Chapter (X)

Edwin B. Wilson: Empiricism and Rationalism, Science, New Series, Vol. 64, No. 1646, (Jul. 16, 1926), pp. 47-49.

MEMBERS of the Harvey Society, ladies and gentlemen, I have been asked to discuss the proper manner of treating data from a statistical and mathematical view point and I have chosen as the precise wording of my topic the more general formulation "Empiricism and Rationalism," to the end that I might emphasize a distinction in point of view between methods, and more generally between aims, in the treatment of data by statistical or mathematical analysis.

For I believe that without a keen appreciation of the distinction between empiricism and rationalism it is impossible properly to understand the problem of the treatment of observational material.

When we seek for definitions of empiricism or rationalism we may well turn to the Century dictionary in which the philosophical definitions were formulated by Charles S. Peirce, an expert in making refined physical observations and in reducing them, and a great logician and philosopher. I understand that in the medical sense empiricism is quackery, so at any rate the Century dictionary states, but this part of the definition may not be due to Peirce. We find the following:

Empiricism: The metaphysical theory that all ideas are derived from sensuous experience-that is, that there are no innate or a priori conception.

And again:

Rationalism: In metaphysics the doctrine of a priori cognitions, the doctrine that knowledge is not all produced by the action of outward things upon the senses but partly arises from the natural adaptation of the mind to think things that are true.

You will notice the difference between these definitions. It isn't that empiricism emphasizes the importance of sensuous experience. It is that it states that all ideas are so derived and that there are no innate or a priori conceptions. This notion is not unfamiliar; one finds it expressed by a good many writers, and particularly by writers in the biologic fields. Some seem to hesitate a little bit at the extreme form of the statement and to qualify it by some sort of assumption that there may be an inheritance of ideas, so that empiricism should be stretched to include not only the sensuous experience of the individual but the sensuous experience of the race as transmitted to the individual. It seems to me that if one so stretches the notion one might almost as well give it up; because it is hard to see wherein sensuous, experience derived through evolution of the race - should differ from innate or a priori conceptions. In fact, one might almost maintain that innate and, a priori conceptions are precisely the quintessence of the sensuous experience of the race. We shall therefore cleave to the original extreme form of the statement that all ideas are derived from sensuous experience and that there are no innate or a priori conceptions.

Rationalism, on the other hand, does not say that all knowledge arises from the natural adaptation of the mind to think things that are true. It states that there are a priori cognitions, that knowledge

is not all produced by the action of outward things upon the senses but partly arises from the natural adaptation of the mind to think things that are true. It is therefore not precisely the antithesis of empiricism.

That antithesis would be found more nearly in the extremist interpretations of the idealism of Berkeley where the existence of external things is made to depend on their perception by the mind. Rationalism is a sort of middle ground and as such might readily be assumed to be nearer the truth than extreme, empiricism or idealism.

We are very prone to extremes and I would not deny that very much advance in science and in philosophy and in art has been made by the struggles of the extremist of one sort or another to prove that a single point of view is adequate for the systematic formulation of a philosophy. As a matter of fact the extremists on both sides are apt somewhat to ridicule the moderate position of any one who occupies intermediate ground; he is, so to speak, between two fires. He has perhaps not the same initiative of attack, not the same uncontrolled zeal of the extremist and this constitutes for him a certain weakness or vulnerability. We are prone to follow special pleaders, whether in religion or in science or in ethics. I might liken empiricism to one end of the spectrum, let us say, the infra-red, and liken idealism to the other end, the ultra violet, and then I should characterize rationalism as constituting the visible light. And I have an idea that we cannot see nature whole in any monochromatic light, whether visible or invisible. Our own interests may be important, but so are the other interests of other persons.

One aim of statistical and mathematical analysis in the treatment of observations is the empirical aim of describing our experience. If we have a large number of observations we may wish to describe them by certain characteristics of the whole group. This leads to using the mean or median to express the center of the group or rather some center of the group. We use other constants, for example, the standard deviation or the probable error or the interquartile range to express a measure of the scattering of the individuals of the group from their center. We can determine other characteristic constants of the group. This is purely descriptive statistics. Its value lies in enabling us to replace the great variety of the group of observations by a lesser variety of somewhat technical descriptive constants computed from the elements of the group.

In other types of problems we need the empirical equation. We have one variable which depends more or less upon another and we make a plot to show the values of one variable coordinated with those of the other. If the values run fairly smoothly we draw a curve threading among them in such a way as to satisfy our esthetic judgment as to the probable relation between the variables. For many purposes such a graphical delineation of the smoothing process may be adequate. But even when it is adequate and in many cases when it is not we have recourse to the empirical equation- which means that we select some type of mathematical expression which in a general way runs along the graphical curve and which contains a certain number of parameters that may be assigned, by one method or another, such values as to make the analytical expression lie extremely close to the observations.

In case there is a great deal of scattering among the observed relationships such as we should find, for example, if we undertook to plot the heights and weights of different individuals, we may have recourse to decidedly complicated methods of calculating what we consider to be the best curve to represent the relation between these variables when abstraction is made from the accidental variations of each variable. This field of effort may be generally subsumed under the title of correlation. We should not restrict this definition to imply that the regression equations need be linear.

In all these cases, whether we are content with representing the characteristics of a group by a few statistical constants, whether we describe the cogrediency of a pair of variables by a graphical or analytical smooth curve, or whether on account of the greater scattering we combine these two notions into the general notion of correlation we are still in the domain of description or of empiricism. We are in the domain which is represented, for example, in botany by the herbarium with the dried plants attached to the sheets with their appropriate descriptions and filed away for reference. We are in a museum.

There is, on the other hand, the rationalistic point of view in almost all science, namely, the effort to apply original thought to the explanation of the relationship between variables. In a certain sense an explanation means a search for causes, and in a certain sense one may maintain that there are no causes; that throughout nature there is only concomitancy; that those who speak in terms of forces and causes are merely using a different kind of description or a different extent of description from the frank empiricists; but certainly the aim of the person who undertakes to discover natural

laws, so called, is somewhat different from the aim of him who undertakes to describe. Their methods also differ. Ordinarily the empiricist multiplies description until it becomes more and more realistic. Ordinarily progress in the rationalistic direction is made by ignoring the lesser variations which may be assumed to be due to accident, or at any rate to lesser causes, and by focusing the attention upon an ideal situation where only a few major causes are working; that is, rationalism proceeds by idealization, whereas empiricism proceeds by realization. For the rationalist it may be a positive handicap to know too much in detail the relations which exist in nature. Often the great generalizations come early. Isaac Newton perhaps had a simpler problem before him when he had the observations of planets as reduced by Kepler and systematized into the three laws of Kepler than he would have had if he had been in possession of knowledge of all the multifarious perturbations introduced in the orbits of each planet by the influences of all the others. You can think of many such cases in the biologic field.

This crucial notion of the r61e of idealization in the discovery of natural law may be exemplified by any number of instances. Consider, for example, the question of motion and of force. The fact of observation is that all moving bodies come to rest unless some effort is expended in maintaining the motion. Prior to the time of Newton this universal experience was interpreted as meaning that a forward force was acting on all uniformly moving bodies. Newton said, No, that which stops the body is in the nature of a resistance, bodies left quite alone must persist in uniform motion. Such an idealization requires insight. It may be doubted whether Newton got it from his sensuous experience. It is possible that he contributed

this idea, and that we are here in the presence of a mind especially adapted to penetrate behind the deceptions of things as they seem and to think things as they are. Lavoisier's law of the indestructibility of matter or conservation of mass is another case of reversing the obvious to find an idealization. Fortunately for the advance of science the reversal of an accepted point of view is not necessary to the discovery of a law of nature, but a persistent intensity of original thought directed toward the formulation of an ideal situation undisturbed by accessory happenings does seem essential. Moreover, one must have the intuition to decide rightly what is accessory and what is fundamental in the problem considered. And further, he must have a feeling for what are the present problems that are worth while.

So long as persons merely observe nature, howsoever intently, and describe, howsoever accurately, that which they observe they experience real difficulty in discovering natural laws and in confirming their discoveries. This is due to nature's infinite variety. It is the experimental method which has so advanced science by leaps and bounds. The experimenter can somewhat control conditions, he can limit the accessory variations, he can repeat and vary his experiments until a general inference becomes possible.

I believe that Maxwell, contemplating the great complexity of the spectrum, once remarked that given a mathematician of sufficient ability a wonderful contribution to our understanding of the constitution of matter could be made by the mathematical analysis of the spectrum. Scientific history now tells us that better experiments, sharper eliminations of the complexities, closer attention to the simplest cases, proper and new coordination of

idealized physical concepts and relatively simple mathematics have set us on what we believe to be the right track. This is, I venture to think, the usual way of advance-idealization, a recombination, sometimes a reversal, of scientific concepts, new experiments, and a little mathematics. It is the breeders, Mendel with peas or Morgan with Drosophila, who urge genetics forward, not the sociologist or statistician. The place for complicated mathematics is in the follow-up, in the codification of the whole field.