REVIEW

GOLDMAN'S PSYCHOLOGISM

A review of Alvin I. Goldman, *Epistemology and Cognition*, Harvard University Press, Cambridge, Massachusetts, 1986, viii+437 pp. $27.50.

This is a very important book. Alvin Goldman has undertaken to enlarge the purview of epistemology, linking it with cognitive science and other social scientific and humanistic disciplines. He calls this enterprise "epistemics", and this book develops the first phase of it concerned with cognitive science. A sequel is promised to deal with social epistemics. I shall briefly summarize Goldman's exciting attempt at integrating epistemology and cognitive science, and then address in more detail a few ways in which Goldman seems to me to fall short of his laudable goals.

Epistemology and Cognition is divided into two parts, 'Theoretical Foundations' and 'Assessing Our Cognitive Resources'. The first lays out a framework for epistemology that takes seriously the results of empirical and theoretical investigations in psychology, while the second explores an interesting sampling of those investigations. The first part should interest even those epistemologists who maintain the traditional separation between philosophy and psychology, but the second should give them reason to see the separation as obsolete.

In Chapter 1, Goldman discusses epistemic evaluation and suggests two important enlargements in the range of evaluation normally claimed by epistemologists. Instead of concentrating merely on the formation of belief, epistemology can also pay attention to the strengths and weaknesses of such processes as hypothesis formation, concept formation, search, and even processes for forming new belief-forming processes. Even more radically, Goldman proposes that the dimensions of evaluation should go beyond traditional evidential concerns to include such standards as reliability, power, and speed. The reliability of a process is a function of the proportion of true to false beliefs that it produces. Power is the capacity to produce a large number of true

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beliefs, and speed is the capacity to produce true beliefs quickly. Later chapters explore these notions in much more detail.

Chapter 2 argues against taking skepticism to be the central problem of epistemology, and Chapter 3 advocates a causal reliability approach to knowledge. The next chapter presents an account of justification in which a belief is justified if it is permitted by a right system of justificational rules (J-rules). The rightness of a system of rules is determined, not by logic, probability theory, social groups, or coherence, but by the maximization of the proportion of true beliefs. This "reliabilism" is developed in Chapter 5, culminating in the "absolute, resource-independent criterion" of justifiedness:

> (ARI) A J-rule system R is right if and only if R permits certain (basic) psychological processes, and the instantiation of these processes would result in a truth ratio of beliefs that meets some specified high threshold (greater than .50). (p. 107)

I will return to a discussion of this principle later.

Chapter 6 discusses non-reliabilist aspects of intelligence: power, speed, and problem solving performance in general. Goldman argues against Laudan that problem solving is tied in with truth, since scientists aim to solve problems with true theories. The next chapter discusses truth, defending a view of correspondence to reality as "fittingness" and a moderate view of scientific realism that neither accepts nor denies convergent realism, the view that science is getting progressively closer to the truth. The final chapter of Part 1 concerns how mental states can have content – semantic properties such as meaning, reference and truth conditions.

In Part II, Goldman assesses our cognitive resources by surveying numerous important areas of psychological research. Chapter 9 discusses reliability, speed, and power in perception. Next memory is examined with respect to such issues as long-term vs. short-term memory, belief perseverance and forgetting. Chapter 11 discusses representation, touching on such topics as hierarchies, analogy, and originality. Imagery is the principal topic of the next chapter on internal codes. Chapter 13 reviews the debates in cognitive psychology about processes of deduction. Then probability is scrutinized with the conclusion that probabilities are not very important to epistemology. Chapter 15 argues

that connectionist winner-take-all networks of the sort that have recently become popular in cognitive science offer a better way of understanding acceptance than schemes that rely on subjective probabilities. Belief updating is understood in the next chapter in terms of an "anchoring and adjustment" model. Finally, Goldman discusses production systems as an example of second-order processes for forming basic processes.

These chapters constitute a sampler of relevant psychological research and are not intended as a survey. They provide examples of how psychology can be germane to epistemology, not a fully worked out system. None of the conclusions that Goldman reaches on the basis of psychological considerations is revolutionary, but many are interesting. He argues, for example, against total evidence requirements and in favor of acceptance of hypotheses rather than continued uncertainty.

Traditional epistemologists will resist Goldman's attempt to integrate epistemology and cognitive science. Some will say that epistemology must be concerned with ideal believers, not the person in the street, and should therefore keep to the higher ground offered by formal logic and probability theory. Normative theories, they will say, should not be muddied by association with descriptive studies such as those offered by psychology. But Goldman is by no means *reducing* epistemology to psychology. The greatest merit of his approach is to ensure that epistemology has something to do with human knowledge, freeing philosophy from arid discussions of the meaning of the term "know" in order to make room for a full discussion of how knowledge arises, a topic to which cognitive science has much to contribute.

Despite my great sympathy for Goldman's general project, I want now to discuss two points at which I think it falters. The most problematic part of his theoretical foundations is the question of whether reliabilism can justify the processes that establish *scientific* knowledge. Using the example of scientific theory choice, I shall argue that a broader account of justification is needed. Second, I shall look at his notion of cognitive process and his claims about the relevance of production systems to the distinction between first and second-order processes.

Reliabilism, as summarized in the principle ARI, seems to me inadequate to establish the rules used by scientists in justifying the acceptance of scientific theories. One might argue with various philosophers of science that scientists do not accept theories, but Goldman's Chapter 15 clearly shows that he does not want to ally himself with Popperians

or instrumentalists. Moreover, he is sympathetic to at least some forms of scientific realism. Hence I presume he would be willing to say that scientists are justified in accepting such major theories as evolution by natural selection, special and general relativity, the atomic theory of matter, and so on. But how are such theories accepted? On one account, a theory is accepted because it provides a better explanation of the evidence than alternative theories (Thagard, 1988). But how could we justify the inferential processes that produce such theories by ARI?

There are at least two problems with justifying scientific inferences by reliabilism. (My argument here is not restricted to the view of theory choice as inference to the best explanation, but should apply with minor changes to other accounts of theory choice that are not probabilistic or instrumentalist.) First, how can we ever get reliability ratings when we have no method of establishing the truth of theories independent of the inferential method of theory justification? In lower-level psychological processes like perception and memory, there are independent ways of determining what truth ratio a particular process has generated: my memory-based belief, for example, that Fred has a moustache can be checked against the memories and perceptions of various people. But our grounds for thinking that the phlogiston theory, for example, is false is just that it was a poorer explanation than the oxygen theory. So we cannot get any reasonable measure of the truth ratio of theory choice by inference to the best explanation.

Even if we could get such a measure, the results might well fall short of Goldman's threshold for truth ratio. The history of science is full of embarrassments. Darwin argued for his long-dead theory of pangenesis in just the same terms that he argued for evolution by natural selection, and Paley's arguments for natural theology had a similar form also. In 1750, an inference to the best explanatory theory in chemistry would doubtlessly have supported phlogiston, despite its demolition by Lavoisier a couple of decades later. Particle and wave theories of light have come and gone. If one were to add up all the scientific theories that have at some time been accepted, it may turn out that, like biological species, the vast majority are currently extinct.

The same may be true of inference to simple generalizations. People are prone to infer from a few examples of A's that are B's that all A's are B's. Perhaps such inferences produce at least as many false beliefs as true ones, since it takes only one counterexample to falsify them.

Nevertheless, discarding inductive generalization from our complement of inductive methods would be rash.

Although this would prevent methods of theory evaluation from being justified by Goldman's ARI principle, we need not conclude that inference to theories is therefore otiose. Instead, we can look for a broader means of establishing justification rules than reliability. ARI appears adequate for everyday cases where truth ratios can easily be established, but it should not be taken as a general account of epistemic justification. I have elsewhere defended a view that allows the justification of inferential methods on the basis of criteria that include Goldman's as well as more Goodmanian ones of fit between inferential principles and practices (Thagard, 1988). On this view, psychology becomes even more important to the establishment of normative principles than it is for Goldman, since psychological experiments are necessary to determine the existing inferential practices. Goldman sees ARI as conflicting with other possible criteria for evaluating justification rules such as their use by one's peers and their production of a coherent set of beliefs. But I see no reason to look for just one criterion for rightness of a system of J-rules. As in theory choice and complex decision making, multiple criteria can and must be reconciled and integrated. A system of J-rules may be chosen, not because their performance exceeds some threshold, but because they are better than other available rules for a variety of reasons.

Now I shall address one of the topics that Goldman discusses in the assessment of cognitive resources, production systems and second-order processes. Second-order processes are processes that produce new processes (p. 94). The notion of cognitive processes is central to Goldman's notion of justification, since J-rules are right if they permit reliable psychological processes. Among the primary processes that are acquired by second-order processes, Goldman distinguishes between basic processes that are innate and *methods* that are acquired.

Goldman's use of the term "process" is a bit strange, since it seems to have both the standard meaning of something going on in the mind and an extended meaning of the structures in the mind that produce what goes on. His discussion of second-order processes centers around ACT*, the influential production system model of Anderson (1983). Productions are if-then structures that are used in programs in a computational analog of *modus ponens*. Goldman runs through Anderson's

example of a production system for doing addition, whose productions include: IF the goal is to do an addition problem, THEN the subgoal is to iterate through the columns of the problem. Goldman counts individual productions as methods, since they can be acquired and they serve to produce new beliefs: firing the production by instantiating the IF clause leads to addition to memory of information included in the THEN clause. It follows that Anderson's mechanisms for learning production rules – generalization, compilation, etc. – are second-order processes in Goldman's sense.

Although it is important to try to make the kinds of distinctions that Goldman is after, Anderson's production system may not be a good test bed in which to make them. Anderson draws a sharp distinction between declarative (propositional) and procedural knowledge in the form of productions. But productions can naturally represent declarative information about the world as well. For example, the generalization that crows are black can be represented by the production: IF x is a crow, then infer that x is black. This is as much a belief as a method for forming beliefs. The process of fixing beliefs here is not the production itself, but the running of the computer program that is able to match the IF parts of available productions against what is known and then enact the THEN part. (For more on production systems, see Holland, Holyoak, Nisbett, and Thagard, Chapter 2.) If it is confused to call a production a process or method, then it is all the more confused to call means of producing new productions second-order processes. Better, perhaps, to call them algorithms that operate on productions to produce new productions. These algorithms (sub-programs, subroutines) are built-in by Anderson.

If Anderson's system could *learn* to do composition or generalization, the mechanisms by which it was able to do so would be second-order in the sense that Goldman is after. A production system can be understood has having the following components:

1. Structures, analogous to atomic sentences, against which the IF clauses of productions are matched. These are usually called "facts" or "messages".
2. Productions, which are structures with an IF and a THEN part.
3. Algorithms for matching facts against productions and selecting productions for firing them and creating new facts.

4. Algorithms for creating new productions.

From the point of view of the program, 1 and 2 are on the same level, and so are 3 and 4. At a higher order would be something like:

5. Algorithms for creating new algorithms for creating new productions.

Aside from Lenat's (1983) work on heuristic generation, almost no work in AI has gone on at this level. There are to my knowledge no detailed models of how people learn rules of deductive or inductive inference. I am not challenging the kinds of distinctions that Goldman is trying to make, only arguing that Anderson's production systems are a poor domain in which to make them. The notions of first- and second-order cognitive processes stand in need of theoretical development and clarification.

These criticisms of *Epistemology and Cognition* do not belie the substantial merits of the book. It is a beacon redirecting the theory of knowledge away from the barrenness of narrow philosophical analysis toward the prospects of a rich collaboration with experimental and theoretical psychology.

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