in the past as to produce present species. If this was a fact, certain things are implied to be true in the present, and the verification of the theory will consist in revealing in experience the truth of these implications. If the forces of evolution have so operated in the past, the remains of organic life will, where preserved, show the gradual variation in type, fitting the succeeding generations better for life. When such conditions of the remains of organic life are shown, the validity of the theory is to some extent evidenced or verified. Thus the verification of a theory, whether it be one of definition or of origin, consists in revealing in experience the facts affirmed by the theory to be true; or the implications of those facts. Therefore, in so far as the materials of a theory can be subjected to observation or experiment, the theory is verifiable. Either the facts affirmed by the theory must be revealed, or the implications made manifest. Those theories founded upon the experimental method have already revealed many of the implications of the facts inferred, in the evidence gathered for the theory. All that stands in the way of further verifying such theories is the improvement of the facilities for experimenting, and the application of these facilities.

Experiment will also be the method of verifying theories which make use of assumptions. The theory of ions assumes the atom to be constructed in a certain way. The theory can be verified in this respect by showing that the implications of this assumption are true. If this assumption is true, the atomic weights of atoms will change in accordance with a certain law. By experiment, it is shown that the atomic weights do change according to that law. In this way the assumption is to a certain extent verified. The assumption may be further verified either by a direct examination of the atom, if that be-

comes possible, or by further showing the implications of the assumption to be true. The theory of ions also involves the inference that changes in mechanical structure give rise to changes in chemical quality. This inference could be verified by changing the mechanical structure of atoms in our laboratories and noting the consequent changes of chemical qualities; or by finding numerous instances where there are with differences of mechanical structure, corresponding differences of chemical quality. Thus we conclude that where a theory is based upon the experimental method, the difficulties in verifying it are simply the difficulties in the way of further observation and experiment.

We, however, meet with peculiar conditions of verification in the theories based upon the method of assumption and deduction. In Hyslop's theory the existence of spirits and their qualities are assumed. The theory can be verified by revealing the existence of spirits by presenting them, if possible, in experience; or by gathering evidences of their existence from experiments. The peculiarity which one finds in the verification of this theory is that in order to verify it, the spirits themselves must be subjected to direct investigation. Being like no other things of which we know, we cannot investigate other things and apply our conclusions to spirits by analogy. Contrast the conditions of verification in the theory of ions. The inference there is that an ion is an electrically charged particle. Now we can experiment with electrically charged particles and can find what their properties are, even though we cannot experiment directly with an ion. In the case of spirits, however, we have nothing like them in experience which we can investigate; and therefore the theory is to be verified only by directly investigating spirits themselves. Until spirits have been directly investigated, and we know what they are like, we cannot infer their existence from any occurrences in experience, because we cannot know until then, that the occurrences are such as spirits are able to produce.

The same situation presents itself when we attempt to verify Locke's theory. Locke assumes that the mind is a plastic medium and that ideas are impressed upon it by operations of matter. This, we could verify by producing, if that were possible, an idea experimentally in that way. We can verify this assumption in no other way. The mind is like nothing in our experience, and we therefore cannot determine by analogy what its qualities are. When therefore an idea occurs, we cannot say it was conditioned by an impression upon a mind; for we do not know whether there is a substance which when impressed will give rise to an idea. We must impress something and thus produce an idea before we can know that impressions of sub-

tances are ideas. In order, therefore, to verify Locke's theory, the mind itself must be directly investigated. We discover, then, that the theories based upon the method of assumption and deduction are peculiar in this respect, that their verification requires a direct investigation of the thing assumed to exist. No inference can be made concerning the assumed objects, until their qualities are known. It is notable that in order to verify these theories, they must be given a foundation in experiment and that when verified they will no longer be theories of assumption and deduction. If this conclusion is sound, we can further affirm that there is only one method by which a verified theory can be reached; for we found from our investigation that there were only two principal methods of theorizing: the method based upon assumption and deduction and that based upon observation and experiment.

We conclude then that whether a theory is based upon the method of experiment or upon the method of assumption, it is verifiable in so far as its materials are subject to experimental investigation. And, considering the theories which we have thus far investigated, there are none but what we can hope in time to verify or disprove experimentally. The individual variations, inheritance, and natural selection of Darwin's theory; the ions and their properties in the theory of ions; the changes of temperature and elemental structure in the theory of inorganic evolution; and the inertia of matter and properties of electricity in the theory that matter is electrical, have all been to some extent investigated, and apparently nothing prevents their being investigated in greater detail. In Hyslop's theory the spirits have not been experimentally investigated; but if spirits exist, we can hope by experiment to discover their existence and properties; and if they do not exist we can hope to explain super-normal knowledge without assumptions concerning them. So in Locke's theory, the mind which Locke assumed has not been revealed by experiment; but if it exists there is no reason to doubt but that it may be; or, if it does not exist we can hope to explain ideas and knowledge in some other way.

If then our investigation covered all types of theories, we could conclude that all theories are verifiable and that there is only a question of more or less difficulty in verification. We cannot, however, securely draw this conclusion until we have investigated a type of theories which Imanuel Kant affirmed to be true a priori, prior to and independent of all experience. Poincare has recently called the same type of theories conventions, neither true nor false; suggested by experience but not of a nature to be verified in it. Among such theories are those, that there are lines which never meet, however far pro-

duced; that matter is indestructible; that energy in its various transformations is constant in quantity; that action and reaction are equal, but in opposite directions; and that a body subjected to no force will move continuously with uniform velocity in a straight line. I shall take the last mentioned theory as representative of the class. We shall consider the question, then; can the theory that a body subjected to no force will move continuously in a straight line, be verified? We cannot withdraw a body from the action of every force, argues Poincare, at least we should not know that we had done so. An experimental law is subject to revision, but this law may be extended to the most general cases; for in these cases experiment is neither able to confirm or contradict it.

Now we first note that this theory deals with bodies, forces and directions of motion; all of which are subjects capable of experimental investigation. By experiment the conditions giving rise to forces can be ascertained. A moving body is a thing of our experience, and its direction of motion can be investigated. Apparently then, all the materials of the theory are capable of experimental investigation. As the conditions giving rise to forces are known, we can ascertain what forces are acting upon a body. As its direction of motion is a thing of experience, we can determine whether the motion is straight or variable. The theory, however, makes an affirmation concerning a body acted on by no force, and such a body we cannot present in experience. We can, however, make inferences concerning such a body, and if those inferences have an experimental foundation, the theory is in so far verified, or may be. Although we cannot remove from the body all forces acting upon it, we can determine the effect of those forces which continue to act upon it; and can infer in what condition the body would be without the action of those forces. However, it is urged, that we cannot know certainly but that some force is acting which has escaped our notice, or which is of a mysterious nature. This is true, and is, I understand, the reason why the law of inertia is a theory, is problematical, and not a fact. It cannot be known positively to be true because we cannot give an exhibition of the law in experience and be certain that ideal conditions maintain. Neither can it ever be known absolutely to be false; for if a body moves with unexplainable irregularity, we cannot be certain but that some unknown force is acting upon it. However, we might infer that the law is false, and verify our inference to a certain extent by experiment; just as we infer it to be true. We infer, because facts cannot be fully revealed in experience; and for the same reason, inferences are always more or less uncertain. A verification is not an actual display of the facts inferred by the theory, in experience; if it

were, the inference would cease to be and fact would exist in its stead. In the case of the ultimate inferences of science, we act upon them with great confidence, not because they cannot be shown certainly to be true or false, but because experiment has so far strengthened the inference of their validity. Between the spheres of fact and pure assumption or convention, lies the scale of inferences more and less certain; and because a theory is not a certainty, we cannot conclude therefore that it is a mere convention: it may be an inference to a greater or less extent verifiable. If I am justified in considering the law of inertia as typical of ultimate scientific inferences, we can conclude that the so-called a priori truths or conventions are inferences based upon and to a great extent verifiable in experience.

We conclude then, from our examination of the verifiability of theories, that theories are verifiable in so far as the grounds upon which their inferences are based are subject to experimental investigation; and it matters not what the problem involved in the theory may be, or what its method of procedure in solution.

From the fact that verification is defined to be the showing of the truth of a theory, the relation between verification and believability of theories is manifest. We have already discovered in our study that those theories for which there is the most experimental evidence, which are most verified; Darwin's theory, The Theory of Ions, and the theory of Inorganic Evolution, are the most believable; while those theories which were not founded upon experiment were not verified and were difficult of verification, were the least believable theories. Believability increases in proportion as verification approaches completeness.

Meaning of Truth of A Theory.

We defined verification to be the showing of the truth of a theory. We shall consider now what is meant by the truth or falsity of a hypothesis. It has been considered, on one side, that the propositions which a theory asserts are either true or false from the moment they are asserted; while, on the other side, it is conceived that theories are not, when proposed, true or false, but are made so by the success or failure of verification. The former view is that verification shows the truth of a theory; the latter that verification makes the truth of a theory. According to one view, at the time Darwin first affirmed that species originated by natural selection, that theory was either true or false, even though entirely unconfirmed or unrefuted; that the conditions of the origin of species existed at that time and either did or did not correspond with Darwin's Statement. While, according to the second conception of truth, Darwin's statement before it

was confirmed and believed, was neither true nor false, and only became true as evidence added to its strength and believability; that when the proposition was first announced, there was no knowledge state in which species represented themselves to have originated in the ascribed manner; that therefore the proposition was sterile, and only as actual knowledge states developed in which species actually implied an origin in the affirmed manner, did the proposition become vital and true.

It is worthy of note that whichever view one adopts concerning the nature of truth, the practical consequences will be the same. One will confirm his theories in the same way, he will consider it confirmed to the same extent and at the same time; he will receive and reject the same theories; and the system of required knowledge will be the same to him. Only, one school will insist that a true theory was true and a false theory was false from the time they were asserted as propositions; while the other school will insist that a theory was only true or false from the time and to the extent that its truth or falsity was believed in or appreciated. So far as practice is concerned, one may choose either conception of truth; his choice will have no influence upon his manner of dealing with theories; neither upon their origin nor upon their usefulness.

In What Sense Do Theories Explain.

In connection with the question of the truth and falsity of theories, I shall consider the question of how far do theories explain; for we should hardly believe that a theory would be considered true or be believed in, which did not explain the phenomena in question. Our research has revealed two distinct kinds of problems and two corresponding kinds of explanations or solutions. Where the problem was one of definition, as in the theory that matter is electrical, an explanation was made by finding the identity of essential qualities in matter and electricity; and where the problem was one of origin, as in Darwin's "Origin of Species," an explanation was made by revealing the conditions under which species originated. These were the only two kinds of explanation attempted by any of the thinkers whom we have studied. No attempt was made in the theory that matter is electrical to determine why electricity attracts, or what the essential nature of attraction is; and no attempt was made by Darwin to show why individuals vary or why inheritance operates. In none of the theories was an attempt made to arrive at final essences or final causes; and so our study justifies us in saying that the explanation which thinkers succeed in making involve no such determinations. Until then investigation reveals a different kind and a more final explanation, we shall consider

that phenomena are fully explained either where their qualities are revealed or the conditions of their origin made manifest.

Usefulness of Theories.

Having considered the simplicity, believability and verifiability of theories in relation to the method by which they were produced, we shall next consider the bearing of these qualities upon the usefulness of theories. And the first essential to a theory being useful is that it be believable; for until a theory is believed in, it will not be acted upon. Those theories which we found to be most verified and thus most believable: Darwin's theory, the theory of Ions, and the theory of inorganic evolution, we shall expect to find among the useful theories; and those which have not been verified, we shall expect to find of little use. Our investigation has revealed that experimental methods gave rise to verifiable and believable theories and that the method of assumption gave rise to theories, difficult of verification and to a small degree believable. Thus there appears a close relationship between the utility of a theory and the method by which it was derived. This will more fully appear when we consider the dependence of utility upon other qualities of theories, which bear a close relationship to method of procedure. We discovered that those theories which were most complex, in the sense that they contained most incomprehensible elements, were the least believable; and that this quality of complexity was a direct result of the use of the method of assumption and deduction as applied by Locke and Hyslop. We also found that theories derived by this method were most difficult of verification because we could infer nothing concerning the assumed objects out of experience until we had directly investigated their natures. Being difficult of verification, they can gain belief slowly, if at all, and until they have been to some extent verified and have gained belief, they of course will remain useless in the spheres of practice and thought.

Our investigation has revealed that the method of assumption and deduction gives rise to theories complex in the sense of containing incomprehensible elements; difficult of verification because they assume the existence of things out of experience like no things in experience; unbelievable because no evidence is offered for the existence of the assumed things and because there is in our experience nothing analogous to them making their nature intelligible to us; and, finally, useless because to no extent verified and believed. On the contrary, our investigation has revealed that theories derived by the method of observation and experiment are simple in the sense that they possess few or no unintelligible elements; are verifiable from the fact that the existences which they imply out of experience are like existences in experience and

therefore inferable from it; are believable because based upon evidence which can be repeatedly tested, and because the things implied to exist out of experience are like things in experience and therefore comprehensible to us; and, finally, useful because verifiable, believable, and applicable to situations in our experience.

If then our investigation has been based upon typical examples of methods of thinking and has been sufficiently thorough, we can warn the thinker against the method of assumption and deduction which gives rise to unbelievable and useless theories, and recommend to him the method of experiment and inference, which yields a theory believable and of practical value.

We have from this study of methods of thinking, arrived at conclusions concerning the qualities of theories and the relative merits of the methods by which they were derived. With that our investigation is concluded.

However, another problem, closely related to the one considered, has occurred to the writer, and although a solution of it would require other material and a much wider research than has been here presented, yet a statement of the problem may be of value.

We may safely consider that each thinker who presents a theory to the world for its sanction, has faith in his own method of thinking, and in the conclusions at which he has arrived. What differences are there in the mental make-up of thinkers, which will account for such diverse methods of thinking and for such diverse susceptibilities to belief in different kinds of theories? Three of the theories which we studied were concerned with the nature of matter, one with the nature of organic life, one with the nature of knowledge, and one with the existence of life after death. Was it the problem which determined the method of thinking? Would Darwin have reasoned as Hyslop did, had he dealt with the question of life after death? Or, had Norman Lockyer have dealt with the question of the nature of knowledge, would he have proceeded as Locke did and have been satisfied with Locke's conclusions? We have determined that the methods used by Darwin and Lockyer were applicable to the problems treated by Hyslop and Locke and vice versa; yet Darwin and Lockyer applied one method, and Locke and Hyslop another, and each apparently felt that his method was the natural, ready and secure methods of reaching the truth.

Men have been roughly classified into thinking, willing and feeling men, according as the propensity for thinking, willing or feeling predominated. Will these broad differences in mental tendency account for the different manners in which men theorize? Can we say that Hyslop believes in his conclusions, which have slight foun-

dation as logical inferences, because his eagerness for accomplishment caused him to accept the first theory with a semblance of strength and blinded his judgment for the value of evidence? or shall we say his judgment was blinded because his conclusions were so dear to him that he must give them a foundation in reason at any cost? Or shall we say that from a religious nature and early training his conclusions became beliefs long before he attempted to theorize about them, and that in his theory he simply presents his beliefs and such excuse in reason as he can find for them?

And shall we explain Locke's conclusions and method of thinking by saying that his judgment for the value of evidence was overpowered because he was eager to explain for the sake of accomplishment, or because his conclusions were dear to him and he wished to give them support? Or shall we conclude that his education made certain conceptions habitual with him, and that he accepted them as the foundation of his theory, without criticism, because he never questioned their self-evidence?

Perhaps we could explain Darwin's and Lockyer's methods of theorizing by finding that there is a predominately thinking man; and that his keen appreciation of the value of evidence and of clear thinking will not permit of his accepting as facts the conceptions which his education has given him without foundation in evidence; and will not allow of his leaving his conceptions vaguely defined. We may find that the appreciation which such a man has for the value of evidence and for the requirements of sound thinking is such that neither his desire for accomplishment nor his desire that certain things should be proved true can overpower his judgment as a thinking man and cause him to be satisfied with unfounded assumptions and vaguely defined or unintelligible conceptions.

The solution of this problem would be of great value. For if trustworthy conclusions could be reached in its solution, education could more exactly aim to correct those tendencies in thinking which cause men to expend great and earnest efforts in creating an unbelievable and useless theory, while others more fortunate in their choice of methods, or by education and endowment more wise, with no more effort and no more concern for the truth and human good, create theories which become instruments for the transformation of thought and for the general advancement of human welfare.

VITA.

The author of this dissertation, Lucas Carlisle Kells, was born at Sauk Centre, Minnesota, June 17th, 1882. He graduated from the High School of Sauk Centre, Minnesota, in June, 1899. He entered the University of Minnesota September, 1899, and studied there until June, 1904, attending graduate courses in Philosophy under Professor Norman Wilde and Professor David Swenson, and in Education under Professor George F. James, during the year 1903-1904. He received the degrees of A. B. and A. M. in 1904. He entered the University of Columbia in New York City in September, 1904, and attended there until June, 1909, pursuing graduate courses in Philosophy and Psychology under Professors Woodbridge, Dewey, Fullerton, Adler and Cattell during the years 1904-1906. In September, 1906, he entered the Columbia Law School, from which he received the degree of LL.B. in June, 1909. In 1904, he was appointed scholar in the department of Philosophy at the University of Columbia, and in the years 1907-8, 1908-9, he held scholarships in the School of Law of Columbia University.