Understanding Psychologists' Understanding

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CHAPTER 6

Conclusion

In chapter 3 I developed a philosophical framework for scientific understanding of phenomena. A central idea in this framework is that scientists scientifically understand a phenomenon if they are able to apply a scientific model successfully to that phenomenon. A key notion in this framework is the intelligibility of a model, which is described as a value attributed to the model by its users. This value reflects their ability to apply the model successfully to a phenomenon. A prerequisite for the successful application of a model to a phenomenon, and thus for scientific understanding, is that the model is intelligible to its users. Other key notions in this framework are the skills of the scientists and the virtues of the models. The intelligibility of a model depends on the virtues of the model and on the skills of the scientists. At the end of chapter 3 I formulated five key questions concerning the key notions of this study. In this chapter I will use my analysis of the case studies in chapters 4 and 5 to answer these questions.

6.1. *Is the intelligibility of models an epistemic value and how does it function in scientific practice?*

The epistemic significance of the intelligibility of scientific models is one of the central issues in the case study of neo-behaviorism. Because of their positivist attitude towards science, neo-behaviorists rejected understanding as a genuine aim of science, viewing prediction and control to be its only aims. If they valued intelligibility of models at all, they regarded it as subordinate to positivist norms such as objectivity and verifiability. An analysis of the actual scientific practice of neo-behaviorism, however, shows that in spite of their positivist attitude even neo-behaviorists aimed at intelligible models. Their models were intelligible to them due to the surplus meaning of the theoretical terms in these models. The meaning of the theoretical terms generally exceeded their operational definitions because these terms were named, for example, "demand" and "reinforcement," and because of the informal formulations that were supplemented to their formal definitions. Neo-behaviorists were able to apply their models to behavioral phenomena as a result of this surplus meaning. The application of theoretical terms in a specific domain required the establishment of operational definitions. This involved judgments to determine if these operational definitions can be considered adequate means to apply the theoretical concepts they represent. These judgments were facilitated by the surplus meaning of the theoretical terms. For instance, due to the surplus meaning of 'reinforcement,' which originated in everyday experiences, Hull recognized that in one experimental situation repeatedly receiving a shock after hearing a noise counts as 'reinforcement,' whereas in another experimental situation obtaining food after depressing a bar counts as 'reinforcement.' Consequently, he was able to apply his models of behavior that contained the theoretical term 'reinforcement' in different domains. Removing the surplus meaning of the terms (if at all possible) would make the models unintelligible, and that would drastically reduce their applicability. Consequently, even in the case of neo-behaviorism, the intelligibility of models has epistemic significance.

Like empirical accuracy, consistency, scope, simplicity, and fruitfulness, the intelligibility of models is one of the epistemic values that are constitutive of science. As I have argued, the various epistemic values are not completely independent. For instance, scientists do not consider a model to be intelligible if it is not empirically accurate. Intelligibility is also related to fruitfulness. According to Tolman, a model is fruitful if it supplies a conceptual structure that facilitates its application to phenomena. For instance, Tolman's model of the behavior of rats in mazes supplies a conceptual structure consisting of goals ('demands') and expectations ('hypotheses'). This conceptual structure enabled Tolman to apply his theoretical model to the concrete situation of rats in mazes. The feature of supplying a conceptual structure is a necessary condition for the intelligibility of a model. However, it is not a sufficient condition. In addition, the application of the model should be *successful,* which is the situation in which Tolman calls the model a "happy" one and which requires that the application meets all the epistemic values of science, and not only that of fruitfulness.

6.2. *What kinds of skills are required for the successful application of a scientific model to a phenomenon?*

The question of what skills are required for the successful application of models to phenomena is one of the central issues in the case study of cognitive science and to a lesser degree also in the case study of neo-behaviorism. The case studies illustrate that the successful application of models to phenomena involves several skillful activities.

First, the successful application of models to phenomena involves making a connection between features of the model and features of the phenomenon. This requires making judgments concerning relevant similarities between model and phenomenon. For instance, it requires a judgment to recognize that obtaining food after depressing a bar and receiving an electric shock can both be conceptualized as instances of 'reinforcement.' By specifying the meaning of the theoretical terms in his learning model, such as 'reinforcement,' Hull was able to connect his model to concrete psychological phenomena. The different ways in which Pollack and Miller connected Shannon's model of a communication system to the phenomenon of the 'magical number seven' illustrates that the specification of the meaning of the theoretical terms in a model is not a matter of course. Whereas Pollack specified the receiver as the listener, Miller specified the communication channel as such. Broadbent, who realized that conceptualizing cognitive phenomena in information-theoretical terms is a technique that has to be mastered, introduced a railway system analogy as a helpful aid for becoming acquainted with the technique of anatomizing psychological phenomena into informational events.

Second, the successful application of models to phenomena involves reasoning via the model. That this is a skillful activity is illustrated in the example of Tolman who was able to recognize qualitatively characteristic consequences of his model of the behavior of rats in mazes by means of the technique of imagining how he would behave if he were a rat. This technique involved empathic imagining, which Tolman used to imagine the 'demands' and 'hypotheses' of the rats in the maze, and means-end reasoning, which he used to imagine how rats would behave as a result of these 'demands' and 'hypotheses.' Another example is Broadbent who was able to recognize qualitatively characteristic consequences of his mechanical model of attention, consisting of a Y-shaped tube with branches in which balls could be placed, due to his experience with causal agency and his skills of visualization and causal reasoning.

6.3. *Which kind of virtues can render a model intelligible to its users?*

Whether the users of a model are able to apply that model successfully to phenomena depends on the match between their skills and the virtues of the model. The case studies, which focus on the use of theoretical models, show that the intelligibility of this kind of models depends on the surplus meaning of the theoretical terms in the model. The surplus meaning of theoretical terms can have various sources. Their origin can be informal, mechanistic interpretations that are supplemented by the formal definitions of the terms. Another source can be the naming of the theoretical terms. The use of the 'mind-as-information-processing-device' metaphor in cognitive psychology shows that technological metaphors also function as sources for surplus meaning.

The surplus meaning of the theoretical terms can render a theoretical model intelligible to its users. For instance, due to the surplus meaning of terms such as 'demand' and 'hypotheses,' Tolman's model of the behavior of rats in mazes possesses the virtue of being anthropomorphically interpretable and facilitating means-end reasoning. Hull also used theoretical terms that were anthropomorphically interpretable. Moreover, he used terms such as 'habit strength' that had a causal-mechanical surplus meaning that made them accessible to causal reasoning. Similarly, Broadbent's mechanical model of attention was intelligible because of its causal-mechanical surplus meaning.

6.4. *On what kind of pragmatic and contextual factors does intelligibility depend?*

The attribution of the value of intelligibility to a model depends on several pragmatic and contextual factors. For instance, it can depend on the availability of certain metaphors, such as the 'mind-as-information-processing-device' metaphor on which the information-theoretical models of early cognitive psychologists were based and which facilitated the application of these models to cognitive phenomena.

These models did not provide understanding for psychologists who were not familiar with this metaphor.

Another factor can be the objectives of the researcher. For instance, because early cognitive psychologists like Pollack and Broadbent were mainly engaged in applied psychology, their objectives differed from Neisser's, who was primarily occupied with theoretical psychology. Because of that, they were interested in other aspects of cognition than Neisser was. As a result, they did not share Neisser's objection to the application of Shannon's model of a communication system to cognitive phenomena. Whereas they focused on the similarities between the model and the phenomena and considered the model to be intelligible, Neisser focused on the differences, such as the fact that cognitive processes are active, whereas in Shannon's model information processing is passive, and consequently argued that the model did not provide understanding.

That intelligibility is a pragmatic and context-dependent concept might give the impression that it depends on the idiosyncrasies and changing tastes of scientists. However, within scientific communities scientists should be able to apply the same models. Therefore, it is important that scientists working in the same research tradition do not vary much in their views about intelligibility. For instance, when cognitive psychology was developed as a new scientific discipline, it was important that psychologists possessed the skills to work with information-theoretical concepts. At that time, however, the 'mind-as-information-processing-device' metaphor was not common knowledge. Therefore, early cognitive psychologists made an effort to promote this metaphor. They tried to familiarize fellow psychologists with the use of information theory and attempted to give them the required skills. This was necessary because only if fellow psychologists were familiar with the metaphor were they able to apply the information-theoretical models of the early cognitive psychologists.

For instance, Miller showed how experiments in absolute judgment could be reinterpreted as experiments on the capacity of people to transmit information, and Broadbent constructed simple models that were meant to cultivate the techniques that were necessary to work with information-theoretical concepts. One of these techniques was the atomization of phenomena into informational events, which is necessary to account for these phenomena by means of flow charts.

One way in which Broadbent tried to give a feeling for the use of flow charts, in which information flows from one stage to another, was by drawing an analogy with railway systems. Conceptualizing the phenomena as informational events involves the recognition of relevant similarities between the information-theoretical models and the psychological phenomena. Broadbent tried to elucidate this to his colleagues by means of a simple mechanical model in which tubes and flaps represented information-theoretical concepts such as communication channels and information filters. The use of this model involves skills that practically everybody masters.

6.5. *Is the characterization of science advocated in this study useful for the explanatory and normative tasks of philosophy of science?*

Major aims of philosophy of science are the description, explanation, and normative appraisal of (the results of) scientific practices. A common feature of these aims is to provide a more or less general characterization of science. The characterization of science advocated in this study asserts that intelligibility of models is an epistemic value of science. In the case study of neo-behaviorism, this characterization is used mainly to provide a more comprehensive explanation of developments in psychology that are, in themselves, well known from textbooks on the history of psychology. In the 1950s neo-behaviorists gradually came to appreciate the surplus meaning of theoretical terms. They started to advocate the use of hypothetical constructs, which possess surplus meaning, instead of intervening variables, which were considered not to possess surplus meaning. This development in psychology, which eventually resulted in the rise of cognitive psychology, can be understood as being driven by the normative question of how the value of intelligibility of models should be incorporated into psychology. For instance, Tolman converted publicly to the use of hypothetical constructs because he realized that the surplus meaning of these hypothetical constructs provided the models in which they were used with a conceptual substrate that might facilitate the successful application of the models.

Although the analysis of the case studies has been mainly descriptive and explanatory, the account of understanding developed in this study also has normative implications. It entails that, because models in science should be intelligible, the use of hypothetical constructs is to be preferred over the use of intervening variables. Thus, contrary to the opinion of some strict neo-behaviorists such as Marx, Tolman's conversion should be appraised positively. Scientists should aim at intelligible models.

In sum, scientific understanding is an important aim of science that has epistemic significance. Adding the value of intelligibility of models to the list of epistemic values that are constitutive of science results in a characterization of science that can be used in the explanation and normative appraisal of scientific practices and results.