EDITORIAL

The Philosophical Basis of the Experimental Method

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The application of the experimental approach to Science and Medicine has its roots in the 16th century. William Harvey (1578-1657), who demonstrated the passage of blood through the veins unidirectionally towards the heart as evidence for circulation of blood, was generally credited as one of the earliest physicians who applied the method of studying nature by direct observation and experiment. Ambroise Paré (1517-1590) was believed to be the first to introduce the concept of the "*controlled experiment*" to clinical practice. In those days when Paré was serving as an army surgeon during the French war against the Spaniards, it was customary to treat gunshot wounds with boiling oil. However, Paré decided one night, when he ran out of oil, to treat some of the wounded soldiers with an improvised mixture of egg yolk, oil of roses and turpentine. Next morning to his surprise, he found that those soldiers that were treated with boiling oil were either dead or were suffering with intense pain and fever from inflamed wounds. The group that was treated with his improvised concoction was remarkably pain-free and did not have inflamed wounds. Eventually, Francis Bacon (1561-1626) formulated the *experimental method* as we understand it today. He existed at a time when the heavens were being re-mapped with the invention of the telescope and the medieval concepts of the universe gave way to revolutionary concepts from Copernicus and Newton. Arising out of a need for a new method that would organise the sprouting of new knowledge in a systematic manner, Bacon proposed and propagated a general approach by which men might gain scientific knowledge of the laws and structure of matter.

It is well appreciated nowadays that all empirical knowledge rests on observations. There are two ways in which we can obtain observations, either passively or actively. In the passive mode, we merely take note and describe the patterns or regularities of nature and express them in the form of "*laws*". The active approach is always preferred. Instead of waiting for nature to provide situations for us to observe, we actively create such situations, or make experiments, so as to produce better observational results. This active approach is particularly fruitful in situations where there are quantitative concepts that can be accurately measured. We first of all, try to determine the relevant factors involved in the phenomenon we wish to investigate. Having decided on the relevant factors, one devises an experiment in which some of those factors are kept constant while others are permitted to vary. The aim is to find laws that relate all the relevant factors.

Today, experimental method is the *sine qua non* of modern science. However, in executing the experimental approach, one must be aware that we are, in fact, making at least four very fundamental assumptions, the validity of which is seldom questioned:

(1) *Orderliness of nature*—It is assumed that natural phenomena in the world around us occurs in a disciplined or orderly manner.

(2) *Uniformity of nature*—It is assumed that for any event, if the conditions are similar, the results will be similar.

(3) *Contiguity of nature*—It is assumed that a causal connection between two events requires that they be contiguous.

(4) *Principle of causality*—It is assumed that each event has necessary antecedent events and an event cannot occur without a cause.

The *orderliness of nature* has always been the framework upon which all scientific observations are made. We all observe certain repetitions of events in our daily lives. We know, for instance, that the facial appearance of old patients with Parkinsonism is characteristically that of an expressionless stare whereas young hyperthyroid patients have a startled look. The face is invariably puffy in patients with glomerulonephritis, typically coarse in myxoedema and classically characterised by slanting eyes and hypertelorism with prominent epicanthic folds in Down's syndrome. All these regularities led us to assume that all events take place in accordance with natural laws. However, in Medicine, most natural laws are *statistical* rather than *universal* in nature. By "*statistical*" we mean that the statement of natural law asserts that regularity occurs only in a certain percentage of cases. If the percentage is specified, or if in some way, a quantitative statement is made about the relation of one event to another, then the law is known as a statistical law.

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Next, in going from the direct observations of facts to the generalisation of these facts into a law that expresses a certain *uniformity of nature* one is embarking on the process of *induction*. It should be obvious that such a law, when so generated, constitutes only indirect knowledge. This immediately raises the question as to the basis on which one is justified in believing that such a law should hold true. Indeed, the conclusion is never certain in *inductive reasoning*. This is very much unlike *deductive reasoning* in which the inference leads from a set of premises to a conclusion just as certain as the premises. In inductive logic, all we can say is that, with respect to the given premises, the conclusion has a certain degree of probability, but the value of this probability can be quantified.

Finally, the principle of *causality* in science has occupied the attention of philosophers since the time of the ancient Greeks. Today, the concept of cause-and-effect relationship remains vague and difficult to define. In everyday life, it is often not exactly clear as to what someone means when he says that one event has "caused" another. What it does imply, to most of us, is the concept of *predictability*. This means that, if the preceding situation was known, the subsequent event could have been predicted, given all the relevant laws of nature, bearing in mind that our knowledge of the laws of science is very much incomplete today.

However, philosophers today continue to differ with scientists and with each other, in their views on the necessity of contiguity in the cause-and-effect relationship.

Perhaps it sounds ironical. The experimental method, on which researchers have been depending for more than four centuries, in developing science, has its foundation shrouded in the realms of philosophy.

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