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Some Problems in Communication Between Philosopher and Scientist

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SOME PROBLEMS IN COMMUNICATION BETWEEN PHILOSOPHER AND SCIENTIST (An Asymptotic Approach to Truth*)

by

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I fully agree that neither the practice of science nor the philosophy of science have benefited appreciably from attempts to stimulate mutual interaction. The chief reason for this less-than-optimum utilization of our limited intellectual resources may lie in our frequent inability to communicate clearly across disciplinary boundaries. Our use of language seems to be precise and meaningful when we deal with other members of our own peer group, but scientists and philosophers often seem to lose this effective use of language when dealing with each other.

It is my purpose in these brief notes to present a few of Professor Martin's key points in terms of the images they create in my mind. This step is essential, not simply to provide additional examples and illustrations of his ideas, but to test whether or not we are communicating appropriately. If we are, fine; let's go on to explore the solid theoretical and practical assistance philosophers and scientists can offer one another. If we are not communicating appropriately, at least we have some crudely charted territory in which to search for language on which we may come to agree.

Before turning to these key points, I should like to deal briefly with one minor point: the use of the term "science education" as it sometimes is understood at a teacher's college which recently has become a liberal arts college. At such institutions, "science education" often has a very specialized meaning in that it relates chiefly to the methods and the content of science teaching as these may be appropriate to science education in public schools. I am confident, after reading Professor Martin's paper, that he does not intend to be limited to such a definition of "science education"; nor do I. Perhaps the phrase "education in science" could be adopted instead. I believe such terminology includes everything from a single semester of general science to a Ph. D. program in a particular science and might be more appropriate for our discussions.

Scientist qua Scientist

Professor Martin frequently uses "scientist *qua* scientist" in discussing problems of value judgments and the acceptance of hypotheses in science. The terminology appears to me to present no difficulty for the scientist: I take it to mean simply a view of the scientist acting as if he were only a scientist. But I am not sure we all appreciate certain implications of the phrase "scientist *qua* scientist", and in this we may be failing to communicate appropriately. I take it as axiomatic that no human being can ever act only in terms of one facet of his being; nor can a person ever be appropriately described as possessing only one such facet. It follows, therefore, that the scientist *qua* scientist does not exist.

*I shall use the word truth in the sense of an ideal measurement or exact (correct) explanation of a physical observation. Thus, we may have stated the truth, but in principle we can never be sure that we have.

Let me be quick to point out that I am not dismissing the use of the concept of the scientist *qua* scientist. In fact, the world of the scientist abounds with the use of quite analogous concepts. Examples would include the concept of the frictionless piston and the ideal gas law. Machines that do not lose energy and gas particles that do not occupy space or interact with one another are clearly not real systems by any stretch of the imagination; yet valuable theoretical and practical results flow from the consideration and application of such apparently naive approximations. Thus, I am willing to grant that the concept of scientist *qua* scientist may be an important tool for the investigation of the philosophy of science and especially the ground of mutual concern to the philosopher-educator and scientist-educator. The utility of this concept in this latter area remains to be demonstrated (as does most of this field, as witness the paucity of recorded studies). No scientist would continue to use the concept of the frictionless piston or the ideal gas law if these concepts did not lead to significant results, and we must ask as much of the concept "scientist *qua* scientist".

Acceptance of Hypotheses

The emphasis given by Professor Martin to the matter of hypothesis acceptance by scientists seems to me to be a particularly central and appealing point of departure. If we (scientist and philosopher) can communicate on a matter so basic to the growth of science, the future for further cooperation is indeed bright. Thus, I am all the more concerned that interested philosophers be sure of one scientist's understanding of Professor Martin's position.

I believe it will be helpful to view acceptance on a continuous scale. An appropriate analogy might be a scale of percent composition of water-alcohol mixtures (Figure 1). In our discussion of acceptance,

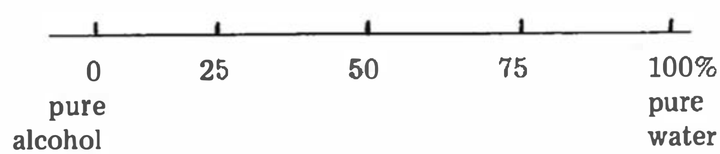

Figure 1

100% or pure water would correspond to the truth. On such a linear scale the hypothesis situated farthest to the right at any time is designated acceptance$_B$. We can now rephrase Professor Martin's description of acceptance$_B$ as the hypothesis that most adequately explains the currently available experimental evidence. Acceptance$_B$ may change with time or it may be the truth. History shows that the former condition is much more probable and, in principle, we cannot be sure of the latter.

Various degrees of sophistication can be ascertained in acceptance$_U$. These approximations would be arranged in order of increasing descriptive and predictive power (Figure 2). It is important to keep in mind, as

$acceptance_{U_1}$ — $acceptance_{U_2}$ — $acceptance_B$ — truth

Figure 2

Professor Martin quite rightly points out, that either form of acceptance (and any submodifications) can be useful in a particular context. Thus I prefer to think of the series:

$$acceptance_{U_1},\quad acceptance_{U_2} \ldots acceptance_{U_n} \equiv acceptance_B \xrightarrow[limit]{} truth$$

as simply an arsenal of tools available for solving a certain class of problems. One important aspect of my job as a scientist is to select the appropriate degree of hypothesis acceptance for the problem. I believe this approach has the added advantage of showing clearly the interrelationships of hypotheses concerning a specific scientific problem.

To illustrate, suppose we are concerned with the pressure-volume-temperature behavior of a certain gas. Over some range of conditions, the ideal gas law (equation 1) may prove to be in agreement

$$P = \frac{RT}{V} \qquad \text{(Eq. 1)}$$

with the behavior of the gas under experimental conditions. But no one seriously believes that the ideal gas law can ever be more than a crude approximation of reality, however useful it may be. As a scientist, in this situation the ideal gas law is a hypothesis that I $accept_{U_1}$. It is important to note that all of the variables in equation 1 can be shown, on both theoretical and experimental grounds, to govern the behavior of gases. The pressure (P), the volume (V), and the temperature (T) of the gas are measurable and related to one another as required by the equation. The term R is a constant of proportionality for one mole of the gas.

If I require more precise agreement with a broader range of experimental conditions, I might employ the Van der Waals hypothesis (equation 2). This new hypothesis, in taking into account the size

$$P = \frac{RT}{V-b} - \frac{a}{V^2} \qquad \text{(Eq. 2)}$$

of molecules and the interactions among molecules, provides a better approximation of the properties of the gas under study. Thus, I $accept_{U_2}$ the Van der Waals hypothesis. The relationship between the ideal gas law and the Van der Waals equation is obvious for the comparable variables (P, V, and T). The constants "a" and "b" illustrate an additional subtlety in the acceptance of scientific hypotheses. These parameters can be related in theory to certain experimental realities ("a" to the interactions of the gas particles and "b" to their excluded volume). However, the optimum values for a given gas must be determined experimentally. We find an example of better experimental (practical) agreement at the expense of complete theoretical understanding.

The series of acceptance$_{U_x}$ can be extended to still higher levels of agreement with experiment. For example, the Beattie-Bridgeman hypothesis (equation 3) retains the theory based idea gas law variables

$$P = \frac{RT\left(1 - \frac{c}{VT^3}\right)}{V^2} \quad V + B_o\left(1 - \frac{b}{V}\right) \quad - \quad \frac{A_o\left(1 + \frac{a}{V}\right)}{V^2} \qquad \text{(Eq. 3)}$$

and the less rigorously derived Van der Waals constants, but adds three more arbitrary constants (A_o, B_o, and c) that must be obtained experimentally and are much less perfectly understood in theory.

Thus, we approach the correct or true understanding of natural phenomena as a limit and we accept imperfection or at least uncertainty of perfection. At any point in time some hypothesis will be the best approximation we have of the truth and will receive acceptance$_B$ *at that time*. It is essential to recognize that any of these hypotheses, regardless of the state of their acceptance, can be the most appropriate tool in a given situation.

In conclusion, let me point out that Professor Martin's example of the two acceptance senses (acceptance$_B$ and acceptance$_U$) shows that he is dealing with a single hypothesis and variable experimental facts. I have attempted to emphasize the frequently observed situation in science where several hypotheses might be applied to the explanation of a single set of experimental observations. Both aspects of the problem need to be treated, and I see no fundamental difference in our explanations. In fact, I am very optimistic about the future benefit of action of the science-philosophy interface.