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THE SCIENTIFIC VERSUS THE PHILOSOPHIC APPROACH TO THE NOVEL PROBLEM[1]

By Professor TRUMAN L. KELLEY

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IT has been common to differentiate between science and philosophy, crediting the former with reliance upon facts and a kinship with data and the latter with a trust in logic and an affinity for the pure and ethereal verities of the mind. The expression "science proves" carries a very different connotation from "philosophy establishes." If it is held that "science proves" by a sound process, but one that is different from a second sound process whereby "philosophy establishes," I assert that the contention is wrong. The thesis of this paper is that there is but one method tending to establish truth in the world of phenomena. This issue can be reduced to that of the places of data and of judgment in reaching decisions in the ordinary affairs of life. I believe you will all agree that if "science proves" data certainly are involved, and if "philosophy establishes" certainly there is a mind at work, but neither data nor the mind can operate alone. To draw a crude, though, I trust, not inaccurate parallel, we can say that life in the biological sense is the interaction of the atmosphere with the soil. Call the soil "data," the atmosphere "mind," then life is "fruitful thought" —the interaction of the two. Dust does not burgeon upon the surface of the moon or even fly into tornadoes, for there is no wind to stir it, and an atmosphere does not swirl in space where there is no dust or other gravitational field to hold it. We can not think without facts, even though we may have facts without thinking. No person or organization can

[1] Address of the retiring vice-president of Section Q—Education, American Association for the Advancement of Science, December, 1929. A part of this address in modified form was first given before Phi Delta Kappa, New York, 1929.

operate without data, *i.e.,* phenomena of life which are at least to a degree measurable and verifiable.

Of course, I can not prove that the soil on the moon does not burst into bloom, much as I may believe it. The scientific accuracy of that statement is not the point, so grant it for the sake of the illustration. Therefore let us investigate in greater detail the part data or measurable items of knowledge play in careful thinking. Any statistic or objective measurement which fits into any classification scheme whatever, *i.e.,* has meaning, is such a bit of systematized knowledge. In addition to this there are novel items, meaningless at the initial moment, but quickly given meaning by the interpreting mind, in short, their novelty disappears and they present themselves as systematized knowledge. Starting with the novel element in an experience we find it quickly taking on the common feature, or statistic, characteristic. Now let us start with the statistic and see if it migrates, in the mind that apprehends it, toward the novel. The objective measurement once gotten is used, and the specific way in which it is used is the matter of importance to us.

Let me picture a situation in which the measurement has apparently taken the place of judgment in order to raise the question of the place of judgment on the one hand and of the measurement upon the other. The activities of the train dispatcher serve our purpose. He receives over the wire information as to the place and rate of movement of the various trains operating within his division. Two trains moving in opposite directions upon a single track would crash did he not heed the objective measures reported to him and see that one train takes a siding. If the expected communication is slow in coming in he must literally long for it, and when it does come grasp it with joy and confidence. There is no trace of rivalry between his judgment and the facts upon which it operates, though these are so potent in the mind of the train dispatcher that they may be said to dominate the situation. This is so because the executive, by a full and free exercise of judgment, *wills* to heed and trust the objective measure. Such importance as it has, has been given to it by an act of judgment based upon earlier experience adequately scrutinized with very similar measures. Thus we are dealing with a scientific conclusion—one impregnated with human judgment and not devoid of it. Because of this science can never be exact, because it is never free of the element of human appraisal.

Let us carry this thought over into school life. A third-grade child is given an ABC reading test and secures a score of 40 on it. It is also known that the average score on this test for all pupils of the third grade in which this child is located is 30 and that the average for the fourth grade is 40. What will the school executive do in this situation? Promote the child one term, promote him two terms, keep him where he is or demote him? The mere figures that I have given do not answer the question. Surely it is inconceivable that the few facts given, unsupplemented by important other facts and unoperated upon by human judgment, do adequately answer a question of promotion. They can not in themselves be sufficient, and teachers and principals should so affirm. Such objective facts should affect a teacher's or principal's judgment, which is the ultimate arbiter, only in so far as the teacher or principal asserts it reasonable that they should. There are a number of things that should operate in the building up of a conviction of trust or distrust of the ABC reading test scores. First, is the agreement, in one's experience, between the test scores and ability of pupils as otherwise ascertained. Second—as pertinent to the individual case—is any accessory information about the pupil that may be available. Third, is the confidence one places in the sponsors and crities of the test (authors and others). And fourth, and ordinarily by far the least important, is the confidence one places in the test as a result of a perusal of the test items. As a result of these investigations one gives little or great heed to the test score.

The point is that it is the executive that *gives* to the score such importance as it has. If, in his best judgment, based upon all the facts that he has been able to muster, the test is not entitled to an important position in determining promotion, then, in the executive channel that determines promotion, it does not and it should not hold an important position. Perhaps some of you disagree with my statement that under these conditions the test "should not" hold an important place. You may say, "Suppose the test is intrinsically an excellent one, then it should hold a high position even though the executive is unaware of its genuine merit." I disagree with this view, for the executive should be the responsible party in the matter and personally held to account for any mistakes. We may hope that it will always be impossible to shift the onus of poor classification to so inanimate a thing as a score on a test.

Unless the executive looks upon the test score as a friendly and serviceable item of information for his own understanding of the child he should not use it. If you are a teacher and learn that little Bessie Jones has weak eyes you will place her in a favorable seat. You are glad that you have this information. As a result of it you and Bessie are better friends—you a better teacher and she a better pupil. The measure of Bessie's eyesight is a friendly fact because you know its implications and it does not mislead you.

Test scores which do not mislead hold the same possibility, making for mutual understanding and friendship between teacher and pupil.

It has been my pleasant duty to test many children. Time and again I have had before me scores for some child upon tests in which I knew from long experience a certain confidence could be placed, and I have literally longed to meet the child in person. Trusting the test scores, not implicitly but to a degree, I felt that I already knew the child, that he was a friend of mine, and I wanted to know him still better—to know wherein the tests had not been quite fair to him and still more to know those reaches of his character about which the test scores had been annoyingly silent.

Treated in this manner the test score is never a substitute for judgment. It is merely an aid in making judgments. It never delimits character, capacity or achievement. It merely helps in the understanding of certain limited portions of these things. It should never circumscribe one's field of effort to understand. While illuminating a limited field it should challenge one to explore the reaches of mental life that stretch beyond.

Suppose a man possesses a small rowboat enabling him to explore the ocean throughout a radius of twenty miles. This does not decrease his knowledge of the ocean entire. On the contrary, it challenges him to get a ship and move out further and to listen to what travelers have to say and to appraise their tales with a sounder judgment. Just so should the information given by one good achievement or mental test enrich one's consciousness of and interest in the subject's life entire.

Certain opponents of objective mental measures assert that tests have a deadening influence upon the curriculum by tending to limit teaching to the narrow fields represented by the tests themselves. This may be so if one becomes so enamored of the test that he loses sight of the child tested. I fear there are such people. I would criticize them, not the instrument they use. In an earlier generation such people were fetish worshipers. Some talisman, some rabbit's foot, some hocus-pocus answered every need. If a storm arose at sea, abracadabra stilled the waters; if a child was sick, abracadabra allayed the fever; if a male heir was desired, abracadabra turned the trick. So to-day, in a somewhat refined manner, we find the believers in the alpha-omega omnibus test. It tells what is good for backward babies; it clears the fevered brow of the dean when the rough-house rowdies walk the carpet; it sheds a great white light when college recommendations are called for, and it does a score of other things as well. You can pick out the modern measurement fetisher by the multitude of widely different things which the test of his choice will do for him.

If a test is in truth a good test it is good for something, not everything. Do we find in any other field of scientific endeavor an instrument that is good for everything? Thermometers measure temperature, barometers pressure, ammeters electrical current, and so it goes. As a thermometer an ammeter is a total failure.

I believe that we should approach any mental measure devised with the idea that its field of utility is limited, but I would be the last to attempt to limit the field by *a priori* considerations. We must by careful trial determine the limits of utility. If we find that they are broad let us keep the instrument with its broad implications. This is not fetish worship—it is knowledge. My criticism is of those who extend the field of application without knowledge. It should be obvious to every one that, as with every other scientific instrument, the judicious use of a test is something achieved only after careful study and much experience. Be confident that the process can not be shortened. Recently a student registered in my beginning class in measurement called me to task for dealing with averages, medians, age and grade norms when all she wanted was to know how to use tests in vocational counseling.

Though my remarks suggest a limit to the field of utility of objective measures I hope they also show the reality of the value of such measures. The score of an individual does not operate of its own accord, but only *via* the mind of an executive who concludes that the case in question properly falls in the class wherein such scores are useful. I have taken much time to make this point, but I believe it is fundamental and, unfortunately, sometimes overlooked. No matter how well fortified by a long past history a certain type of measurement may be, it must take on the characteristics of a novel event in order to be properly interpreted in a new situation. The breadth of view and caution demanded of the test devotee is of the same order as that demanded of any scientist working with specialized measurements of any sort.

To generalize: It matters not whether we think of the interpreting individual as viewing all the elements in the case as novel or as viewing all the elements as lying within his organized knowledge. Whatever the view, the so-called novel or the so-called old elements all call for the same critical appraisal. If the elements felt to be novel are not subsumed under some existing-in-the-mind system, terror, or the taking-a-chance type of decision, results, and if the elements felt to be old are subsumed under an old system without a new and specific vindicating judgment there results a decision characterized by formality and lack

of adaptability. The adequate mental process, whether that of philosopher or of scientist, scrutinizes the felt old and the felt new as though each were both old and new.

Ordinarily a decision, though made in the light of an executive's entire experience, must be promptly made and can not wait to be verified by a time-consuming study. Herein we may look for a difference between the philosophic and the scientific mental process. I will quote the distinction that Dr. Kilpatrick draws in this connection.[2] He states that science ordinarily postulates the question, "If I do this what will happen," but that philosophy can not wait to see what will happen. He says, "Philosophy in contrast faces a situation of necessary action. . . . Note that any situation confronting is actual and must be met, and that any choice or course whatever, including refusal to act, is *an* answer which carries with it its appropriate harvest of consequences. Philosophy then asks, 'In the light of all this what shall I do?'" I believe that Dr. Kilpatrick has here stated *the* essential difference between science and philosophy —other differences follow therefrom. Philosophy is willing to attack any problem, any time, anywhere, and give an immediate answer. Science is not. I would not cite this as to the credit of either the one or the other, but do cite it with Kilpatrick and Dewey[3] as a difference of great moment.

The philosophic question, "In the light of all this what shall I do?" may be paraphrased without inaccuracy as, "In the ignorance as to consequences that enshrouds me, what shall I do?" for, of course, the "appropriate harvest" is not known at the time the decision and resulting act is made. The philosophic answer to an issue is, "Do something and the best you can," while the scientific answer is, "If in doubt delay decision and investigate." Each procedure has its place in this life, this hurly-burly in infinite time. It is something of a travesty upon the mind of man that it is philosophy, sometimes thought of as the enduring, that responds to the hurly-burly, and it is science, changing science, that seeks to be judged by the standards of the permanent. Let us note some of the consequences of these outlooks.

The scientist procrastinates decisions, is other worldly, is of little aid in time of stress. He functions where deliberation and experimentation are possible, and his method is that of experimental analysis, synthesis and verification. On the other hand, the philosopher provides an almost immediate solution. He counsels in times of stress and rides every emergency. His method is that of inadequate analysis, because logical only and not experimental, and inadequate, but much synthesis. Knowing that he has a unique situation to deal with he makes much of "integrations" and "total situations." His total picture, to which he reacts, may be grossly at variance with the real[4] total situation present, but of this he knows nothing because no experimental synthesis of factors has been made.

The statement that[5] "the [philosophical] effort is, as far as may be possible, to find a course of action which will save all the interests, which will integrate all into one course of action that best saves all" is also an excellent statement of the purpose of multiple correlation and of any scientific attempt to explain total outcomes. Though science moves more slowly and with greater assurance here, not being free to synthesize except as experimentation gives warrant, still it moves with the same purpose as does philosophy. In connection with this issue Dr. Kilpatrick implies that science deals only with parts of situations, while philosophy deals with them entire. Now there is no logic that deals with wholes as wholes. If a problem case involving a cross-eyed, untrustworthy, brilliant, crippled, butcher's boy presents itself, what technique can treat this as a whole and without analysis? A logical or experimental analysis must be incorporated in any reasonable attempt to arrive at a solution of the total problem. How will you ever get the case referred to the oculist and how, unless there is analysis, will you ever get the cooperation of the father unless you call upon the butcher, etc.? Philosophy at its best must involve very detailed logical analysis followed by equally careful synthesis. As practiced, and, one would think, even advocated by Dr. Bode[6] in his recent work "Conflicting Psychologies of Learning," the chief emphasis should be upon synthesis. Now experimental science, or that which involves the checking of an hypothesis against an outcome, depends upon analysis as a major feature in the process of arriving at the truth. Why is there a short-circuiting of this step in the philosophic approach? Perhaps a parable is in order.

There was once a very wise man who put a cat in a box with mice outside, and every time the cat scratched its ear, lo and behold, the box opened, the cat jumped out, and the one mouse caught tasted good. As time went on the ear-scratch movement decreased, almost to the vanishing point, but the jump through

[2] W. H. Kilpatrick, "The Relations of Philosophy and Science in the Study of Education," *School and Society*, 30: 39–48, July 13, 1929.

[3] See Kilpatrick, *loc. cit.*

[4] Meaning, of course, not some "thing in itself," but a thing as conceived to exist after very careful study. "Reality" in an ultimate sense can have no scientific, *i.e.*, verifiable, meaning.

[5] Kilpatrick, *loc. cit.*

[6] Boyd H. Bode, "Conflicting Psychologies of Learning," p. 231, 1929.

the door continued to be followed by some plaintive squeak, "The brave cat caught me." The sad part of the tale is that the cat never learned that the wise man had so fixed things that in general the more efficient the ear scratch the bigger the mouse caught, for any squeak nearly convulsed him with joy.

Is philosophy satisfied with any outcome? Dr. Kilpatrick[7] thinks not, but upon this point I fail to follow him. He writes: "having answered, philosophy awaits the outcome to test the validity of its answer as truly as does science." How can philosophy await the outcome as truly as does science? The philosophical act must be terminated at some time, just as must the scientific, and, as previously pointed out, philosophy can not wait—no, its act is terminated when conduct commences. Let me give a case which might easily have grown out of the philosophy of but a few generations ago. Suppose that philosophy concludes that bleeding is good for anemia, a vein is cut and the patient dies, then surely philosophy is to be charged with the death. No spiritual apology will convince a regretful wraith that the philosophic act is still in process. True, had the case been given to science she might have shirked the task, pleaded ignorance and kept her hands off and said, "Let philosophy have the credit." While admitting this penchant of science to procrastinate, still, when a judgment, whether scientific or philosophical, is passed resulting in decisive conduct the problem as originally set is terminated. I must conclude that philosophy does not await outcomes—it acts—whereas science does await the outcomes of its experimental set-ups before it acts in the non-experimental, or important, life situation. If we run through the steps in the complete act of thought, much as given by John Dewey,[8] except that I have added a final step, number 8, we can clearly locate a difference between philosophic and scientific thinking. The steps are:

1. A felt difficulty.
2. A definition of the difficulty.
3. A tentative solution.
4. A mental elaboration of the solution, leading to
   a. Additional tentative solutions and elaborations, if felt necessary, finally leading to
5. The belief that the solution is all right.
6. An experimental verification.
7. An appraisal of the experimental findings leading to acceptance of mental solution and a decision for immediate conduct, or to rejection and a reinstatement of a felt difficulty. The process is continued until a verified solution which is immediately serviceable is obtained.
8. A forward look, or mental picturing of future situations to which the present solution is pertinent.

[7] Kilpatrick, *loc. cit.*
[8] "How We Think," 1909.

The first five steps are common to philosophy and science, but the sixth step, experimental verification, requires appreciable time not available to one who must act. Science continues and carries through the complete act of thought; philosophy does not. The distinction here made is reflected in the difference in activity of acknowledged scientists and philosophers. A distinction which I have occasionally heard calling the thinking part of the scientist's endeavors philosophic and the measurement and manipulative aspects scientific is a distinction that would not occur to or appeal to a scientist, as it would chop him up into unrecognizable parts. There are three important consequences of the difference noted. The philosophic solution is timely no matter how urgent the problem; the philosophic solution is more likely to be wrong than the scientific, and third, the philosophic forward look should be one of misgiving and largely a query.

My mind reverts to the sad parable of the cat. To the philosopher any outcome of his cerebration suffices. There is no conceivable method of determining the real excellence of a proposed course of action in a novel situation at the time it is first proposed. The pragmatic test is how it actually works out, but by the time this test is made the solution given by philosophy is long past. We seem to have reached the conclusion that the only solution to the urgent novel problem is the philosophic one, and that it is no solution because its fitness is and must remain unknown until it is too late to alter it, *i.e.*, until consequences, good or evil, have actually followed. In the strictly logical sense that every present moment is a novel one and that something immediately takes place in reaching the next moment, I believe that this is true, but do not draw the important conclusion that therefore, in immediate problems, we should not turn to science, but resign ourselves to the unverified speculations of philosophy.

That these are unverified Dr. Bode appreciates, for he says,[9] "The more we emphasize man's power to shape his own destiny, the more necessary it becomes to recognize the possibility that he will make a mess of it." Though he realizes this his only comfort is philosophy, for he writes:

> In any event the problem [of whither we are headed] calls for an interpretation and organization of values, which is not a problem for scientific research, but a problem of philosophy. It is not a problem for science because it is not a problem that lends itself to the application of scientific technique. The scientist has his own special devices for collecting and interpreting data, but these devices prove inadequate when the situation calls for a recreating or reinterpreting of old values and old ideals. . . . If the foregoing discussion is correct, then

[9] Bode, *op. cit.*, p. 300.

most of the industry called the "scientific determination of objectives" is on a par with catching birds by putting salt on their tails.

With this I utterly disagree, for the problem of our educational and social ideals is not a problem that must be solved upon the moment. If so solved it would be unsatisfactory even to the philosopher, for to-morrow brings another moment. Far better that a year, a decade, in some matters a generation, be spent in determining educational and social objectives and techniques found by trial to be in line with past progress than that we "settle" the problem by speculation. If one asserts that what constitutes "past progress" is beyond comprehension he is indeed a pitiable optimist if he nevertheless believes that he can define "future progress." We can not settle the problem of objectives for long by any method, but the ten-year experimental study holds promise of fitness and permanence not to be expected in the cloistered solution. Philosophically every moment is novel and calls for a new interpretation. Practically, every moment is surcharged with physical and emotional settings that have sprung from the past and that have been characteristic of innumerable past situations. The novelty of the moment, though real, may be insignificant in importance in comparison with the non-novel elements that are present. One of the features of the moment is the novelty in the organization of non-novel elements. From the viewpoint of the gestalter this dominates the situation. This is just a point of view and a very unhappy one, for it can never be proved, for, according to hypothesis, no two situations are alike, and accordingly a testing out and verification is never possible. The scientific point of view is to look upon the novel situation as characterized by certain cue or critical elements, or critical combinations of elements, which can be reinstated. The beauty of this view is that it can be proved right or wrong, as the case may be, by trial. This view-point has engendered mighty advance in the physical and biological sciences, and surely psychological and social advance lies in the same direction, for only thus is verification of progress possible.

I have made no distinction between science and philosophy on the basis of remote purpose or outlook and of course subscribe to the idea that a mind-body dualism is not necessary to a scientific point of view, and also to the idea that there is great need of and value in a criticism of historic conceptions. Dr. Kilpatrick considers that[10] "the need for the continual criticism of current thought assumptions in the light of their wider bearings would of itself, apart from all other considerations, suffice to give to philosophizing a permanent place among the higher services of thought to man." The stimulus to evolution consequent to this service can hardly be overestimated, but is it not above all a service rendered by science? From Roger Bacon to Einstein the great cues to a criticism of current thought assumptions have come from science. Philosophy has tagged along and consolidated these scientific salients, but she has not made them. Did the score of philosophical interpretations of relativity precede or follow the experimental findings? Of course they followed. Did the philosophy of Bertrand Russell instigate companionate marriage or did popular interest in it raise an issue that he attempted to place in a rational understanding of mankind? Undoubtedly it was this latter, and so it goes. The intense and keen, but orbital arguments of the middle ages illustrate the value of a criticism of current thought assumptions not leavened by new scientific facts. That science should be the leader in this is inherent in the process of science, for when the verification step of experimental science fails to yield a check with hypothesis there is, practically speaking, an inevitable reexamination of the premises, which of course are merely current thought assumptions. There is no comparable cue stimulating the questioning of assumptions in philosophy. The jolt that sets off the questioning process is from the outside—it is unanticipated experience.

My advocacy of experimental investigation in the attack upon problems of social value is because of the method of science, not because it is exact. There is no "exact science." A definition of science not permitting of error both in the data and in the judgments of human beings who interpret scientific facts is of no practical use. While upon this matter of error we may say that it is scientific to know that there are different degrees of exactness inherent in different stages of an argument. Science recognizes this time and again when philosophy (as practiced) ignores it. Having discarded any thought of exactness in science we can then turn to the important idea of the reliability of measures, findings and judgments. Philosophy has been slow, to its detriment, in following science in this. Until philosophy attaches probable errors to its concepts it will fall far short of its possibilities. In recent generations it has willingly accepted the findings of its younger brother, science, but it should go further and adopt concepts of methodology from it also.

I wonder if there is a conspiracy among philosophers to belittle science and claim its peculiar merit for themselves. Whitehead writes,[11] "There will be

[10] Kilpatrick, *loc. cit.*

[11] Quoted from Dr. Kilpatrick's article. A. N. Whitehead, "Science and the Modern World," pp. 69 and 82, 1925.

some fundamental assumptions which adherents of all the variant systems within the epoch unconsciously presuppose. Such assumptions appear so obvious that people do not know what they are assuming because no other way of putting things has ever occurred to them." Again, "A civilization which can not break through its current abstractions is doomed to sterility after a very limited period of progress." I take these words, not as Whitehead meant them, but as a fine argument for science. To discover errors it only requires that experimental setups involving hypotheses based upon these unknown errors be attempted. Then as the attempt fails the error is revealed.

To what fields must science be limited? Specifically, should some one say that education is outside the pale, would he also say the same of law, sociology, economics, psychology, biology, geology, chemistry and physics? The relationships of physics and those of man to man are of the same order in consciousness. I can not see how one can deny dualism and still draw a line in the list just given separating the scientific from the non-scientific. If one draws no line and concludes that physics can never become a science (a little surprise for the physicists) I for one shall agree, in the sense that as far in the future as the mind can dimly perceive physical issues will arise for which no scientific answer is available—*i.e.*, no answer experimentally and adequately tested out. In the same sense only do I grant that education can never become a science.

Let us sum up the place of philosophy in life and specifically in education. It seems to hold an actual position which I deem to be different from its legitimate one, so let me speak of its actual position first. I will illustrate by reference to a field with which I am familiar—that of test construction. An author devises a test of honesty, let us say. He philosophizes most armchairishly, not failing to consider the experimental evidence reported upon earlier tests having something to do with honesty. He counts his hour or two (or ten or twenty, if you like) of armchair agitation as high grade and adequate for the solution of the issues. So he publishes his original contribution for the use of an expectant world that will no longer wait. True, it may be only that fraction of the world represented by the author that will no longer wait. However, this inability to wait is definitely a part of the philosophical attitude that never matures into the scientific attitude. The decision by the author that his exercises test honesty has been reached by speculation in lieu of investigation. Here philosophy is merely a makeshift, quite unnecessary, for science. This is my lesser criticism of it.

If there is necessity for prompt action any sort of a shift is welcome, so it is not disparaging to say that philosophy is the best method for the expeditious selection of makeshifts. Surely, excepting habitual acts, the majority of the acts of life will fall in this class.

My major criticism is that the test author, having made his speculations and come to his final conclusions, feels very contented with himself—he thinks he has done something worth while and of lasting value. Unfortunately, as he writes fully and with utter sincerity, many of his readers think so too, and thus they also are content and may so remain for years if they attempt no experimental verification of the test. Philosophy is here the great narcotic, the soothing-syrup for author and readers, when in truth a gadfly is needed. It has played this rôle throughout history and it does so to-day.

What is the merit of the philosophical conclusion? Because it is a makeshift it has a place—just the important and unavoidable place of the expedient. Think of a forty-niner in his rush to the gold fields of California in his eastern Conestoga wagon, and suppose that he break a whiffletree out in the Nevada desert. If he is the kind of a man who will not use a makeshift and sends back for a new whiffletree, he might by some be called a scientist—I would use a less complimentary term. Whatever he is called would not apply for long, for he would soon be a scrap of dried bones. In this case the solution will not wait. The time necessary to carry out the complete act of thought, with its step of experimental verification, is not present. Something must be done promptly, and when done it may be called a philosophic solution. This does not state that it is a "right" solution, or even a serviceable one. If the forty-niner tries to mend his whiffletree with a piece of yucca he will probably waste time and increase his danger. If he break up his wagon seat and use the timber he may pull through. Whatever he does has one indubitable merit—that of promptness. There is no certain merit in it on the basis of long-time adequacy. This is characteristic of every philosophic solution. The scientific solution is, or rather aims to be, a more or less permanent solution. The philosophic solution frequently should not even aim to be this, for when such is aimed at there is commonly time for the try-out step, so that experimental verification can enter in and the solution become scientific.

Problems demanding immediate answers, or at least answers before adequate investigations can be made, will always be with us. We shall always need philosophy. There can be no issue here. Not only so—we are going to need it increasingly in the future. If the area of a small circle represents scientific knowledge its periphery may well represent unsolved issues

which, when first met, will ordinarily demand a philosophic solution. With the increase of this circle as science advances goes an increase in the periphery. I neither hope nor look for a decrease in philosophy as science advances, but just the reverse.

We shall need more and above all better philosophy. It seems to me that the most adequate philosopher will have the following characteristics. He will be a man of wide culture, familiar with the arts and sciences, with the psychology of man and with the values of life. He will be an accurate thinker—a sound logician—and have an extensive acquaintance with the facts and the methods of science. There is a peculiar necessity that he be aware of the scientific method. This method aims to secure more permanent solutions to its problems than does any other. It accepts the fact that time and investigation are necessary to this end. Though philosophy acts where these things are impossible the philosopher should attempt to parallel in his thinking what the experimentalist does in fact—only so can there be a tolerably promising philosophic solution of the problem.

Let me illustrate this by a problem which arose during the war. It was necessary to select men for training as officers. It seemed evident that the best selection would depend upon possession by the men of certain traits such as mental ability, physical stamina, moral courage, cooperativeness, leadership, etc. Ratings upon these traits by superior officers of men in camps could be gotten. The problem was how to combine them into single gross ratings which could be used in the actual selection of men. Time prevented an experimental investigation, so philosophizing had to be appealed to. An experimental investigation in which these various trait measures were used to estimate demonstrated success as officers would have yielded the weights that should be attached to the measures separately in order to get the most reliable aggregate measures of fitness as officer material. In short, the experimental treatment would have analyzed the data and then combined the separate trait scores into the most meaningful total ability scores. The concepts of total correlation and of partial correlation (not of course assuming any limited type of relationship, as that of linearity, between measures) here operate and they alone do operate. No logical treatment not paralleling this can be as adequate as one which does parallel it. The more completely the philosopher parallels in his thinking the analysis and synthesis which the experimental treatment would yield the better is his philosophical solution. The great endeavor of the philosopher here should be to ape mentally the steps of science. He can not have a technique which is better (omitting the time factor) than the scientific technique. Just the moment that he demonstrably did have science would claim it as its own, for true science has no fetishes that it clings to in the face of evidence.

CONTRIBUTIONS TO PHYTOPHARMACOLOGY OR THE APPLICATIONS OF PLANT PHYSIOLOGY TO MEDICAL PROBLEMS[1]

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INTRODUCTORY

As early as 1921, while studying general laws underlying physiological and pharmacological reactions, the author conceived the idea of making a comparative study of the action of various drugs on living plant protoplasm in contrast to animal protoplasm. The study of pharmacology, as carried on in our medical schools and research institutions, concerns itself almost exclusively with the effects of drugs and poisons on animals and, strictly speaking, is zoopharmacology, just as the study of physiology in the same institutions is confined exclusively to the physiological functions of animals, or zoophysiology. There is, however, a very important department of biology dealing with plant physiology, to which the name of phytophysiology is sometimes applied, and the writer was curious to inquire into the effects of drugs and poisons on living plants and in this way developed a new department of biology, to which the term *phytopharmacology* might be applied. These studies were begun with an examination of a number of alkaloids, the most interesting of which happened to be cocaine, and the findings in connection with a study of this substance were of such importance that they were followed by other studies along novel and unexpected lines of experimentation, resulting in important discoveries not only of purely scientific value but also of practical worth to pathology, medical diagnosis and therapeutics.

[1] Read before Section N—Medical Sciences, of the American Association for the Advancement of Science, at the Des Moines meeting, January 1, 1930.