Journal of the Minnesota Academy of Science

Volume 1 | Number 2 Article 5

1874

Prerequisites to a Proper Study of Science

Charles Simpson

PREREQUISITES TO A PROPER STUDY OF SCIENCE.

BY CHARLES SIMPSON, M. D.

[Read before the Academy December 2, 1873.]

The subject upon which I have decided to invite your attention, is not one which belongs strictly to any one department of Science. It is, rather, the outgrowth of my own perplexities, in classifying the various disjointed items of scientific interest, and appropriating them as part of my own mental outfit, and concerns the whole subject of scientific investigation. Regarding the observations which I shall make in this paper, my standpoint may be assumed to be on the boundary wall which encloses and overlooks the broad domain of Science, from which I am able to inspect the designs, progress and proficiency of the vast multitude of workmen, as they toil unweariedly at their respective tasks. From such a survey, it may be supposed that while the greater part of the operations excites admiration and astonishment, there may be, on the other hand, much that calls up a suspicion that a great deal of labor and enthusiasm has been either wasted or misapplied.

Method, in the accomplishment of any work, in any given field, is of the first importance. It is a waste of energy in the workman to enter upon his labor without, in the first place, having a definite notion, not only of the grand object he has in view, but also of the means by which he hopes to attain his end, and the limits of his capacity in the employment of the means. In the building of any structure, it is not only necessary that the mechanic should have a knowledge of its length, breadth and height, the style of architecture and adornment, he must, as necessarily, have considered the kind and form of his materials, and their adequacy to meet the requirements of the original design. So, in every sphere in which labor is expended, it is always obligatory on one, to so far understand the matter in hand, as to secure, as far as may be, the successful issue of his undertaking, and prevent the waste of his energies in disgraceful and disheartening failure.

For a long period in the world's history, Science made little or no progress. Literature and the arts flourished side by side with dazzling brilliancy, ages before systematic knowledge of physical nature had even a name or a place. True, facts were known, or, rather, things were believed which have since been shown to be facts; but what we, to-day, understand as *Science* is a thing of comparatively modern birth—a product of the world's maturer years and wiser thoughts. The wildest imagination, the dreamiest speculation and sober truth, may be said to have weltered together in utter chaos, until the advent of the scientific method of investigation, promulgated by the matchless genius of Bacon, placed truth on surer footing and in reputable company. The inductive or experimental method made science a possibility. Without it, the best minds of earth all but frittered away their strength in striving to reach the unattainable, and succeeded in making nothing so conspicuous as the folly of their attempt. My present object, however, is not to describe, in detail, either of the two great systems of logic, but to hint briefly at certain prerequisites to a successful, vigorous and healthy progress in the cultivation of scientific thought, and to point out as clearly as may be, the dangers attending the indiscriminate use or the willful abuse of the two most powerful weapons in the armory of knowledge—speculation and experiment.

Among scientific men, and, indeed, in all men, we find this difference in mental bias: One man has a predilection for observing and collating individual, and, perhaps, entirely isolated facts, caring little for the arrangement of these so as to embody a general truth or law; while another, caring less for what to him are tedious details, spreads at once the wings of his imagination and soars to a bold hypothesis, which it may take ages either to verify or condemn. Such tendencies among our leaders in science—the representatives of the different modes are readily identified—are constantly apparent to every one conversant with the scientific literature of the day. Now, in science, as in religion and politics, we have, as in the nature of things we must have, both leaders and followers, and the latter from the same necessity, must vastly outnumber the former.

But it is really no disparagement to the large body of scientific workers, who are properly credited with knowing something of physics, geology, botany, archeology, etc., to say that they are after all, nothing but smatterers—dependants who are compelled to rely for their scientific sustenance on masters, who are liable, like all mortals, to be swayed by the human infirmities of ambition, jealousy and caprice. It would be asking too much of the average amateur scientist, to require that he should be able to verify all the data upon which the various scientific conclusions are supposed to depend. He must take things at second hand, if he would have his knowledge possess a respectable appearance of scope. He must allow the exercise of that faculty of our mentality which has been denominated respectively, faith, hero-worship and credulity, in order to have even interest enough in the subjeet to fairly comprehend what others are doing in contributing to the aggregate of knowledge. But he must have a care—he ought to be in possession of some standard which *he* can use, in testing the reliability or otherwise, of the various things which are handed down to him by his superiors, and thus avoid the mortification of having, at some future day, to recant a doctrine of which, at one time, he may have been a noisy advocate—or, the other equally disagreeable predicament of clinging fondly and blindly to a view which the rest of the world shall have long ago completely outgrown. To guard against being imposed upon by new and dazzling generalizations, and to check the impetuosity of that Pickwickian infatuation which is aroused, oftentimes, by the bare idea of something new, it seems to me, a familiarity with, and a clear conception of the following fundamentals would be of much practical importance, viz: 1. The limits of our knowlidge. 2. What Science demands as evidence. 3. The sphere of hypothesis.

1. That there are certain limits to our knowledge, either definite or vaguely defined is a fact that has been long recognized by a few. But, like other great truths pertaining either to physical nature or the laws of thought, the full demonstration of the Relativity of all knowledge is a thing of but recent date. At the present day, all thinkers recognize the truth of this

fundamental proposition, but like many other abstruse deductions, its clearness and force are not felt by the mass of average intelligent persons, unless a necessity or accident of discussion has, here and there driven some to its careful consideration. Sir William Hamilton, I believe, has the honor of first presenting the subject with clearness and philosophic accuracy, and insisting on its recognition as one of the landmarks of true philosophy. Others since his time, have re-presented the argument—foremost among the number Herbert Spencer, perhaps, the most gigantic thinker of modern times, who supplements Hamilton's reasonings by others, which, together, produce such momentum, that cavil is well nigh impossible. Briefly stated, the doctrine only insists that knowledge, properly so-called, is limited to phenomena—their relations, likenesses and differences. When we attempt to go beyond this, to pass from appearances to the constitution of the thing, we find ourselves hedged about by insurmountable difficulties, and if we seem to ourselves to make some progress, we are, at last, involved in absurdities of thought. For example: we attempt to gain a conception of matter, and select, say—a bar of iron for the purpose; we enumerate all the various attributes which are supposed to be inherent in the metal; we say it has extension—it occupies so much space—it has color, density, temperature, and so on, citing all the conceivable properties which can belong to it, and yet, we have obtained a knowledge of nothing except the attributes, and of these, only their relations to each other as states of consciousness. We are no farther advanced, in our search for the reality in matter, we are still conscious that something, we know not what, has eluded us. Shall we say that matter is the sum of its attributes, and that if all its attributes were known, the sum of such would be matter? The bare statement shows the absurdity of such an idea. By no effort, can we think of the mere attribute of a thing as being a constituent part of the thing itself, any more than we can think of the shadow as being a part of the substance. The *substance* of matter is utterly incomprehensible to us, and remains so after exhausting every expedient. But, suppose we try to grasp the reality in matter by assuming, after the manner of modern chemistry, that it is

made up of infinitesimally small particles, which shall be named *atoms*, surrounded by an atmosphere of space or force or something else, we find ourselves in even a worse predicament than before, for, besides the old difficulty, we have drawn into the case various unthinkable suppositions, and although we have transferred our conceptions from the sensible to the insensible, have finally to think of atoms as having extension, resistance, etc, which leaves us in the mazes of the same labyrinth which perplexed us before. All we can know of the absolute in matter, is comprehended in the following query by Prof. Huxley: "For what, after all," he asks, "do we know of this terrible matter except as a name for the unknown and hypothetical cause of states of our own consciousness?" A similar, or if possible, greater difficulty may be encountered, if we would seek to realize in thought, the ultimate nature of *force*. We can state safely that we know nothing whatever of force except from its relation to matter, and conversely, we have no knowledge of matter apart from some one or more of the phases of force. If we define force as that power in matter which *acts*, we only express a phenomenon, and are still in the dark as to its absolute nature and its connection with matter. The fact that we are entir y incapable of thinking of the one as existing independently of the other *may* point to their indissoluble relation as factors, whose product is that external reality of which we are at all times vaguely conscious; but granting that, their real nature is even yet so far beyond our scrutiny, that look in whatever direction we may, every effort to pierce the impenetrable mystery that surrounds them, invariably results in disappointment. We might, if we chose, find ourselves similarly circumstanced with regard to motion, time and space, as Spencer has done with such clearness and percision, but the above sufficiently illustrates the limits beyond which our knowledge cannot go.

It is to be regretted that those well defined limitations are not more industriously kept before the minds of readers, writers and speakers. Much valuable time might be saved, much contention avoided, much nonsense left unuttered, were it possible to convince many of our scientific men and the

majority of theologians, that the nature of matter, force and the final cause, are subjects which they know nothing at all about. While we cannot conceive of the absolute at all, nor form the faintest resemblance to a rational idea of matter or its correlative *force*, what is gained, it may well be asked, by discussing such questions as the identity of matter and force, or advancing theories which demand us to think of the latter as existing independently of the former? All such proceedings are indicative of an untamed imagination, and are at once futile and suicidal. We are fast approaching the time when men who in many respects are justly entitled to be called scientific, should cease to believe that they believe, and instead, betake themselves, in the first place, to a diligent tracing out of the limits which circumscribe all knowledge, and secondly, to an earnest exploration of the territory within the boundary line, a very large part of which is still a *terra incognita*, leaving the vast and impenetrable area beyond to a time when our faculties may be reinforced by others fitted to the undertaking. The development of the argument on which the doctrine of the Relativity of our knowledge is securely based, has not been my intention, neither would it be admissible within the scope of the present paper. If I have succeeded in showing, or even in drawing attention to the fact, that its recognition lies at the very foundation of scientific inquiry, I have done all that was intended.

2. What science demands as evidence is equally important, the lines of limitation as sharply drawn, and its constant recognition as imperative as the foregoing. The laws of evidence that are recognized as of universal application are, of course, also the guides in all matters pertaining to science. There are, however, certain modifications in details, some confirmatory steps insisted upon, that may be considered peculiar to the Scientific method. It may be affirmed, at the outset, that science is not satisfied with an *a priori* conclusion. She must have verification by actual test before she will affix the label, on which the word *fact* is written in striking characters. In a word, experiment is the final test of all things that are susceptible of positive knowledge.

To give a familiar instance of the rigidness and exactness required by that part of the scientific world which constitutes authority, before any new fact is registered as such, we cannot do better than to refer to the past and present status of the doctrine of spontaneous generation. That all life comes from life, has been alternately accepted and rejected, as the results of experiments differed in the hands of different investigators. Until a year or two ago, the question stood by common consent 'not proven,' as illustrated by the words of Prof. Huxley when he says: "All I feel justified in affirming is, that I see no reason for believing that the feat has been performed yet." Quite recently, however, the same experiments have been performed, all the previous precautions observed—the manipulations as delicate and exact as before—and the outcome would seem to favor the idea, that life may come spontaneously, and the dictum *omne vivum ex vivo* not true after all. What the next campaign shall disclose, which side of the controversy shall seem to have the victory, it would be rash for any one to predict. Now, if these oscillations in the results of these frequently recurring series of experiments prove anything at all, they prove the immense difficulty and the great tendency to error, which attach to this question. The mere fact that Dr. Bastian has instituted experiments to show that in a solution in which there was no life, and into which no germs could come, so far as he was able to exclude them, low forms of life may appear; and has succeeded in satisfying himself and some others, that spontaneous generation is possible—all this I say, is not all that Science demands of these witnesses. There must be repetition of those experiments, not only by Dr. Bastian, but by others, whose names have not been pledged to the support of the doctrine; a certain length of time must elapse, to give biased minds an opportunity to resume an equilibrium, and for cool judgment to review the evidence; and it must be finally shown that under certain conditions life *always* and invariably comes spontaneously. Then, and not till then, will it be time to declare that it is a law of Nature to generate life anew, and that that was probably the way by which life first appeared on our planet. We must await the result with pa-

tience, for we have no good reason to expect that a decision will be pronounced very soon, but come when it may, the subject must be viewed with calmness and impartiality—the only enthusiasm that can be tolerated with impunity, being that which proceeds from an eagerness to know the truth, and that alone.

As has been already intimated, it is held to be just as possible in Science as in a court of justice, that a witness may be mistaken, or may prevaricate. Hence, the testimony of one man, or the results of his investigations, are not taken as final, but are subjected over and over again to cross-examination. In the history of experimentation, it is the rule, rather than the exception, that the results of one man's labor are corrected by his successors, and theirs in turn by others, and so on, perhaps, through a long succession of alternations, before the stamp of certainty can be impressed on the result. When we take into consideration the conflicting testimony concerning any trivial incident of common life, which, from its connection with some wrong done to society, finds its way to the presence of a judge and jury, it is a matter of no surprise, and it is no disparagement to Science to confess, that her followers often receive different impressions from the observation of the same thing. It simply shows that some men have powers of observation that are either not originally sufficient, or are not adequately developed to prevent them from falling into that far too common blunder of "viewing things unequally." All that concerns us now, is to know that such is the case, so that due caution may be exercised in the bestowal of credence. Amateur scientists, especially, cannot afford to ignore the safeguard which the veteran finds in the indulgence of habitual scepticism. Witness, for instance, the cool reception which the English men of Science tendered to the report of Crookes and his colleagues—the committee who undertook to formulate the phenomena of modern spiritualism as presented by Home, the celebrated medium. This committee announced the discovery of a "psychic force," on the strength, it would appear, of their failure to convict Home of trickery and humbug. No one, of course, was prepared to say that there is no such thing as "psychic

force" in Nature; for, while so little of Nature is known, it would be sublime presumption to specify *what there is not*, but it was held, and very justly, to be presumption equally audacious, and a lack of common prudence in a shocking degree, to trumpet the discovery of a new force on such meagre data, or rather, on no data at all. The proper report for this committee to have made, which, however, would not have been quite so flattering to the enthusiasts in whose interest they were, perhaps, unconsciously enlisted, would have been, that they knew nothing whatever about the matter—which after all, when properly rendered, is just what this expression "psychic force" amounts to. Their mistake partook somewhat of the *post hoc propter hoc* fallacy—but with elements in it even more inexcusable—which mistakes coincidence for cause and effect, as the savage who thus associates comets and eclipses with dire calamities, or the parent or friend who attributes recovery from a dangerous illness to the exhibition of some harmless, inert medicine. To conclude, however, this part of my subject: the kind of evidence which Science insists upon are facts, and to determine what shall be recognized as facts, she has decreed that all experiments shall be tested and retested; that all observations shall be repeated over and over, not only by the original observer, but by a "cloud of witnesses," and to guard more effectually against the occasional intrusion of error, she has retained the services of that great assayer of all things—Time.

The classification and generalization of facts so as to form a general law or idea, properly belongs to what shall be said of Hypothesis.

3. Our idea of cause and effect is intuitive, or at all events, we are unable to conceive of anything as being uncaused. The knowledge of a fact, therefore, naturally brings with it the inquiry as to its cause, or the phenomena lying back of it and unperceived. As Science advances and observers become more numerous and more watchful, the number of accredited facts increases with rapidity, and as their causation is not always apparent, would remain, in a great measure, useless and repulsive, were not some expedient at hand to rescue them

from inutility and, perhaps, oblivion. The knowledge of a solitary fact, or of a group of solitary facts, of itself does not furnish that satisfaction which the intellect is continually reaching after. The tendency of the mind is to form for itself some arrangement of its facts for the purpose of gaining *an idea*, or in other words, a general cause, or something that is uniformly associated with phenomena and underlie them. Here is seen the value, indeed, the necessity, of hypothesis. As facts of kindred nature are aggregated, and their relations to each other noted, the mind at once endeavors to assign them to one common cause, or to consider them as the manifestations of some general method of natural procedure or *law*. The imagination reaches out on all sides for something, which shall solve the numerous problems thus presented to the intellect, or at all events, for something that shall answer as a foundation upon which a superstructure may be reared, of such ample dimensions that every fact may be embodied and used in its construction. Rarely, indeed, has the imagination failed to do something of this kind. Many a frail edifice has been built, and soon has tottered to the ground in ruins, but always to be rebuilt with more caution and improved skill, until, at length, many a noble temple rears its dome heavenward, the wonder of the uninitiated and the delight of the devotee.

The history of hypothesis from its first appearance as an aid to the struggling and bewildered mind, in its search for knowledge, down to these later times, when the scientific imagination has become so powerful and acute as well nigh to usurp the province of sober reason, would make a volume as ponderous as it would be curious and instructive. The phenomena of the heavens—the motions of the planets and their moons, eclipses, comets and meteors—were among the earliest perplexities to science, and, in turn, we have in astronomy, the Ptolemaic and Copernican *theories*. The curious behaviour of solids, fluids and gases under certain conditions, prompted the inquiries, which, by and by, developed into alchemy, and, finally, into that stupendous monument of human labor—modern chemistry, alongside of which, and in many places pervading

its very substance, we find the *atomic theory*. The observations made on the rocks which form the substratum of our soil, out of which has grown the science of Geology, have also given birth to the Neptunian and Plutonic theories of the earth, and the theory which amalgamates the two, and assisted materially in the construction of that most sweeping generalization of facts of which we have any idea—the *nebular hypothesis*. The phenomena attending life and its propagation, the deviations from the rule that like begets like, and the curious diversity of species to be accounted for, have necessitated the *evolution hypothesis* and the included hypothesis of Darwin. We have an undulation theory, and with it the subtle, undefinable, incomprehensible *ether;* we have forces of all kinds—attractive, repulsive and "tangential," these again subdivided all the way from gravitation to the vital and so-called psychic force, and we may have them all correllated or not just as we choose. In fact, all departments have their theories; they constitute the scaffolding by which we are enabled to lay stone upon stone on the walls of the uncompleted temple of knowledge. It is, nevertheless, salutary employment to the mind, to pause occasionally among these colossal structures of the imagination, and ask seriously and honestly, what relation they bear to substantial reality; whether they are calculated to stand the test of time and weather, or like the house that was built upon the sand, are in danger of tumbling into hopeless ruin when the first storm shall assail them. It is wholesome, at short intervals, to ponder well first principles, especially when we feel ourselves prone to take for granted what neither we nor anybody else has pretended to prove. We have become so familiar with theory, having associated with it from our youth up, that it is often difficult to persuade ourselves that it is only at best a shadow —and often may not be even that. Therefore, I say, it is well, betimes, to cultivate assiduously first principles, to eliminate theory from our hoarded knowledge, and then look aghast at the residuum. However much we may wish a theory to be true, however hard we may labor to prove it so, and to convince ourselves and others that it is so, we are deceiving ourselves most bitterly if we cannot comprehend that hypoth-

esis is nothing more than a kind of tentative knowledge—a mere *ruse* to satisfy the mind for the time being until it shall have made a better investment.

It seems to me that we must have reached the climax in the age of speculation in science—so far as this century is concerned. There is an evident disgust arising among the wisest of our best men for the mass of unwarranted theorizing which the last few years have accumulated, and the disastrous results which have accrued to the mass of scientific underlings who have not always clearly apprehended the sphere of pure hypothesis, nor deported themselves with that moderation which becomes the conscientious student of Nature. Facts must have both number and strength, before even the attempt should be made to string them on a theory. The oldest and strongest theories known to science will hardly bear the strain which a vigorous panic may soon bring upon them. A series of able articles in the *Popular Science Monthly* on "The Primary Concepts of Modern Science" has already given evidence how much even the widely known and generally trusted atomic theory may suffer from a vigorous onslaught. Epochs of convulsion and upheaval must come, as master minds in turn sway the opinions of the scientific world. A Newton or a Bacon may be among us, almost ready to appear, and it may be of some consolation to each humble devotee of Nature to be assured, in his own mind, that he has marked well the boundaries of his knowledge, and has given his unqualified allegiance to no untried, unsubstantial speculation.