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by

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I am in fundamental agreement with most of Professor Martin's views, I think, and will therefore begin my remarks not with a critique of those views but with what I take to be further elaboration.

First, then, besides the analytic and speculative types of philosophy of science, I would recommend a third type which we might call *normative* philosophy of science. It is a species of normative philosophy generally and it may be briefly characterized as the view that one of the primary responsibilities of a philosopher is to evaluate, appraise or assess whatever it is he is reflecting upon. For example, rather than simply analyzing various ideas or concepts of scientific explanation, laws, theories and models, a normative-type philosopher of science would try to find good reasons for preferring one analysis of an idea or concept to another. His basic assumption about scientific notions is like that of Lewis Carroll's Humpty Dumpty—or Jesus Christ's on the Sabbath, for that matter; they're made for us, not the reverse. So we should try to make them well rather than poorly. We should, for example, specify the characteristics of a good scientific explanation so that such explanations do whatever it is we think they should do.

In fact, as we have just seen in Professor Martin's paper, philosophers who seem to want to do nothing more than analyze concepts, frequently end up recommending this or that analysis as preferable for one or another reason. They end up telling us what we *should* do, whether or not anyone logically or as a matter of fact actually does do that. From the normative-type philosopher's point of view, that is exactly what a philosopher should be doing. It is not the only thing he should be doing, but it is a very important part of what he should be doing.

Second, I think that there is a shorter path to take to prove that scientists *as* scientists must make value judgments. The argument is just this: In any scientific community judgments must be made distinguishing good and bad research practices. That's one of the main things a scientist's education is about. For examples, one learns to form control and experimental groups; one learns that in order to find out what causes what when, one must control certain variables; and one learns that one ought to be very suspicious about the conclusions reached from experiments made without adequate controls. In short, a scientist learns to *evaluate*, *appraise* or *assess* his own and other's research practices. This is one way value-judgments must enter into science; scientists *as* scientists must make such judgments. Unless you take the view that there is no such thing as a sloppy, careless, silly, stupid, poor, fallible or hack scientist, I don't see how you can reject the view that scientists must evaluate their brethren. And that seems to me to be the easiest way to prove

that scientists *as* scientists make value-judgments.

Third, in order to assess the value of philosophy of science for science educators, I would suggest beginning with the fact that the needs and wants of scientists are not the same as nonscientists. Moreover, science students do not have the same needs and wants as nonscience students. This is, of course, an old stumbling block for course and curriculum planners, not to mention students themselves. No doubt there are people hearing my remarks now who have very definite beliefs and attitudes about my assertion. No one will doubt that most nonscience students don't *want*, say, Chemistry I poured down them as if they were going to become chemists. We all know what they want: they want out! The arguments arise over what they *need*, some of us saying they need the same introduction to science that science students need and others saying that they need a quite different introduction.

The interesting thing about arguments over what people need is that they tend to be very much like arguments over what people want. That's because you can't decide what anyone needs until you decide what they *ought* to have to be normal or nice, and the latter decision(s) are largely value-judgments. You might say, for example, that men need oxygen, but that is only true if you assume that the proper, normal or good state for men to be in is a living one rather than a dead one or a gasping-for-air-until-your-face-turns-blue-one.

I begin with the assumption that the needs of nonscience students are not like those of science students for the simple reason that the ultimate proper, normal or good states for both kinds of students are intended to be different. The science student is intending to use his science background to earn his daily bread, get his kicks and possibly to find what he takes to be a worthwhile niche in the world. The nonscience student is intending to survive his encounter with science, including its devotees of all kinds, as painlessly as possible. He does not intend to make a living on the strength of his scientific expertise or to enjoy developing such expertise, and most certainly, he does not imagine that he is going to find what he takes to be a worthwhile sort of existence by studying science. To appreciate the depth of difference between the aims or motives of these two types of students is, I think, tantamount to granting that their needs with regard to education in science are quite different. That is why I suggest that we begin with this assumption.

Once this is granted, I think we can make roughly the points about the relevance of philosophy of science to science education that Professor Martin indicated. I would expect, however, that philosophy of science would be even more relevant to the education of nonscience students in science than to anyone else. But that, I hasten to add, is an empirical claim which may well be false. (At Guelph our students are allowed to opt out of a "straight science" course by taking our philosophy of science course instead. They come in droves, about 120 a term or 360 a year. But we've never run a controlled experiment to find out if our course is closer to their hearts, aims or ideas about what they ought to get in a university education. We like to think it is close to all these things and more, but maybe it's just a way out of "straight science" and maybe that's all they want.)

Finally, I would like to try to defend a somewhat novel position with respect to the problem of the relation of so-called practical values to believing that something is true or false. Professor Martin's position, you recall, is that such values cannot be relevant to believing that something is true or false. My view is briefly that such a position is at best question-begging, and at worst pointless and highly misleading. (I should perhaps add that some outstanding philosophers are on record as seeing this issue almost exactly as Professor Martin sees it, e.g., Hempel, Levi and Jeffrey.)

To accomplish this, let us first distinguish between three things, namely, (1) hypotheses, (2) important features of hypotheses and (3) value imputed to those features. Thus, for example, consider Leon Festinger's famous *hypothesis:*

(H) Human beings try to remove cognitive dissonance.

where two things are considered to be in a dissonant relation if "in some way, they do not belong together or fit together." *Important features* of H would include such things as how much behavior H explains, how consistent H is with experimental evidence, how well H coheres with other theories, laws or hypotheses about human motives, how clear or precise H is conceptually, and so on. Finally, each of these features may have some *value* imputed to it, e.g., one might say that coherence with other theories is extremely valuable while conceptual clarity is somewhat less valuable, or one might say that all important features are equally valuable, or something like that.

Given these fairly innocuous stipulations, I think we can throw some new light on the relation of practical values to believing H or some other hypothesis.

Consider the important feature of hypotheses that we refer to as *coherence* with other hypotheses (i.e., laws, theories or well-established beliefs generally). Those who have proposed the coherence theory of truth as a *criterion* or *test* rather than as a *definition* of the meaning of the word 'true', have been unanimous in their claim that the more coherent our total corpus of accepted hypotheses or beliefs is, the more likely it is that what we believe is true. It is very difficult to explain the mechanics of coherence and how coherent sets of hypotheses tend to support one another, but the intuition seems to me to be certainly on the right track. We recognize the importance of a coherent variety of evidence in our courts, our scientific research and in everyday life. We want not just lots of different evidence, but lots of different evidence that tends to hang together, to point in the same direction as it were. When we obtain such evidence we obtain more support for whatever hypotheses the evidence points to. But that is not all. The more evidence, hypotheses, theories, etc., we can hang together, the greater is our opportunity to produce an axiomatically systematized corpus of knowledge—or at least, of beliefs. Furthermore, when we talk of obtaining unified, systematic, axiomatically organized sets of hypotheses or beliefs, we are talking about something that is of tremendous practical value. The more we can pack into a simple axiomatic system, the easier it is to store and systematically recall whatever we have there—easier in the purely practical senses of saving time, energy, wear and tear on our data processing

capabilities, and so on. In short then, this important *feature* of hypotheses that we call 'coherence' may be said to have *both* practical or pragmatic *and* theoretical or epistemic value.

At this point you may be able to anticipate the crunch of my argument. Now the question is: How should we describe our situation? Should we say, for example:

> (1) A certain feature of say, H, namely, its coherence with other well-established beliefs gives it epistemic or theoretical value *in virtue of which* H is worthy of belief,

or

> (2) A certain feature of H, namely, its coherence with other well-established beliefs gives it pragmatic or practical value *in virtue of which* H is worthy of belief,

or, finally,

> (3) A certain feature of H, namely, its coherence with other well-established beliefs makes H worthy of belief?

The principle of parsimony or Occam's Razor clearly favors (3), and I am 100 per cent in agreement. For the case at hand, the choice of either (1) or (2) over (3) creates but does not solve any problems at all. Moreover, the choice of (1) or (2) tends to turn our fundamental problem completely upside down, making it virtually impossible to make progress in this area. For notice that *before* we begin talking about pragmatic and epistemic value, we can talk perfectly well about the feature of coherence making H worthy of belief (i.e. believable) and useful in systematization. Indeed, our value-talk here seems to be entirely parasitic on our feature-talk. It is *because* a given feature does such and such that we say it has such and such value, *not* the other way around. What other criterion do we have to impute pragmatic or epistemic value to any feature of a hypothesis? None at all. Thus, it is pointless and highly misleading to affirm either (1) or (2).

Ignoring all of the above, suppose someone did want to affirm (1) or (2). What should his choice be? Clearly, I think, (1) must be regarded as preferable to (2) when one considers what it is that epistemic or theoretical values on the one hand and pragmatic or practical values on the other are supposed to do or to be about. Epistemic values are supposed to be about beliefs, while pragmatic values are supposed to be about actions. Hence, a priori we know that one sort of value is relevant to belief while the other is not. If this sounds unpersuasive, then you see my point exactly. This move is just question-begging.