Conclusion
Peaceful Coexistence?

We have arrived, finally, at the conclusion of the saga of four decades. It has been more the story of a personal odyssey than an unbiased history. Inasmuch as I was a graduate student in philosophy in 1948, my career as a philosopher spans the entire period. I do not recall when I first read the Hempel-Oppenheim essay, but I did discuss it in my classes in the early 1950s. My specific research on scientific explanation began in 1963, and I have been an active participant in the discussions and debates during the past quarter-century. Full objectivity can hardly be expected.

Certain large areas have been left virtually untouched. I have deliberately neglected such topics as explanation in biology, explanation in psychology, explanation in history, and explanation of human action largely because I am not well enough informed about the substantive subject matter. Certain related issues, especially causality, have been treated only in passing, because the literature is so vast, and because this essay is already far too long. I know that there are other important pieces of work, especially during the latter part of the four decades, that have not been mentioned. As the decades passed the volume of literature increased exponentially, and judgments about the recent past are probably more subjective than those pertaining to more remote times. My decisions about what to discuss and what to omit are, without a doubt, idiosyncratic, and I apologize to the authors of such works for my neglect. But I have made an honest effort to discuss the material that has mainly influenced the present state of the subject. That said, let me offer my personal appraisal of the situation.

5.1 Consensus or Rapprochement?

Is there a new consensus in philosophy of science regarding the nature of scientific explanation? Not to any very noticeable extent. There are, however, a few basic points on which there seems to be widespread agreement among those who are contributing actively to the philosophical discussion of the subject.

(1) At the beginning of the four decades, the view was rather widely held that it is no part of the business of science to provide explanations – that explanations can be found, if at all, only in the realms of theology and transcendental metaphysics. At present, virtually all philosophers of science of widely diverse persuasions agree that science can teach us, not only *that*, but also *why*. This is an important piece of progress. It is now generally acknowledged that one of the most important fruits of modern science is understanding of the world. We do not have to go outside of science to find it.

(2) There seems to be general agreement – but by no means as unanimous as opinion on the preceding point – that the 'received view' of the mid-1960s is not viable. Contemporary deductivism may retain some of the core of the 'received view', but it rejects the expansive attitude toward probabilistic explanations of particular facts, and recognizes the need for an improved view of the nature of deductive explanation.

(3) It is noteworthy that the Hempel-Oppenheim paper undertook to furnish a formal explication of at least one type of scientific explanation, providing the syntax and semantics of a formal language and offering precise logical definitions. Most subsequent treatments, including those of Hempel himself, have not aimed for that degree of formal rigor. There is, I think, a general tacit recognition that the kinds of tools employed by Hempel and Oppenheim are not especially fruitful for handling the problems encountered in this area. For my own part – but I emphasize that this is *not* part of any general consensus – I believe that what constitutes a satisfactory scientific explanation depends upon certain contingent facts about the universe, for example, what kinds of mechanisms actually operate in the physical world.

(4) There appears to be fairly wide agreement on the importance of the pragmatics of explanation, and on the recognition that this aspect was not accorded sufficient emphasis in the 'received view'.

Beyond these four points, I cannot think of any other areas in which consensus actually obtains. Nevertheless, another question should be raised, namely, is a new consensus *emerging* in philosophy of science? This question calls for a risky prediction, but I shall hazard a guess. It seems to me that there are at least three powerful schools of thought at present – the pragmatists, the deductivists, and the mechanists – and that they are not likely to reach substantial agreement in the near future.

Still another question should be raised. Even if there is no general consensus at present, and no bright prospects for one to emerge soon, is there a basis for a substantial degree of rapprochement among the differing viewpoints? Here I think an affirmative answer can be given.

Around the beginning of the second decade, when serious controversy about the nature of scientific explanation erupted, two points of view – those associated primarily with the names of Hempel and Scriven – appeared in opposition to each other. The Hempelian view, which became the received view, emphasized deductive subsumption, the covering law thesis, and nomic expectability. We have chronicled many of the vicissitudes it has suffered; the net result, I think, is that it emerges at the close of the fourth decade in the form of the unification thesis. This view, whose chief proponents are Friedman and Kitcher, holds that scientific understanding increases as we decrease the number of independent assumptions that are required to explain what goes on in the world. It seeks laws and principles of the utmost generality and depth. This is a view to which I believe Popperians also subscribe. As I have said above (§4.3), the explanatory goal of this approach is the construction of a coherent world picture, and the fitting of particular facts within this framework. On this conception, explanatory knowledge is not of some additional kind that transcends descriptive knowledge. Explanations serve to organize and systematize our knowledge in the most efficient and coherent possible fashion. Understanding, on this view, involves having a world-picture – a *scientific Weltanschauung* – and seeing how various aspects of the world and our experience of it fit into that picture. The world-picture need not be a deterministic one; nothing in this view precludes basic laws that are irreducibly statistical.

The unification approach, as defended recently by Watkins and pursued in this book (Kitcher & Salmon 1989) by Kitcher, is, I believe, viable. In Kitcher's terminology, it is a "top-down" approach. It fits admirably with the intuitions that have guided the proponents of the received view, as well as those that inspire scientists to find unifying theories. This is the form in which the epistemic conception of scientific explanation can flourish today.

From the beginning, the most prominent critics of Hempel – especially Scriven – stressed two themes, causality and pragmatics. Often the two were closely related, for many of them took causality to be inescapably context-dependent. As things developed, however, the emphasis upon causality and upon objective statistical relevance relations issued in the ontic conception of scientific explanation, in which the objective relations among events could be considered quite apart from pragmatic considerations. As this approach had developed by the close of the fourth decade, it became the causal/mechanical view that is advocated by – among others – Humphreys, Railton, and me.

Although it would be unfair for me to assume that Humphreys and Railton would agree, as I see it, this version of the ontic conception has developed into a view that makes explanatory knowledge into knowledge of the hidden mechanisms by which nature works.[1] It goes beyond phenomenal descriptive knowledge into knowledge of things that are not open to immediate inspection. Explanatory knowledge opens up the black boxes of nature to reveal their inner workings. It exhibits the ways in which the things we want to explain come about. This way of understanding the world differs fundamentally from that achieved by way of the unification approach. Whereas the unification approach is "top-down," the causal/mechanical is "bottom-up."

When we pause to consider and compare these two ways of looking at scientific explanation, an astonishing point emerges. These two ways of regarding explanation are *not incompatible* with one another; each one offers a reasonable way of construing explanations. Indeed, they may be taken as representing two different, but compatible, aspects of scientific explanation.[2] Scientific understanding is, after all, a complex matter; there is every reason to suppose that it has various different facets.

Let me illustrate this point by recounting an actual incident.[3] Several years ago, a friend and colleague—whom I shall call *the friendly physicist*—was sitting on a jet airplane awaiting takeoff. Directly across the aisle was a young boy holding a helium-filled balloon by a string. In an effort to pique the child's curiosity, the friendly physicist asked him what he thought the balloon would do when the plane accelerated for takeoff. After a moment's thought the boy said that it would move toward the back of the plane. The friendly physicist replied that *he* thought it would move toward the front of the cabin. Several adults in the vicinity became interested in the conversation, and they insisted that the friendly physicist was wrong. A flight attendant offered to wager a miniature bottle of Scotch that he was mistaken—a bet he was quite willing to accept. Soon thereafter the plane accelerated, the balloon moved forward, and the friendly physicist enjoyed a free drink.

Why did the balloon move toward the front of the cabin? Two explanations can be offered, both of which are correct. First, one can tell a story about the behavior of the molecules that made up the air in the cabin, explaining how the rear wall collided with nearby molecules when it began its forward motion, thus creating a pressure gradient from back to front of the cabin.[4] This pressure gradient imposed an unbalanced force on the back side of the balloon, causing it to move forward with respect to the walls of the cabin. Second, one can cite an extremely general physical principle, Einstein's *principle of equivalence*, according to which an acceleration is physically equivalent to a gravitational field. Since helium-filled balloons tend to rise in the atmosphere in the earth's gravitational field, they will move forward when the airplane accelerates, reacting just as they would if a gravitational field were suddenly placed behind the rear wall.

The first of these explanations is causal/mechanical. It appeals to unobservable entities, describing the causal processes and causal interactions involved in the explanandum phenomenon. When we are made aware of these explanatory facts we understand how the phenomenon came about. The second explanation illustrates the unification approach. By appealing to an extremely general physical principle, it shows how this odd little occurrence fits into the universal scheme of things. It does not refer to the detailed mechanisms. This explanation provides a different kind of understanding of the same fact. It is my present conviction that both of these explanations are legitimate and that each is illuminating in its own way.

If this assessment of the situation is correct, we have grounds for a substantial degree of rapprochement between two approaches to scientific explanation that have been in conflict for at least three decades. In so saying, I do *not* intend to suggest that there was no real opposition between these views from the beginning, and that all of the controversy has been beside the point. On the contrary, at the beginning of the second decade there was genuine disagreement between Hempel and Scriven, and there was subsequently genuine disagreement between Hempel and me on the relative merits of I-S and S-R explanations. Over the intervening years, however, both viewpoints have evolved and become more mature. This evolution has, I believe, removed the sources of earlier conflict and made possible an era of peaceful coexistence.

At this point there is a strong temptation to take a page from Carnap's *Logical Foundations of Probability* and announce that there are two concepts of scientific explanation—explanation$_1$ and explanation$_2$—both of which are perfectly legitimate, and which must not be confused with one another. The question is how to characterize them and their relations to each other. Let us identify explanation$_1$ with causal/mechanistic explanation. It could fairly be said, I believe, that mechanistic explanations tell us how the world works. These explanations are local in the sense that they show us how particular occurrences come about; they explain particular phenomena in terms of collections of particular causal processes and interactions—or, perhaps, in terms of noncausal mechanisms, if there are such things. This does not mean that general laws play no role in explanations of this kind, for the mechanisms involved operate in accordance with general laws of nature. Furthermore, it does not mean that explanations$_1$ can only be explanations of particular occurrences, for causal/mechanical explanations can be provided for general regularities. The causal/mechanical explanation offered in the case of the helium-filled balloon can be said to apply quite generally to lighter-than-air entities in similar circumstances. The molecular kinetic theory of gases provides a causal/mechanical explanation of such regularities as Boyle's law. Explanations$_1$ are *bottom-up* explanations, in Kitcher's terminology, because they appeal to the underlying microstructure of what they endeavor to explain.

Explanation$_2$ then becomes explanation by unification. Explanation in this sense is, as Friedman emphasized, global; it relates to the structure of the whole universe. Explanation$_2$ is *top-down* explanation. To reinforce the global character of explanation$_2$ we might restrict its applicability, as Friedman did, to explanations of regularities, but I do not think anything of much importance hinges on such a limitation.

If the foregoing suggestions are correct, we can reconcile the currently viable versions of the epistemic and ontic conceptions. That leaves the pragmatic view.

If the pragmatic approach is construed as the claim that scientific explanation can be explicated entirely in pragmatic terms, then I think our examination of Achinstein's, Bromberger's, and van Fraassen's work seriously undermines it. To give a correct characterization of scientific explanation we need to identify the kinds objective relevance relations that make an explanation *scientifically correct*. This task falls outside of pragmatics.

If, however, we see the pragmatic approach as illuminating *extremely important features* of explanation, without doing the whole job, we can fit it nicely into the foregoing account. As I remarked in §4.6, if we adopt Railton's concepts of *ideal explanatory text* and *explanatory information*, pragmatic considerations can be taken as determining what aspects of the ideal text are *salient* in a given context. The ideal text contains the objective *relevance relations* upon which correct explanations must be founded.

When we make reference to the ideal explanatory text, the question naturally arises whether it conforms to the unification conception or the causal/mechanical conception. The answer is, I think, both. If one looks at the main example Railton offered to illustrate his notion of a D-N-P ideal text—namely, alpha-decay of a uranium nucleus—we see that it contains elements of both. It appeals to the most general theory of quantum phenomena, but it also details the specific mechanism involved in the decay of one particular nucleus. Indeed, looking at that example, one is tempted to say that the top-down and bottom-up approaches are just two different ways of 'reading' the ideal explanatory text. Pragmatic considerations determine which way of 'reading' is appropriate in any given explanatory context. In the case of the friendly physicist, for example, an appeal to Einstein's equivalence principle would have been totally inappropriate; however, the causal/mechanical explanation might have been made intelligible to the boy and the other interested adults.

My remarks about the relationships among (what I see as) the three currently viable approaches to explanation have necessarily been brief and sketchy. They are reflections that have grown directly out of the writing of this essay. It remains to be seen whether they can be filled out in detail and applied more generally to a wide variety of examples of scientific explanation. If so, a new consensus can emerge from our present understanding of the topic.

5.2 Agenda for the Fifth Decade

Nothing could be more pleasing than the emergence of a new consensus along the lines just sketched, but whether that occurs or not, there are certain remaining problems that demand further serious consideration.

First among them, I believe, is a problem—or pair of problems—that has been with us from the beginning. This is the problem—raised, but not adequately answered, in the 1948 Hempel-Oppenheim paper—of lawlike statements and purely qualitative (or projectable) predicates. On this issue dissensus reigns. It is obviously crucial to anyone who adopts any sort of covering law view, but it is equally crucial to those who reject that conception if, like Scriven, they admit that laws have a role-justifying function.

Second, the problem of causality is still with us. It becomes especially critical for those who find an explanatory role for probabilistic causes. As my brief remarks have indicated, considerably more work is needed to clarify this concept. Recent interchanges with I. J. Good (W. Salmon 1988a), in addition to my critique of the Fetzer-Nute system, have convinced me that conflicting fundamental intuitions are rampant.

The foregoing two problems are hoary philosophical chestnuts on which much ink has been spilled. That situation will, no doubt, continue. The third problem is rather different, I believe. It has to do with quantum mechanical explanation. The chief source of the problem is the famous Einstein-Podolsky-Rosen paper.[5] It has, of course, been widely discussed, but not often explicitly in the context of scientific explanation. That paper, in effect, describes a thought-experiment and predicts its result. The issue has become more urgent recently as a result of Bell's theorem and the Aspect experiment on remote correlations (see, e.g., Mermin 1985 or Shimony 1988). Now there is an actual experimental outcome to explain. Opinions vary on the significance of these results. Some say that they are of little consequence, showing only that the results conform to the theoretical prediction of quantum mechanics. To the discredit of the received view, it would support that position and claim that, because of subsumption under a well-confirmed theory, the experimental result is explained. At the opposite end of the spectrum of opinion are some who say that Bell's theorem and Aspect's confirmation of the quantum mechanical prediction constitute the most important development in the history of physics. I cannot accept that assessment either. With N. David Mermin, I accept the *moderate view* that "anyone who isn't worried about this problem has rocks in their head."[6]

The situation, basically, is this. There are impressive remote correlations in the spin-states of photons that cannot be explained by local causal principles; action-at-a-distance appears to be manifested. The results can be derived from spin conservation, but it is nonlocal conservation, and we have no mechanism by which to explain it. I have no idea what an appropriate explanation would look like; we may need to know more about the microcosm before any explanation can be forthcoming. But I do have a profound sense that *something* that has not been explained needs to be explained. As I said at the close of *Scientific Explanation and the Causal Structure of the World*, "to provide a satisfactory treatment of microphysical explanation constitutes a premier challenge to contemporary philosophy of science" (279). That still strikes me as correct.

Notes

Introduction

1. See Rudolf Carnap (1966, reissued 1974, pp. 12–17) for interesting comments on the transition from the denial to the acceptance of the view that science can furnish explanations. This passage includes an interesting discussion of Hans Driesch's vitalism (including the appeal to entelechies), and of reactions to it by the logical positivists of the Vienna Circle.

2. It is possible, of course, to adopt a hypothetical or 'suspend the truth' attitude in which one asks how a particular event could be explained *if it were to occur*. This is *not* Velikovsky's attitude.

3. For a brief and accessible introduction see Gale (1981). The heading of this rather flamboyant article reads, "Certain conditions, such as temperature, were favorable to the emergence of life on earth. The anthropic principle argues the reverse: the presence of life may 'explain' the conditions." In the article Gale adds, "It is fair to say, however, that not all cosmologists and philosophers of science assent to the utility of the anthropic principle, or even to its legitimacy. Here I shall describe some of the ways in which the principle has been applied and let the reader judge its validity" (p. 154). For a more thorough and technical, as well as more recent, treatment see Barrow and Tipler (1986).

4. That feature, in itself, should give us pause, for it is an elementary logical fallacy to infer the truth of the premises from the truth of the conclusion of a valid deductive argument. As a matter of fact, neither Hempel nor I considers the traditional hypothetico-deductive schema an adequate characterization of scientific confirmation, but it seems to be so regarded by many people; see, for example, Braithwaite, *Scientific Explanation*, (1953 p. 9). Discussions of the shortcomings of the hypothetico-deductive method can be found in W. Salmon (1984, §30) or W. Salmon (1967, Chap. VII).

5. Samuel E. Gluck (1955) made a brief stab at the task, but it was insufficiently general and failed to take notice of such basic difficulties as the ambiguity of statistical explanation. One interesting feature of his article is the claim that, because of the inherently probabilistic character of physical measurement, even what we take to be D-N explanations in quantitative sciences are actually statistical explanations. This point has been a longstanding source of worry for deductivists.

6. There are, of course, precursors of the theory set forth in this article, including Aristotle and John Stuart Mill. An important twentieth-century precursor is Karl R. Popper, whose 1935 work sketches a version of D-N explanation, though not in the depth of detail of Hempel-Oppenheim. Moreover, Popper's book was not highly influential until the English translation (1959) was published.

The First Decade

1. For one explicit comment, see 1953, p. 347.

2. For a recent detailed and sophisticated discussion of the nature of laws see John Earman (1986, chap. 5).

3. For purposes of this discussion it is not necessary to draw a distinction between counterfactual and subjunctive conditionals. In the example, "If this table salt were placed in water it would dissolve," it does not matter whether or not the particular sample is at some future time placed in water.

4. I once made a very crude estimate of the amount of gold in the earth's seas, and it came out to be more than 1,000,000 kg; if sufficient resources were devoted to the project, somewhat more than 100,000 kg could be extracted from sea water and fashioned into a sphere.

5. It has been speculated that tachyons—particles that travel faster than light—exist, but on pain of contradiction with special relativity, they cannot be used to send messages.

6. In these remarks about the coextensiveness of laws and statements that support counterfactuals I am, of course, excluding counterfactuals based on logical truths and/or on definitions.

7. This may represent Braithwaite's fundamental view of the problem.

8. This point is closely related to the pragmatic view of John Stuart Mill, Charles Saunders Peirce, and David Lewis, according to which the laws are those generalizations that end up as fundamental principles in the ideal limit of scientific investigation. One crucial question with respect to this approach is whether ideal science must eventuate in a unique final form, or whether alternatives are possible. If alternatives are possible, this pragmatic resolution of the problem would not pick out a unique set of laws, for the future course of science is unpredictable. Consequently, the distinction between laws and nonlaws would be basically epistemic; the distinction would not be objective.

9. See the concept of resiliency in Brian Skyrms (1980).

10. A great deal of light will be shed on this issue by Bas van Fraassen's forthcoming book, *Laws and Symmetries*.

11. At this point in his discussion he is advancing this view for consideration, rather than asserting it, but this is precisely the conclusion he does draw at the end of this chapter, pp. 317–18.

12. Partly because of its somewhat opaque title and partly because of its formidable complexity this book received little attention. It was later reprinted under the more descriptive title, *Laws, Modalities, and Counterfactuals* (Berkeley & Los Angeles: University of California Press, 1976). In my foreword to this volume I attempted to survey the issues as they stood in 1976, and to provide a more accessible account of Reichenbach's major ideas.

13. Ernest Nagel, *The Structure of Science* (New York: Harcourt, Brace and World, 1961), Chap. 4.

14. This discussion was continued in (Goodman, 1947) and (Carnap, 1947a).

15. I am paraphrasing the Hempel-Openheim definitions, but I shall preserve their original numbering.

16. See W. Salmon, foreword, in Reichenbach (1947), pp. xxxii–xxxiii.

17. The expression "iff" is a standard abbreviation for "if and only if."

18. For the sake of a concrete interpretation of this counterexample, it will do no harm to restrict the range of our variables to humans.

19. In *no* sense is this remark intended as a historical comment; I do *not* mean to suggest that they were on the verge of sending it off for publication and spotted the problem just in the nick of time. I am merely drawing a parallel between this technical problem and that pointed out by Eberle, Kaplan, and Montague.

20. By the *conjunctive normal form* of a formula we mean an equivalent formula (containing just those sentential variables occurring essentially in the original) which is a conjunction each of whose terms is a disjunction of sentential variables or their negations.

21. It is a serious terminological error, I believe, to refer to the D-N model of scientific explanation as "*the* covering law model," for although it is one model that conforms to the general idea that explanation always involves subsumption under laws, it is by no means the only such model. Indeed, Hempel's I-S model is also a covering law model.

22. In conversation, when he visited the workshop at the Minnesota Center for Philosophy of Science.

23. It appears that Hempel published nothing on scientific explanation, beyond the Hempel-Oppenheim article, during this first decade of our chronicle.

24. For purposes of historical accuracy it should be noted that this chapter is based upon Braithwaite's 1946 presidential address to the Aristotelian Society. At about the same time Ernest Nagel (1956) produced an important study of functional explanation. This paper was prepared in 1953 as a reserach report at Columbia University. Neither Braithwaite nor Nagel makes any reference to the Hempel-Oppenheim paper in their discussions of teleological or functional explanation.

25. Like Braithwaite and Nagel, Scheffler also makes no mention of the Hempel-Oppenheim article. It might be remarked facetiously that if Scheffler had been sufficiently attuned to the historical situation he would have published this paper on teleology in 1957, and the 1957 critique of Hempel and Oppenheim in 1958.

26. Both Hempel and Nagel rely heavily on Merton's extensive discussion of *functional analysis*. Nagel's work (1956) contains a detailed analysis of Merton's treatment of this topic.

27. Although the first published version of the I-S model did not appear until three years later, it seems evident that Hempel had a pretty clear idea of what it would be like when he wrote the 1959 article.

28. Scriven (1959) would, I believe, be one example.

29. See, however, Scheffler (1957) for a discussion of the bearing of the referential opacity of intentional contexts in this connection.

30. Nagel (1961, chap. 1) lists four types of explanation: deductive, probabilistic, functional or teleological, and genetic, leaving open at that stage whether the latter two can be reduced to one or both of the former two.

31. John Canfield (1966) covers the discussion of functional explanation during a good deal of the first two decades of our story. It contains, in addition to classic papers by important authors, a clear and perceptive introduction by Canfield.

32. Wright (1973) contains important anticipations of the theory set out in his book.

The Second Decade

1. As we noted in §0.2, the most serious attempt before 1962 seems to be (Gluck, 1955), but it is much too sketchy to present a clearly articulated theory, and it fails to notice the serious difficulties involved in statistical explanation.

2. His book *The Philosophy of Science* (1953) contains many references to scientific explanation, but does not provide an explicit account of that concept. His *Foresight and Understanding* (1961) deos offer an explicit account.

3. In *Scientific Explanation* (1984, p. 130) I incorrectly attributed to Bromberger the view that all explanations can be appropriately requested by means of why-questions. I regret this error.

4. [Bromberger's footnote] 'Can think of no expression' and 'can think of no answer' as short for 'can imagine nothing, conjure up nothing, invent nothing, remember nothing, conceive nothing' . . . does not cover the familiar states of momentary amnesia during which one has the answer 'on the tip of one's tongue' but cannot utter it.

5. Broberger's footnote: "As an achievement term 'to explain' is also often used to credit people with certain scientific discoveries. 'Newton explained why the tides vary with the phases of the moon' may serve to mark the fact that Newton was the one who solved the riddle, who found the answer to a question with regard to which everybody had been in either a p-predicament or a b-predicament. To have explained something in this sense is to be one of the first to have explained it in the [previous] sense . . . to be one of the first to have been in a position to explain . . . it to a tutee."

6. See the charming dedication to Hempel under "NOTES" on p. 107.

7. These restrictions are contained in the definition of *general abnormic law* given in Bromberger (1966, p. 98).

8. For technical reasons an additional restriction—(4) the general rule completed by *L* has the property that if one of the conjuncts in the antecedent is dropped the new general rule cannot be completed by an abnormic law—is needed, but the main thrust if this account can be appreciated without it.

9. As Broberger notes explicitly, "unless" has to be contrued as the exclusive disjunction.

10. However, see Grünbaum (1963), Fetzer (1974), and Rescher (1963).

11. It should be recalled, from our discussion of functional or teleological explanation in §1.3, that Hempel did not base his qualms about explanations of these sorts on the problem of the temporal relation between the function and its goal.

12. I do not believe Bromberger ever published this precise example; his actual examples, which have the same import, are the height of a tower and the height of a utility pole to which a guy wire is attached.

13. Bas van Fraassen is an exception. In his 1980 work (pp. 132–34) he suggests that there are possible contexts in which such an explanation would be legitimate. We shall discuss his theory of explanation in §4.4 below.

14. This 'law' does, of course, make reference to particular entitites—earth, sun, and moon—but that, in itself, is not too damaging to the example. After all, in this respect it is just like Kepler's laws of planetary motion and Galileo's law of falling bodies. Like these, it qualifies as a derivative law, though not a fundamental law.

15. Scheffler (1957) subjected the symmetry thesis to searching criticism. To the best of my knowledge, this article is the first significant published critique of the Hempel-Oppenheim article.

16. See Grünbaum (1963) for a fuller discussion of this point.

17. As Philip Kitcher pointed out to me in a personal communication, Hempel could be defended against this example by arguing that "a *natural selection* explanation of the presence of a trait is really a deduction that the probability that the trait becomes fixed in a finite population is high."

18. This example is due to Henry Kyburg (1965). A variant of this example (due to Noretta Koertge) has unhexed table salt placed in holy water; and the 'explanation' of the dissolving is that the water was blessed and whenever table salt is placed in holy water it dissolves.

19. I offered one such method, based on Reichenbach's treatment of laws (Salmon, 1979).

20. In the introduction to this essay I noted that an earlier paper on statistical explanation by Samuel E. Gluck may qualify as a precursor.

21. I shall us the term "statistical law" to refer to factual generalizations, such as the chance of getting 6 if a standard die is tossed, or the probability that a carbon-24 nucleus will decay in 5730 years. One could say that statistical laws are empirical generalizations, provided it is clearly understood that this does *not* mean that only directly observable properties are involved. I shall use the term "law of probability" to refer to axioms and theorems of the mathematical calculus of probability. Such laws are not empirical and they do not have factual content.

22. I am not objecting to the use of idealizing simplifications in dealing with philosophical problems, but their limitations must be kept in mind.

23. Recalling the fact that, for the limiting frequency interpretation, the individuals have to be taken in some specific order, I must confess to a bit of queasiness here.

24. We shall find reasons below for doubting this assessment of the relative importance of D-S and I-S explanations.

25. Whether this statistical law asserts that r is the actual fraction of Fs within a finite class F, or the limiting frequency of Fs within an infinite class F, is an issue that need not concern us here.

26. If we are thinking of probabilities as limiting frequencies in infinite sequences, $P(G|F)$ may equal 1 and $P(G|F.H)$ may equal 0.

27. Hempel (1962) succumbed to this temptation, but he soon realized the essential difficulty, as he explains in (1965, p. 401, note 21).

28. I have slightly modified Hempel's notation, but not in any way that affects our discussion.

29. As we noted in discussing the precise Hempel-Oppenheim explication, the actual requirement for D-N explanation is that the explanans contain essentially at least one theory, where a theory may contain existential quantifiers and need not contain any universal quantifier. In the technical explication of a potential explanans, the explanatory theory must be true (since all theories, in the special sense of Hempel and Oppenheim, are, by definition, true). It would seem more reasonable to require only that the general premise be essentially generalized, for certainly we want to consider the explanatory power of theories (in the usual sense) that need not be true.

30. As we noted above, p. 16, although Braithwaite's *Scientific Explanation* contains a chapter devoted to explanations of laws, he does not come to grips with the fundamental problem noted by Hempel and Oppenheim.

31. Hempel published a revised version of RMS (1968), pp. 116–33, which he designated "RMS*." It embodies some technical revisions designed to overcome an objection by Richard Grandy, but these do not affect any of the philosophical issues we are discussing.

32. Linus Pauling's claims in this regard were receiving a good deal of publicity in the early 1960s (see Pauling, 1970).

33. I owe this example to the eminent geneticist Tracy Sonneborn. In a social conversation about hormones and sex, I asked him what would happen to a man who took oral contraceptives. Without a monent's hesitation he replied, "Well, he wouldn't get pregnant."

I am indebted to the eminent archaeologist William A. Longacre for furnishing further information regarding this question. He kindly sent me a copy of the 2 June 1987 issue of the tabloid *Sun* (vol. 5, no. 22) which carried the front page headline "WIFE FEEDS HUBBY BIRTH CONTROL PILLS TO STOP HIM CHEATING." According to the story (p. 35), "Determined to stop her husband from fooling around, a betrayed housewife came up with the idea of feeding him birth control pills—and the dumbfounded hubby was frightened out of his wits when the pills made him impotent." When she confessed that she had been concealing them in his food he became furious and "stormed out of the house and has since filed for divorce . . . on the grounds of mental and physical cruelty."

The Third Decade

1. It is worth noting that Hempel introduces the term "statistically relevant" in this article, but he does not use it to refer to a statistical relevance relation (as that concept is generally understood).

2. As the issue was addressed here, it was buried rather deep in a paper whose title gave hardly any hint that it dealt with this topic.

3. This paper is a much expanded and highly revised version of one presented at a University of Pittsburgh workshop in 1965.

4. I discuss these three conceptions—the epistemic, the modal, and the ontic—rather briefly in (1982, 1986); and also in greater detail in (1984, chaps. 1 and 4). We shall return to them in this essay when we get to the fourth decade.

5. The answer is obvious in the sense of Christopher Columbus. The story is told of a dinner attended by Columbus sometime after his first voyage to the new world. Some of the guests were belittling his accomplishment by suggesting that it was not all that difficult. Columbus requested an egg from the kitchen, which he passed around asking each guest to try to stand it on end. When all had failed and it came back to him, he gave it a sharp tap on the table, breaking in the shell at one end, whereupon it remained upright. "You see," he said, "it is easy after you have been shown how."

6. I have in mind chiefly Peter Railton and myself.

7. Suppose, for example, that we have a class of tosses consisting of tosses of many different coins. Suppose further that many of the coins are biased, some toward heads, others toward tails. Some of the coins are fair. Now if each of the biased coins is biased in the same degree toward heads or tails (as the case may be), if as many are biased toward heads as toward tails, and all of the coins are tossed equally often, then the probability of heads in the entire class will be ½. This class may be relevantly partitioned into three cells—tosses with coins biased toward heads, tosses with coins biased toward tails, and tosses of fair coins. The probability of heads in the third cell is equal to the probability of heads in the original class, but that does not mean that the partition is not relevant.

8. I am modifying the example somewhat for purposes of the present discussion.

9. These arguments were also contained in his doctoral dissertation, *Foundations of Inductive Explanation* (1973).

10. The treatment of the topic in this article was seriously flawed, and it is completely superseded by my 1984 work, (chap. 3).

11. We might roughly define violet light as that having wave-lengths in the range of approximately 3600–3900 Å and red light as that having wave-lengths in the range of approximately 6500–7100 Å. It is a *fact* that the normal human range of vision extends from about 3600 Å to about 7100 Å.

12. The addition to Hempel's RMS is italicized.

13. In developing the statistical-relevance model of scientific explanation, I employ a non-epistemically-relativized counterpart of RMS. It is the requirement that reference classes used in explanations of this sort be *objectively homogeneous*. A number of the considerations that enter into the foregoing revision of Hempel's RMS were developed in the attempt to provide an adequate characterization of objective homogeneity. See W. Salmon (1984, chap. 3).

14. This attempt was seriously flawed in several ways. It is completely superseded by my 1984 work (chap. 3).

15. The members of F must be taken in some order. If F is finite the order makes no difference; if F is infinite, choose some natural order, such as the temporal order in which the events occur or are discovered.

16. This requirement is analogous to Richard von Mises's principle of insensitivity to place selections in his definition of the *collective*.

17. Philip Kitcher criticizes this proposal as follows, "I suspect that the omnipresence of correlations will make for inhomogeneity everywhere. This [proposal] will not get around the spurious correlation problem. There's bound to be some (possibly hokey) property that all correlates of the Bs have." If he is right, there is more work to be done on the concept of objective homogeneity. One suggestion, essentially adopted by Coffa, is to restrict consideration to nomically relevant (not just statistically relevant) factors.

18. This 'law' needs more careful formulation. Innumerable automotive and plumbing problems have been occasioned by the fact that water expands when it is cooled.

19. I have treated these issues in some detail (1979).

20. This is a highly contentious issue. In a personal communication Philip Kitcher comments, "Here I think you are describing a different chance setup. It depends how far you go back in the causal chain. If the setup involves the producing machine, then the Laplacian description seems right. If we start with some already selected coin of unknown constitution, then it seems that [the other] is right. We don't have an ambiguous description *of the same situation.*" My answer to this ploy is that we have two different descriptions of two different *types* of chance setups. The event in question actually belongs to both. If we want to characterize *this chance setup*, we have to decide which type to assign it to.

In another personal communication Paul Humphreys writes, "Your argument here applies only to long-run propensity interpretations, and not to single case propensities. Under the single case account, the continued operation of the machine is irrelevant to each specific trial, and under either experiment you describe, the propensity will be either less than or greater than ½, although in the first experiment it will remain fixed, whereas in the second experiment it will change depending on which kind of disk is picked on each trial." My answer to Humphreys is that he has done what any good limiting frequency or long-run propensity theorist would do. He has picked the appropriate type of chance setup to characterize *this trial.*

21. Because Coffa did not develop the idea or spell out any details, I had completely missed the point and forgotten all about it until I very recently reread his disseration. Every important philosophical discovery has to have a precursor; Coffa plays that role for Humphreys.

22. Hempel's response to Rescher can be found in (Hempel, 1965, pp. 403-6).

23. This book contains a comprehensive bibliography of works on scientific explanation up to its date of publication.

24. Indeed, any but the simplest putative Hempelian explanation of an individual event, because it involves subsumption under one or more laws, can be construed as an explanation of a regularity. The explanation of the bursting radiator, for example, is an explanation of why *any* radiator of a similar type, subjected to similar conditions, will burst.

25. Kicher responds, of course, that the Hempel-Oppenheim criteria are too weak. Where they required merely that the primitive predicates be purely qualitative, Kicher seems to want to require that they signifiy natural kinds.

26. Kitcher will argue, of course that typically not all of the Hs will represent predicates that are projectable from their instances.

27. Kitcher responds, "I'm not sure you could project either generalization without having a background theory about organisms that would give you both at once—or that would tell you that one is true if and only if the other is."

28. In a personal communication Kitcher also rejects this example: "I'm not sure we could accept any of these without accepting them all. The reason is that the projection from a finite sample seems to depend on believing that the relevant predicates pick out crucial classes in nature. There's no basis for thinking of the large-small cases, for example, as a privileged class for projection without thinking that the class of *all* two-body systems is projectable. Sometimes, I believe, you can't make a *restricted* projection. You either go all the way or nowhere."

29. Philip Kitcher, "Explanation, Conjunction, and Unification," *Journal of Philosophy* LXXIII (1976), p. 209.

30. In a personal communication Kitcher reponds: "Not necessarily, if the conditions on acceptability concern the projectability of predicates." Kitcher's remarks about projectability in response to my criticism of Friedman are interesting and important. If, however, this is the avenue to salvation for Friedman's program, he clearly needs to add a theory of projectability to the proposal he has offered.

31. A.A. Few, "Thunder," *Scientific American* (July, 1975), pp. 80–90. [Kitcher's reference.]

32. The first two dogmas were elaborated in W. V. Quine's classic essay "Two Dogmas of Empiricism," (1951).

33. This is the position Jeffrey took (1969); however, I do not agree with his way of making the distinction between those that are and those that are not.

34. If these temporal relations are not obvious, think of a given photon approaching the vicinity of the flagpole. If it passes by the flagpole without being absorbed, it reaches the ground a little later than it passed by the flagpole. A companion photon, traveling alongside of the above-mentioned one in a parallel path that intersects with the flagpole, will be absorbed a little before the other reaches the ground. As a very rough rule of thmb, the speed of light is a billion ft/sec; the photons travel about one foot per nanosecond.

35. I offered one suggestion on how this could be done in "Postscript: Laws in Deductive-Nomological Explanation—An Application of the Theory of Nomological Statements" (1979).

36. Moves of this sort were made in Fetzer (1981).

37. Carnap argues in careful detail for his denial of rules of acceptance (1950, §44b, 50–51). We need not go into his reasons for this approach here, for we are concerned only with its consequences in this context.

38. It has been noted that the special theory of relativity, while prohibiting the acceleration of ordinary material particles from speeds below that of light to superluminal speeds, may not preclude the existence of particles—called *tachyons*—that always travel faster than light. It is generally agreed, I believe, that there is, at present, no empirical evidence for their existence. Moreover, the presumption is that, if they should exist, they would be incapable of serving as signals or transmitting information. See my 1975 work (2nd ed., 1980, pp. 105, 122–24) for a discussion of the problems that would arise if tachyons actually existed.

39. Many philosophers would analyze processes as continuous series of events. While this can surely be done, there is, in my opinion, no particular reason for doing so,and there are some significant disadvantages. See my 1984 work (pp. 140–41, 156–57) for a discussion of this issue. See also John Venn's nice remark quoted on p. 183.

40. A material object that is at rest in one frame of reference will, of course, be in motion in other frames of reference.

41. In speaking of interventions that produce marks, I do *not* mean to suggest that such occurrences must be a result of human agency. For example, light from a distant star may be marked as a result of passage through a cloud of interstellar gas that selectively absorbs light of certain frequencies while letting others pass through unaffected.

42. The pseudo-process consisting of the moving spot of light can be changed from white to red from some point onward by putting a red lens on the beacon, but that does not qualify as an intervention *in the pseudo-process* because it is done elsewhere.

43. I often put so-called scare-quotes around the word "process" when it is being used to refer to pseudo-processes, for many people might be inclined to withhold that term when they realize that the process in question is pseudo. Reichenbach called them "unreal sequences."

44. The Lone Ranger's horse Silver was described as "A fiery horse with the speed of light." For the image of the horse on the screen that is possible in principle.

45. In the infinitesimal calculus we do, to be sure, define the concept of *instantaneous velocity*, but that definition requires consideration of the position of the object at neighboring instants of time. See my 1970 work, which contains Russell's article on Zeno's Paradoxes, and my 1975 work (chap. 2) for a fuller account.

46. Because of my own disciplinary limitations I have not participated in this field.

47. Perhaps I should add, or a bit of teleological non-action, such as not removing a tree that just happened to grow where it did, because it provides some wanted shade.

48. I do not find Nagel's criticisms of Wright particularly weighty.

49. These include Andrew Woodfield (1976) and Michael Ruse (1973).

50. It should be recalled, as previously mentioned, that Hempel addressed the problem of functional explanation in such areas as anthropology, sociology, and psychology, as well as biology. Nagel confines his attention, in these lectures, to biology. It is *much* harder to argue against functional equivalents in these other fields than it is in biology.

The Fourth Decade

1. I have argued this issue briefly (1967, pp. 729–32), and in greater detail (1969).

2. Coffa had previously provided searching critiques of both of these models in his doctoral disseration (1973).

3. This theory was also presented in his doctoral dissertation; see §3.3 above.

4. Before his 1977 publication at any rate. As I remarked above, it is not clear how the I-S model can survive abandonment of the high-probability requirement.

5. I discussed these general conceptions at length (1984, chaps. 1 and 4), and more briefly (1982, 1985).

6. I have no qualms about considering "micrometer" a term of the observational vocabulary, for it is defined in terms of "meter," which in view of the International Prototype and zillions of meter sticks in homes, stores, laboratories, and shops throughout the world, is surely an observational term.

7. Perrin actually studied the Brownian movements of particles suspended in liquids, but that fact does not affect the final results as applied to gases.

8. In offering this response on behalf of the modal conception I am, of course, assuming that knowledge of physical necessity and impossibility are not fully contained within our descriptive knowledge of the world. I shall return to this issue shortly.

9. I take it that predictive knowledge qualifies directly as part of descriptive knowledge, for knowledge of what is going to happen in the future is surely included in descriptive knowledge of the world.

10. See J. L. Mackie (1974) for detailed discussion of this approach. Mackie, himself, does not adopt it.

11. See, for example, Carnap (1966, 1974) for an exposition of this view of causality in the context of scientific explanation.

12. See David Lewis, *Counterfactuals* (1973). As I mentioned above, Lewis himself attemps to break out of the circle by adopting the view that laws are the basic principles in an ideally complete science. In my foregoing remarks on this topic, it will be recalled, I raised the crucial question of the uniqueness of characterization—a problem Lewis acknowledges.

13. Some physicists have proposed the "many-worlds" interpretation of quantum mechanics to resolve the problem of measurement (see De Witt and Graham, 1973). I am not favorably incluined toward this interpretation for much the same reasons.

14. It should be recalled that the term "theory," as it occures in the Hempel-Oppenheim formal explication, does not involve any appeal to unobservables. It simply refers to general statements that may contain existential as well as universal quantifiers.

15. I shall dicuss the legitimacy of this claim to empirical knowledge of unobservables in §4.5.

16. To those who suggested that such feelings are observable, at least by the subject, they responded that introspection is not a scientifically acceptable kind of observation.

17. I have argued this point most explicitly in my 1985 publication; it is also discussed in my 1984 work (pp. 229–38).

18. See my *Scientific Explanation* (pp. 13–15) for a striking historical example.

19. There are, of course, unsatisfactory answers to questions, but I would suppose they should be called unsatisfactory explanations. Not all explanations are good explanations.

20. See Frolich (1980), especially the photographs on p. 154.

21. Indeed, the only detailed critiques of van Fraassen's treatment of explanation so far published of which I am aware are in Salmon (1984) and Kitcher and Salmon (1987). The criticisms expressed in my work are entirely different from those given in Kitcher and Salmon. Achinstein (1983) gives brief attention to van Fraassen's theory of explanation.

22. For van Fraassen's response to this argument, as well as to mine, see Churchland and Hooker (1985, pp. 297-300).

23. A rather good sample of the range of opinion can be found in (Churchland and Hooker, 1985) and in (Leplin, 1984). Essays by Fine, Laudan, Boyd, and McMullin can be found in the Leplin volume.

24. In his useful discussion, "Structural Explanation" (1978, pp. 139–47), Ernan McMullin stresses the causal foundations of structural explanations, but he too steers clear of quantum phenomena.

25. It is ideal in the sense not of something we should necessarily strive to realize, but, rather, of (a Platonic?) something that may not exist in the physical world. It is the sort of thing Laplace's demon might be able to realize, if it concerned itself with explanations.

26. Ironically, the published article contains a misprint, which I have corrected, in the first two words of this passage. Instead of "Is it" the original reads "It is." Has Freud struck yet again?

27. I suspect Railton might agree (see Railton, 1981, pp. 243–44).

28. At the close of §3 of his paper in this volume (Kitcher & Salmon 1989), Kitcher offers his critique of Railton and me on the issue of the role of mechanisms in explanations.

29. This was reportedly the terse recommendation of this famous architect when, many years ago, he was brought to Pittsburgh by the city fathers to give advice on what could be done to improve the city.

30. This material is incorporated, to a large degree, in Fetzer (1981). Nute was Fetzer's collaborator on the formal aspects of probabilistic causality, but not on the general theory of scientific explanation.

31. A probability of one is not equated with a universal disposition and a probability of zero is not equated with a universal negative disposition.

32. One would expect the stronger result, that p and not-q are jointly possible, to be derivable.

33. As we saw in §3.2, however, Hempel's doctrine of essential epistemic relativization of inductive-statistical explanation brought him dangerously close to the brink of deductivism.

34. I discuss this example and others in some detail (1984, pp. 111–20).

35. Railton remarks, incidentally, that he is not strongly opposed to discarding the parenthetic addendum (1981, p. 236). He remians, however, strongly opposed to the view that explanations are always arguments.

36. Popper (1959, pp. 198–205) offers a criterion for deciding when the number of micro-events is large enough to justify this kind of replacement; Watkins employs the same criterion in his account.

37. I have discussed the status of Principle I, and other closely related principles (1984, especially pp. 111–20).

Conclusion

1. It should not be supposed that all mechanical explanations appeal to unobservable mechanisms. One might explain the workings of some gadget solely in terms of observables to someone who had not noticed the mechanical relationships among them—e.g., the way in which squeezing the handbrake on a bicycle brings the bicycle to a stop. However, deeper scientific explanations do seem usually to invoke unobservables.

2. Gregory Cooper, who was an active participant in the Minnesota Workshop, independently recognized the compatability of these two approaches earlier than I did. His thought on this matter is contained in his doctoral disseration. I am happy to acknowledge his priority with respect to this point.

3. This little story was previously published (W. Salmon, 1981 pp. 115–25). I did not offer an explanation of the phenomenon in that article.

4. Objects denser than air do not move toward the front of the cabin because the pressure difference is insufficient to overcome their inertia.

5. Albert Einstein et al., "Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?" *Physical Review* 47 (1935), pp. 777–80. In *The Book of Revelations* 13:18 it is said that the number of The Beast is 666; I believe it is 777.

6. N. David Mermin, "Is the Moon Really There When No One Is Looking? Quantum Theory and Reality," *Physics Today* (1985).

Chronological Bibliography

- Designates item on scientific explanation of special significance and/or receiving more than passing mention in this essay.

☐ Designates an item not directly on scientific explanation cited in this essay.

Standard textbooks on philosophy of science—many of which contain sections on scientific explanation, without contributing to research on the subject—are not included in this bibliography.

Antiquity

• Aristotle, *Posterior Analytics*.

Modern Prehistory

1843

• Mill, John Stuart, *A System of Logic*, first edition. London: John W. Parker.

1906

• Duhem, Pierre Maurice Marie, *La Théorie physique, son objet et sa structure*, first edition. Paris. [Second edition, 1914; English translation of second edition, *The Aim and Structure of Physical Theory*. Princeton: Princeton University Press, 1954.]

1913

☐ Perrin, Jean, *Les Atomes*. Paris: Alcan. [English translation New York: Van Nostrand, 1923.]

1919

Broad, C. D., "Mechanical Explanation and Its Alternatives," *Proceedings of the Aristotelian Society* 19, pp. 85-124.

1926

Ducasse, C. J., "Explanation, Mechanism, and Teleology," *Journal of Philosophy* 23, pp. 150-55.

1935

Broad, C. D., C. A. Mace, G. F. Stout, and A. C. Ewing, "Symposium: Mechanical and Teleological Causation," *Proceedings of the Aristotelian Society*, supplementary vol. 14, pp. 83-112.

Cornforth, K., "Symposium: Explanation in History," *Proceedings of the Aristotelian Society*, supplementary vol. 14, pp. 123-41.

☐ Einstein, Albert, B. Podolsky, and N. Rosen, "Can Quantum-Mechanical Description of Reality Be Considered Complete?" *Physical Review* 47, pp. 777-80.

• Popper, Karl R., *Logik der Forschung*. Vienna: Springer. [Imprint 1935, actually published in 1934]

1942

• Hempel, Carl G., "The Function of General Laws in History," *Journal of Philosophy* 39, pp. 35–48. [Reprinted in Hempel (1965); reprint pagination used for references in this book.]

1943

☐ Goodman, Nelson, "A Query on Confirmation," *Journal of Philosophy* 40, pp. 383–85.

• Rosenblueth, Arturo, Norbert Wiener, and Julian Bigelow, "Behavior, Purpose, and Teleology," *Philosophy of Science* 10, pp. 18-24.

White, Morton, "Historical Explanation," *Mind* 52, pp. 212-29.

1945

Feigl, Herbert, "Some Remarks on the Meaning of Scientific Explanation," *Psychological Review* 52, pp. 250–59. [Reprinted in Herbert Feigl and Wilfrid Sellars, eds., *Readings in Philosophical Analysis* (New York: Appleton-Century-Crofts).]

1946

Braithwaite, R. B., "Teleological Explanations: The Presidential Address," *Proceedings of the Aristotelian Society* 47, pp. i-xx.

Hospers, John, "On Explanation," *Journal of Philosophy* 43, pp. 337–46.

Miller, D. L., "The Meaning of Explanation," *Psychological Review* 53, pp. 241–46.

1947

☐ Carnap, Rudolf, "On the Application of Inductive Logic," *Philosophy and Phenomenological Research* 8, pp. 143–47.

☐ ——(a), "Reply to Nelson Goodman," *Philosophy and Phenomenological Research* 8, pp. 461–62.

Ginsberg, Morris, "The Character of Historical Explanation," *Proceedings of the Aristotelian Society*, supplementary vol. 21, pp. 69–77.

☐ Goodman, Nelson, "The Infirmities of Confirmation Theory," *Philosophy and Phenomenological Research* 8, pp. 149–51.

☐ ——(a), "The Problem of Counterfactual Conditionals," *Journal of Philosophy* 44, pp. 113–28. [Reprinted as chap. I of Goodman's *Fact, Fiction, and Forecast* (Cambridge, MA: Harvard University Press, first edition 1955).]

MacIver, A. M., "The Character of Historical Explanation," *Proceedings of the Aristotelian Society*, supplementary vol. 21, pp. 33-50.

Miller, D. L., "Explanation vs. Description," *Philosophical Review* 56, pp. 306–12.

☐ Reichenbach, Hans, *Elements of Symbolic Logic*. New York: Macmillan Co.

Strong, E. W., "Fact and Understanding in History," *Journal of Philosophy* 44, pp. 617–25.

Walsh, W. H., "The Character of Historical Explanation," *Proceedings of the Aristotelian Society*, supplementary vol. 21, pp. 51–68.

The First Decade

1948

• Hempel, Carl G., and Paul Oppenheim, "Studies in the Logic of Explanation," *Philosophy of Science* 15, pp. 135–75. [Reprinted in Hempel (1965); reprint pagination used for references in this book.]

☐ Quine, Willard van Orman, "Two Dogmas of Empiricism," *Philosophical Review* 60, pp. 20–43.

1949

Feigl, Herbert, "Some Remarks on the Meaning of Scientific Explanation," in Herbert Feigl and Wilfrid Sellars, eds., *Readings in Philosophical Analysis* (New York: Appleton-Century-Crofts), pp. 510–14.

Flew, Antony, "Psychoanalytic Explanation," *Analysis* 10, pp. 8–15.

Kneale, William, *Probability and Induction*. Oxford: Clarendon Press, pp. 92–110. [Reprinted, under the title "Induction, Explanation, and Transcendent Hypotheses," in Herbert Feigl and May Brodbeck, eds., *Readings in the Philosophy of Science* (New York: Appleton-Century-Crofts, 1953), pp. 353–67.]

☐ Merton, R. K., *Social Theory and Social Structure*. New York: Free Press. [Second edition, revised and enlarged, 1957.]

1950

☐ Carnap, Rudolf, *Logical Foundations of Probability*. Chicago: University of Chicago Press. [Second edition 1962.]

Cohen, Jonathan, "Teleological Explanation," *Proceedings of the Aristotelian Society* 51, pp. 225–92.

Nagel, Ernest, "Mechanistic Explanation and Organismic Biology," *Philosophy and Phenomenological Research* 11, pp. 327–38.

Taylor, Richard, "Comments on the Mechanistic Conception of Purposefulness," *Philosophy of Science* 17, pp. 310–17.

☐ Velikovsky, Immanuel, *Worlds in Collision*. Garden City, N. Y.: Doubleday & Co.

Wilkie, J. S., "Causation and Explanation in Theoretical Biology," *British Journal for the Philosophy of Science* 1, pp. 273–90.

1951

Deutsch, Karl W., "Mechanism, Teleology and Mind," *Philosophy and Phenomenological Research* 12, pp. 185–223.

Nilson, S. S., "Mechanics and Historical Laws," *Journal of Philosophy* 48, pp. 201–11.

1952

☐ Carnap, Rudolf, *The Continuum of Inductive Methods*. Chicago: University of Chicago Press.

• Gardiner, Patrick, *The Nature of Historical Explanation*. Oxford: Clarendon Press.

☐ Radcliffe-Brown, A. R., *Structure and Function in Primitive Society*. London: Cohen and West Ltd.

Strong, E. W., "Criteria of Explanation in History," *Journal of Philosophy* 49, pp. 57–67.

Watkins, J. W. N., "Ideal Types and Historical Explanation," *British Journal for the Philosophy of Science* 3, pp. 22–43.

1953

• Braithwaite, Richard Bevin, *Scientific Explanation*. Cambridge: Cambridge University Press.

Gregory, R. L., "On Physical Model Expanations in Psychology," *British Journal for the Philosophy of Science* 4, pp. 192–97.

Hofstadter, Albert, "Universality, Explanation, and Scientific Law," *Journal of Philosophy* 50, pp. 101–15.

Nagel, Ernest, "Teleological Explanation and Teleological Systems," in Sidney Ratner, ed., *Vision and Action* (Rutgers University Press: New Brunswick, NJ), pp. 192–223.

Skinner, B. F., "The Scheme of Behavior Explanations," in B. F. Skinner, *Science and Human Behavior* (New York: Free Press).

☐ Toulmin, Stephen, *The Philosophy of Science*. London: Hutchinson's University Library.

☐ Wittgenstein, Ludwig, *Philosophical Investigations*. New York: Macmillan.

1954

Brown, Robert, "Explanation by Laws in Social Science," *Philosophy of Science* 21, pp. 25–32.

Dray, William H., "Explanatory Narrative in History," *Philosophical Quarterly* 4, pp. 15–27.

☐ Malinowski, B., *Magic, Science and Religion, and Other Essays*. Garden City, N. Y.: Doubleday Anchor Books.

☐ Reichenbach, Hans, *Nomological Statements and Admissible Operations*. Amsterdam: North-Holland Publishing Co.

1955

Gallie, W. B., "Explanations in History and the Genetic Sciences," *Mind* 64, pp. 161–67. [Reprinted in Gardiner (1959), pp. 386–402.]

Gluck, Samuel E., "Do Statistical Laws Have Explanatory Efficacy?" *Philosophy of Science* 22, pp. 34–38.

☐ Goodman, Nelson, *Fact, Fiction, and Forecast*. Cambridge: Harvard University Press.

Hayek, F. A., "Degrees of Explanation," *British Journal for the Philosophy of Science* 6, pp. 209–25.

1956

Danto, Arthur C., "On Explanations in History," *Philosophy of Science* 23, pp. 15–30.

Ellis, Brian, "The Relation of Explanation to Description," *Mind* 65, pp. 498–506.

Feigl, Herbert, and Michael Scriven, eds., *Minnesota Studies in the Philosophy of Science*, vol. I. Minneapolis: University of Minnesota Press.

Hospers, John, "What is Explanation?" in Antony Flew, ed., *Essays in Conceptual Analysis* (London: Macmillan & Co., Ltd), pp. 94–119.

Hutten, E. H., "On Explanation in Psychology and in Physics," *British Journal for the Philosophy of Science* 7, pp. 73–85.

• Nagel, Ernest, "A Formalization of Functionalism (With Special Reference to its Application in the Social Sciences)," in Ernest Nagel, Logic Without Metaphysics (Glencoe, Ill.: The Free Press), pp. 247–83.

☐ Reichenbach, Hans, *The Direction of Time*. Berkeley & Los Angeles: University of California Press.

1957

Argyle, Michael, "Explanation of Social Behaviour," in Michael Argyle, *The Scientific Study of Social Behaviour* (London: Methuen), chap. 3.

• Donagan, Alan, "Explanation in History," *Mind* 66, pp. 145–64. [Reprinted in Gardiner (1959).]

• Dray, William, *Laws and Explanation in History*. London: Oxford University Press.

Frankel, Charles, "Explanation and Interpretation in History," *Philosophy of Science* 24, pp. 137–55. [Reprinted in Gardiner (1959), pp. 408–27.]

Goldstein, L. J., "The Logic of Explanation in Malinowskian Anthropology," *Philosophy of Science* 24, pp. 156–66.

Madden, Edward H., "The Nature of Psychological Explanation," *Methodos* 9, pp. 53–63.

☐ Merton, R. K., *Social Theory and Social Structure*, 2nd ed., revised and enlarged. New York: Free Press.

• Scheffler, Israel, "Explanation, Prediction, and Abstraction," *British Journal for the Philosophy of Science* 7, pp. 293–309.

Watkins, J. W. N., "Historical Explanation in the Social Sciences," *British Journal for the Philosophy of Science* 8, pp. 104–17.

The Second Decade

1958

Feigl, Herbert, Michael Scriven, and Grover Maxwell, *Minnesota Studies in the Philosophy of Science* II. Minneapolis: University of Minnesota Press.

Goudge, T. A., "Causal Explanations in Natural History," *British Journal for the Philosophy of Science* 9, pp. 194–202.

☐ Hanson, Norwood Russell, *Patterns of Discovery*. Cambridge: Cambridge University Press.

• Hempel, Carl G., "The Theoretician's Dilemma," in Feigl et al. (1958), pp. 37–98. [Reprinted in Hempel (1965); reprint pagination used for references in this book.]

Papandreou, Andreas G., "Explanation and Prediction in Economics," *Science* 129, pp. 1096–1100.

Passmore, John, "Law and Explanation in History," *Australian Journal of Politics and History* 4, pp. 269–76.

Rescher, Nicholas, "On Prediction and Explanation," *British Journal for the Philosophy of Science* 8, pp. 281–90.

□ ——(a), "A Theory of Evidence," *Philosophy of Science* 25, pp. 83–94.

• Scheffler, Israel, "Thoughts on Teleology," *British Journal for the Philosophy of Science* 9, pp. 265–84.

• Scriven, Michael, "Definitions, Explanations, and Theories," in Feigl, Scriven, and Maxwell (1958), pp. 99–195.

Skarsgard, Lars, "Some Remarks on the Logic of Explanation," *Philosophy of Science* 25, pp. 199–207.

Yolton, J. W., "Philosophical and Scientific Explanation," *Journal of Philosophy*" 55, pp. 133–43.

1959

Beattie, J. H. M., "Understanding and Explanation in Social Anthropology," *British Journal of Sociology* 10, pp. 45–60.

Dray, William H., " 'Explaining What' in History," in Gardiner (1959), pp. 403–8.

Ebersole, F. B., and M. M. Shrewsbury, "Origin Explanations and the Origin of Life," *British Journal for the Philosophy of Science* 10, pp. 103–19.

• Gardiner, Patrick, ed., *Theories of History*. New York: The Free Press.

Hanson, Norwood Russell, "On the Symmetry Between Explanation and Prediction," *Philosophical Review* 68, pp. 349–58.

Harris, E. E., "Teleology and Teleological Explanation," *Journal of Philosophy* 56, pp. 5–25.

• Hempel, Carl G., "The Logic of Functional Analysis," in Llewellyn Gross, ed., *Symposium on Sociological Theory* (New York: Harper & Row). [Reprinted in Hempel (1965); reprint pagination used for references in this book.]

Joynt, C. B., and Nicholas Rescher, "On Explanation in History," *Mind* 68, pp. 383–88.

Pitt, Jack, "Generalizations in Historical Explanation," *Journal of Philosophy* 56, pp. 578–86.

• Popper, Karl R., *The Logic of Scientific Discovery*. New York: Basic Books. [English translation of Popper (1935).]

• Scriven, Michael, "Explanation and Prediction in Evolutionary Theory," *Science* 30, pp. 477–82.

• ——(a), "Truisms as the Grounds for Historical Explanation," in Patrick Gardiner, ed., *Theories of History* (Glencoe: The Free Press), pp. 443–75.

Stannard, Jerry, "The Role of Categories in Historical Explanation," *Journal of Philosophy*" 56, pp. 429–47.

Sutherland, N. S., "Motives as Explanations," *Mind* 68, pp. 145–59.

Yolton, J. W., "Explanation," *British Journal for the Philosophy of Science* 10, pp. 194–208.

1960

Dodwell, P. C., "Causes of Behaviour and Explanation in Psychology," *Mind* 69, pp. 1–13.

□ Hempel, Carl G., "Inductive Inconsistencies," *Synthese* 12, pp. 439–69. [Reprinted in Hempel (1965); reprint pagination used for references in this book.]

1961

Barker, Stephen, "The Role of Simplicity in Explanation," in Herbert Feigl and Grover Maxwell, eds., *Current Issues in the Philosophy of Science* (New York: Holt, Rinehart, and Winston), pp. 265–73. [See also comments by Wesley C. Salmon, Paul Feyerabend, and Richard Rudner, and Barker's replies.]

Bromberger, Sylvain, "The Concept of Explanation," Ph. D. dissertation, Princeton University.

• Eberle, R., D. Kaplan, and R. Montague, "Hempel and Oppenheim on Explanation," *Philosophy of Science* 28, pp. 418–28.

Feigl, Herbert, and Grover Maxwell, eds., *Current Issues in the Philosophy of Science*. New York: Holt, Rinehart, and Winston.

Good, I. J., "A Causal Calculus (I-II)," *British Journal for the Philosophy of Science* 11, pp. 305-18; 12, pp. 43-51. See also "Corrigenda," 13, p. 88.

• Kaplan, David, "Explanation Revisited," *Philosophy of Science* 28, pp. 429-36.

Mandelbaum, Maurice, "Historical Explanation: The Problem of 'Covering Laws'," *History and Theory* 1, pp. 229-42.

• Nagel, Ernest, *The Structure of Science: Problems in the Logic of Scientific Explanation*. New York: Harcourt, Brace & World.

Rescher, Nicholas, and Carey B. Joynt, "The Problem of Uniqueness in History," *History and Theory* 1, pp. 150-62.

Scriven, Michael, "Discussion: Comments on Weingartner," *Philosophy of Science* 28, p. 306.

Sellars, Wilfrid, "The Language of Theories," in Herbert Feigl and Grover Maxwell, eds., *Current Issues in the Philosophy of Science* (New York: Holt, Rinehart, and Winston), pp. 57-77.

Stover, R. C., "Dray on Historical Explanation," *Mind* 70, pp. 540-43.

• Toulmin, Stephen, *Foresight and Understanding*. Bloomington: Indiana University Press.

Weingartner, Rudolph H., "Discussion: Explanations and Their Justifications," *Philosophy of Science* 28, pp. 300-5.

——(a), "The Quarrel about Historical Explanation," *Journal of Philosophy* 58, pp. 29-45.

1962

Alexander, Peter, "Rational Behaviour and Psychoanalytic Explanation," *Mind* 71, pp. 326-41.

Bartley, W. W. III, "Achilles, the Tortoise, and Explanation in Science and History," *British Journal for the Philosophy of Science* 13, pp. 15-33.

Brodbeck, May, "Explanation, Prediction, and 'Imperfect' Knowledge," in Feigl and Maxwell (1962), pp. 231-72.

• Bromberger, Sylvain, "An Approach to Explanation," in R. S. Butler, ed., *Analytical Philosophy—Second Series* (Oxford: Basil Blackwell), pp. 72-105. [American edition, New York: Barnes and Noble, 1965.]

Chomsky, Noam, "Explanatory Models in Linguistics," in Ernest Nagel, Patrick Suppes, and Alfred Tarski, eds., *Logic, Methodology and Philosophy of Science*, Proceedings of the 1960 International Congress (Stanford: Stanford University Press), pp. 528-50.

Feigl, Herbert, and Grover Maxwell, eds., *Minnesota Studies in the Philosophy of Science* III. Minneapolis: University of Minnesota Press.

Feyerabend, Paul, "Explanation, Reduction, and Empiricism," in Feigl and Maxwell (1962), pp. 231-72.

• Grünbaum, Adolf, "Temporally-Asymmetric Principles, Parity Between Explanation and Prediction, and Mechanism vs. Teleology," *Philosophy of Science* 29, pp. 146-70.

• Hempel, Carl G., "Deductive-Nomological vs. Statistical Explanation," in Feigl and Maxwell (1962), pp. 98-169.

——(a), "Explanation in Science and in History," in Robert G. Colodny, ed., *Frontiers of Science and Philosophy* (Pittsburgh: University of Pittsburgh Press), pp. 7-34.

Kim, Jaegwon, "Explanation, Prediction, and Retrodiction: Some Logical and Pragmatic Considerations," Ph. D. dissertation, Princeton University.

Margenau, Henry, "Is the Mathematical Explanation of Physical Data Unique?" in Ernest Nagel, Patrick Suppes, and Alfred Tarski, eds., *Logic, Methodology and Philosophy of Science*, Proceedings of the 1960 International Congress (Stanford: Stanford University Press), pp. 348-55.

Passmore, John, "Explanation in Everyday Life, in Science, and in History," *History and Theory* 2, pp. 105-23.

Rescher, Nicholas, '*The Stochastic Revolution and the Nature of Scientific Explanation*,' *Synthese* 14, pp. 200-15.

• Scriven, Michael, "Explanations, Predictions, and Laws," in Feigl and Maxwell (1962), pp. 170-230.
——(a), "Discussion: Comments on Professor Grünbaum's Remarks at the Wesleyan Meeting," *Philosophy of Science* 29, pp. 171-74.
Treisman, Michel, "Psychological Explanation: The 'Private Data' Hypothesis," *British Journal for the Philosophy of Science* 13, pp. 130-43.

1963

Alexander, Peter, *Sensationalism and Scientific Explanation*. New York: Humanities Press.
Baker, A. J., "Historical Explanation and Universal Propositions," *Australasian Journal of Philosophy* 41, pp. 317-35.
Baumrin, Bernard H., ed., *Philosophy of Science: The Delaware Seminar*, vols. 1-2. New York: John Wiley & Sons.
Brandt, Richard, and Jaegwon Kim, "Wants as Explanations of Actions," *Journal of Philosophy* 60, pp. 425-35.
• Bromberger, Sylvain, "A Theory about the Theory of Theory and about the Theory of Theories," in Baumrin (1963, vol. 2), pp. 79-105.
Brown, Robert, *Explanation in Social Science*. Chicago: Aldine Publishing Co.
Dray, William H., "Historical Explanation of Actions Reconsidered," in Hook (1963), pp. 105-35.
Fain, Haskell, "Some Problems of Causal Explanation," *Mind* 72, pp. 519-32.
Grünbaum, Adolf, "Temporally Asymmetric Principles, Parity Between Explanation and Prediction, and Mechanism versus Teleology," in Baumrin (1963, vol. 1), pp. 57-96. [Substantially the same as Grünbaum (1962).]
Hempel, Carl G., "Explanation and Prediction by Covering Laws," in Baumrin (1963, vol. 1), pp. 107-33.
Henson, R. B., "Mr. Hanson on the Symmetry of Explanation and Prediction," *Philosophy of Science* 30, pp. 60-61.
Hesse, Mary, "A New Look at Scientific Explanation," *Review of Metaphysics* 17, pp. 98-108.
Hook, Sidney, ed., *Philosophy and History*. New York: New York University Press.
• Kim, Jaegwon, "On the Logical Conditions of Deductive Explanation," *Philosophy of Science* 30, pp. 286-91.
Morgenbesser, Sidney, "The Explanatory-Predictive Approach to Science," in Baumrin (1963, vol. 1), pp. 41-55.
Rescher, Nicholas, "Discrete State Systems, Markov Chains, and Problems in the Theory of Scientific Explanation and Prediction," *Philosophy of Science* 30, pp. 325-45.
——(a), "Fundamental Problems in the Study of Scientific Explanation," in Baumrin (1963, vol. 2), pp. 41-60.
☐ Salmon, Wesley C., "On Vindicating Induction," *Philosophy of Science* 30, pp. 252-61.
• Scheffler, Israel, *The Anatomy of Inquiry*. New York: Alfred A. Knopf.
• Scriven, Michael, "The Temporal Asymmetry Between Explanations and Predictions," in Baumrin (1963, vol. 1), pp. 97-105.
——(a), "The Limits of Physical Explanation," in Baumrin (1963, vol. 2), pp. 107-35.
——(b), "New Issues in the Logic of Explanation," in Sidney Hook, ed., *Philosophy and History* (New York: New York University Press), pp. 339-61.
——(c), "Review of Ernest Nagel, *The Structure of Science*," *Review of Metaphysics* 17, pp. 403-24.
Sellars, Wilfrid, "Theoretical Explanation," in Baumrin (1963, vol. 2), pp. 61-78.

1964

Canfield, John, "Teleological Explanations in Biology," *British Journal for the Philosophy of Science* 14, pp. 285-95.
Donagan, Alan, "Historical Explanations: The Popper-Hempel Theory Reconsidered," *History and Theory* 4, pp. 3-26. [Reprinted in Dray (1966).]
Gallie, W. B., *Philosophy and the Historical Understanding*. London: Chatto & Windus.

Gustafson, Don F., "Explanation in Psychology," *Mind* 73, pp. 280–81.

Jarvie, Ian C., "Explanation in Social Science," *Philosophy of Science* 15, pp. 62-72. [Review of Robert Brown, *Explanation in Social Sciences*.]

Kim, Jaegwon, "Inference, Explanation, and Prediction," *Journal of Philosophy* 61, pp. 360–68.

Martin, Michael, "The Explanatory Value of the Unconscious," *Philosophy of Science* 31, pp. 122-32.

Sorabji, Richard, "Function," *Philosophical Quarterly* 14, pp. 289-302.

• Taylor, Charles, *The Explanation of Behaviour*. London: Routledge and Kegan Paul.

Workman, Rollin W., "What Makes an Explanation," *Philosophy of Science* 31, pp. 241-54.

1965

Ackermann, Robert, "Discussion: Deductive Scientific Explanation," *Philosophy of Science* 32, pp. 155–67.

Balmuth, Jerome, "Psychoanalytic Explanation," *Mind* 74, pp. 229–35.

Canfield, John, "Teleological Explanation in Biology: A Reply," *British Journal for the Philosophy of Science* 15, pp. 327-31.

Feyerabend, Paul, "Reply to Criticism," in Robert S. Cohen and Marx Wartofsky, eds., *Boston Studies in the Philosophy of Science* 2 (Dordrecht: D. Reidel Publishing Co.), pp. 223-61.

Gorovitz, Samuel, "Causal Judgments and Causal Explanations," *Journal of Philosophy* 62, pp. 695–711.

☐ Harman, Gilbert, "Inference to the Best Explanation," *Philosophical Review* 74, pp. 88–95.

• Hempel, Carl G., *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science*. New York: The Free Press.

• ——(a), "Aspects of Scientific Explanation," in *Aspects*.

Hesse, Mary B., "The Explanatory Function of Metaphor," in Yehoshua Bar-Hillel, ed., *Logic, Methodology and Philosophy of Science*, Proceedings of the 1964 International Congress (Amsterdam: North-Holland Publishing Co.), pp. 249–59.

• Kyburg, Henry E., Jr., "Comment," *Philosophy of Science* 32, pp. 147-51.

Lehman, Hugh, "Functional Explanation in Biology," *Philosophy of Science* 32, pp. 1-19.

——(a), "Teleological Explanation in Biology," *British Journal for the Philosophy of Science* 15, p. 327.

Mischel, Theodore, "Concerning Rational Behaviour and Psychoanalytic Explanation," *Mind* 74, pp. 71-78.

Newman, Fred, "Discussion: Explanation Sketches," *Philosophy of Science* 32, pp. 168–72.

Putnam, Hilary, "How Not to Talk about Meaning," in Robert S. Cohen and Marx Wartofsky, eds., *Boston Studies in the Philosophy of Science* 2 (Dordrecht: D. Reidel Publishing Co.), pp. 205–22.

• Salmon, Wesley C., "The Status of Prior Probabilities in Statistical Explanation," *Philosophy of Science* 32, pp. 137–46.

Sellars, Wilfrid, "Scientific Realism or Irenic Realism," in Robert S. Cohen and Marx Wartofsky, eds., *Boston Studies in the Philosophy of Science* 2 (Dordrecht: D. Reidel Publishing Co.), pp. 171-204.

Smart, J. J. C., "Conflicting Views About Explanation," in Robert S. Cohen and Marx Wartofsky, eds., *Boston Studies in the Philosophy of Science* 2 (Dordrecht: D. Reidel Publishing Co.), pp. 151-69.

1966

Ackermann, Robert, and Alfred Stenner, "A Corrected Model of Explanation," *Philosophy of Science* 33, pp. 168–71.

• Bromberger, Sylvain, "Why-Questions," in Robert G. Colodny, ed., *Mind and Cosmos* (Pittsburgh: University of Pittsburgh Press), pp. 86–111.

☐ Canfield, John, ed., *Purpose in Nature*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Canfield, John, and Keith Lehrer, "Discussion: A Note on Prediction and Deduction," *Philosophy of Science* 33, pp. 165–67.

☐ Carnap, Rudolf, *Philosophical Foundations of Physics* (edited by Martin Gardner). New York: Basic Books. [Reissued in 1974 as *An Introduction to the Philosophy of Science*.]

Collins, Arthur W., "The Use of Statistics in Explanation," *British Journal for the Philosophy of Science* 17, pp. 127–40.

——(a), "Explanation and Causality," *Mind* 75, pp. 482-85.

Dray, William H., *Philosophical Analysis and History*. New York: Harper & Row.

Feyerabend, Paul, "Article-Review: *The Structure of Science* by Ernest Nagel," *British Journal for the Philosophy of Science* 17, pp. 237–48.

Fine, Arthur I., "Explaining the Behavior of Entities," *Philosophical Review* 75, pp. 496–509.

Gruner, Rolf, "Teleological and Functional Explanation," *Mind* 75, pp. 516–26.

Hempel, Carl G., *Philosophy of Natural Science*. Englewood Cliffs, NJ: Prentice-Hall, Inc. [Unlike other introductory texts in philosophy of science, this book has profoundly influenced the views of scientists, especially behavioral scientists, on the nature of scientific explanation.]

Leach, James, "Discussion: Dray on Rational Explanation," *Philosophy of Science* 33, pp. 61–69.

Lehman, Hugh, "R. E. Merton's Concepts of Function and Functionalism," *Inquiry* 9, pp. 274–83.

Ling, J. F., "Explanation in History," *Mind* 75, pp. 589–91.

Madden, Edward H., "Explanation in Psychoanalysis and History," *Philosophy of Science* 33, pp. 278–86.

Mellor, D. H., "Inexactness and Explanation," *Philosophy of Science* 33, pp. 345–59.

Mischel, Theodore, "Pragmatic Aspects of Explanation," *Philosophy of Science* 33, pp. 40–60.

Scriven, Michael, "Causes, Connections, and Conditions in History," in Dray (1966), pp. 238–64.

Simon, Herbert A., and Nicholas Rescher, "Cause and Counterfactual," *Philosophy of Science* 33, pp. 323–40.

Stegmüller, W., "Explanation, Prediction, Scientific Systematization, and Non-Explanatory Information," *Ratio* 8, pp. 1–24.

1967

Alston, William, "Wants, Actions, and Causal Explanation," in H. Casteneda, ed., *Intentionality, Minds, and Perceptions* (Detroit: Wayne State University Press).

Angel, R. B., "Discussion: Explanation and Prediction: A Plea for Reason," *Philosophy of Science* 34, pp. 276–82.

Coffa, J. Alberto, "Feyerabend on Explanation and Reduction," *Journal of Philosophy* 64, pp. 500–8.

Cunningham, Frank, "More on Understanding in the Social Sciences," *Inquiry* 10, pp. 321–26.

Dietl, Paul, "Paresis and the Alleged Asymmetry Between Explanation and Prediction," *British Journal for the Philosophy of Science* 17, pp. 313–18.

Goh, S. T., "Discussion: Newman and Explanation Sketches," *Philosophy of Science* 34, pp. 273–75.

Gruner, Rolf, "Understanding in the Social Sciences and History," *Inquiry* 10, pp. 151–63.

Kim, Jaegwon, "Explanation in Science," in Paul Edwards, ed., *The Encyclopedia of Philosophy* (New York: Macmillan Publishing Co. and Free Press), vol. 3, pp. 159–63.

Madell, Geoffrey, "Action and Causal Explanation," *Mind* 76, pp. 34–48.

Malcolm, Norman, "Explaining Behavior," *Philosophical Review* 76, pp. 97–104.

Noble, Denis, "Charles Taylor on Teleological Explanation," *Analysis* 27, pp. 96–103.

□ Salmon, Wesley C., *The Foundations of Scientific Inference*. Pittsburgh: University of Pittsburgh Press.

Shope, Robert K., "Explanation in Terms of 'the Cause'," *Journal of Philosophy* 64, pp. 312–20.

Suchting, W. A., "Deductive Explanation and Prediction Revisited," *Philosophy of Science* 34, pp. 41–52.

Taylor, Charles, "Teleological Explanation—a Reply to Denis Noble," *Analysis* 27, pp. 141–43.

The Third Decade

1968

•Beckner, Morton, *The Biological Way of Thought*. Berkeley & Los Angeles: University of California Press.

Brody, B. A., "Confirmation and Explanation," *Journal of Philosophy* 65, pp. 282–99.

Coffa, J. A., "Discussion: Deductive Predictions," *Philosophy of Science* 35, pp. 279-83.

Finn, D. R., "Categories of Psychological Explanation," *Mind* 77, pp. 550-55.

• Fodor, Jerry A., *Psychological Explanation*. New York: Random House.

——(a), "The Appeal to Tacit Knowledge in Psychological Explanation," *Journal of Philosophy* 65, pp. 627-40.

Good, I. J., "Corroboration, Explanation, Evolving Probability, Simplicity and a Sharpened Razor," *British Journal for the Philosophy of Science* 19, pp. 123-43.

Harman, Gilbert, "Knowledge, Inference, and Explanation," *American Philosophical Quarterly* 5, pp. 161-73.

• Hempel, Carl G., "Maximal Specificity and Lawlikeness in Probabilistic Explanation," *Philosophy of Science* 35, pp. 116-33.

Humphreys, Willard C., "Discussion: Statistical Ambiguity and Maximal Specificity," *Philosophy of Science* 35, pp. 112-15.

Leach, James, "Explanation and Value Neutrality," *British Journal for the Philosophy of Science* 19, pp. 93-108.

Martin, Michael, "Situational Logic and Covering Law Explanation in History," *Inquiry* 11, pp. 388-99.

Massey, Gerald J., "Hempel's Criterion of Maximal Specificity," *Philosophical Studies* 19, pp. 43-47.

Mellor, D. H., "Two Fallacies in Charles Taylor's *Explanation of Behaviour*," *Mind* 77, pp. 124-26.

Paluch, Stanley, "The Covering Law Model of Historical Explanation," *Inquiry* 11, pp. 368-87.

Wright, Larry, "The Case Against Teleological Reductionism," *British Journal for the Philosophy of Science* 19, pp. 211-23.

1969

Aronson, Jerrold L., "Explanations without Laws," *Journal of Philosophy* 66, pp. 541-47.

Boden, Margaret A., "Miracles and Scientific Explanation," *Ratio* 11, pp. 137-44.

Goodfield, June, "Theories and Hypotheses in Biology: Theoretical Entities and Functional Explanation," in Robert S. Cohen and Marx Wartofsky, eds., *Boston Studies in the Philosophy of Science* 5, pp. 421-49.

Gruner, Rolf, "The Notion of Understanding: Replies to Cunningham and Van Evra," *Inquiry* 12, pp. 349-56.

Hanna, Joseph, "Explanation, Prediction, Description, and Information," *Synthese* 20, pp. 308-44.

Hein, Hilde, "Molecular Biology vs. Organicism: The Enduring Dispute between Mechanism and Vitalism," *Synthese* 20, pp. 238-53.

Iseminger, Gary, "Malcolm on Explanations and Causes," *Philosophical Studies* 20, pp. 73-77.

• Jeffrey, Richard C., "Statistical Explanation vs. Statistical Inference," in Nicholas Rescher, ed., *Essays in Honor of Carl G. Hempel* (Dordrecht: D. Reidel Publishing Co.), pp. 104-13. [Reprinted in Salmon, et al. (1971).]

Levi, Isaac, "Are Statistical Hypotheses Covering Laws?" *Synthese* 20, pp. 297-307.

Levison, A. B., and I. Thalberg, "Essential and Causal Explanations," *Mind* 78, pp. 91-101.

Macklin, Ruth, "Explanation and Action: Recent Issues and Controversies," *Synthese* 20, pp. 388-415.

Manier, Edward, "'Fitness' and Some Explanatory Patterns in Biology," *Synthese* 20, pp. 185-205.

McCullagh, C. B., "Narrative and Explanation in History," *Mind* 78, pp. 256-61.

Rescher, Nicholas, "Lawfulness as Mind-Dependent," in Nicholas Rescher, ed., *Essays in Honor of Carl G. Hempel* (Dordrecht: D. Reidel Publishing Co.), pp. 178-97.

Rosenkrantz, Roger D., "On Explanation," *Synthese* 20, pp. 335-70.

☐ Salmon, Wesley C., "Partial Entailment as a Basis for Inductive Logic," in Nicholas Rescher, ed., *Essays in Honor of Carl G. Hempel* (Dordrecht: D. Reidel), pp. 47-82.

Stegmüller, Wolfgang, *Wissenschaftliche Erklärung und Begründung*. Berlin, Heidelberg, & New York: Springer-Verlag.

Van Evra, James W., "Understanding in the Social Sciences Revisited," *Inquiry* 12, pp. 347-49.

Wilson, Fred, "Explanation in Aristotle, Newton, and Toulmin," *Philosophy of Science* 36, part I, pp. 291-310; part II, pp. 400-28.

1970

Ayala, Francisco J., "Teleological Explanations in Evolutionary Biology," *Philosophy of Science* 37, pp. 1-15.

Borger, R., and F. Cioffi, *Explanation in the Behavioural Sciences*. Cambridge: The University Press.

Brittan, Gordon, Jr., "Explanation and Reduction," *Journal of Philosophy* 67, pp. 446-57.

Churchland, Paul, "The Logical Character of Action-Explanations," *Philosophical Review* 79, pp. 214-36.

Ellis, B. D., "Explanation and the Logic of Support," *Australasian Journal of Philosophy* 48, pp. 177-89.

Goh, S. T., "Some Observations on the Deductive-Nomological Theory," *Mind* 79, pp. 408-14.

——(a), "The Logic of Explanation in Anthropology," *Inquiry* 13, pp. 339-59.

• Greeno, James G., "Evaluation of Statistical Hypotheses Using Information Transmitted," *Philosophy of Science* 37, pp. 279-93. [Reprinted under the title "Explanation and Information" in Salmon, et al. (1971).]

Hedman, C. G., "Gustafson on Explanation in Psychology," *Mind* 79, pp. 272-74.

• Hesse, Mary, *Models and Analogies in Science*. Notre Dame: University of Notre Dame Press.

Kyburg, Henry E., Jr., "Discussion: More on Maximal Specificity," *Philosophy of Science* 37, pp. 295-300.

Margolis, Joseph, "Puzzles regarding Explanation by Reasons and Explanation by Causes," *Journal of Philosophy* 67, pp. 187-95.

Morgan, Charles G., "Discussion: Kim on Deductive Explanation," *Philosophy of Science* 37, pp. 434-39.

Nissen, Lowell, "Canfield's Functional Translation Schema," *British Journal for the Philosophy of Science* 21, pp. 193-95.

Omer, I. A., "On the D-N Model of Scientific Explanation," *Philosophy of Science* 37, pp. 417-33.

☐ Pauling, Linus, *Vitamin C and the Common Cold*. San Francisco: W. H. Freeman and Co.

• Rescher, Nicholas, *Scientific Explanation*. New York: Free Press.

• Salmon, Wesley C., "Statistical Explanation," in Robert G. Colodny, ed., *The Nature and Function of Scientific Theories* (Pittsburgh: University of Pittsburgh Press), pp. 173-231. [Reprinted in Salmon et al. (1971).]

☐ ——(a), ed., *Zeno's Paradoxes*. Indianapolis: Bobbs-Merrill.

Schlegel, Richard, "Statistical Explanation in Physics: The Copenhagen Interpretation," *Synthese* 21, pp. 65-82.

Suppes, Patrick, *A Probabilistic Theory of Causality*. Amsterdam: North-Holland.

Taylor, Charles, "Explaining Action," *Inquiry* 13, pp. 54-89.

1971

Achinstein, Peter, *Law and Explanation*. Oxford: Clarendon Press.

Alexander, Peter, "Psychoanalysis and the Explanation of Behaviour," *Mind* 80, pp. 391-408.

Alston, William P., "The Place of Explanation of Particular Facts in Science," *Philosophy of Science* 38, pp. 13-34.

Economos, John James, "Explanation: What's It All About?" *Australasian Journal of Philosophy* 49, pp. 139-45.

Fetzer, James H., "Dispositional Probabilities," in Roger C. Buck and Robert S. Cohen, eds., *PSA 1970* (Dordrecht: D. Reidel Publishing Co.), pp. 473-82.

Gaukroger, Stephen, *Explanatory Structures*. Brighton: Harvester Press.

Greeno, James G., "Theoretical Entities in Statistical Explanation," in Roger C. Buck and Robert S. Cohen, eds., *PSA 1970* (Dordrecht: D. Reidel Publishing Co.), pp. 3-26.

Hovard, Richard B., "Theoretical Reduction: The Limits and Alternatives to Reductive Methods in Scientific Explanation," *Philosophy of the Social Sciences* 1, pp. 83-100.

Jeffrey, Richard C., "Remarks on Explanatory Power," in Roger C. Buck and Robert S. Cohen, eds., *PSA 1970* (Dordrecht: D. Reidel Publishing Co.), pp. 40-46.

Martin, Michael, "Neurophysiological Reduction and Psychological Explanation," *Philosophy of the Social Sciences* 1, pp. 161–70.

Mullane, Harvey, "Psychoanalytic Explanation and Rationality," *Journal of Philosophy* 68, pp. 413–26.

Nickles, Thomas, "Covering Law Explanation," *Philosophy of Science* 38, pp. 542–61.

Nilson, Sten Sparre, "Covering Laws in Historical Practice," *Inquiry* 14, pp. 445–63.

Ruse, Michael, "Discussion: Functional Statements in Biology," *Philosophy of Science* 38, pp. 87–95.

Salmon, Wesley C., "Explanation and Relevance," in Roger C. Buck and Robert S. Cohen, eds., *PSA 1970* (Dordrecht: D. Reidel Publishing Co.), pp. 27–39.

• Salmon, Wesley C., et al., *Statistical Explanation and Statistical Relevance*. Pittsburgh: University of Pittsburgh Press.

• von Wright, G. H., *Explanation and Understanding*. Ithaca, NY: Cornell University Press.

Watson, Patty Jo, Steven A. LeBlanc, and Charles Redman, *Explanation in Archaeology: An Explicitly Scientific Approach*. New York: Columbia University Press. [Second edition, Watson et al., (1984).]

White, J. E., "Avowed Reasons and Causal Explanation," *Mind* 80, pp. 238–45.

Zaffron, Richard, "Identity, Subsumption, and Scientific Explanation," *Journal of Philosophy* 68, pp. 849–60.

1972

Ball, Terrence, "On 'Historical' Explanation," *Philosophy of the Social Sciences* 2, pp. 181–92.

☐ Binford, Lewis, *An Archaeological Perspective*. New York: Harcourt.

Boden, Margaret A., *Purposive Explanation in Psychology*. Cambridge, MA: Harvard University Press.

Brody, Baruch, "Towards an Aristotelian Theory of Scientific Explanation," *Philosophy of Science* 39, pp. 20–31.

Fabian, Robert G., "Human Behavior in Deductive Social Theory: The Example of Economics," *Inquiry* 15, pp. 411–33.

Harré, Rom, and P. F. Secord, *The Explanation of Social Behaviour*. Totowa, N.J.: Rowman and Littlefield.

Lehman, Hugh, "Statistical Explanation," *Philosophy of Science* 39, pp. 500–6.

Martin, Michael, "Confirmation and Explanation," *Analysis* 32, pp. 167–69.

——(a), "Explanation in Social Science: Some Recent Work," *Philosophy of the Social Sciences* 2, pp. 61–81.

Miettinen, Seppo K., "Discussion: On Omer's Model of Explanation," *Philosophy of Science* 39, pp. 249–51.

Morgan, Charles G., "Discussion: On Two Proposed Models of Explanation," *Philosophy of Science* 39, pp. 74–81.

☐ Nye, Mary Jo, *Molecular Reality*. London: Macdonald.

Rapoport, Anatol, "Explanatory Power and Explanatory Appeal of Theories," *Synthese* 24, pp. 321–42.

Tuomela, Raimo, "Deductive Explanation of Scientific Laws," *Journal of Philosophical Logic* 1, pp. 369–92.

Varela, Francisco G., and Humberto R. Maturana, "Discussion: Mechanism and Biological Explanation," *Philosophy of Science* 39, pp. 378–82.

Wallace, William A., *Causality and Scientific Explanation*. Ann Arbor: University of Michigan Press.

White, J. E., "Hedman on Explanation," *Mind* 81, pp. 595–96.

Wimsatt, William, "Teleology and the Logical Structure of Function Statements," *Studies in the History and Philosophy of Science* 3, pp. 1–80.

Wright, Larry, "Explanation and Teleology," *Philosophy of Science* 39, pp. 204–18.

——(a), "Discussion: A Comment on Ruse's Analysis of Function Statements," *Philosophy of Science* 39, pp. 512–14.

1973

Bennett, P. W., "Avowed Reasons and the Covering Law Model," *Mind* 82, pp. 606-7.
• Coffa, J. Alberto, *The Foundations of Inductive Explanation.* Doctoral dissertation, University of Pittsburgh.
☐ DeWitt, Bryce S., and Neill Graham, *The Many-Worlds Interpretation of Quantum Mechanics.* Princeton: Princeton University Press.
Finocchiaro, Maurice A., *History of Science as Explanation.* Detroit: Wayne State University Press.
Gower, Barry, "Martin on Confirmation and Explanation," *Analysis* 33, pp. 107-9.
Hull, David, "A Belated Reply to Gruner," *Mind* 82, pp. 437-38.
Krausser, Peter, "A Cybernetic Systemstheoretical Approach to Rational Understanding and Explanation, especially Scientific Revolutions with Radical Meaning Change," *Ratio* 15, pp. 221-46.
☐ Lewis, David, *Counterfactuals.* Cambridge, MA.: Harvard University Press.
Morgan, Charles G., "Discussion: Omer on Scientific Explanation," *Philosophy of Science* 40, pp. 110-17.
Nickles, Thomas, "Discussion: Explanation and Description Relativity," *Philosophy of Science* 40, pp. 408-14.
Ruse, Michael, *Philosophy of Biology.* London: Hutchinson University Library.
——(a), "Discussion: A Reply to Wright's Analysis of Functional Statements," *Philosophy of Science* 40, pp. 277-80.
——(b), "Teleological Explanations and the Animal World," *Mind* 82, pp. 433-36.
Salmon, Wesley C., "Reply to Lehman," *Philosophy of Science* 40, pp. 397-402.
Shelanski, V. B., "Nagel's Translations of Teleological Statements: A Critique," *British Journal for the Philosophy of Science* 24, pp. 397-401.
Sklar, Lawrence, "Statistical Explanation and Ergodic Theory," *Philosophy of Science* 40, pp. 194-212.
Srzednicki, Jan, "Statistical Indeterminism and Scientific Explanation," *Synthese* 26, pp. 197-204.
• Stegmüller, Wolfgang, *Probleme und Resultate der Wissenschaftstheorie und analytischen Philosophie,* Band 4, Studienausgabe Teil E. Berlin/New York: Springer-Verlag.
Steinberg, Danny, "Discussion: Nickles on Intensionality and the Covering Law Model," *Philosophy of Science* 40, pp. 403-7.
Stemmer, Nathan, "Discussion: Brody's Defense of Essentialism," *Philosophy of Science* 40, pp. 393-96.
Tondl, Ladislav, *Scientific Procedures, Boston Studies in the Philosophy of Science* 10, chap. V.
Wright, Larry, "Function," *Philosophical Review* 82, pp. 139-68.

1974

Bogen, James, "Moravcsik on Explanation," *Synthese* 28, pp. 19-26.
Brody, Baruch, "More on Confirmation and Explanation," *Philosophical Studies* 26, pp 73-75.
Buroker, Jill Vance, "Kant, the Dynamical Tradition, and the Role of Matter in Explanation," in Kenneth F. Schaffner and Robert S. Cohen, eds., *PSA 1972* (Dordrecht: D. Reidel Publishing Co.), pp. 153-64.
• Coffa, J. Alberto, "Hempel's Ambiguity," *Synthese* 28, pp. 141-63.
Collins, Paul W., "The Present Status of Anthropology as an Explanatory Science," in Raymond J. Seeger and Robert S. Cohen, eds., *Philosophical Foundations of Physics, Boston Studies in the Philosophy of Science* 11, pp. 337-48.
• Fetzer, James H., "Grünbaum's 'Defense' of the Symmetry Thesis," *Philosophical Studies* 25, pp. 173-87.
• ——(a), "Statistical Explanations," in Kenneth Schaffner and Robert S. Cohen, eds., *PSA 1972* (Dordrecht: D. Reidel Publishing Co.), pp. 337-47.
• ——(b), "A Single Case Propensity Theory of Explanation," *Synthese* 28, pp. 87-97.
• Friedman, Michael, "Explanation and Scientific Understanding," *Journal of Philosophy* 71, pp. 5-19.
• Grene, Marjorie, *The Understanding of Nature: Essays in the Philosophy of Biology.* Dordrecht: D. Reidel Publishing Co.

Hopson, Ronald C., "The Objects of Acceptance: Competing Scientific Explanations," in Kenneth Schaffner and Robert S. Cohen, eds., *PSA 1972* (Dordrecht: D. Reidel Publishing Co.), pp. 349-63.

Klein, Martin J., "Boltzmann, Monocycles and Mechanical Explanation," in Raymond J. Seeger and Robert S. Cohen, eds., *Philosophical Foundations of Physics, Boston Studies in the Philosophy of Science* 11, pp. 155-75.

☐ Mackie, J. L., *The Cement of the Universe*. Oxford: Clarendon Press.

Mayr, Ernst, "Teleologica and Teleonomic, a New Analysis," in Robert S. Cohen and Marx Wartofsky, eds., *Boston Studies in the Philosophy of Science* 14, pp. 91-118.

Moravcsik, Julius M. E., "Aristotle on Adequate Explanations," *Synthese* 28, pp. 3-18.

Salmon, Wesley C., "Comments on 'Hempel's Ambiguity' by J. Alberto Coffa," *Synthese* 28, pp. 165-69.

Singleton, J., "The Explanatory Power of Chomsky's Transformational Generative Grammar," *Mind* 83, pp. 429-31.

• Teller, Paul, "On Why-Questions," *Nous* 8, pp. 371-80.

Thorpe, Dale A., "Discussion: The Quartercentenary Model of D-N Explanation," *Philosophy of Science* 41, pp. 188-95.

Wigner, Eugene P., "Physics and the Explanation of Life," in Raymond J. Seeger and Robert S. Cohen, eds., *Philosophical Foundations of Physics, Boston Studies in the Philosophy of Science* 11, pp. 119-32.

Wright, Larry, "Mechanisms and Purposive Behavior," *Philosophy of Science* 41, pp. 345-60.

1975

Achinstein, Peter, "The Object of Explanation," in Körner (1975), pp. 1-45. [See also comments by Rom Harré and Mary Hesse, and Achinstein's reply.]

Baublys, Kenneth K., "Discussion: Comments on Some Recent Analyses of Functional Statements in Biology," *Philosophy of Science* 42, pp. 469-86.

• Brody, Baruch, "The Reduction of Teleological Sciences," *American Philosophical Quarterly* 12, pp. 69-76.

Burian, Richard M., "Conceptual Change, Cross-Theoretical Explanation, and the Unity of Science," *Synthese* 32, pp. 1-28.

Crowell, E., "Causal Explanation and Human Action," *Mind* 84, pp. 440-42.

Cummins, Robert, "Functional Analysis," *Journal of Philosophy* 72, 741-65.

Eglin, Peter, "What Should Sociology Explain—Regularities, Rules or Interpretations?" *Philosophy of the Social Sciences* 5, pp. 277-92.

Englehardt, H. T., Jr., and S. F. Spicker, eds., *Evaluation and Explanation in the Biomedical Sciences*. Dordrecht: D. Reidel Publishing Co.

Fetzer, James H., "On the Historical Explanation of Unique Events," *Theory and Decision* 6, pp. 87-97.

——(a), "Discussion Review: Achinstein's *Law and Explanation*," *Philosophy of Science* 42, pp. 320-33.

☐ Few, A. A., "Thunder," *Scientific American* 233, no. 1 (July), pp. 80-90.

Good, I. J., "Explicativity, Corroboration, and the Relative Odds of Hypotheses," *Synthese* 30, pp. 39-74.

Koertge, Noretta, "An Exploration of Salmon's S-R Model of Explanation," *Philosophy of Science* 42, pp. 270-74.

——(a), "Popper's Metaphysical Research Program for the Human Sciences," *Inquiry* 18, pp. 437-62.

• Körner, Stephan, ed., *Explanation*. Oxford: Basil Blackwell.

Martin, Michael, "Explanation and Confirmation Again," *Analysis* 36, pp. 41-42.

Minton, Arthur J., "Discussion: Wright and Taylor: Empiricist Teleology," *Philosophy of Science* 42, pp. 299-306.

Mucciolo, Laurence F., "Neurophysiological Reduction, Psychological Explanation, and Neuropsychology," *Philosophy of the Social Sciences* 5, pp. 451-62.

Salmon, Wesley C., "Theoretical Explanation," in Körner (1975), pp. 118–45. [See also comments by L. J. Cohen and D. H. Mellor, and Salmon's reply.]

□ ——(a), *Space, Time, and Motion: A Philosophical Introduction*. Encino, CA: Dickenson Publishing Co. [Second edition, Minneapolis: University of Minnesota Press, 1980.]

Sanders, Robert E., and Larry W. Martin, "Grammatical Rules and Explanation of Behavior," *Inquiry* 18, pp. 65–82.

• Scriven, Michael, "Causation as Explanation," *Nous* 9, pp. 3–16.

Studdert-Kennedy, Gerald, *Evidence and Explanation in Social Science*. London: Routledge & Kegan Paul.

1976

Addis, Laird, "On Defending the Covering Law Model," in R. S. Cohen, C. A. Hooker, A. C. Michalos, and J. W. Van Evra, eds., *PSA 1974* (Dordrecht: D. Reidel Publishing Co.), pp. 361–68.

Beckner, Morton, "Functions and Teleology," in Grene and Mendelsohn (1976), pp. 197–212.

□ Belnap, Nuel D., Jr., and J. B. Steel, Jr., *The Logic of Questions and Answers*. New Haven: Yale University Press.

Boorse, Christopher, "Wright on Functions," *Philosophical Review* 85, pp. 70–86.

Cherry, Christopher, "Explanation and Explanation by Hypothesis," *Synthese* 33, pp. 315–40.

Davidson, Donald, "Hempel on Explaining Action," *Erkenntnis* 10, pp. 239–54.

Downes, Chauncey, "Functional Explanations and Intentions," *Philosophy of the Social Sciences* 6, pp. 215–25.

Fetzer, James H., "The Likeness of Lawlikeness," in Robert S. Cohen et al., eds., *Boston Studies in the Philosophy of Science* 32 (Dordrecht: D. Reidel Publishing Co.), pp. 337–91.

Gardenfors, Peter, "Relevance and Redundancy in Deductive Explanations," *Philosophy of Science* 43, pp. 420–31.

Girill, T. R., "The Problem of Micro-Explanation," in Frederick Suppe and Peter D. Asquith, eds., *PSA 1976*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 47–55.

——(a), "Evaluating Micro-Explanations," *Erkenntnis* 10, pp. 387–406.

• Grene, Marjorie, and Everett Mendelsohn, eds., *Topics in the Philosophy of Biology, Boston Studies in the Philosophy of Science* 27, part III, Problems of Explanation in Biology, pp. 145–263.

Grobstein, Clifford, "Organizational Levels and Explanation," in Grene and Mendelsohn (1976), pp. 145–52.

Hempel, C. G., "Dispositional Explanation and the Covering Law Model: Response to Laird Addis," in R. S. Cohen, C. A. Hooker, A. C. Michalos, and J. W. Van Evra, eds., *PSA 1974* (Dordrecht: D. Reidel Publishing Co.), pp. 369–76.

Hesslow, Germund, "Two Notes on the Probabilistic Approach to Causality," *Philosophy of Science* 43, pp. 290–92.

Jobe, Evan, "A Puzzle Concerning D-N Explanation," *Philosophy of Science* 43, pp. 542–49.

Kauffman, Stuart, "Articulation of Parts Explanation in Biology and the Rational Search for Them," in Grene and Mendelsohn (1976), pp. 245–63.

King, John L., "Statistical Relevance and Explanatory Classification," *Philosophical Studies* 30, pp. 313–21.

• Kitcher, Philip, "Explanation, Conjunction, and Unification," *Journal of Philosophy* 73, pp. 207–12.

Krüger, Lorenz, "Discussion: Are Statistical Explanations Possible?" *Philosophy of Science* 43, pp. 129–46.

Levin, Michael D., "The Extensionality of Causation and Causal-Explanatory Contexts," *Philosophy of Science* 43, pp. 266–77.

——(a), "On the Ascription of Functions to Objects, with Special Reference to Inference in Archaeology," *Philosophy of the Social Sciences* 6, pp. 227–34.

• Manninen, J., and R. Tuomela, eds., *Essays on Explanation and Understanding*. Dordrecht: D. Reidel Publishing Co. [A collection of essays pertaining to von Wright (1971).]

Martin, Rex, "Explanation and Understanding in History," in Manninen and Tuomela (1976), pp. 305–34.

McLachlan, Hugh V., "Functionalism, Causation and Explanation," *Philosophy of the Social Sciences* 6, pp. 235–40.

• Mellor, D. H., "Probable Explanation," *Australasian Journal of Philosophy* 54, pp. 231–41.

Morgan, Charles G., "Tuomela on Deductive Explanation," *Journal of Philosophical Logic* 5, pp. 511–25.

Munch, Peter A., "The Concept of Function and Functional Analysis in Sociology," *Philosophy of the Social Sciences* 6, pp. 193–214.

Nathan, N. M. L., "On the Non-Causal Explanation of Human Action," *Philosophy of the Social Sciences* 6, pp. 241–43.

Niiniluoto, Ilkka, "Inductive Explanation, Propensity, and Action," in Manninen and Tuomela (1976), pp. 335–68.

Pattee, H. H., "Physical Theories of Biological Co-ordination," in Grene and Mendelsohn (1976), pp. 153–73.

☐ Reichenbach, Hans, *Laws, Modalities, and Counterfactuals*. Berkeley & Los Angeles: University of California Press. [Reprint of Reichenbach (1954) with a new foreword by Wesley C. Salmon.]

Riedel, Manfred, "Causal and Historical Explanation," in Manninen and Tuomela (1976), pp. 3–26.

Ringen, Jon D., "Explanation, Teleology, and Operant Behaviorism: A Study of the Experimental Analysis of Purposive Behavior," *Philosophy of Science* 43, pp. 223–53.

☐ Salmon, Wesley C., foreword to Reichenbach (1954).

Simon, Thomas W., "A Cybernetic Analysis of Goal-Directedness," in Frederick Suppe and Peter D. Asquith, eds., *PSA 1976*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 56–67.

Tuomela, Raimo, "Causes and Deductive Explanation," in R. S. Cohen, C. A. Hooker, A. C. Michalos, and J. W. Van Evra, eds., *PSA 1974* (Dordrecht: D. Reidel Publishing Co.), pp. 325–60.

——(a), "Explanation and Understanding of Human Behavior," in Manninen and Tuomela (1976), pp. 183–205.

——(b), "Morgan on Deductive Explanation: A Rejoinder," *Journal of Philosophical Logic* 5, pp. 527–43.

van Fraassen, Bas C., "To Save the Phenomena," *Journal of Philosophy* 73, pp. 623–32.

Williams, Mary B., "The Logical Structure of Functional Explanations in Biology," in Frederick Suppe and Peter D. Asquith, eds., *PSA 1976*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 37–46.

Wimsatt, William C., "Complexity and Organization," in Grene and Mendelsohn (1976), pp. 174–93.

• Woodfield, Andrew, *Teleology*. New York: Cambridge University Press.

• Wright, Larry, *Teleological Explanations*. Berkeley/Los Angeles/London: University of California Press.

——(a), "Functions," in Grene and Mendelsohn (1976), pp. 213–42.

1977

Achinstein, Peter, "What Is an Explanation?" *American Philosophical Quarterly* 14, pp. 1-16.

——(a), "Function Statements," *Philosophy of Science* 44, pp. 341–67.

Causey, Robert L., *Unity of Science*. Dordrecht: D. Reidel Publishing Co.

• Coffa, J. Alberto, "Probabilities: Reasonable or True?" *Philosophy of Science* 44, pp. 186–98.

Cummins, Robert, "Programs in the Explanation of Behavior," *Philosophy of Science* 44, pp. 269–87.

Cupples, B., "Three Types of Explanation," *Philosophy of Science* 44, pp. 387–408.

Fetzer, James H., "A World of Dispositions," *Synthese* 34, pp. 397–421.

Gluck, Peter, and Michael Schmid, "The Rationality Principle and Action Explanations: Koertge's Reconstruction of Popper's Logic of Action Explanations," *Inquiry* 20, pp. 72–81.

Good, I. J., "Explicativity: A Mathematical Theory of Explanation with Statistical Applications," *Proceedings of the Royal Society of London* 354, pp. 303-30.
Goode, Terry M., "Explanation, Expansion, and the Aims of Historians: Toward an Alternative Account of Historical Explanation," *Philosophy of the Social Sciences* 7, pp. 367-84.
• Hempel, Carl G., "Nachwort 1976: Neuere Ideen zu den Problemen der statistischen Erklärung," in Carl G. Hempel, *Aspekte wissenschaftlicher Erklärung* (Berlin/New York: Walter de Gruyter), pp. 98-123.
Kung, Joan, "Aristotle on Essence and Explanation," *Philosophical Studies* 31, pp. 361-83.
Martin, Michael, "Neurophysiological Reduction and Type Identity," *Philosophy of the Social Sciences* 7, pp. 91-94.
McCarthy, Tim, "On an Aristotelian Model of Scientific Explanation," *Philosophy of Science* 44, pp. 159-66.
Nagel, Ernest, "Teleology Revisited," *Journal of Philosophy* 74, pp. 261-301. [Reprinted in Nagel, 1979.]
Nickles, Thomas, "On the Independence of Singular Causal Explanation in Social Science: Archaeology," *Philosophy of the Social Sciences* 7, pp. 163-87.
——(a), "Davidson on Explanation," *Philosophical Studies* 31, pp. 141-45.
Rosenberg, Alexander, "Concrete Occurrences vs. Explanatory Facts," *Philosophical Studies* 31, pp. 133-40.
• Salmon, Wesley C., "An 'At-At' Theory of Causal Influence," *Philosophy of Science* 44, pp. 215-24.
——(a), "Hempel's Conception of Inductive Inference in Inductive-Statistical Explanation," *Philosophy of Science* 44, pp. 180-85.
• ——(b), "Objectively Homogeneous Reference Classes," *Synthese* 36, pp. 399-414.
• ——(c), "A Third Dogma of Empiricism," in Robert Butts and Jaakko Hintikka, eds., *Basic Problems in Methodology and Linguistics* (Dordrecht: D. Reidel Publishing Co.), pp. 149-66.
——(d), "Indeterminism and Epistemic Relativization," *Philosophy of Science* 44, pp. 199-202.
Sayre, Kenneth, "Statistical Models of Causal Relations," *Philosophy of Science* 44, pp. 203-14.
Shrader, Douglas W., Jr., "Discussion: Causation, Explanation, and Statistical Relevance," *Philosophy of Science* 44, pp. 136-45.
Tuomela, Raimo, *Human Action and its Explanation*. Dordrecht: D. Reidel Publishing Co.
——(a), "Dispositions, Realism, and Explanation," *Synthese* 34, pp. 457-78.
Utz, Stephen, "Discussion: On Teleology and Organisms," *Philosophy of Science* 44, pp. 313-20.
• van Fraassen, Bas C., "The Pragmatics of Explanation," *American Philosophical Quarterly* 14, pp. 143-50.
von Bretzel, Philip, "Concerning a Probabilistic Theory of Causation Adequate for the Causal Theory of Time," *Synthese* 35, pp. 173-90.
Wright, Larry, "Rejoinder to Utz," *Philosophy of Science* 44, pp. 321-25.

The Fourth Decade

1978

Aronovitch, Hilliard, "Social Explanation and Rational Motivation," *American Philosophical Quarterly* 15, pp. 197-204.
Bridgstock, Martin, and Michael Hyland, "The Nature of Individualistic Explanation: A Further Analysis of Reduction," *Philosophy of the Social Sciences* 8, pp. 265-70.
Cummins, Robert, "Explanation and Subsumption," in Peter D. Asquith and Ian Hacking, eds., *PSA 1978*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 163-75.
Derden, J. K., "Reasons, Causes, and Empathetic Understanding," in Peter D. Asquith and Ian Hacking, eds., *PSA 1978*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 176-85.
Dorling, Jon, "Discussion: On Explanations in Physics: Sketch of an Alternative to Hempel's Account of the Explanation of Laws," *Philosophy of Science* 45, pp. 136-40.

Essler, Wilhelm K., "A Note on Functional Explanation," *Erkenntnis* 13, pp. 371-76.
Girill, T. R., "Approximative Explanation," in Peter D. Asquith and Ian Hacking, eds., *PSA 1978*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 186-96.
Glymour, Clark, "Two Flagpoles Are More Paradoxical Than One," *Philosophy of Science* 45, pp. 118-19.
• Hanna, Joseph, "On Transmitted Information as a Measure of Explanatory Power," *Philosophy of Science* 45, pp. 531-62.
Hempel, Carl G., "Dispositional Explanation," in Raimo Tuomela, ed., *Dispositions* (Dordrecht: D. Reidel Publishing Co.), pp. 137-46. [An extensively revised version of Hempel (1965), pp. 457-63.]
Levin, Michael E., and Margarita Rosa Levin, "Flagpoles, Shadows and Deductive Explanation," *Philosophical Studies* 32, pp. 293-99.
• McMullin, Ernan, "Structural Explanation," *American Philosophical Quarterly* 15, pp. 139-47.
Moor, James H., "Explaining Computer Behavior," *Philosophical Studies* 34, pp. 325-27.
Pinkard, Terry, "Historical Explanation and the Grammar of Theories," *Philosophy of the Social Sciences* 8, pp. 227-40.
Quay, Paul M., "A Philosophical Explanation of the Explanatory Functions of Ergodic Theory," *Philosophy of Science* 45, pp. 47-59.
• Railton, Peter, "A Deductive-Nomological Model of Probabilistic Explanation," *Philosophy of Science* 45, pp. 206-26.
Rosen, Deborah, "In Defense of a Probabilistic Theory of Causality," *Philosophy of Science* 45, pp. 604-13.
Saliers, Don E., "Explanation and Understanding in the Social Sciences," *Philosophy of the Social Sciences* 8, pp. 367-71.
• Salmon, Wesley C., "Why Ask, 'Why?'?—An Inquiry Concerning Scientific Explanation," *Proceedings and Addresses of the American Philosophical Association* 51, pp. 683-705.
Sayre, Kenneth, "Discussion: Masking and Causal Relatedness: An Elucidation," *Philosophy of Science* 45, pp. 633-37.
Shrader, Douglas, Jr., "Discussion: Sayre's Statistical Model of Causal Relations," *Philosophy of Science* 45, pp. 630-32.
Stern, Cindy, "Discussion: On the Alleged Extensionality of 'Causal-Explanatory Contexts'," *Philosophy of Science* 45, pp. 614-25.
Stiner, Mark, "Mathematical Explanation," *Philosophical Studies* 34, pp. 135-51.
Thagard, Paul R., "The Best Explanation: Criteria for Theory Choice," *Journal of Philosophy* 75, pp. 76-92.

1979

Chopra, Y. N., " 'Explaining and Characterizing Human Action," *Mind* 88, pp. 321-33.
Cupples, Brian, "Discussion: Moor and Schlesinger on Explanation," *Philosophy of Science* 46, pp. 645-50.
Enc, Berent, "Function Attributions and Functional Explanations," *Philosophy of Science* 46, pp. 343-65.
Fair, David, "Causation and the Flow of Energy," *Erkenntnis* 14, pp. 219-50.
• Fetzer, James H., and Donald E. Nute, "Syntax, Semantics, and Ontology: A Probabilistic Causal Calculus," *Synthese* 40, pp. 453-95.
☐ Gardner, Michael, "Realism and Instrumentalism in the 19th Century," *Philosophy of Science* 46, pp. 1-34.
Hanna, Joseph F., "An Interpretive Survey of Recent Research on Scientific Explanation," in Peter D. Asquith and Henry E. Kyburg, Jr., *Current Research in Philosophy of Science* (East Lansing, MI: Philosophy of Science Assn.), pp. 291-316.
Martin, Michael, "Reduction and Typical Individuals Again," *Philosophy of the Social Sciences* 9, pp. 77-79.

Meixner, John B., "Homogeneity and Explanatory Depth," *Philosophy of Science* 46, pp. 366–81.

Nagel, Ernest, "Teleology Revisited," in *Teleology Revisited and Other Essays in the Philosophy and History of Science* (New York: Columbia University Press), pp. 275–316. [First published in 1977.]

Nerlich, Graham, "What Can Geometry Explain," *British Journal for the Philosophy of Science* 30, pp. 69–83.

Salmon, Wesley C., "Postscript: Laws in Deductive-Nomological Explanation—An Application of the Theory of Nomological Statements," in Wesley C. Salmon, ed., *Hans Reichenbach: Logical Empiricist* (Dordrecht: D. Reidel Publishing Co.), pp. 691–94.

☐ (a), "Propensities: A Discussion Review," *Erkenntnis* 14, pp. 183–216.

Thomas, J/P, "Homogeneity Conditions on the Statistical Relevance Model of Explanation," *Philosophical Studies* 36, pp. 101–6.

Van Parijs, Philippe, "Functional Explanation and the Linguistic Analogy," *Philosophy of the Social Sciences* 9, pp. 425–44.

Wilson, Ian, "Explanatory and Inferential Conditionals," *Philosophical Studies* 35, pp. 269–78.

Wolfson, Paul, and James Woodward, "Scientific Explanation and Sklar's Views of Space and Time," *Philosophy of Science* 46, pp. 287–94.

Woodward, James, "Scientific Explanation," *British Journal for the Philosophy of Science* 30, pp. 41–67.

1980

Cooke, Roger, "Discussion: A Trivialization of Nagel's Definition of Explanation for Statistical Laws," *Philosophy of Science* 47, pp. 644–45.

Cupples, B., "Four Types of Explanation," *Philosophy of Science* 47, pp. 626–29.

Currie, Gregory, "The Role of Normative Assumptions in Historical Explanation," *Philosophy of Science* 47, pp. 456–73.

Fetzer, James H., and Donald E. Nute, "A Probabilistic Causal Calculus: Conflicting Conceptions," *Synthese* 44, pp. 241–46.

Forge, John, "The Structure of Physical Explanation," *Philosophy of Science* 47, pp. 203–26.

☐ Frohlich, Cliff, "The Physics of Somersaulting and Twisting," *Scientific American* 242 (March), pp. 154–64.

Gardenfors, Peter, "A Pragmatic Approach to Explanations," *Philosophy of Science* 47, pp. 404–23.

Good, I. J., "Some Comments on Probabilistic Causality," *Pacific Philosophical Quarterly* 61, pp. 301–4.

——(a), "A Further Note on Probabilistic Causality: Mending the Chain," *Pacific Philosophical Quarterly* 61, pp. 452–54.

Gruender, David, "Scientific Explanation and Norms in Science," in Peter D. Asquith and Ronald N. Giere, eds., *PSA 1980*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 329–35.

Hooker, C. A., "Explanation, Generality, and Understanding," *Australasian Journal of Philosophy* 58, pp. 284–90.

Humphreys, Paul, "Cutting the Causal Chain," *Pacific Philosophical Quarterly* 61, pp. 305–14.

Klein, Barbara V. E., "What Should We Expect of a Theory of Explanation," in Peter D. Asquith and Ronald N. Giere, eds., *PSA 1980*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 319–28.

Kline, A. David, "Screening-off and the Temporal Asymmetry of Explanation," *Analysis* 40, pp. 139–43.

Lambert, Karel, "Explanation and Understanding: An Open Question?" in Risto Hilpinin, ed., *Rationality in Science* (Dordrecht: D. Reidel Publishing Co.), pp. 29–34.

Laymon, Ronald, "Idealization, Explanation, and Confirmation," in Peter D. Asquith and Ronald N. Giere, eds., *PSA 1980*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 336–50.

Omer, I. A., "Minimal Law Explanation," *Ratio* 22, pp. 155–66.

Post, John F., "Infinite Regresses of Justification and of Explanation," *Philosophical Studies* 38, pp. 31–52.

• Railton, Peter, *Explaining Explanation*. Ph.D. dissertation, Princeton University.

☐ Salmon, Wesley C., "Probabilistic Causality," *Pacific Philosophical Quarterly* 61, pp. 50–74.

□ Skyrms, Brian, *Causal Necessity*. New Haven: Yale University Press.
• van Fraassen, Bas C., *The Scientific Image*. Oxford: Clarendon Press.
Woodward, James, "Developmental Explanation," *Synthese* 44, pp. 443–66.

1981

Addis, Laird, "Dispositions, Explanation, and Behavior," *Inquiry* 24, pp. 205–27.
Cooke, Roger M., "Discussion: A Paradox in Hempel's Criterion of Maximal Specificity," *Philosophy of Science* 48, pp. 327–28.
Creary, Lewis G., "Causal Explanation and the Reality of Natural Component Forces," *Pacific Philosophical Quarterly* 62, pp. 148–57.
• Fetzer, James H., *Scientific Knowledge*. Dordrecht: D. Reidel Publishing Co.
——(a), "Probability and Explanation," *Synthese* 48, pp. 371–408.
Gale, George, "The Anthropic Principle," *Scientific American* 245, no. 6 (Dec.), pp. 154–71.
• Garfinkel, Alan, *Forms of Explanation*. New Haven and London: Yale University Press.
□ Hacking, Ian, "Do We See Through a Microscope?" *Pacific Philosophical Quarterly* 62, pp. 305–22.
Hanna, Joseph, "Single Case Propensities and the Explanation of Particular Events," *Synthese* 48, pp. 409–36.
Huff, Douglas, and Stephen Turner, "Rationalizations and the Application of Causal Explanations of Human Action," *American Philosophical Quarterly* 18, pp. 213–20.
• Humphreys, Paul, "Aleatory Explanation," *Synthese* 48, pp. 225–32.
• Kitcher, Philip, "Explanatory Unification," *Philosophy of Science* 48, pp. 507–31.
Matthews, Robert J., "Explaining Explanation," *American Philosophical Quarterly* 18, pp. 71–77.
Niiniluoto, Ilkka, "Statistical Explanation," in G. Floistad, ed., *Contemporary Philosophy 1966–1978* (The Hague: Martinus Nijhoff), pp. 157–87.
——(a), "Statistical Explanation Reconsidered," *Synthese* 48, pp. 437–72.
Otte, Richard, "A Critique of Suppes' Theory of Probabilistic Causality," *Synthese* 48, pp. 167–90.
Pitt, Joseph C., *Pictures, Images, and Conceptual Change*. Dordrecht: D. Reidel Publishing Co.
• Railton, Peter, "Probability, Explanation, and Information," *Synthese* 48, pp. 233–56.
• Rogers, Ben, "Probabilistic Causality, Explanation, and Detection," *Synthese* 48, pp. 201–23.
Salmon, Merrilee H., "Ascribing Functions to Archaeological Objects," *Philosophy of the Social Sciences* 11, pp. 19–26.
Salmon, Wesley C., "Causality: Production and Propagation," in Peter D. Asquith and Ronald N. Giere, eds., *PSA 1980*, vol. 2 (East Lansing, MI: Philosophy of Science Assn.), pp. 49–69.
□ ——(a), "Rational Prediction," *British Journal for the Philosophy of Science* 32, pp. 115–25.
Suppes, Patrick, and Mario Zanotti, "When Are Probabilistic Explanations Possible?" *Synthese* 48, pp. 191–200.
Tuomela, Raimo, "Inductive Explanation," *Synthese* 48, pp. 257–94.
Wicken, Jeffrey S., "Causal Explanations in Classical and Statistical Thermodynamics," *Philosophy of Science* 48, pp. 65–77.

1982

Abel, Ruben, "What is an Explanandum?" *Pacific Philosophical Quarterly* 63, pp. 86–92.
Brown, James Robert, "Realism, Miracles, and the Common Cause," in Peter D. Asquith and Thomas Nickles, eds., *PSA 1982*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 98–105.
Cohen, G. A., "Functional Explanation, Consequence Explanation, and Marxism," *Inquiry* 25, pp. 27–56.
Ellett, Frederick S., Jr., and David P. Ericson, "On Reichenbach's Principle of the Common Cause," *Pacific Philosophical Quarterly* 64, pp. 330–40.
Farr, James, "Humean Explanations in the Moral Sciences," *Inquiry* 25, pp. 57–80.
Forge, John, "Physical Explanation: With Reference to the Theories of Hempel and Salmon," in Robert

McLaughlin, ed., *What? Where? When? Why?* (Dordrecht: D. Reidel Publishing Co.), pp. 211-29.

Glymour, Clark, "Causal Inference and Causal Explanation," in Robert McLaughlin, ed., *What? Where? When? Why?* (Dordrecht: D. Reidel Publishing Co.), pp. 179-91.

Hutchison, Keith, "What Happened to Occult Qualities in the Scientific Revolution?" *Isis* 73, pp. 233–53.

Leslie, John, "Anthropic Principle, World Ensemble, Design," *American Philosophical Quarterly* 19, pp. 141-52.

Levy, Edwin, "Critical Discussion: Causal-Relevance Explanations: Salmon's Theory and its Relation to Reichenbach," *Synthese* 50, pp. 423–45.

Lipton, Peter, "Nagel Revisited" (Review of Ernest Nagel: *Teleology Revisited*), *British Journal for the Philosophy of Science* 33, pp. 186-94.

MacKinnon, Edward M., *Scientific Explanation and Atomic Physics.* Chicago: University of Chicago Press.

Mandelbaum, Maurice, "G. A. Cohen's Defense of Functional Explanation," *Philosophy of the Social Sciences* 12, pp. 285–88.

Meixner, John, "Are Statistical Explanations Really Explanatory?" *Philosophical Studies* 42, pp. 201-7.

Pork, Andrus, "A Note on Schemes of Historical Explanation: Problem of Status," *Philosophy of the Social Sciences* 12, pp. 409-14.

• Salmon, Merrilee H., *Philosophy and Archaeology.* New York: Academic Press.

Salmon, Wesley C., "Comets, Pollen, and Dreams: Some Reflections on Scientific Explanation," in Robert McLaughlin, ed., *What? Where? When? Why?* (Dordrecht: D. Reidel Publishing Co.), pp. 155-78.

——(a), "Further Reflections," ibid., pp. 231-80.

Taylor, Denise Meyerson, "Actions, Reasons and Causal Explanation," *Analysis* 42, pp. 216-19.

van Fraassen, Bas C., "Rational Belief and the Common Cause Principle," in Robert McLaughlin, ed., *What? Where? When? Why?* (Dordrecht: D. Reidel Publishing Co.), pp. 193-209.

1983

• Achinstein, Peter, *The Nature of Explanation.* New York: Oxford University Press.

Cartwright, Nancy, *How the Laws of Physics Lie.* New York: Oxford University Press.

• Cummins, Robert, *The Nature of Psychological Explanation.* Cambridge, MA: MIT Press.

Fetzer, James H., "Probabilistic Explanations," *PSA 1982*, vol. 2, pp. 194-207.

• Hanna, Joseph, "Probabilistic Explanation and Probabilistic Causality," in Peter D. Asquith and Thomas Nickles, eds., *PSA 1982*, vol. 2, pp. 181-93.

Hausman, Daniel M., "Causal and Explanatory Asymmetry," in Peter D. Asquith and Thomas Nickles, eds., *PSA 1982*, vol. 2, pp. 43-54.

Howson, Colin, "Statistical Explanation and Statistical Support," *Erkenntnis* 20, pp. 61–78.

• Humphreys, Paul, "Aleatory Explanation Expanded," in Peter Asquith and Thomas Nickles, eds., *PSA 1982*, vol. 2, pp. 208-23.

Perry, Clifton, "The Explanatory Efficacy of Individualism," *Philosophy of the Social Sciences* 13, pp. 65-68.

Platts, Mark, "Explanatory Kinds," *British Journal for the Philosophy of Science* 34, pp. 113–48.

Short, T. L., "Teleology in Nature," *American Philosophical Quarterly* 20, pp. 311-20.

Sober, Elliott, "Equilibrium Explanation," *Philosophical Studies* 43, pp. 201-10.

Walt, Stephen, "A Note on Mandelbaum's 'G. A. Cohen's Defense of Functional Explanation'," *Philosophy of the Social Sciences* 13, pp. 483-86.

1984

Achinstein, Peter, "A Type of Non-Causal Explanation," in Peter A. French, Theodore E. Uehling, Jr., and Howard K. Wetterstein, eds., *Causation and Causal Theories, Midwest Studies in Philosophy* 9, (Minneapolis: University of Minnesota Press) pp. 221-44.

Amundson, Ron, and Laurence Smith, "Clark Hull, Robert Cummins, and Functional Analysis," *Philosophy of Science* 51, pp. 657–60.

Collins, Arthur, "Action, Causality, and Teleological Explanation," in Peter A. French, Theodore E. Uehling, Jr., and Howard K. Wetterstein, eds., *Causation and Causal Theories, Midwest Studies in Philosophy* 9, pp. 345–70.

Fetzer, James H., "Review of Peter Achinstein, *The Nature of Explanation*," *Philosophy of Science* 51, pp. 516–19.

☐ Leplin, Jerrett, ed., *Scientific Realism*. Berkeley/Los Angeles/London: University of California Press.

McMullin, Ernan, "Two Ideals of Explanation in Natural Science," in Peter A. French, Theodore E. Uehling, Jr., and Howard K. Wetterstein, eds., *Causation and Causal Theories, Midwest Studies in Philosophy* 9, pp. 205–20.

Nissen, Lowell, "Discussion: Woodfield's Analysis of Teleology," *Philosophy of Science* 51, pp. 488–94.

Papineau, David, "Representation and Explanation," *Philosophy of Science* 51, pp. 550–72.

• Salmon, Wesley C., *Scientific Explanation and the Causal Structure of the World*. Princeton: Princeton University Press.

☐ ——(a), *Logic*, third edition. Englewood Cliffs, NJ: Prentice-Hall.

• Sintonen, Matti, *The Pragmatics of Scientific Explanation. Acta Philosophica Fennica* 37. Helsinki: Societas Philosophica Fennica.

——(a), "On the Logic of Why-Questions," in Peter D. Asquith and Philip Kitcher, eds., *PSA 1984*, vol. 1 (East Lansing, MI: Philosophy of Science Assn.), pp. 168–76.

• Sober, Elliott, "Common Cause Explanation," *Philosophy of Science* 51, pp. 212–41.

Tuomela, Raimo, "Social Action-Functions," *Philosophy of the Social Sciences* 14, pp. 133–48.

• Watkins, John, *Science and Scepticism*. Princeton: Princeton University Press.

Watson, Patty Jo, Steven A. LeBlanc, and Charles Redman, *Archaeological Explanation: The Scientific Method in Archaeology*. New York: Columbia University Press.

Woodward, James, "Explanatory Asymmetries," *Philosophy of Science* 51, pp. 421–42.

——(a), "A Theory of Singular Causal Explanation," *Erkenntnis* 21, pp. 231–62.

1985

Apel, Karl-Otto, *Understanding and Explanation: A Transcendental-Pragmatic Perspective*. Cambridge, MA: MIT Press.

Carleton, Lawrence R., "Levels in Discription and Explanation," *Philosophy Research Archives* 9, pp. 89–110.

☐ Churchland, Paul M., and Clifford A. Hooker, *Images of Science*. Chicago: University of Chicago Press.

Doppelt, Gerald, "Finocchiaro on Rational Explanation," *Synthese* 62, pp. 455–58.

Ehring, Douglas, "Dispositions and Functions: Cummins on Functional Analysis," *Erkenntnis* 23, pp. 243–50.

Finocchiaro, Maurice A., "Aspects of the Logic of History-of-Science Explanation," *Synthese* 62, pp. 429–54.

Grene, Marjorie, "Explanation and Evolution," in Robert S. Cohen and Marx Wartofsky, eds. *A Portrait of Twenty-five Years* (Dordrecht: D. Reidel Publishing Co.), pp. 177–97.

Hausman, David B., "The Explanation of Goal-Directed Behavior," *Synthese* 65, pp. 327–46.

Heil, John, "Rationality and Psychological Explanation," *Inquiry* 28, pp. 359–71.

☐ Humphreys, Paul, "Why Propensities Cannot Be Probabilities," *Philosophical Review* 94, pp. 557–70.

• Jobe, Evan K., "Explanation, Causality, and Counterfactuals," *Philosophy of Science* 52, pp. 357–89.

• Kitcher, Philip, "Two Approaches to Explanation," *Journal of Philosophy* 82, pp. 632–39.

——, van Fraassen, B., and Salmon, W. "Symposium on Wesley Salmon's *Scientific Explanation and the Causal Structure of the World,*" *Journal of Philosophy* 82, pp. 632–54.

☐ Mermin, N. David, "Is the Moon There When Nobody Looks? Reality and the Quantum Theory," *Physics Today* 38 (no. 4, April), pp. 38–47.

Olding, A., "Short on Teleology," *Analysis* 45, pp. 158-61.

Papineau, David, "Probabilities and Causes," *Journal of Philosophy* 82, pp. 57-74.

Pearce, David, and Veikko Rantala, "Approximative Explanation is Deductive Nomological," *Philosophy of Science* 52, pp. 126–40.

Prior, Elizabeth W., "What is Wrong with Etiological Accounts of Biological Function?" *Pacific Philosophical Quarterly* 66, pp. 310–28.

• Salmon, Wesley C., "Empiricism: The Key Question," in Nicholas Rescher, ed., *The Heritage of Logical Positivism* (Lanham, MD: University Press of America), pp. 1–21.

——(a), "Conflicting Conceptions of Scientific Explanation," *Journal of Philosophy* 82, pp. 651-54.

• Sober, Elliott, "A Plea for Pseudo-Processes," *Pacific Philosophical Quarterly* 66, pp. 303–9.

• van Fraassen, Bas C., "Salmon on Explanation," *Journal of Philosophy* 82, pp. 639–51.

Wilson, Fred, *Explanation, Causation, and Deduction.* Dordrecht: D. Reidel Publishing Co.

1986

Achinstein, Peter, "The Pragmatic Character of Explanation," in Peter D. Asquith and Philip Kitcher, eds., *PSA 1984*, vol. 2 (East Lansing, MI: Philosophy of Science Assn.), pp. 275–92.

☐ Barrow, John D., and Frank J. Tipler, *The Anthropic Cosmological Principle.* Oxford: Clarendon Press.

Bromberger, Sylvain, "On Pragmatic and Scientific Explanation: Comments on Achinstein's and Salmon's Papers," in Peter D. Asquith and Philip Kitcher, eds., *PSA 1984*, vol. 2 (East Lansing, MI: Philosophy of Science Assn.), pp. 306–25.

☐ Earman, John, *A Primer of Determinism.* Dordrecht: D. Reidel Publishing Co.

Forge, John, "The Instance Theory of Explanation," *Australasian Journal of Philosophy* 64, pp. 127–42.

Humphreys, Paul, "Review of *Scientific Explanation and the Causal Structure of the World* by Wesley C. Salmon," *Foundations of Physics* 16, 1211–16.

Kincaid, Harold, "Reduction, Explanation, and Individualism," *Philosophy of Science* 53, pp. 492-513.

Robinson, Joseph D., "Reduction, Explanation, and the Quests of Biological Research," *Philosophy of Science* 53, pp. 333–53.

Salmon, Wesley C., "Scientific Explanation: Three General Conceptions," in Peter D. Asquith and Philip Kitcher, eds., *PSA 1984*, vol. 2 (East Lansing, MI: Philosophy of Science Assn.), pp. 293–305.

Skarda, Christine A., "Explaining Behavior: Bringing the Brain Back in," *Inquiry* 29, pp. 187–202.

Smith, Quentin, "World Ensemble Explanations," *Pacific Philosophical Quarterly 67*, pp. 73–86.

Sober, Elliott, 'Explanatory Presupposition,' *Australasian Journal of Philosophy* 64, pp. 143–49.

1987

Bigelow, John, and Robert Pargetter, "Functions," *Journal of Philosophy* 84, pp. 181-96.

Fetzer, James H., "Critical Notice: Wesley Salmon's *Scientific Explanation and the Causal Structure of the World,*" *Philosophy of Science* 54, pp. 597-610.

Grimes, Thomas R., "Explanation and the Poverty of Pragmatics," *Erkenntnis* 27, pp. 79–92.

Irzik, Gurol, and Eric Meyer, "Causal Modeling: New Directions for Statistical Explanation," *Philosophy of Science* 54, pp. 495-514.

• Kitcher, Philip, and Wesley C. Salmon, "Van Fraassen on Explanation," *Journal of Philosophy* 84, pp. 315-30.

Levine, Joseph, "*The Nature of Psychological Explanation* by Robert Cummins," *Philosophical Review* 96, pp. 249–74.

Seager, William, "Credibility, Confirmation and Explanation," *British Journal for the Philosophy of Science* 38, pp. 301-17.

Sober, Elliott, "Explanation and Causation" (Review of Wesley Salmon, *Scientific Explanation and the Causal Structure of the World), British Journal for the Philosophy of Science* 38, pp. 243-57.

Torretti, Roberto, "Do Conjunctive Forks Always Point to a Common Cause?" *British Journal for the Philosophy of Science* 38, pp. 186-94.

The Fifth Decade

1988

Grünbaum, Adolf, and Wesley C. Salmon, eds., *The Limitations of Deductivism*. Berkeley & Los Angeles: University of California Press.

Koura, Antti, "An Approach to Why-Questions," *Synthese* 74, pp. 191-206.

Pitt, Joseph C., ed., *Theories of Explanation*. New York: Oxford University Press. [An anthology on scientific explanation.]

——(a), "Galileo, Rationality and Explanation," *Philosophy of Science* 55, pp. 87-103.

• Salmon, Wesley C., "Deductivism Visited and Revisited," in Grünbaum and Salmon, (1988).

——(a), "Intuitions: Good and Not-So-Good," in William Harper and Brian Skyrms, eds., *Causation, Cause, and Credence*, vol. I (Dordrecht: Kluwer Academic Publishers), pp. 51-71.

□ Shimony, Abner, "The Reality of the Quantum World," *Scientific American* 258, no. 1 (Jan. 1988), pp. 46-53.

Temple, Dennis, "Discussion: The Contrast Theory of Why-Questions," *Philosophy of Science* 55, pp. 141-51.

1989

• Kitcher, Philip, and Wesley C. Salmon, eds., *Scientific Explanation*. Minneapolis: University of Minnesota Press.

Date Unknown

Humphreys, Paul, *The Chances of Explanation*. Princeton University Press.

van Fraassen, Bas C., *Laws and Symmetries*.