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Theorizing the World: How Explanations Reveal Reality

by

Dien Ho

A dissertation submitted to the Graduate Faculty in
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the degree of
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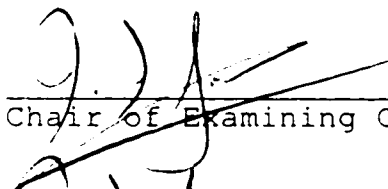
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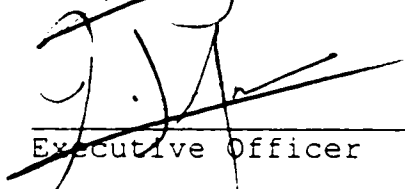
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Chapter One: The Essentially Epistemic Nature of Explanation

1.1 Introduction

The idea that explanation is closely connected to epistemic concepts like understanding, removal of puzzlement, and knowledge of the world is hardly novel. Aristotle, for one, tells us that "men do not think that they know a thing till they have grasped the 'why' of it."¹ Even Hempel, who largely purges all epistemic notions from his covering law model, recognizes the "pragmatic sense" of explanation. He tells us that in explaining something to someone, one "[makes] it plain and intelligible to him, to make him understand it."²

In the face of the intimate connection between explanation and epistemology, there has nevertheless been steadfast resistance to epistemic theories of explanation; that is, theories that explicitly define explanatory adequacy on the basis of some epistemic notions such as advancement of understanding.³ The resistance, I suspect,

¹ Physics II, chapter 3

² Hempel (1965), p. 425

³ Exceptions to this general trend include Bas van Fraassen, and Peter Gardenfors. In chapter two, I will examine their accounts in turn.

stems from worries that an epistemic theory would render explanatory adequacy a relativistic notion since what grants one person understanding might do nothing for another. Alan Musgrave typifies this line of argument,

Whether an explanation removes puzzlement depends very much on the person we are considering. What relieves one man's puzzlement may enhance the next woman's. I dare say that some of the most efficacious puzzlement relievers in the history of thought have been explanations which are not scientific at all and which are, from a scientific point of view, quite inadequate (what about "God moves in mysterious ways," said in explanation of anything whatever which is puzzling?). I dare say that on occasions the incurious have had their puzzlement removed by a scientific explanation—but they should not have. For if it is feelings of puzzlement we want to get rid of, we should turn not to science but to the whiskey bottle!⁴

To consider an epistemic concept of explanation an indispensable part of scientific reasoning, as the argument goes, is to run the risk of losing objectivity in science.⁵

Implicit behind the arguments against the epistemic theory are two non-trivial assumptions: (1) that it is possible to construct a non-epistemic theory of explanation; (2) that an epistemic theory of explanation

⁴ Curd and Cover (1998), p. 1103

⁵ We might adopt Hempel's (1965) definition of objectivity here where by "objective" he means that "scientific research seeks to account for empirical phenomena by means of laws and theories which are objective in the sense that their empirical implications and their evidential support are independent of what particular individuals happen to test or to apply them." (p. 426)

necessarily lacks any meaningful objective standard of explanatory adequacy. In this chapter, I will argue that (1) is false. My claim is that if we are to have any theory of explanation at all, it must be an epistemic theory. First, let's say something explicit about the distinction between epistemic and non-epistemic theories of explanation.

1.2 Epistemic vs. non-epistemic approach

Any analysis of the explanation concept should offer us a set of necessary and sufficient conditions such that anything that satisfies these conditions is an (adequate) explanation. An explanation relates, at the minimum, two things: the explanans (i.e., that which does the explaining) and the explanandum (i.e., that which is explained).⁶ For every instance of the schema "E explains why p," that sentence is true only if E and p stand in the

⁶ The terms "explanans" and "explanandum" were introduced by Hempel (1948). The "at the minimal" qualifier is needed because I wish to leave open the possibility that there might be other necessary conditions for explanatory adequacy. Bas van Fraassen, for example, takes the explanation relation to be a four-place relation consisting of the answer to the why-question, the topic of the question, the contrast class and the relevance relation. Likewise, one might introduce contextual information regarding the explanation episode as a part of the conditions of explanatory adequacy in order to accommodate the level debate. However, it should be clear that the three components--explanans, explanandum and the explanation relation--form the core of the explanation concept. In any case, for the purpose of this chapter, I am merely interested in one of the components.

appropriate explanatory relation. Thus, three natural questions arise in any analysis of the nature of the explanation relation: (1) What is the definition of the appropriate relation? (2) What sort of things are explananda (e.g., propositions, sentences, facts, phenomena, etc.); and (3) What sort of things are explanantia? We can categorize theories of explanation in terms of their answers to these questions. According to Hempel's Deductive-Nomological model, for example, the "appropriate relation" is logical entailment, the explanans is a group of true sentences that contains at least one indispensable law-like sentence, and the explanandum must be a full sentence that describes the explanandum-phenomenon. Alternatively, Wesley Salmon's causal model construes the appropriate relation as causality either in the form of spatio-temporal continuity or statistical relevance, and explananda and explanantia as events. Any satisfactory analysis of explanation should provide answers to these three questions.

In general, a theory of explanation is considered epistemic if the answer to any of the questions essentially contains references to typical epistemic concepts like

beliefs, knowledge, understanding, puzzlement, etc.⁷ For instance, an account of explanation that claims that the objects of explanations are psychological puzzlements would be an epistemic account even if the answers to the remaining two questions are non-epistemic. Similarly, one who argues that a particular (mind-independent) event explains another via some epistemic relation also offers an epistemic theory of explanation. It is important to keep in mind that the epistemic/non-epistemic distinction applies to analyses of the concept of explanation in general, thus, the fact that some particular explanation contains references to individual mental states (e.g., explaining actions by appealing to the agent's desires and beliefs) does not mean that the explanation is an epistemic one in our sense.

Epistemic theories of explanation have often been referred to as pragmatic theories of explanation. The conflated use of the two terms, however, is unfortunate. Typically, a pragmatic theory of a concept X entails that some features of the relevant individuals are pertinent in the definition of X. For instance, a pragmatic theory of

⁷ As I will argue shortly, there is a connection between the nature of the explanandum and whether or not a proper theory of explanation is epistemic.

meaning might say that the meaning of a given utterance is the intended meaning of the speaker implied by certain conversational maxims and the context of the conversation. In the case of explanation, a pragmatic theory likewise refers to certain features of the interlocutors in order to answer the three questions above. Yet clearly, there are features of interlocutors other than epistemic ones; therefore, an epistemic theory is a particular kind of pragmatic theory. Suppose one claims that a set of sentences is an adequate explanans for an event just in case it is offered by a person who is a well-respected specialist. Being a well-respected specialist is a property of an interlocutor; hence, the theory qualifies as a pragmatic theory. At the same time, such a theory is certainly not epistemic for it does not contain any epistemic properties, at least not in any straightforward sense. We can see that the standard criticism leveled by someone like Musgrave against pragmatic theories of explanation is instead really aimed at epistemic theories.⁸

⁸ A curious analogy emerges. Surely no semanticists would conclude that a semantic theory is inevitably "relativistic" because it makes references to features of interlocutors. One of the main goals of Grice's project is to establish objectivity in pragmatics. I suspect the opponents to epistemic theories of explanation are confusing the context-dependency of explanatory adequacy with factlessness or subjectivity.

Our definition of an epistemic theory of explanation nicely mirrors the labeling practice in contemporary philosophical discussions. Bas van Fraassen, for instance, considers his approach an epistemic view since it takes the relevance relation (a necessary component of an explanation) as dependent on the interests of the inquirers.⁹ Philip Kitcher's unification view and Sylvain Bromberger's question-based approach would also qualify as epistemic theories accordingly. Placing all these diverse theories under the same conceptual rubric brings forth the crucial difference between epistemic and non-epistemic theories. While non-epistemic theorists recognize the epistemic work done by explanations (e.g., removal of puzzlement or gain in understanding), they insist that theories of explanation should be defined independent of these practical "side-effects." Epistemic theorists, on the other hand, consider capturing the epistemic function of explanation to be an indispensable part of any successful analysis of explanation.

I will present two arguments about why a theory of explanation must be epistemic in nature. To wit, both the

⁹ To be more precise, van Fraassen himself makes the mistake of conflating the use of pragmatic and epistemic. I see no reasons why he would oppose amending his labeling practice and referring to his view as epistemic.

explananda and the explanation relation must contain epistemic elements; as such, no non-epistemic theory of explanation (such as Hempel's) can qualify as an adequate analysis.

1.3 The objects of explanations

It is commonly assumed by philosophers who work on the nature of explanation that the object of an explanation is something that exists in the world, something that is mind-independent and non-epistemic. Carl Hempel certainly subscribed to this view. For Hempel, the objects of explanations are events that are describable by full sentences. Causal theorists like Wesley Salmon who believe that explanations amount to the uncovering of causes also subscribe to this objective view. The presupposition that the object of an explanation consists of mind-independent entities has a lot of intuitive appeal. Explanations give us understanding of *an objective mind-independent reality*. So of course the object of an explanation *is* mind-independent.

The conceptual connection between understanding the world and the proper object of an explanation, however, has been largely unexplored. In fact, it has been generally taken for granted that the objects of explanations are

metaphysically clean entities like sentences, events, phenomena, etc. In most of the current debates, the question is not whether explananda are mind-independent entities but what *kinds* of mind-independent entities.

This acceptance of the mind-independent view of the explanandum has led to the favoring of a particular type of analysis of explanation. Although largely unarticulated, the implicit reasoning, I suspect, goes something like this: if the object of an explanation is an objective entity in the world and if explanation is a two-place relation of the form *A explains B*, then we have two options before us. Either the explanantia is likewise mind-independent or it is not. The latter option is a non-starter, so the argument goes, because to say so is to say that having the right beliefs, for example, explains why dinosaurs became extinct. But clearly why dinosaurs became extinct had nothing to do with what one thinks. Thus, we must conclude that both values of the two-place explanation relation are objective mind-independent things, which means that the explanation relation is a relation between entities in the world. The natural conclusion to draw, it seems to many, is that relations (such as causal connection, statistical relation and logical inferences)

serve as the only plausible candidates for the appropriate analysans.

Given this important philosophical implication, it is worthwhile for us to look closely at the question of whether explananda are *in fact* metaphysically clean entities. My contention is that the answer is "no." The objects of explanations always contain references to the epistemic conditions of the inquirers. As such, without modifications, a theory of explanation that fails to recognize this latter point is doomed to fail. More importantly, my conclusion will also undercut the motivation that I mentioned earlier in reducing the explanation relation to some objective non-epistemic relation like causality.

Before I begin, I should point out a simplification. I have been using the phrase mind-independent to refer to entities that do not include references to any epistemic states like beliefs. This is a matter of convenience that sacrifices some precision. Not all mind-dependent things are epistemic and not all epistemic things are mind-dependent. My only aim is to challenge the claim that the objects of explanations are objective things like phenomena or events independent of any epistemic point of view. Since I will largely focus on notions of the explanandum

that do not refer to any inquirer's epistemic conditions, I will use the phrase non-epistemic and mind-independent interchangeably.

We begin our investigation with a close look at Hempel's covering-law model (which was first articulated in print in 1948 in a joint paper written with Paul Oppenheim called "Studies in the Logic of Explanation"). The reason for going back to Hempel is two-fold: first, although the covering-law model has largely fallen out of favor, the contemporary analytic debate on the nature of explanation really began with Hempel's work and he has set the ground rules for all subsequent discussions. Considering the fact that we are challenging a fundamental tenet of explanation, it is wise to look at the philosophical problem in its freshness from Hempel's point of view. Second and more importantly, Hempel has made a number of insightful remarks concerning the proper object of an explanation -- these passages hide a problem that unravels the mind-independent view of the explanandum.

Hempel tells us that the objects of explanations are events or phenomena. Not all events, however, can be the objects of explanation. In his discussion of the proper objects of explanation, he raises the following important point:

In sum, a request for an explanation can be significantly made only concerning what we have called sentential facts and events; only with respect to them can we raise a question of the form 'why is it the case that p?'. As for concrete events, let us note that what we have called their aspects or characteristics are all of them describable by means of sentences; each of these aspects, then, is a sentential fact or event (e.g., that the eruption of Mt. Vesuvius in A.D. 79 lasted for so many hours; that it killed more than 1000 persons in Pompeii, and so on); with respect to such particular aspects of a concrete event, therefore, the question of an explanation can significantly be raised. And clearly, when we speak of explaining a particular event, such as the abdication of Edward VIII, we normally think only of certain aspects of the event as being under scrutiny; what aspects are thus meant to be singled out for explanatory attention will depend on the context of the inquiry.¹⁰

In other words, for Hempel, an explanation concerns "aspects of a concrete event" which are only describable by means of full sentences. This demarcation criterion between permissible and impermissible explananda strikes me as rather doubtful. After all, "Edward VIII abdicated" is a full sentence thus satisfying his full-sentence requirement; yet, the abdication of Edward VIII is supposedly a coarse event which is not a proper explanandum according to Hempel. What is the difference?

Nonetheless, there does appear to be something right about Hempel's observation that "Edward VIII abdicated" by itself can solicit multiple explanations, each aiming to

¹⁰ Hempel (1965), p. 422

explain a different aspect of the same event. "Edward VIII abdicated" is simply too descriptively coarse to pick out the proper explanandum. Let us call this problem of identifying the correct explanandum "the proper explanandum problem" ("PEP" for short). More precisely, PEP demands a proper level of metaphysical or descriptive fineness such that we can single out a unique and intended explanandum. In other words, we want to know how to individuate an explanandum such that we can correctly answer the question "what is to be explained?"

It is important to point out that PEP is not a problem between sentences and their referents. PEP points out that the intended explanandum *p* must be fine enough so that we can identify a unique object of explanation (regardless of whether *p* is a sentence, a proposition, a state of affairs, or a phenomenon). In other words, an under-differentiated *p* can solicit different explanations depending on what it is about *p* that we want to have explained. Hempel is quite right that the differentiation is often taken care of by salient contextual information. However, he is wrong in claiming that "being describable by a full sentence" is an adequate condition to avoid PEP. Take his example, "The eruption of Mt. Vesuvius in A.D. 79 killed more than 1000 persons in Pompeii." What is it about that fact that needs

to be explained? Is it the fact that it killed people in Pompeii? Or that more than 1000 people died? The sentence itself does not tell us which of these aspects is the proper object of the explanation.

Recent works on contrastive explanations have further underscored the significance of PEP. Fred Dretske's seminal paper on contrastive statements expresses similar doubts about the sufficiency of Hempel's full-sentence criterion.¹¹ Take any full sentence *S*, embed it within a larger context *C*. By altering the "contrastive contour" of *S*, one can alter the truth of *C*(*S*). For instance,

S: Peter sold his typewriter to Brian for \$100.
C: Peter's urgent need for money explains why...
C(*S*): Peter's urgent need for money explains why Peter sold his typewriter to Brian for \$100.

Whether or not *C*(*S*) is true, according to Dretske, depends on where we place the contrastive emphasis. Suppose Peter sold his typewriter as opposed to lending it to Brian because he urgently needed money, then *C*(*S*) might be true. However, if we place the emphasis instead on *Brian* because we want to know why Peter sold his typewriter to *Brian* instead of *Sue*, *C*(*S*) might be false. For the particular *S* in this example, one can place the contrastive foci in

¹¹ Dretske (1972)

apparently six different locations. Each of these variations of $C(S)$ can have different truth values. Since S is a full sentence, it satisfies Hempel's full sentence requirement but the full sentence here clearly fails to identify the proper explanandum.¹²

Peter Lipton has further elaborated on Dretske's observations.¹³ Explananda, argues Lipton, are not simple events (or whatever mind-independent entities) but they always include contrastive components. We don't explain "why p ", we explain "why p rather than q " where " q " serves as the contrastive foil to " p ." Lipton further argues that contrastive explanations cannot be reduced to non-contrastive ones. Once we explicitly amend a full sentence with the appropriate contrast to specify the intended explanandum, the contrastive explanation remains contrastive.

I will not evaluate Lipton's claim that contrastive explanations cannot be reduced to non-contrastive ones. What I want to do is to focus on his claim that the inclusion of contrastive components properly identifies the

¹² One interesting issue here is why some contexts admit of contrastive stresses and others do not. My suspicion is that contrastive stresses work only for contexts that contain modal (non-extensional) relations (e.g., believe, explain, blame).

¹³ For a detail articulation of Lipton's view, see his 1991.

objects of explanations. To judge the success of the contrastive approach, we need to ask ourselves whether the addition of contrastive foils solves PEP.

I want to argue that the addition of contrastive foils does not appear to be a sufficient measure. Consider the stories below:

Clyde tells Aaron that he plans to sell his computer for \$100 because he no longer needs the computer and he needs cash. A week later, Aaron learns from Clyde that he has instead sold his typewriter. Aaron asks, "Why did you sell your typewriter rather than your computer?"

Bob, an old friend of Clyde, knows that Clyde assigns a great deal of sentimental value to his typewriter. During a recent visit, he learned from Clyde that Clyde has sold his typewriter for \$100. Bob knows that Clyde readily could have sold his computer instead. Puzzled by Clyde's action, he asks "Why did you sell your typewriter rather than your computer?"

Although both Aaron and Bob made the same utterance "Why did you sell your typewriter rather than your computer?", there is a sense in which they asked about different things (i.e., different explananda). For Aaron, the observation that prompted his demand for an explanation was Clyde's failure to sell his computer, while for Bob, it was Clyde's selling of his treasured typewriter. The difference can be further accentuated when we observe that an answer sufficient for Aaron's question need not be sufficient for Bob's. Supposing for the moment that in response to

Aaron's question the answer "Clyde's inability to find a buyer for his computer" explains why Clyde sold his typewriter rather than his computer. The same answer is not suitable for the identical contrastive question asked by Bob. Bob does not care about Clyde's failure to sell his computer, the real question for him is why Clyde chose to sell the typewriter. This shows that contrastive inclusion is not sufficient to single out the proper explananda. Is it necessary?

David-Hillel Ruben has argued that not all explananda are contrastive in nature. He writes,

Suppose I want to explain the fact that Carl is a good philosopher. I do so by describing his excellent philosophical training, in the company of great philosophical masters. Sometimes I might have contrasts in mind: why he is a good philosopher rather than a good carpenter; why he rather than Hans is a good philosopher. But sometimes at least there is no obvious contrast, and, in the example I have mentioned, the information about his training seems to explain why he is a great philosopher, tout court. There is no obvious 'rather than' about it.¹⁴

Ruben seems right about this. Sometimes there is just no natural contrast in the explanandum. Of course, the contrastive theorist can insist that "Carl is a good philosopher" is a shorthand version of "Carl is a good philosopher rather than one that is not good" and that the

¹⁴ Ruben (1990), p. 40

ordinary context makes the contrastive explication unnecessary. If the introduction of contrastive foils aims to solve PEP, then here is an example in which the foil appears redundant. The foil adds nothing that is not already there. One standard logical analysis of "p rather than q" construction is to formalize it as "p and $\sim$ q."¹⁵ In this case, take p to be "Carl is a good philosopher", and we can then regiment "Carl is a good philosopher rather than one that is not good" as "Carl is a good philosopher and it is not the case that Carl is not a good philosopher". And of course, that is just "Carl is a good philosopher." When asked, "What is it about Carl being a good philosopher that you want to know?" the answer "That he is a good philosopher" appears to be perfectly and *literally* accurate.

Although the overall project fails, some of the contrastive lessons should not be entirely ignored. In all the examples we have examined so far, there is a common theme: the heavily interest-dependent nature of explananda. Lipton's contrastive foils succeed at times because they highlight what it is *about* the given phenomena that the inquirer wants to have explained. Ruben's good philosopher

¹⁵ See Temple (1988) for a defense of this view.

example, likewise, has force only because the literal non-contrastive utterance makes clear exactly what is of explanatory interest. These examples point to the fact that varying interests of the inquirer can lead to different explananda.

Alan Garfinkel has noticed a similar connection between contrastive foils and interests. For any question of the form "Why B rather than any of the other alternatives to B in which A is true," Garfinkel argues that it is roughly equivalent to "Given A, why B?" The "given" clause indicates "what the outer bound is on the variation in B: we are to consider only such alternatives to B as also satisfy A."¹⁶ But why should such limitation be necessary? The reason, Garfinkel believes, is

...our need to have a *limited* negation, a determinate sense of what will count as the consequent's "not" happening. Lacking such a determinate sense of alternatives, one has difficulty seeing how we could give explanations at all; they would have to be so all encompassing as to be impossible.¹⁷

To illustrate his point, Garfinkel asks us to consider the old bank robbery joke. Willie Sutton was arrested shortly after a bank robbery. While he was in prison, a priest approached him and asked "Why did you rob the bank?"

¹⁶ Garfinkel (1981), p.29

¹⁷ Ibid., p. 30

Sutton answered, "Because there was money there."

Presumably, Sutton failed to understand what the priest was really interested in knowing. The priest wanted to know why he robbed the bank rather not robbed anything at all while Sutton thought the question really was why he robbed a bank rather than some other place. The "rather than" clause in these examples nicely translate into Garfinkel's jargon. According to Garfinkel's analysis, the priest's "Why did you rob the bank?" question becomes "Given you could have robbed the bank or not, why did you rob it?" Without knowing what the priest is interested in knowing when he asks the why-question, there is no way to know what he is actually asking about. The "given clause" reveals the epistemic interests and conditions of the inquirer, it tells us what it is about the observation that is in need of an explanation from the point of view of the inquirer. So for Garfinkel, to solve PEP we must know something about the interest of the inquirer.

Garfinkel, in my opinion, comes as close to getting to the root of the problem as any of the theorists we have considered. We will return to his point again in the final chapter. From Hempel, to Dretske, to Lipton, and now to Garfinkel, the analyses point toward one conclusion: namely that the object of an explanation can only be identified by

learning about the epistemic condition/interest of the inquirer. This is strong evidence suggesting that explananda cannot be mind-independent entities like sentences, propositions, facts or phenomena. These things tell us nothing about the epistemic conditions of the inquirer, thus, they contain at best half the story. In my view, explananda are in fact ordered pairs consisting of the observation at hand (*O*) and the inquirer's body of beliefs (*B*). This $\langle O, B \rangle$ pair captures exactly why previous attempts to solve PEP have been unsuccessful. Hempel's full-sentence move is clearly inadequate for it fails to take into account one of the two components. Lipton's contrastive addition also fails. Although adding the foil does tell us a great deal about the inquirer's beliefs (satisfying *B*), it is not always explicit enough. If I am right, then surely contrastive foils are of no philosophical significance. As long as we get the right pair, whether or not we do it by contrast is irrelevant. Indeed, one might wonder just what is so important about our "rather than" construction that it alone manages to capture the object of an explanation.¹⁸

¹⁸ One hint that contrastive components cannot be necessary for explanation is that there are languages such as Chinese that do not have a "rather than" connective yet the term "explanation" functions quite adequately.

Moreover, our result is consistent and confirmed by Ruben's observation that literal non-contrastive utterances can do an adequate job of identifying the explanandum. According to our analysis, if *B* is saliently communicated some other way, *O* can remain non-contrastive.

Some examples will help to illustrate the nature of the pair $\langle O, B \rangle$. Suppose John asks "Why did Mary enter the building?" The first thing we identify is *O* and in this case it is Mary's entering the building that we are interested in. Second, we need to know something about the inquirer's beliefs (e.g., *B*) and how *O* fails to connect with *B*. Let us fill in the example with the following contextual information:

Mary and her accomplices are about to rob a bank and she is the driver of the getaway car. The inquirer, who oversees the entire heist, observes that Mary is entering the building. Surprised by the deviation from their agreed plan, he asks "Why did Mary enter the building?"

In this straightforward example, the explanandum is the observation of Mary's entering the building (*O*) relative to the inquirer's belief that Mary should act in accordance with the agreed plan and stay in the car (*B*).

Compare that with this variation. During the robbery, a pedestrian across the street sees Mary entering the building. He happens to be Mary's employer at the local

convenient store and he believes that Mary should be at work. Puzzled by the observation, he too asks "Why is Mary entering the building?" In this case, the explanandum is the ordered pair <Mary's entering the building, relevant beliefs including the belief that she should be at work>.

The important conclusion is this: explananda must contain references to beliefs. As such, any theory of explanation that does not take explananda to be epistemic entities cannot be correct and that includes Hempel's covering-law model, Salmon's causal model, Kitcher's unification, and Gardenfors' belief-contraction model. Of course, modifications might be made to salvage the plausibility of these analyses but these analyses are literally false as they stand.

Those who still wish to resist my argument might make the following reply.¹⁹ In order to account for the relativity of explanation (i.e., an answer that is adequate for one person's why-question might not be adequate for someone else asking the "same" question), they claim that the standard of explanatory adequacy and not the object of the explanation changes from context to context. A scientist might explain the breaking of a window by

¹⁹ I thank Sanford Goldberg for bring this objection to my attention.

appealing to the molecular bonds of glass molecules while a layman explains it by citing the neighbors' errant baseball. In either case, our opponents claim that both groups are explaining the same thing. What varies between these two examples is that the standard of explanatory adequacy has changed and this shift is analogous to epistemic contextualism's claim that the standard of knowledge varies according to context.

There are two responses I can make here. First, epistemic contextualism usually pins the shift of the standard of knowledge on the "scope" of the knowledge claim. As the class of relevant alternatives increases, the standard of knowledge likewise heightens. On the basis of this, we can rank knowledge claims in terms of their strength relative to their scope. No such relative ranking takes place for explanations. Moreover, there are often strict rules guiding the relationship between contexts and standards.²⁰ Not only is there no developed corresponding theory for the explanatory contextualists, worse yet, there is no hint as to *why* explanatory adequacy should vary across different contexts. Epistemic contextualists tell a story in terms of scope to explain the connection between

²⁰ David Lewis (1986) being a paradigmatic example.

contexts and standards. What is the story being told here for explanation? No doubt, what counts as an answer to one why-question in one context might not be so in a different context. From the relativity of explanation alone, it does not follow that the standard of explanatory adequacy has changed. The value of being-the-father-of varies across non-related individuals; nevertheless, there is one standard that applies across the entire domain.

Second, contextualism flies in the face of some strong pre-theoretical intuitions. Take a standard pair of contrastive statements:

Sidney decided to go to Theo's party (rather than stay home and study).

Sidney decided to go to Theo's party (rather than Sophie's party).

The contextualists tell us the reason that something might explain (i) but not (ii) is that the standard of explanatory adequacy changes between them. This is surely false. We can apply the exact same standard of explanatory adequacy in both cases (e.g., something counts as an explanation for (i) or (ii) only if it identifies a salient psychological cause for Sidney's actions). Contrast the contextualist response with the far less awkward one offered by our epistemic view. It says that sentences (i) and (ii) are about different things and the contrastive

foils highlight the difference in interests that form the objects of the explanations.

Having said that, we need not deny that the standard of explanatory adequacy might be contextually sensitive. Since explanation is closely related to understanding, we might say that what counts as understanding (like what counts as knowledge) might vary from context to context. This last claim is compatible with the view that explananda are epistemic entities. In fact, I suspect that those who are sympathetic to our opponents are conflating the two kinds of contextual dependency. The explanation relation (E) might be something like

$$E(e, \langle O, B \rangle, c)$$

that relates three things: the explanans (e), the explanandum $\langle O, B \rangle$ and the context of evaluation (c). But we should not confuse the context dependency (c) with the epistemic dependency of the explanandum. All that the contextual theorists show is that there might be an extra variable in considering the truth of an explanation but we can perfectly accommodate that within the epistemic view of the explanandum. According to our view, the relativity of explanation can occur at two different places. An answer to a given why-question might fail to satisfy a different inquirer asking the same question because the context (c)

has shifted; hence, the standard of explanatory adequacy has changed. Alternatively, it might be that the inquirer has a different set of beliefs (*B*) and therefore the explanandum has changed and in turn, the initial answer no longer applies to the new explanandum. Failure to distinguish these two types of context sensitivities has led the contextualists to conclude erroneously that the relativity of explanation can only be accounted for by accepting the claim that the standard of explanatory adequacy varies with each context. On the contrary, the epistemic view not only can account for the relativity of explanation but it can also explain the different and often subtle forms of relativity, something strict contextualism cannot do.

Let me take a step back and ask the deeper question: why should an explanandum be an ordered pair $\langle O, B \rangle$? What is the point of an explanation? Sylvain Bromberger's work on the pragmatics of explanation provides a suggestive answer. Bromberger attempts to distinguish ordinary ignorance from explanation ignorance by equating the latter kind with the lack of understanding. Examine his two following sentences:

- (1) What is the height of Mt. Kilimanjaro?
- (2) Why do tea kettles emit a humming noise just before the water begins to boil?

(1) differs from (2) because one is "prepared to say [one] does not understand why tea kettles emit a humming noise just before the water begins to boil, whereas [one is] not prepared to say anything of the sort about what the height of Mt. Kilimanjaro is."²¹ According to Bromberger, an individual is in a p-predicament with regard to (2) but not to (1) and being in a p-predicament entails a lack of understanding. More specifically, "A is in a p-predicament with regard to a particular why-question Q if and only if, on A's views, Q admits of a right answer, but A can think of no answer to which, on A's views, there are no decisive objections."²² For the Mt. Kilimanjaro question, one can think of a host of possible answers (e.g., '15,000 feet', '3 kilometers', and others) and also a host of decisively wrong answers (e.g., 'Morton White', '19,321 lbs', '12 feet' and so on). Contrast that with the tea kettle example. Although one can likewise conceive of a host of decisively wrong answers,

this time I am unable to conceive of any others—I can think of nothing, I can remember nothing, that can survive confrontation with what I take to be conditions of the right answer. And this is clearly a consequence of not only of the character of those

²¹ Bromberger (1992), p. 27

²² Ibid., p.29

conditions but also of the limits of my intellectual repertoire.²³

In addition to p-predicaments, Bromberger introduces another epistemic condition that he calls b-predicaments. A is in a b-predicament with regard to Q if and only if Q has a correct answer but none of the answers A can come up with is the correct one. Together, these two predicaments are the sole epistemic sources for explanations and an adequate explanation is one that removes the corresponding predicament.

The spirit behind Bromberger's proposal seems correct; namely, that the lack of an explanation represents a more substantive kind of ignorance. It is more than not knowing a fact, it is not knowing how the observation at hand fits into one's epistemic corpus. Moreover, Bromberger is right to point out that the limits of one's "intellectual repertoire" have something to do with explanation ignorance.²⁴ The details of his analysis, however, are incorrect. Recall Bromberger claims that someone is in a p-predicament (i.e., no understanding) regarding Q if she believes Q admits a right answer but she cannot think of a

²³ Ibid., p. 28

²⁴ I take it that Bromberger's "intellectual repertoire" contains a wide range of things including beliefs, knowledge claims, ability to make elementary inferences, etc.

response that she believes does not have a decisive objection. To see what is wrong with Bromberger's analysis, examine the following example:

John believes that the question "why does water heat up when placed in a microwave oven?" admits of a right answer and he knows that the right answer has something to do with the microwave exciting the water molecules and in turns raising the temperature. He learned this latter fact from glancing at the cover of a science journal. When pressed to explain how microwave excites water molecules, it becomes clear that John has no idea what microwave is.

There is no doubt that John does not understand why water heats up when placed in a microwave oven but he is clearly not in a p-predicament since he has at least one answer that he does not have a decisive objection to. Likewise, he is not in a b-predicament because the answer he has actually is the correct answer. Since there is no predicament, we should conclude that John is not in need of an explanation, yet this is blatantly not the case.

The shortcomings of Bromberger's view point to the fact that possession of the appropriate beliefs does not qualify as understanding. Understanding requires that the belief in question be related to the other relevant beliefs of the inquirer. The interplay (including incompatibilities) between phenomenon and beliefs is clearly more complex than Bromberger suggests. Since a clarification of this relation takes us deep into a

detailed analysis of the nature of the explanation relation, our preliminary remarks suffice for now to establish the conclusion that the object of an explanation necessarily contains epistemic components. We will revisit the relationship between the inquirer's observation and her beliefs in the third chapter, where I will give an explicit epistemic definition of the explanation relation. To wit, an inquirer asks for explanations because the observation appears anomalous relative to what she believes and an explanation establishes a regularity between her observation and her beliefs.

The important thing to note is that in individuating the explanandum as a combination of her epistemic conditions and some observation, the inquirer in fact specifies the precise failure of her intellectual repertoire that she seeks to remedy. To that extent, the lack of connection between what the inquirer believes and what she observes is the object of an explanation. To explain the ordered pair $\langle O, B \rangle$ is not a matter of specifying why this ordered pair exists; instead, an adequate explanation of $\langle O, B \rangle$ tells the inquirer how to adjust her beliefs (including learning new ones, dropping false ones and acquiring new beliefs about the connections of her other beliefs) so as to connect the two.

We ask for explanations because, to put it metaphorically, the world runs into our minds. The object of an explanation is this disconnectedness between what we see and what we believe. As I mentioned earlier, one motivation to treat the explanation as an objective relation is that we have always thought that the object of an explanation is a mind-independent non-epistemic entity like an event. The considerations I gave, hopefully, will raise some doubts concerning this conclusion. To explain is to make certain adjustments to one's beliefs (including adding beliefs, abandoning false beliefs and learning new beliefs about the relationships between one's preexisting beliefs) so as to avoid the failure of one's intellectual repertoire. What counts as an appropriate adjustment (i.e., the definition of explanatory adequacy) therefore lies within the domain of epistemology. As we will see, these adjustments will be guided by objective relations in the world.

1.4 Epistemic work and the explanation relation

The second reason for supposing that a correct analysis of explanation must be epistemic centers on the nature of the explanation relation. In analyzing the explanation relation (which I take to be at least a two-

place relation), we want to offer ideally a bi-conditional of the form:

A explains B if and only if A X's B.

The right-hand side of the bi-conditional constitutes the set of necessary and sufficient conditions (the analysandum) for the explanation relation. Of course, the conditions might only pick out a relation that is extensionally equivalent, so an analysis of explanation must go further to argue that the set of conditions offered represents an *explication* of the target concept.²⁵

A natural question arises: what criteria should we use to judge the acceptability of a given analysis? Clearly, there are internal criticisms one could offer such as pointing out that it is inconsistent. The more important criticisms, however, come from external considerations. It seems obvious to me that in justifying an analysis of the explanation concept we must show at the minimum that the analysans does the work that the explanation relation is supposed to do.

²⁵ I realize that there are powerful arguments against the intension/extension distinction. Since an adequate discussion of the issues would take us far field, I propose that we bracket these considerations. My justification stems mainly from the fact that the contemporary debate on the distinction has hardly been settled. Moreover, in the worst-case scenario, we can always make use of Lewis' possible-world semantics to give a more extensionalist-friendly interpretation of the argument. For convenience, I choose to present my arguments with "old-fashion" jargon.

Take an analogous case in ethics. One widely shared belief concerning object-level ethical claims is that they are normative. A proposed analysis of moral concepts should preserve (if not explain) their normativity; for otherwise it makes one wonder why this analysis is in fact an analysis of moral concepts.²⁶

This leaves open an important question: what work is an explanation supposed to do? Or what is the purpose of an explanation? No doubt having explanations allows us to change our environment. Knowing why a plane crashed helps us to avoid plane crashes in general. Nonetheless, explanations serve epistemic functions first and foremost. As we saw in the last section, explananda are clearly

²⁶ It might be worthwhile to make a distinction here between supplying a set of necessary and sufficient conditions for a concept X and providing an analysis of X. Act-hedonistic-utilitarianism, for instance, tells us that

An act X is good if and only if X maximizes the most pleasure for the most amount of people.

The right hand side of the bi-conditional is the set of necessary and sufficient conditions for X being good and it contains no reference to moral terms. Indeed, some argue that the reason such a set of conditions is illuminating is that it makes no use of the concepts of the left-hand side. However, an analysis of moral goodness should give us more than just a set of conditions, it should also tell us why the proposed set of conditions successfully captures morality. Jeremy Bentham certainly took this concern seriously for he painstakingly attempted to demonstrate that pleasure is the only thing that has intrinsic value in order to establish the normativity of the utility identification. Therefore, my concern here is not with "reductive" analysis per se. It is perfectly acceptable to provide a set of reductive necessary and sufficient conditions as a part of an analysis but somewhere in the analysis, there should be arguments as to why this set of conditions is the right set of conditions.

results of the world running into our beliefs. To explain is to adjust our beliefs such that they better map onto the world. In this sense, explanation provides understanding of the world for us and this function is transparently epistemic in nature.

A thought experiment might help tease out the intuition that explanations are *essentially* epistemic in nature. Consider an all-powerful Brute who has few true beliefs. He can bend the world to his liking, any and all of his desires are satisfied. For him, the world consists of few physical obstacles (save from perhaps what the laws of physics dictate). We can learn three lessons from considering the relationship between the Brute and explanations in general. Firstly, although he can bend the world to his liking, he remains ignorant of why things happen and thus he is still in need of explanations. Compare the Brute to his antithesis: an all-knowing Sage who is causally inert. The Sage has no need for explanations for by definition she already knows everything. She is epistemically ideal even though she can never translate her knowledge into any practical results. If explanations are sought only as instruments to satisfy non-epistemic ends, then anyone like the Brute who can satisfy those ends without explanations would have no need

for explanations. As the Brute demonstrates, being all-powerful does not preclude the need for explanations. The second thing the Brute shows is that there is something inherently defective about psychological accounts of explanation; i.e., those accounts that define explanatory adequacy as that which makes one feels psychologically at ease. Because he is all-powerful, the Brute can alter his psychological state effortlessly such that his initial epistemic needs no longer and will never bother him. But obviously he is still in need of an explanation though he may be ignorant of this latter fact. Lastly, suppose in an effort to rid himself of his epistemic discords (those which would normally have led to demands for explanations), the Brute fills his mind with powerful though false theories and beliefs. The result is complete and utter epistemic solace. Rather than holding him as an epistemic ideal, we pity the Brute. His tremendous power merely draws him deeper into an inner world of fantasies and we would hardly consider him to possess any genuine understanding of the world. If gaining understanding is the ultimate function of explanations, then surely there are no explanations here. False theories and false beliefs can no more explain, contrary to the claims of philosophers like van Fraassen, than they can be the basis of knowledge.

The Brute and the Sage show that explanations serve essentially epistemic ends. This fact is consistent with Bromberger's contention that the lack of an explanation is a kind of ignorance. In order to grasp the nature of explanation, we must see it as that which grants us understanding. It might be the case that learning about the causal connections of things (including the explanandum) leads to a better understanding of the way the world is. Nevertheless, this is so only if one argues that seeing the world as casually connected is the sole basis of understanding. Not only have no argument along this line been offered by the causal modelists, I doubt that such an argument can be successfully made. Understanding is simply too broad and too epistemic to be straightforwardly identified with causation. I can, for instance, understand why Joe made a certain chess move by seeing how the move was conducive to his winning the game. Sketching out a complete causal story is not only superfluous for understanding, it entirely misses the point of comprehending the why of the move.

To explain is to revise one's beliefs so that they are better mapped onto the world. This is why false beliefs cannot explain because they take one farther away from what is the case. An explanatory belief-alteration is guided by

objective relations. Meanwhile, we conclude that the explanation relation essentially performs epistemic functions. Although some non-epistemic relations might be extensionally equivalent to it, they serve as adequate analyses only if they too perform the same functions. Thus, there is an epistemic priority for the explanation relation. Any analysis that blindly reduces an epistemic relation to a non-epistemic one owes us an account of why the proposed analysis is an analysis of the explanation relation.

1.5 Further evidence for the epistemic view of explanation

So far we have offered two different arguments as to why a theory of explanation must be epistemic in nature: (1) the objects of explanation essentially make references to the epistemic conditions of the inquirer, and (2) the explanation relation is first and foremost an epistemic function. Some of the standard results and examples in the literature further confirm our view. In this section, I provide two instances.

I - Artificial explanations

Some of the examples of explanation used in the literature often have an air of artificiality to them. Take Hilary

Putnam's example "Why is the square peg not going through the round hole?" What beliefs must someone have such that she cannot understand the observation that the square peg is not going through a round hole? What kind of answer is she looking for? Of course, it is possible that within some bizarre context, we can find someone who is reasonably perplexed by a square peg's not going through a round hole. Our uneasiness with these examples confirms the epistemic view, since according to our view, one can only identify the explanandum if one knows the epistemic condition of the inquirer. When little or no epistemic information is supplied, we must compose a likely body of beliefs such that the observation would reasonably give rise to a demand for an explanation. In Putnam's example, the observation is so mundane that composing such bodies of beliefs taxes our imagination to its limits, thus giving rise to the feel of artificiality.

Having said that, it is paramount to remember that there are circumstances in which one could reasonably request explanations of the Putnam varieties. The key issue here is that without knowing the epistemic background of the inquirer, there is no way for us to know what it is about the phenomenon that is in need of an explanation. Even if we narrow the domain of interest to say a

microscopic explanation, we still might not know what it is about a square peg's not going through a round hole that needs to be explained in terms of microphysics. For example, is there some failure of the principles of microphysics to account for the inability of a square peg (as opposed to pegs of other shapes) to go through a round hole? The important point to realize is that there is no privileged explanatory context in which a phenomenon is really explained. All explanations are relative to contexts and inquirers' interests. In our heavily favored scientific atmosphere, one tends to think that science tells us what there really is; thus, explanations in the sciences are the genuine objective explanations. The fact of the matter is that even if we restrict explanations to scientific ones, explananda are still relative to the epistemic conditions of the inquirer. After all, different scientists at different times or in different areas might ask the same explanation-seeking question but have very different explananda in mind.

We should note that we often ask for explanations of phenomena that do not puzzle us, as in the context of an examination. In addition, showing how the same explanation schema occurs in different situations often is valuable for theoretical purposes (as I will demonstrate later). In

this latter case, an explanation might be given without the presence of an inquirer particularly puzzled by the explanandum. For example, a scientist might show that Newton's laws of inertia can explain the path of a celestial body as well as that of a cannon ball. These explanations might not actually be given in response to anyone's perplexity. Nevertheless, the point of the demonstration is to show how these explanations fit the observation into specific sets of beliefs (regardless of whether these beliefs are actually held by anyone). In this respect, neither actual perplexity nor its elimination is necessary for the adequacy of an explanation.

To put the point differently, our epistemic account is epistemic only in the sense that the object of an explanation consists of the relationship or the lack thereof between a phenomenon and a corpus of beliefs. In explaining, one unites the phenomenon with the corpus. The fact that the corpus is hypothetical does not diminish the adequacy of a particular explanation. A corollary of this view is that an inquirer might not actually have her perplexity removed in having received the right explanation; for instance, she might simply have failed to

pay attention.²⁷ We can thus distinguish an epistemic account of explanation from a psychological account. While an epistemic account takes explanation to be about alterations of beliefs, a psychological account claims that an explanation eases the corresponding perplexity. Our epistemic account takes the elimination of actual perplexity to be neither necessary nor sufficient for explanatory adequacy.

II - Explanatory asymmetry

As the asymmetry example is commonly told, one can explain the length of the shadow by appealing to the height of the flagpole that casts the shadow along with simple trigonometric functions. Yet one cannot explain the height of the flagpole by using the length of the shadow and the respective trigonometric functions. The logical inference and evidential relation seem to be exactly the same in both cases, thus, there appear to be asymmetries in explanations. Our epistemic view would diagnose the

²⁷ Of course, if the explanation given is something that the inquirer could not understand in principle (e.g., the explanation is couched in terms that the inquirer cannot know), then one wonders if the explainer has in fact picked out the right explanandum. Imagine a physical explanation given to a pre-scientific inquirer. We might not be able to provide the kind of explanation that our pre-scientific inquirer demands, so in this case, we are better off saying "I cannot explain why the volcano exploded in terms of the God's anger because volcanic behaviors are not guided by divine mood."

implausibility of the second explanation by pointing out that ordinarily, it is highly unlikely that one would come across a body of beliefs in which (a) the height of the tower is in need of an explanation, and (b) the length of the shadow could play any role at all in the proper belief-revision. If we can conjure up such a body of beliefs, our epistemic view predicts that the asymmetry would disappear. Van Fraassen draws up exactly such an epistemic condition in his tale "The Tower and the Shadow." According to his story, we are to imagine a chevalier who built a tower of a particular height in order to cast a shadow over the spot on which he murdered his lover. The height of the tower, in the context, seems clearly explainable by noting the desired length of the shadow. The persuasive force of van Fraassen's story stems entirely from his ability to come up with a body of beliefs in which (a) and (b) are satisfied. The alleged asymmetry to explanations is a consequence of some contingent facts about our normal epistemic conditions. From a radically different epistemic point of view, it might be the case that explaining the length of the shadow on the basis of the height of the flagpole would be counter-intuitive.

This, of course, allows for the possibility that there might be genuine asymmetries. Even van Fraassen has

conceded that, given our current world view, a star's red-shift cannot explain why it is receding. I suspect the "degree" of asymmetry is a consequence of different grades of epistemic significance. "The Tower and the Shadow" shows that the flagpole asymmetry is a relatively low-level asymmetry: a change in the epistemic conditions of the context erases the alleged asymmetry. On the other hand, the red-shift example requires some massive alterations. Since causality is an irreflexive relation, a star's red-shift cannot be the cause of its recession. If causal laws are to play any roles at all in the proper belief revision, it is hard to see how citing a star's red-shift can ever explain why it is receding. Now, it might be the case that in a universe in which the laws of nature are fundamentally different, a star's red-shift could play a role in explaining its recession. Unless we have arguments to show that there is no such possible world, we cannot say a priori that the alleged asymmetry is necessary. Asymmetries come in degrees of strength and their relative strength is a product of the level of alteration to one's beliefs in order to construct a context in which a body of beliefs can reasonably satisfy considerations like (a) and (b). The asymmetry problem is a manifestation of the traditional Quinean epistemic picture. Whether or not an

explanatory connection exists depends on other beliefs that we have and the price we are willing to pay to admit such a connection into our web of beliefs. The flagpole problem points out the fact that relative to a set of beliefs, explaining the height of the flagpole on the basis of the shadow appears to violate some other epistemic commitment that we have. For example, as I will argue later on, one indispensable part of an explanation is that there is a projectable regularity between antecedent conditions and the observation in question. Ordinarily we believe that the length of a shadow has nothing to do with the height of the flagpole; hence, our reluctance to think that the former can play any role in the explanation of the latter. However, once we tell a rich enough story, the length of the shadow can become explanatorily relevant by highlighting a different set of beliefs. What is so compelling about van Fraassen's story is that it taps into a projectable regularity that we already believe; namely, that people often satisfy their desires by acting on accepted beliefs. In this case, the chevalier desires to cast a shadow over a particular spot and given his understanding of trigonometry, he builds a flagpole of a certain height.

1.6 The moral of the story

The central thesis of this chapter is the claim that it is impossible to construct a non-epistemic theory of explanation. Explananda always contain references to epistemic concepts (of the inquirers) and the explanation relation is essentially epistemic. To explain is to revise our beliefs as guided by our understanding of the way the world is. Seen from this perspective, non-epistemic theories of explanation appear to be hopelessly impoverished. A central question remains unanswered: how do we revise our beliefs (in an explanatory manner) such that we gain a better understanding of the world? The next two chapters will answer this question. In the second chapter, I will examine some models of explanations both epistemic and non-epistemic in order to learn from their inadequacies. In the third chapter, I will propose a positive account of an epistemic realist model of explanation. Once we have an objective method of revising belief that produces understanding, the criticism that epistemic theories of explanation inevitably lack any meaningful standard of explanatory adequacy is no longer a concern.

Chapter Two: Models of Explanation

2.1 Introduction

The central issue concerning the nature of explanation is the explication of the relationship between the explanandum (that which is explained) and the explanans (that which does the explaining). Even those who argue that explanations are citations of relevant singular events agree that there must be some selection criteria as to what counts as "relevant."¹ These criteria, however, are manifestations of the proper explanatory relation between an explanans and an explanandum: to say that *A* (and not *B*) explains *C* is to say that *A* and *C* are related in a manner in which *B* and *C* are not. In this respect, the very project of specifying conditions for explanatory adequacy is to explicate the explanation relation. The project presupposes that an inquirer who has all the isolated pieces of information necessary for an explanation would not have an explanation unless she knows how they are related.² As such, explanatory understanding differs

¹ In Scriven (1962), for example, we find "[an] explanation requires that there be a connection, but not any particular one—just one of a wide range of alternatives."

² Kim has made similar observations. See his (1957).

significantly from other epistemic activities. In asking for an explanation, the inquirer is not seeking a justification or an assurance of the truth of the explanandum.³ Rather, she looks to connect the explanandum with her other beliefs to form an explanatory whole. It is in virtue of placing the explanandum in an appropriate structure that something gets explained. Let us call this principle regarding the relational or structural nature of explanation "the binding principle."

We can construe the various models of explanation as offering competing analyses of the explanation relation. In uncovering the nature of explanation, it is useful to view the philosophical landscape from this new perspective. In this chapter, I will offer a brief examination of past attempts to explicate the explanation relation. The aim is to identify the correct explication by marking off incorrect ones.

2.2 Hempel's covering-law model

Hempel's covering-law model enjoyed the designation of "the received view" for over twenty years. Hempel's work on explanation revitalized interest in the topic and its

³ As many philosophers have noticed, in asking "why p?", the inquirer often if not always assumes the facticity of p.

influence has been so overwhelming that one can argue that all subsequent works on explanation are reactions to and commentaries on his view. We begin our survey with Hempel not only because he sets the terms for the later debates, but also because his view still contains much that is right.

There are two defining characteristics of Hempel's covering-law model: (1) all explanations are sound arguments that logically relate the explanans (the premises of the argument) to the explanandum (the conclusion); and, (2) laws must play an indispensable role in the logical inference. Within the general covering-law rubric, Hempel outlines two primary types of explanations. In a deductive-nomological explanation (D-N explanation, for short), the explanans deductively entails the explanandum. In an inductive-statistical explanation (I-S explanation), the explanans renders the explanandum highly probable. Alternatively, we can think of a D-N explanation as being a special case of an I-S explanation with the probability of the explanandum rendered to 1 by the explanans.

It is clear from examining Hempel's writing that he is committed to the binding principle:

What a scientific explanation...aims is not [an] intuitive and highly subjective kind of understanding, but an objective kind of insight that is achieved by a

systematic unification, by exhibiting the phenomena as manifestations of common, underlying structures and processes...⁴

The structural connection between the explanandum and the explanans is doubly ensured by both the logical relation between them and the obligatory presence of a law among the premises. A natural question arises: why does Hempel need both of these connections in order to systematize the explanandum? The answer, I think, lies in his attempt to use the logical connection as a realizer for the modal necessity of laws. Recall the key to Hempel's explanation is to subsume the explanandum under some law. Subsumption here is defined as a purely logical/syntactical notion. For a D-N explanation, an explanandum *E* is subsumed under law *L* just in case *L*, together with some empirical facts *F* deductively entail *E*. Given the proper *L* and *F*, *E* is logically necessary. Putting these points together, we can say that for Hempel laws bind the explananda and other facts in the world and the connections between them are logically necessary (at least from the explanatory point of view and once they have been put into sentences).

⁴ Hempel (1966), p. 83. Philip Kitcher refers to the structural view of Hempel's model as the unofficial view of the covering law model.

For I-S explanations, however, the analysis is a bit more complex. An I-S explanation has the following schema:

$$\begin{array}{c} F_i \\ \hline P(G|F)=r \\ \hline G_i \end{array}$$

The premises of the argument consist of a statement describing some initial condition (F_i) and a statistical law of the form a given instance of F has a probability r of being an G . Although in *Aspects of Scientific Explanation*, Hempel appeals to frequency interpretation of statistical probability to make sense of statistical law, he explicitly states that his account does not depend on any particular interpretation of statistical laws. The double-line of the schema indicates that the explanans does not deductively entail the explanandum; rather, it confers a level of logical probability identical to r . For Hempel, the logical probability is to be understood by the following rule,

If e is the statement " $(P(G|F)=r) \ \& \ Fb$ ", and h is " Gb ", then $c(h|e)=r$.

" $c(h|e)=r$ " tells us the degree by which an hypothesis h is confirmed relative to e . Following Carnap, Hempel suggests that the confirmation relationship between the two is a *logical/sentential* relationship. Thus, for I-S explanations, Hempel believes that the explanans is related

to the explanandum via an inductive logical relation. Suppose for the moment that we believe statistical laws state objective physical propensities. Such an interpretation would be compatible with Hempel's I-S model since we can translate the probability value r of the law into the confirmation value between the explanans and the explanandum. For Hempel, so long as the value is high, the explanans explains the explanandum. Again, like D-N explanations, Hempel is utilizing logical relations (be it deductive or inductive) to explicate whatever nomological force of the statistical laws in the explanans.

To say that something is systematized is to say that members of the system are sensitive to changes within system (however contingent the arrangement itself might be). Hempel's commitment to the binding principle forces him to articulate just how the explanandum would be sensitive to other facts about the world. Traditional nomological connection with its rich modality is an obvious candidate but it comes with metaphysical baggage that is troublesome to anyone with a positivistic inkling. Hempel's ingenious solution is to substitute logical necessity for nomological necessity via his logical subsumption criterion. And in the case of I-S explanations, he substitutes statistical laws with

inductive logical support. As a result, he introduces laws as the connections that are implicit in the binding principle and gives us some necessity (albeit only a logical one) in the case of D-N explanations while avoiding the talk of metaphysics altogether.

The main problem with Hempel's move is that unlike logical connections, some nomological connections (e.g., causal laws) are "directional."⁵ For example, although a red shift occurs if and only if a star is receding, we know that the red shift is a result of the recession of the star and not the other way around. Moreover, take the standard irrelevancy objection. One can derive the conclusion "Paul is not pregnant" from the premises "Paul has been taking birth control pills" and "Anyone who takes birth control pills does not become pregnant." Yet, obviously, the deduction fails to be explanatory. All these objections trade on the fact that nomological connections are fundamentally different from logical connections. A causal modelist, for instance, might say that A and B form a law-like connection if and only if there is some causal

⁵ I qualify the remark with "some" because I don't believe law is a well-defined notion. Are Kepler's Laws laws? They certainly do no more than describe regularities of planetary orbits. Laws strike me as a union of different types of regularities all put under one heading. Nomological necessity itself might be a cluster of different ideas.

connection (with all its gory intensional properties) between them. To suggest that logical interconnectedness is all there is to a nomologically-ordered world is, to use a old Chinese proverb, mistaking fisheyes for pearls. Logical connections are simply too weak to capture the explanatorily significant features of real laws.

In addition to the conceptual poverty of logical connections, a deeper problem exists with the covering-law model. Recall a central motivation behind Hempel's view is his commitment to seeing explanations as the systematizing of phenomena. Yet why should it be that the only way to systematize phenomena in an explanatory manner is to construe the world as ordered by laws (with only logical properties to boot)? If one adopts a stringent view of laws (i.e., there are only laws of physics), then unless one can subsume the explanandum by translating or reducing it to a counterpart in physics, there are no explanations of it. This is an incredibly chauvinistic view. Imagine someone watching a game of chess and wanting to know why Kasparov exposes his queen to obvious danger. Unless one can subsume the explanandum (e.g., "Kasparov moves his queen to a7") under some law of physics, we cannot explain the move. Not only is this counter-intuitive, but even if we can translate the explanandum into, say, the jargon of

physics, an explanation of that would obviously miss the point of the inquiry! One might reply by claiming that Hempel is interested in scientific explanation and explaining a move in chess clearly falls out of the intended domain. But the line between scientific and non-scientific explanation is unclear, and, more importantly, the claim would rule out all explanations other than those in physics. What about other disciplines like biology, chemistry, psychology, or systems research? Even if we limit Hempel's view to just the standard sciences, we are still left with the unsavory conclusion that a perfectly acceptable explanation in, say history, is really not an explanation until it is translated into the basic sciences. Or we have to propagate the existence of real laws in any disciplines that claim to provide explanations.

In light of these difficulties, a number of positive things remain concerning Hempel's covering-law model. Firstly, Hempel is right to take seriously the structuralist view of explanation. An explanation involves showing how the explanandum occurred as a result of antecedent conditions and the structure of the universe and for Hempel the structure consists of laws (probabilistic and otherwise). This last point is clear when we notice his insistence that a law-like sentence plays an

indispensable role in an explanation. Knowledge of antecedent facts and the explanandum event cannot amount to an explanation of the latter; in order to explain, one must show that the occurrence of the explanandum had something to do with or be sensitive to the antecedent facts. In other words, if the antecedent facts were different, the occurrence of the explanandum event should also be affected (perhaps it would not have occurred or be less likely to occur, and so on). The discussion so far has been exceedingly vague but the sensitivity relationship between explanation and structural connection will become clearer as we continue.

2.3 Salmon's statistical relevance model and causal model

Philosophers who work on explanations often draw a dichotomy between the argument view and the non-argument view of explanation. As the names suggest, the argument view states that explanations are logical arguments and the non-argument view says otherwise. Hempel's covering-law model is a paradigmatic example of the argument view. This standard dichotomy, I believe, is rather unhelpful. I suggest instead that we think of a model in terms of whether it takes the connections between the explanans and the explanandum to be logical ones. To this extent, Wesley

Salmon's statistical relevance view (S-R explanations), does not differ significantly from Hempel's, contra the opinions of many contemporary commentators. Both take the explanation to be logical-statistical relations. Unlike Hempel, however, Salmon does not believe that the explanans must render the explanandum necessary or highly probable in order to explain it (i.e., the Hempelian necessitation clause). As long as the explanans *changes* the probability of the explanandum, the explanans explains the explanandum. Since explanations are not arguments, the explanans can be any collection of sentences. It can, for example, be a narrative, a list, or a fairy tale, providing that it registers all the statistically relevant facts about the explanandum. For Salmon, a fact F is statistically relevant for the explanandum E if and only if $P(E|F) \neq P(E)$. This collection of all the relevant statistical facts about the explanandum constitutes an explanation of it. And for those who remain doubtful that such a list exhaustively defines an explanation, Salmon asks rhetorically,

[w]e know every factor that is relevant to an A having property B . We know exactly the weight that should have been attached to the prediction that A will be a B . We know all of the regularities (universal or statistical) that are relevant to our original question. What more could one ask of an explanation?⁶

⁶ Pitt (1988), p. 77

By definition, one has listed *all* the statistically relevant facts; indeed, from an informational point of view, what else could there be?

Salmon's information clearinghouse view might initially appear odd but its peculiarity should disappear when one realizes that, for Salmon, an explanation of individual events is no more than establishing "the weights that would appropriately attach to such explanandum events for purposes of betting and other practical behavior."⁷ In other words, to explain an individual event, it suffices that one learn all there is to learn in order to determine a maximally informed judgment regarding the subjective probability of the event in question. Interestingly enough, a consequence of this view is that learning about the statistical facts concerning the explanandum might actually lower its probability. Salmon openly accepts this consequence and proudly presents it as an improvement over and an argument against Hempel's high probability requirement (in his I-S model) because it provides explanations for certain explananda that the I-S model cannot. For instance, suppose we have an atom of Uranium-238 and an atom of Polonium-214 and the decay of one of the

atoms makes the Geiger counter click once. Suppose further that it was a Uranium atom that disintegrated. If we ask "Why did the Geiger counter click in interval $(t, t+m)$?", the correct answer appears to be "An uranium-238 atom with half-life such-an-such disintegrated..." When compared to our initial position of not knowing which particle actually disintegrated, the new piece of statistical knowledge lowers the probability of the explanandum. To see this, suppose within time interval $(t, t + m)$ the chance of the Uranium atom disintegrating is 0.3 and the chance for the Polonium atom is 0.8. We determine the probability of an atom disintegrating is $(P(\text{Uranium}) \times P(\text{not Polonium})) + (P(\text{Polonium}) \times P(\text{not Uranium})) = 0.62$. Once we learn that it is a uranium atom that has disintegrated, the probability of the explanandum actually goes down to 0.3.

It seems highly counter-intuitive to say that the explanation of p can actually lower its probability. Recall that in asking a why question, the inquirer generally presupposes the truth of the explanandum. If Salmon is right, then for cases like the uranium example, an inquirer who commits to the truth of the explanandum on the basis of subjective probabilistic calculation might

⁷ Ibid, p. 76

actually withdraw her commitment in light of the explanation! Typically, an inquirer's demand for an explanation is warranted only if the presupposition of the question is true. But according to Salmon, her apparently warranted question paradoxically becomes instantly unwarranted when she receives the *proper* explanation.

One might reply to this objection by pointing out that the inquirer would never withdraw her commitment to the truth of the explanandum even in light of the new explanans. If this is so, then a different problem surfaces. We say that once the explanandum E is learned to have occurred (and nothing else), the inquirer assigns 1 to $P(E|K)$ where K is the set of her current accepted beliefs. The new explanation does not lower the probability she assigns to the explanandum since she still believes E has occurred and her $P(E|K)$ is still 1. At best, what Salmon has shown is that in an hypothetical case where E has not yet occurred, in having received an "explanation" for E the inquirer would have assigned a lower probability than the actual value of the $P(E|K)$, but then the required presupposition that E is true is violated (since it has not happened yet). Therefore, there is no warranted explanation here. Either way, Salmon's example does not

show that an explanation can actually lower the probability of the explanandum.

Nancy Cartwright has further argued that statistical relevance is neither a necessary nor a sufficient condition for explanations.⁸ To demonstrate her point, she asks us to imagine that some poison ivy has been sprayed by a 90% effective defoliant. The fact that a particular poison ivy was sprayed explains why it is dead. However, according to Salmon, since the probability of a particular ivy's being alive has also been changed by the defoliant spray, it follows that an ivy's having been sprayed by defoliant explains why it is alive! Consider another example. Imagine a fictional case in which paresis can only come about via syphilis or epilepsy and that the probability of developing paresis given either condition is 0.1. To explain why Jones has paresis, the right answer appears to be either "he has syphilis" or "he has epilepsy" but since the probability of his developing paresis given either syphilis or epilepsy is already 0.1, the additional information about which condition he actually has should add no explanatory strength contrary to our intuitions. The paresis case is of course a variation of the decay

⁸ Cartwright (1979)

problem but with equal probabilities between the two disjuncts.

On behalf of Salmon, we can offer an easy reply to Cartwright's objections. In explaining an individual event, Salmon tells us we must be maximally informed; e.g., we should learn all the statistically relevant facts. Cartwright's paresis example is somewhat misleading. Presumably, knowing that Jones has, say, syphilis is statistically relevant to his developing paresis since his having syphilis does alter his probability of developing paresis. Thus, this fact would be part of the maximal set of statistically relevant facts concerning Jones' paresis. Likewise, the explanation of why a particular poison ivy stays alive after being sprayed with defoliant consists of more than just the sole statistically relevant fact that it has been sprayed by a 90% agent. Rather, it is a set of numerous relevant facts concerning why this poison ivy stays alive including the normal life span of poison ivy, the weather conditions, resistance to defoliant, etc. In these counterexamples, Cartwright appears to have unfairly limited what counts as a S-R explanation. Nevertheless, I think she has pointed out the significant fact that for the S-R model, there is no sense in talking about *the* fact that explains why something is the case. Instead, we have at

best a conglomerate of statistical facts each of which might or might not affect the final occurrence of the explanandum-observation in question.

In relaxing the connection between explanans and the explanandum, however, Salmon might have inadvertently become too permissive. It is important that we appreciate just how radical Salmon's rejection of the necessitation clause is (i.e., the explanandum should be necessary or rendered highly probable relative to the explanans). For Salmon, the *only* thing explanations tell us is what subjective probabilities to assign to the explanandum-sentences. Not only do explanations not show why the explanandum is objectively necessary, they do not even show why they are probable, likely, unlikely, and impossible, etc. Explanations are completely detached from what actually goes on in the world and this fact manifests itself most obviously when we realize that the relevant statistical facts concerning p explain both the occurrence and non-occurrence of p . The fact that p actually occurs is irrelevant to the explanation. This should strike us as intuitively bizarre since if Salmon is right, why should we insist that a proper why-question presupposes the truth of the explanandum?

The apparent appeal of the S-R model has a lot to do with the fact that accumulating statistically relevant facts concerning the explanandum does go some way in advancing our understanding of it. When we find out that a typical patient suffering from stage IV gastric cancer has a nine-month life expectancy given the first-line therapeutic protocol, we learn something about our patient and the disease. And when the patient dies, we form a partial picture of what could have caused her death. In the absence of any real explanations of why the patient died, statistical facts are the next best things.⁹ Nevertheless, Salmon's laundry list of probabilistic facts cannot be an adequate explanans because it entirely fails to connect, in any sense stronger than statistical relevance, with the explanandum. The list does not tell us what facts actually played a role in the coming about of the explanandum. An S-R explanation does not systematize the world, it merely reports all the brute facts. If I want to know why there are no more dinosaurs, a reply that lists all the statistical facts concerning dinosaurs is surely a bad joke. After all, I want to know what really happened and

⁹ I do not deny that there can be genuine probabilistic features of the world that can factor into an explanation. Indeed, as I will demonstrate later on, indeterministic explanandum events can be explained.

not just how various things might have affected the probability of the survival of dinosaurs! S-R explanations transparently fail to provide the conceptual glue between the explanans and the explanandum that the binding principle tells us must exist in any explanation. In this sense, the S-R model cannot be a plausible analysis.

Salmon and those with strong antirealist leanings (e.g., van Fraassen, who actually expresses some sympathy to Salmon's S-R model) might argue that my view of explanation is simply untenable. They charge that to say more than what is empirically adequate is to take an unwarranted step into a metaphysical darkness. If that is the response, then the debate has shifted away from the nature of explanation to that of realism. The discussions so far rest on our intuitive understanding of explanations without explicitly articulating the metaphysical assumptions (e.g., how real is the structural glue). Let us return to this trek shortly in our discussion of van Fraassen's view; for now, we should simply note that Salmon's S-R model is an error theory insofar as it entails that our ordinary understandings of explanation are radically false.

Given the objections raised against his view, including some that we have examined here, Salmon has

heavily supplemented his S-R model with causality. Hume's arguments against causation have always stood as major obstacles to empiricists who wish to make use of a modally robust concept of causation. In order to develop a plausible model of causal explanation, Salmon undertakes the arduous task of solving Hume's problem. The result is Salmon's "At-At" theory of causal propagation. Since we are interested in determining whether a causal account can in general be the right analysis of explanation, we will only briefly discuss his "At-At" theory.

For Salmon, causal relation does not relate events, as traditionally conceived; rather, it relates processes. Although no rigorous definition is offered, Salmon tells us roughly that a process differs from an event in that an event, as opposed to a process, is "relatively localized in space and time." A baseball colliding with a window is an event while the baseball going from the bat to the window is a process. And among all processes in general, some are causal and some are not. Following Reichenbach, Salmon argues that a genuine causal process "is capable of transmitting a mark; a pseudo-process is not." He uses the following example to illustrate the distinction. A car traveling down a road at a certain speed is a causal process for if it had collided with something, the car

would continue to carry the mark of the collision with all the dents and scratches. Contrast that with the shadow cast by the car along the road. The shape of the shadow depends entirely on the topology of the objects upon which the shadow is cast. The instant the car passes a wall, the shape of the shadow changes; therefore, the shadow traveling down the same road is a pseudo-process. More explicitly, the principle of mark transmission (MT) says:

Let P be a process that, in the absence of interactions with other processes, would remain uniform with respect to a characteristic Q , which it would manifest consistently over an interval that includes both of the space-time points A and B ($A \neq B$). Then, a mark (consisting of a modification of Q into Q'), which has been introduced into process P by means of a single local interaction at point A , is transmitted to point B if P manifests the modification Q' at B and at all stages of the process between A and B without additional intervention.¹⁰

A causal process has the ability to transmit a mark - a modification to the process' structure - to later processes. This theory of transmission of structural property is called the "At-At theory" because it suffices for a mark to "move" through a causal process that it be at various places at various times. Hidden powers that so worried Hume do not enter the picture.

¹⁰ Pitt (1988), p. 89

All the causal processes are interwoven into a global causal net consisting of what Salmon calls "conjunctive forks" and "interactive forks" (both defined as variations of Reichenbach's theory of cause). These forks structure the relations among all the causal processes. To explain, according to Salmon, is to identify relevant parts of the causal net prior to the event's happening. So, for example, to explain why my window broke (an event), I list the causal process of the baseball leaving a bat (an interactive fork), its traveling through space (a causal process) and the collision of the ball and the window (an interactive fork). The identification of all these causal processes and how they relate to one another form the proper explanation.

Objections against the details of Salmon's At-At theory are abundant. Let us assume for the moment that Salmon has successfully developed a robust theory of causation that is empiricist-friendly. Does citing the relevant causes of something suffice for an explanation of it? Salmon certainly thinks so but it is surprising that he offers little in terms of arguments to support this important claim. There are good reasons to believe that causes are not the same as explanations. If explanations are no more than identifications of proper causes, then no

explanations are possible for abstract explananda. For example, there cannot be explanations of mathematical truths and explanations of laws, and, more significantly we know there are no such things *a priori*. It might turn out to be the case that there really are no explanations in mathematics but surely this cannot be determined *a priori*. Explanations in ethics are even more problematic. Often we explain why certain acts are wrong by showing that the type of act in question violates some fundamental moral principles. For example, we might say that murder is wrong because it violates our *prima facie* respect for someone's right to life. But the right to life is an abstract entity (if it is an entity at all) that does not cause anything. As far as I can see, there are two ways Salmon can reply to this objection: (1) He can say that his account of explanation is not exhaustive. There are, in fact, other kinds of explanations. (2) He can relax his notion of causation to include non-physical processes as part of the causal nexus. I think (1) is the better of the two responses. In any case, he owes us an account of why there should be different kinds of explanations.

Van Fraassen has pointed out that we often appeal to non-causal laws (such as laws of co-existence) in order to explain. For instance, we might appeal to Boyle's law to

explain why a particular volume of gas has the pressure and the temperature that it does. None of this can be accommodated in any straightforward manner within Salmon's causal model.

Assuming that we have an acceptable theory of causality, I have no objections in principle against causation playing a role in some explanations. In fact, it is likely that many of our explanations depend on citing the proper causes. Nevertheless, no arguments have been given to show that explanations must be causal. Indeed, if explanations involve the systematizing phenomena, as Hempel suggests, there is a *prima facie* reason to believe that causation cannot be the whole story. After all, there are obviously other ways to systematize our beliefs than seeing the world as a giant causal nexus. To uncover the true nature of explanation, we want to know what makes all these modes of systemization explanatory. The causal model of explanation, in this respect, cannot be the final analysis. Just as Salmon overreacted to objections against Hempel's view by abandoning the necessitation clause (i.e., the explanans must render the explanandum either highly probable or necessary) and thereby over-loosening the relationship between the explanans and the explanandum, he overreacts again in response to objections raised against

his own S-R model. The inclusion of causation in all explanations is simply too tight.

2.4 Van Fraassen's pragmatic model of explanation

Arguably, one of the most important contributions to the current debate on explanation is van Fraassen's pragmatic theory of explanation. Unlike many of his contemporaries, van Fraassen supplies a full philosophical program (including views on the aim of science, laws, realism vs. anti-realism, etc.) that accompanies and supports his view of explanation. In fact, as we shall see, given van Fraassen's constructive empiricism, his pragmatic theory of explanation follows as a natural consequence.

In *The Scientific Image*, van Fraassen argues that an explanation is neither an argument, nor a proposition, nor a list of statistically relevant facts. It is an answer to an explanation-seeking why-question. A given why-question Q has three components. First, there is the topic (P_k) of the question. For the question "Why was Trotsky assassinated?", the topic is "Trotsky was assassinated." We can think of the topic of a question as a presupposition—a proposition that is implied by all the direct answers to Q . Second, any why-question Q contains

either implicitly or explicitly a contrast class which according to van Fraassen is determined by the context of the explanation episode. So for example, the contrast class for our present example might be "Trotsky was not assassinated," "Trotsky was tortured," "Trotsky was sent into exile." Question *Q* presupposes that in its contrast class, only the topic is true. We can think of van Fraassen's contrast class as functioning very much like Lipton's contrastive foils. To put it in terms of our discussion in Chapter One, we can say that the contrast class narrows the aspect of the explanandum-phenomenon about which the inquirer wants an explanation. Finally, there is the "respect-in-which" the explanation is desired that tells us what kind of answer the inquirer seeks. This relevance relation *R* can be something like "the events leading up to" the explanandum or the reason that caused the action or an identification of the underlying mechanism, and so on. Again, the selection of a relevance relation for a given explanation is determined by the context of the explanation episode. In this sense, van Fraassen's explanations are doubly context sensitive (both in terms of the selection of the contrast class and of the relevance relation). We can abbreviate the three components and define a given why-question *Q* as a triplet

consisting of $\langle P_k, X, R \rangle$ where P_k stands for the topic, X is the contrast class $\{P_1, \dots, P_k, \dots\}$ and R indicates the relevance relation. A proper answer to why- Q is defined as P_k in contrast to (the rest of) X because of A . To translate van Fraassen's model into the standard jargon, we can say that A is the explanans, P_k in contrast to (the rest of) X is the explanandum and the "because of" relation is the explanatory connection between the two.

Since he takes explanation to be an answer to a why-question, van Fraassen must therefore tell us what constitutes a good answer. He outlines three central conditions by which an answer is to be evaluated. The first is the evaluation of A itself. Is A acceptable or likely to be true? Second, to what extent does A shift the subjective probability in favor of P_k as opposed to other members of the contrast class X . Third, how does the answer fare in comparison to other possible and actual answers to the same question. Within this last condition, there are three further sub-conditions and they are: (1) is A more probable than its competitors; (2) does A favor P_k more than its competitors; and (3) is A made irrelevant (wholly or partly) by the other answers; i.e., is A screened off (in Salmon's sense) by other answers. Taking all these factors into consideration, we can thereby rank

all the answers. Whichever comes out as the one with the highest index score is our proper answer to the why-question.

The first important thing we should note is that the explanans given (e.g., A) is only statistically connected to the explanandum. Van Fraassen's pragmatic model is clearly an improvement over Salmon's S-R model since it consists of more than just a list of statistically relevant facts. It explicitly says that A is that which best favors the subjective probability of the explanandum when compared to other members of the contrast class and when compared to other possible answers. Like Salmon, however, van Fraassen's statistical relevance relation is a metaphysically thin one. Indeed he tells us,

Is [the relevance relation] not where the inextricably modal or counterfactual element comes in? But not at all: in my opinion, the word 'because' here signifies only that A is relevant, in this context, to this question. Hence the claim is merely that A bears relation R to $\langle P_k, X \rangle$.¹¹

Putting the matter as such, we can state the central question here as follows: is the shifting of subjective probability in favor of P_k sufficient for an explanation of it?

¹¹ Van Fraassen (1980), p.143

Peter Achinstein has offered an argument to demonstrate that the answer is "no."¹² Consider an hypothesis h that says Smith is a man. Define S_1 as the proposition that Smith swims at Bethany Beach and S_2 as the proposition that Smith swims at Rehobeth Beach. Suppose our background information includes the fact that 60 percent of the swimmers at Bethany are men and 45 percent of the swimmers at Rehobeth are men. From the background information, we can say that S_1 favors h more than S_2 does but it is not the case that $P(\text{Smith is a man because he swims at Bethany Beach}) > P(\text{Smith is a man because he swims at Rehobeth beach})$ in light of the favoring facts.¹³ Both probabilities should be 0 since we know swimming at a beach has nothing to do with someone's being male. Although S_1 (as opposed to its competitor) does shift subjective probability in favor of h , it needs not change the probability of " h because of S_1 "; thus, the shifting of probability cannot be a sufficient condition for an adequate explanation because it does not render the answer

¹² Achinstein (1983)

¹³ One might wonder what sense it makes to talk of the probability of an explanation. The problem should disappear once we realize that the probability is assigned to sentences and like any indicative sentences, sentences concerning explanations can also afford probabilistic assignments.

" h because of S_1 " any more likely to be true. Van Fraassen can of course argue that contrary to Achinstein we do know that swimming at a particular beach has something (albeit only statistically so) to do with someone's being male. The stipulated fact that S_1 raises the probability of h entails that there is a relation. To this extent, Achinstein's argument relies on a metaphysical assumption that van Fraassen would not accept; namely, that there are empirical connections stronger than statistical correlations.

Although I think van Fraassen can readily make the above reply, Achinstein, I believe, touches on a central problem with van Fraassen's model. Given his commitment to constructive empiricism, constant conjunctions and statistical facts have no modal force. If the relevance relation is defined entirely in terms of the brute correlations, then the binding principle is not and cannot be met by van Fraassen. In this sense, van Fraassen's model pays mere lip service to the traditional concept of explanation. Explanations are about storytelling: we construct relevant relations to convince ourselves that things are related to one another. Explanations allow us to see the world in terms of fictional interconnections.

These connections might be useful but it would be a mistake to confuse them with any genuine objective relations.

Indeed, since the truth of A is but one of many factors in evaluating A, it is not a necessary condition. As long as A does a very good job of favoring the subjective probability of the explanandum over the other members of the contrast class, it explains even if it is unlikely to be true. For van Fraassen, blatantly false theories can explain and it is possible for them to do a superior job of explaining than other theories. He thoroughly accepts this conclusion because he does not take the search for explanations to be a central or even a remotely important goal of science. The aim of science is to come up with empirically adequate theories. Explanations are there merely to satisfy our inherent psychological need to believe that things happen for a reason.

Salmon and Kitcher have advanced a detailed version of this argument by pointing out that van Fraassen's lack of constraints on the relevance relation leads to the problematic consequence that just about anything can count as an answer to any why-question.¹⁴ The argument is

¹⁴ Salmon and Kitcher (1987)

surprisingly simple: all it requires is that we stipulate an artificial relevant relation such that it holds between the answer and the topic and that it renders the answer as favoring the topic over any other members of the contrast class. There appear to be no resources within the pragmatic model to block this type of trivialization argument.

Should van Fraassen worry about this argument? For him, explanations are *intra-theoretical* relations. Explanations and relevance relations always occur relative to a set of background beliefs. What Salmon and Kitcher have shown is that there can be wildly different sets of background beliefs giving rise to relevance relations that provide counter-intuitive explanations. The fact that we find these explanations bizarre is merely a consequence of our not sharing the background beliefs. Salmon and Kitcher's artificial relations are no more threatening to van Fraassen than a seventeenth-century physicist's inability to comprehend an explanation in modern physics. Indeed, if we do find ourselves holding these alien background beliefs, then the explanations they provide would not strike us as peculiar.

Salmon and Kitcher's argument does illustrate a fundamental conflict between van Fraassen's pragmatic model

and our commonsensical understanding of explanations. In general, we take explanations to be critical components for gaining understanding of the world—a kind of understanding that we could not attain by knowing all the isolated facts. Explanations are supposed to pick out real objective relations and not just pragmatic lines we draw between empirical dots. When I ask someone why such-and-such is the case, I do not want to know if there is a relevance relation within some accepted theory that can shift my subjective probability toward the explanandum; rather, I want to know what *objective* condition brought about the explanandum. Explanations are not purely *intra-theoretical* entities. Instead, explanations form a reflective equilibrium with corresponding theories in that explanations drive the formation of theories while simultaneously drawing explanatory strength from them. We often give explanations couched in terms of a theory that is not well-confirmed, but the fact that the theory explains provides us with further evidence for the theory. Given that van Fraassen rejects the primacy of explanations in scientific enterprises, it is no wonder that explanations become minor *intra-theoretical* consequences of accepted theories. None of this constitutes a decisive argument against van Fraassen; he can shift the debate to

the nature of science and the role of explanations. Nevertheless, it is worth noting that van Fraassen is proposing an error theory. Like any error theory, we should adopt it only as a last resort; and in this case, to accept van Fraassen's model is to give up our commonsensical view of explanations.

This conclusion is particularly sound given what van Fraassen has said about empiricism in his most recent work.¹⁵ Van Fraassen recognizes that traditional empiricism (or what he calls naive empiricism) is self-defeating. The argument goes as follows. Any philosophical position adopts the meta-philosophical principle below:

Principle Zero: For each philosophical position X there exists a statement $X+$ such that to have (or take) position X is to believe (or decide to believe) that $X+$.¹⁶

Van Fraassen calls $X+$ "the dogma or the doctrine of position X ." Empiricism can therefore be defined as something like,

(NE) To be an empiricist = to believe that $E+$ (the empiricist dogma)

Regardless of what $E+$ is, we know that, as a corollary to (NE), an empiricist critique of X entails a demonstration

¹⁵ Van Fraassen (2002)

¹⁶ Ibid, p. 41

that X and $E+$ are incompatible. Moreover, empiricism typically takes any disagreement with factual hypotheses to be an admissible part of its domain of investigation. In other words, as long as an hypothesis is genuinely factual, it always can participate as a viable consideration within the empirical camp. The reason is that as a consequence of rejecting metaphysics, empiricism denies any *a priori* settlements of factual disagreements. Now, imagine an empiricist arguing with a metaphysician. To present a critique of metaphysics, the empiricist must show that the metaphysician's view is incompatible with $E+$. But to do so is to invite some metaphysical hypotheses into the empiricist camp and consider it a viable alternative, hence violating a deep empiricist dogma that we are only to consider empirically sound hypotheses (e.g., hypotheses that are derived from observations alone). Otherwise, the empiricist must reject metaphysical hypotheses *a priori* and commits the other great metaphysical sin.

In many respects, van Fraassen's argument resembles a typical dilemma faced by political liberals who preach the importance of being tolerant. Should they tolerate those who espouse intolerance? Empiricists can stonewall, insist on their dogmas and refuse to engage anyone else, but as van Fraassen rightly points out, this move would lead

empiricism to either a hopeless justificatory regress or the charge of basing one's philosophical position on some arbitrary grounds. Van Fraassen instead urges us to reject Principle Zero and advocates the view that adopting a philosophical position does not entail holding certain dogmas. To be an empiricist, for example, is to behave in a certain way (e.g., typically open-minded), to take certain methodologies seriously and to have certain non-dogmatic beliefs. One simply needs to make certain lifestyle choices. Van Fraassen calls this way of life the empirical stance. Given the lessons of anti-foundational epistemology since the positivist era, the stance maneuver (e.g., the stance stance) is a natural consequence.

Obviously when we undercut any rational ground for holding an empiricist position we wonder how we can go about justifying our "lifestyle" to those who are less than sympathetic to it. For whatever is left of the fact/value distinction, we want to convince others that empiricism is the correct view and not merely fun, exciting, and appealing to lovers of desert landscapes. Van Fraassen has no magical response here. Instead he diagnoses the argument as follows,

What is behind the [worry] is probably something like the following. Since the differing stances also involve value judgments and attitudes toward life,

love, and laughter, their basis may be thought to be purely subjective...not susceptible to rational debate. But if that is indeed what is behind it then I cannot really take it seriously...We need not look far to see that rational discourse is possible on matters that touch our values, attitudes, and commitments. So I'd just like to say: look around you, take part, welcome to the real world!¹⁷

It is unclear exactly what he means by "rational discourse." No doubt we have *civilized* discourse concerning matters of taste but *rational* discourse? Are there really rational arguments one could make to convince someone that *Titanic* is in fact a terrible movie? With the severely weakened empiricism supporting his pragmatic theory of explanation, one is less inclined to feel the draw of his position. Much of his meta-philosophy is right but it is clear that we can legitimately (from van Fraassen's point of view) reject his error theory and give serious due to our pre-theoretical intuitions concerning the nature of explanations. Often, the ladder of intuition places metaphysics on top with epistemology under it and ethics trailing last. We abandon the top-level intuitions only if revisions at the lower level fail to do the job. Once we have jettisoned the priority of metaphysics and view all positions as mere lifestyle choices, why not pursue a metaphysically robust theory of explanation that

¹⁷ Ibid, p. 62

can actually make sense of the way scientists and laymen treat explanations?

2.5 Epistemic models

In chapter one, I argued that explanations are revisions of beliefs that aim to connect the explanandum and the epistemic condition of the inquirer in an explanatory manner. Peter Gärdenfors' belief-revision model of explanation comes closest to realizing this view. For Gärdenfors, explanation is about lowering the surprise value of the explanandum relative to the epistemic condition of the inquirer. Since usually the explanandum is known, for ordinary cases "we in a sense pretend that [the explanandum] is surprising."¹⁸

Like Salmon, Gärdenfors does not require that the explanans render the explanandum highly probable. However, he also agrees with van Fraassen in rejecting Salmon's S-R view that some explanations can actually lower the probability of the explanandum. He tells us,

[c]alling an argument that lowers the probability of the explanandum an explanation seems to me to contravene completely any reasonable concept of explanation. If one asks for an explanation of why a phenomenon occurred and the answers makes the occurrence even more unlikely, then one would feel

¹⁸ Gärdenfors (1988), p. 167

deceived and would even more desire an explanation of why the phenomenon occurred.¹⁹

Unfortunately, Gärdenfors offers no argument as to why an explanans that lowers the probability of the explanandum cannot qualify as an explanation. But since we have already discussed this issue at great length, we will move on to examine his positive thesis.

Amidst the formal definitions that he uses to model epistemic states, the central idea of Gärdenfors' epistemic theory of explanations is rather simple. Take K to be the current epistemic state of the inquirer, "explaining E (in a given state of belief K) amounts to finding an answer to the question 'If I did not know that E , what acceptable sentences T [a finite set of probability sentences] or C [a finite set of singular sentences] could be used to raise the probability of E (diminish the surprise of E) without begging the question?'"²⁰ Some notations here would help to clarify Gärdenfors' view. There are at least three distinct epistemic states in play: K , K_E^- , and $(K_E^-)_{T\&C}^+$. K corresponds to the inquirer's current epistemic condition. K_E^- is a contracted version of K with the explanandum

¹⁹ Ibid, p. 169

²⁰ Ibid, p. 179

excluded (i.e., when we pretend we did not know E).

Finally, $(K_E^-)_{T\&C}^*$ represents the result of adding T and C to K_E^- and E is known in K only if T and C deductively entail E . The explanatory value of T and/or C is measured in terms of the changes in the belief value of the end stage $(K_E^-)_{T\&C}^*$ when compared to the hypothetical initial stage K_E^- .

Three crucial points are worth noting. First, Gärdenfors does not require that an explanation be a conjunction of laws (or probability sentences in his case) and singular sentences, contra the standard Hempelian view. A lone probability or singular sentence can suffice. Second, an increase in belief value (defined in terms of Reichenbach's single-case probability calculus) of E indicates a positive explanatory value regardless of how small the increase of the belief value is. Finally, as a corollary to the second point, Gärdenfors' model entails that explanations can come in degrees. In fact, since two different beliefs (e.g., one is statistical and the other a singular belief) can raise the belief value of E by the same amount, they are both equally adequate explanations. In other words, Gärdenfors allows ample room for multiple explanations for the same explanandum. We will return to these points shortly but for now let us take a look at

Gärdenfors' demonstration of his model in diagnosing the famous paresis/syphilis case.

As it is conventionally told, a patient can only develop paresis if he has syphilis but the probability of a syphilitic developing paresis is incredibly small.²¹ Using this example to challenge Hempel's I-S model, Scriven argues that citing a patient's syphilitic condition explains why he has paresis even though it does not render his paresis highly probable. For Gärdenfors, the example fits extremely nicely with his belief value model. Suppose the probability of someone developing paresis given syphilis is 0.0001. Let Q be the property of having paresis and thus the explanandum is Qa (namely, a has paresis). The belief value of Qa relative to K_{Qa}^- is 0.0001.²² Let S be the property of having syphilis. According to Scriven's example, we can suppose that $P(Qx|Sx) = 0.1$ and $P(Qx|\neg Sx) = 0$. The conjunction of these

²¹ As a matter of medical fact, one can develop paresis without suffering from syphilis.

²² To determine the belief value for Qa , Gärdenfors using the following measurement:

Let K be an epistemic state with possible worlds W , belief function B , and a defined measure P of expected probability. Let R be the strongest predicate for which it is accepted as true in K that Ra , that is, for which $I(Ra)$ [interpretation of Ra] = W . If nothing else of relevance to Qa is known about a , then $B(I(Qa)) = P(Q|R)$. (p. 177)

two statistical facts constitutes T and the fact that a has syphilis (Sa) constitutes the singular sentence C . The belief-value of $(Qa|T\&C)$ relative to the epistemic condition of K_{Qa}^- is therefore 0.1. Thus, there is an increase in belief value which explains why learning about a 's syphilitic condition is explanatory.

Although I disagree with Scriven that citing someone's syphilitic condition explains her paresis, there are other more serious objections to Gärdenfors' view. Raising the belief-value of the explanandum, I argue, is neither necessary nor sufficient for an explanation. Let us begin by seeing how it is not sufficient. Recall that for Gärdenfors, any increase in belief value corresponds to an increase in explanatoriness. As such, if a belief (singular or statistical) were to increase the belief value of the explanandum by the slightest margin, Gärdenfors would conclude that the additional belief is explanatory. This view is surely wrong. Examine the following example. As in a typical lottery, someone can only win in our lottery if she buys a ticket. Assume the odds of winning are 1 in 10,000. Our fortunate contestant in this example wins the lottery and an inquirer asks "why did Huang win the lottery?" Let the explanandum be "Huang won the lottery" or Wh . According to Gärdenfors' analysis, we can

suppose that the belief value for $Wh = 0.0000001$ relative to not knowing Wh . Let Dx present someone's having bought a lottery ticket and Wx present someone's winning the lottery, we can then say $p(Wx|Dx) = 0.0001$ (T) and $p(Wx|\sim Dx) = 0$ (T). Moreover, we also know that Dh (C). Analogous to the paresis case, the belief value of $(Wh|T\&C)$ relative to not knowing $Wh = 0.0001$; hence, by Gärdenfors' analysis, T and C are explanatory. In other words, the fact that Huang bought a ticket explains (in some degree) why he won the lottery. No doubt, his having bought a ticket might be part of a complete explanation of why he won but to say that the fact alone has explanatory force is clearly mistaken.

Moreover, Gärdenfors makes no explanatory distinction among statistical factors that raise the belief value of the explanandum. So, if the belief that Huang's having bought a lottery ticket and the belief that the lottery was rigged each raises the belief value of the explanandum tenfold, then both have the same explanatory force! Obviously, we want to say that some factors are more explanatorily relevant than others even when they make the same probabilistic difference.

I mentioned earlier that one of the consequences of Gärdenfors' view is that there can be multiple explanations

for the same explanandum. Although I will not offer an argument here, I simply wish to note that as much as it is deceptive to call something that lowers the probability of the explanandum an explanation, it is just as deceptive and frustrating to receive a multitude of answers to a single why-question. Gärdenfors' belief value model leaves one with an epistemic cliffhanger that is akin to Salmon's probabilistic plunge. Imagine what it would be like to receive a Gärdenfors' answer to "why p?" It is compatible with his view that we receive a number of answers all of which are appropriate from Gärdenfors' point of view. Surely, we want to know which of these answers is the right answer. We want to know what really happened. Furthermore, it is entirely unclear to me what sense we can make of the claim that explanations come in degrees. I can see that a given answer is a more complete explanation than some other one, but it seems that when a better explanation is given, the inferior one is displaced.

In addition to being an insufficient condition, raising the explanandum's belief value is not even a necessary condition. For a moment, suspend Gärdenfors' hypothetical requirement; namely, we explain by subtracting the explanandum from the inquirer's current epistemic state. Suppose an Omniscient Being tells me that dinosaurs

became extinct 20 million years ago. Because I know that the source of my information is never wrong, I hold this belief with the firmest of commitments and I assign it maximal belief value. Nevertheless, I wonder why dinosaurs became extinct 20 million years ago. A paleontologist friend explains to me that a giant meteor hit Earth about 20 million years ago causing massive cloud dust that blocked sunrays from reaching the Earth's surface. The resulting severe drop in temperature wiped out virtually all cold-blooded species. The answer I received does not and need not (for explanatory purposes) raise the belief value of the explanandum (since it is maximal already) but it appears to qualify as an adequate explanation. In other words, if the motivation behind Gärdenfors' view is the desire to analyze the explanation relation in terms of making the observation less surprising, then this example shows that we can have appropriate explanation without ever receiving a sense of epistemic solace. Gärdenfors' requirement that we suspend our belief in the occurrence of the explanandum and measures hypothetical epistemic gain runs counter to the motivation of his account. According to Gärdenfors, explanations do not give us any actual or real epistemic gain but only hypothetical would-be

benefits. If he is right, why we do want explanations at all?

Certainly if I did not know that dinosaurs became extinct 20 million years ago, the new information would have risen my subjective probability concerning the explanandum. Nevertheless, this latter fact is at best a mere accidental consequence of an adequate explanation (if it is a consequence at all) and not what explanations are. The problem with Gärdenfors' view is that like so many others, he conflates the raising of subjective expectations with achieving explanatory coherence. Hempel warns us that we ought not to think of explanations as reducing the unfamiliar to the familiar; here it seems Gärdenfors has failed to heed the warning. Gärdenfors is right that explanations involve belief revisions but his conditions of revision are totally trapped within the subjective realm. What we need instead is to structure the explanandum with our view of the world such that together they represent what the world is really like. Philosophers have shied away from such metaphysical boastings but I intend to show in the next chapter that between the Scylla of realism and the Charydis of psychological ease lies the path of a promising holistic route. I will argue that explanations are an indispensable part of the formation our worldview.

2.6 Conclusion

In this chapter we have looked at a host of attempts to explicate the explanatory connection between the explanandum and the explanans. I believe that Hempel has by and large outlined the right picture but unfortunately, positivistic constraints lead him to substitute nomological modality with logical relations. Salmon, in response to Hempel, tries to avoid Hempel's mistake by further loosening the explanatory connection. The resulting statistical relevance turns out to be too thin of a conceptual glue to hold together a meaningful explanatory structure. Causality is then introduced as a remedy but it too is an overreaction for causality unduly restricts how we see the world as interconnected. Van Fraassen's pragmatic model abandons all sense of objectivity by allowing us to define whatever relevance relation we would like. Its apparent success turns out to be no more than a cheap thrill for it leads to the unpleasant conclusion that anything can explain anything. With his own demolition of traditional empiricism, van Fraassen has lost whatever rationale we have to abandon our commonsensical view of explanation. Finally, Gärdenfors' pragmatic model rightly sets explanation within the context of belief-revision but

when it comes to articulating criteria of revisions, his proposal turns out to be far too simplistic. The old mistake of confusing epistemic solace with metaphysical structuring rears its ugly head in Gärdenfors' model. The key lesson for us, it appears, is that explanations must connect the explanandum with the explanans and that the connection requires more than logical relations, statistical correlations and subjective ease. The problem with the various models of explanations (perhaps with the exception of van Fraassen's) is that they all rightly accept (often implicitly) a concept of explanation that sees the world as richly connected but their explications of the explanatory connection are all in terms of conceptually feeble notions. Given the empiricist-dominated atmosphere of current analytic philosophy, the trick is to develop a concept of explanatory connectedness that is strong enough to do the job but not so strong as to rely on metaphysically dubious notions.

Chapter Three: A Positive Account

3.1 Introduction

In the previous chapters, I argued that an explanation seeks to reconnect an observation with the epistemic corpus of the inquirer. We also looked at various attempts to explicate the appropriate connection and we have concluded that none of them can capture our ordinary understanding of an explanation. In this chapter, I wish to argue that only projectable regularities can shoulder the explanatory job and I will put forth a positive analysis of explanation.

3.2 The indispensability of projectable regularities

We saw in the last chapter that any proposed explanatory connection that does not supply a sufficiently robust sense of necessitation between the explanans and the explanandum is doomed to fail. In this section, I wish to offer two positive reasons for the indispensability of projectable regularities in explanations. I use the phrase "projectable" here because I wish to include traditional nomic connections (like laws of nature) and also other "softer" connections (e.g., a particular chess opening is conducive to winning). In a nutshell, whatever is "projectable" qualifies for the purpose of explanation.

For Goodman, a regularity is projectable if it is susceptible to confirmation. Indeed the two notions (e.g., projection and confirmation) are really variants of the same non-deductive inference: the hypothesis "All A's are B's" trivially entails that the next A will be a B. We do not need to adopt the new terminology if the traditional concept of a law is sufficiently modified. My motivation here is to accommodate an earlier concern that if we are restricted to physical laws and their structures, then no explanations given in non-physics vocabularies are permissible. This restriction strikes me as being too heavy-handed. As we continue our discussion of explanation, the notion of a projectable regularity will become clearer. For now, it is sufficient to note that there appear to be two different kinds of regularities: accidental and projectable. The latter differs from the former in that projectable regularities provide metaphysical grounds for predictions and other knowledge claims regarding the unobserved.

The first argument for the indispensability of projectable regularities is based on the observation that all genuine explanations support generalization. Consider one of Hempel's favorite examples: the expansion of an iron bar. Suppose the inquirer wants to know why an iron bar

expanded. In receiving the explanation "Because the bar was heated," the inquirer places the explanandum-phenomenon within a projectable relation (e.g., heating an iron bar leads to its expansion). Whatever the underlying mechanism linking the expansion to the heating, we know this much: *if* the heating of the bar explains why it expanded, then the fact that the heating of the bar explains its expansion is a positive reason to believe the generalization that whenever iron bars are heated, they expand. Imagine what it entails to deny this generalizing nature of explanation. It would mean that in cases where A explains B, this fact adds *nothing* concerning the general connection between A and B! In the present example, it is as if we tell our inquirer "Although *this* iron bar expands because it was heated, this fact alone should not change your view at *all* concerning whether the next heated iron bar will expand." How could that be? In making a prediction about the behavior of the next iron being heated, surely former explanatory facts regarding iron bars and expansion play a role. Likewise, even for "historically singular" events like the extinction of dinosaurs, if the collision of a large meteor really explains why dinosaurs became extinct, then this explanatory fact must raise our expectation that

if there were to be dinosaurs and a similar meteor hit Earth, the dinosaurs would not survive.

It is important to distinguish our claim that explanations support generalizations from Hempel's symmetry thesis that all explanations are potential predictions and all potential predictions are explanations. According to Hempel, an explanation is potentially a prediction in the sense that if one knew the explanans prior to the occurrence of the explanandum event, one could have predicted its occurrence. The symmetry thesis has been rightly criticized on the ground that many legitimate explanations do not afford predictions (e.g., explanation of geological past or evolutionary explanations). Contrary to Hempel's, our generalization thesis says that if *a* explains *b*, then the fact that *a* explains *b* is a piece of positive evidence for the generalization that occurrences of events of type *a* is accompanied by occurrences of events of type *b*. To put the point in a simpler but less accurate manner, the fact that *a* explains *b* confirms the generalization all *A*'s are *B*'s where *a* and *b* are particular tokens of the type *A* and *B*. This thesis differs from Hempel in that it neither implies nor is implied by his symmetry thesis. The denial of Hempel's symmetry thesis is entirely compatible with our view.

The reason why explanations give ground for generalizations of the sort that we just described is that when we offer an explanation, we submit to the inquirer a projectable regularity between the explanandum and other events in the world. A projectable regularity allows the inquirer to make further predictions with it. The only way we can account for the generalizing nature of explanations is to accept the claim that explanations essentially contain projectable regularities. Indeed, all that does the generalizing work is the inclusion of a projectable regularity within an explanation. Without the presence of some projectable regularity, what reasons do we have for believing that explanatory facts have any predictive import?

Secondly, as some philosophers (including Scriven) have noted, subsuming the explanandum under some regularities is not sufficient to explain it. Suppose for example that we want to explain why this particular copper wire conducts electricity. If we follow Hempel's advice by subsuming it under the regularity "all copper wires conduct electricity" (which Hempel considers a law), we should thus have explained why this copper wire conducts electricity. But this is plainly not the case. How does the existence of other positive instances (without exceptions) grant any

explanatory force? The fact that all copper wires conduct electricity is at best a consequence of the appropriate explanation but it is not the explanation itself. We can put the point more bluntly. Regularities indicate the possibility of some projectable regularities but they themselves do not supply the needed explanatory power.¹ We can artificially construe all sorts of constant conjunctions that lack any nomic force. Constant conjunctions are literally wherever you want to see them. As such, it seems highly implausible to say that subsuming an explanandum under these artificial regularities grants us any objective understanding or genuine increase in our causal power.

The issue here can be seen as analogous to our intuitive grasp of confirmation. As Goodman points out, some regularities are allegedly confirmed or supported by positive instances and some are not. The observation that all emeralds examined so far have been green confirms the hypothesis that all emeralds are green; on the other hand,

¹ Marc Lange (2000) contains a wonderful discussion and criticism of the regularity view of law (he calls it the "Humean" view). Some of the philosophers who hold the regularity view include David Hume, David Lewis, Carl Hempel, and Bas van Fraassen (insofar as there are laws). For any philosophers who hold the regularity view of law and think that laws play an indispensable role in explanations, it follows that they believe that mere regularities have explanatory force (e.g., Hempel). More significantly, the present discussion is meant to motivate the importance of projectable regularities in explanations as opposed to a criticism of any particular view.

the fact that all observed men who have been in the auditorium were all third sons does not add any weight at all to the general claim that all men entering the auditorium are third sons. If the regularity that all copper wires conduct electricity has explanatory import, then the more copper wires that we observe conducting electricity, the more plausible the explanation becomes. Yet, this confirmation phenomenon does not occur: we do not become more confident in our explanation as we come across more instances of conductive copper wires. Proliferation of positive instances, by themselves, does *nothing* for the plausibility of the explanation.² The reason, I propose, is that it is not the regularity of a law that grants explanatory power but its modal force. "All copper wires conduct electricity" cannot explain because it does not have any modal force, it is not projectable, and it is not confirmable in Goodman's sense. No wonder the piling on of positive instances fails to raise the explanation's plausibility. This is particularly problematic for Hempel since he takes the difference between projectable regularities and non-projectable ones to be largely

² The proliferation of positive instances can indirectly add explanatory strength in that these instances indicate the presence of a projectable regularity. More on this point later.

pragmatic (e.g., how we use the regularities); hence, he is vulnerable to our objection.³

A somewhat different way to understand the second point is that we see events in the world as relating to one another in two respects. On the one hand, the occurrence of some events is entirely independent of the occurrence of others. The fall of the Roman empire, for instance, had nothing to do with what I had for lunch yesterday. On the other hand, some events are sensitive to the occurrence of other. Ingesting a large quantity of cyanide affected the death of person involved. Goodman has offered an interpretation of the "sensitivity" relation as supporting counterfactual. The occurrence of *B* is sensitive to the occurrence of *A* just in case if *A* were the case, then *B* would be the case. There is no need for us to endorse Goodman's interpretation *per se*, for our purposes, it suffices that we recognize the distinction between events that are sensitive to each other and events that are not. The "modal force" of projectable regularities amounts to

³ For a thorough articulation and defense of the regularity view of law, see Ayer (1963). In the case of Hempel, there is the additional requirement that laws do not contain local references (temporal and spatial). The reason is that Hempel believes that laws are general in that they apply not just in a particular region of space and time. Goodman (1983) has argued persuasively that any intuitively acceptable laws can be transformed into ones that contain references to particulars and vice versa; hence, he raises serious questions about Hempel's non-locality requirement.

just the sensitivity between events codified by a regularity.

I propose that explanations must contain regularities that have modal force and that are more than just mere regularities. This conclusion rules out various accounts of explanation immediately. Van Fraassen's pragmatic approach, for instance, would be incompatible with our view. For starter, van Fraassen explicitly rejects regularities that have modal force (as we defined it); thus, any explication of the explanation relation by appealing to these regularities would be unacceptable to him. I realize that philosophers have often considered regularities like "all copper wires conduct electricity" as genuine laws and that my proposal here apparently runs radically counter to this standard view insofar as it would deny that these regularities are laws. Nevertheless, as I have mentioned in previous chapters, I do not take the notion of law to be homogeneous. There certainly seem to be both laws of the nomic/projectable sense that I am currently considering and laws of brute generalizations (e.g., Kepler's laws). In this respect, I qualify my remarks to apply only to laws in the first sense. I also do not deny the possibility that inductive enumeration is a plausible form of reasoning. What I do deny is that the

uniform behavior or other instances of the same explanandum type necessarily provides explanatory force.

The view that only projectable regularities confer explanatory power is further confirmed by the fact that we often feel initially ambivalent toward some explanations. Consider the following:

Q: Why did Thebes have an army?

A: All Greek city-states had armies.

If we read some projectable regularity into the answer (e.g., that it was politically necessary for a city-state to have an army), then the generalization has some explanatory power.⁴ Since in offering an explanation the respondent implies or explicitly states a projectable regularity, the inquirer commonly suppresses her ambivalence by chalking it up to a case of ignorance. In other words, she believes the respondent is being helpful and thus assumes that the projectable regularity contained in the proposed answer is likely to exist (contrary to her prior beliefs). The level of ambivalence towards a particular explanation is directly proportional to the evidence she has for the existence of the projectable

⁴ Notice the importance of expanding explanatory regularities to include not just laws but projectable regularities. Without the expansion, such an explanation would not be acceptable unless one either claims that the explanation can be reduced to physical nomic connections or that political necessities are on a par with physical necessities.

regularity suggested by the explanation. Even for our copper wire example, the explanation given (i.e., "all copper wires conduct electricity") can be a proper explanation if it implicitly means something more. Notice how much better the explanation becomes of why this copper wire conducts electricity if it is elaborated to something like the following: this copper wire conducts electricity because it belongs to a family of metals that has such-and-such microscopic structure and having such-and-such microscopic structure allows the material to conduct electricity, etc. I am not espousing a version of reductionism, the point here is that some generalizations have explanatory force because they imply (within the proper contexts) projectable regularities. In this case, the deep microscopic structure ensures certain macroscopic properties. Nevertheless, it is crucial that we understand it is the presence of projectable regularities that ultimately does the explaining.

3.3 Some alleged examples of explanations without laws

Philosophers who do not believe that laws are necessary for explanations often cite alleged examples of acceptable explanations that do not contain projectable regularities. Jerrold Aronson, for example, gives five

examples of explanations without projectable regularities.

They are:

- (a) The ink bottle is on its side because John knocked it over.
- (b) The piston moves back and forth because the connecting rod pushes and pulls the piston back and forth.
- (c) A and B stay together because the bar holds them together.
- (d) Protons and neutrons remain in the nucleus because π mesons bind them in the nucleus.
- (e) The rods move at equal angular velocity because the gears maintain their rates equally.⁵

I contend that these examples are either explanations that contain implicit projectable regularities or they are not explanations at all. The surface grammar of an explanatory claim and a non-explanatory one can be identical, and therefore we can be easily confused as to whether something is a genuine explanation (as opposed to being a proper reply to a non-explanation-seeking question). For example, imagine a context in which a non-physicist witnesses the effect of Wilson's cloud chamber and has the following dialogue:

Q: Why is there a bright streak across the oil vapor in the cloud chamber?

A: Oh, Wilson flipped on the switch.

Why does A's answer strike us as being seriously misdirected (as opposed to Aronson's example (a))? First,

⁵ Aronson (1969), p. 544. Aronson attributes the first example to Scriven.

we assume in the case of (a) that no one is genuinely puzzled by the fact that an ink bottle falls on its side when it is struck. So, the next most charitable interpretation of (a) is to supply the imaginary context to set (a) within an exchange to identify the cause of (a). In the cloud chamber example, we antecedently suppose that the layman in the context does not understand why there is a streak across the oil vapor. A's answer appears to be misdirected because we assume that Q is not looking for a causal agent to whom to assign responsibility, but instead is looking for an explanatory account of the phenomenon. No doubt, identifying the cause of the explanandum is an integral part of a causal explanation, but without the causal law specified (implicitly or explicitly), it is not a sufficient explanation. Our intuition that (a) is acceptable stems from the fact that identifying causes is sufficient for some other non-explanatory activities (e.g., assignment of guilt). If we were to reset the context of the cloud chamber example such that we know that Q clearly seeks the person responsible for activating the cloud chamber, then A's remark would be adequate for Q's question. The rest of Aronson's four examples can be treated analogously. Learning that a rod connects the piston, for example, reveals to the inquirer how it is that

the piston moves back and forth. However, it does not explain why it is moving back and forth (as opposed to moving sideways). To have the explanation, the inquirer will need to know some elementary principles of mechanics. In general, we do know these principles, so in the absence of explicit information about the context, we assume that the inquirer must be interested in something other than an explanation. The examples that Aronson outlines convey an air of appropriateness because they are either disguised how-answers or explanations with suppressed regularities. Nevertheless, they are not explanations without projectable regularities.

It is critical when confronting alleged examples of explanation that we are careful to identify their actual nature. Neither surface grammar, nor truth, nor linguistic propriety can guarantee that we are dealing with real explanations, even though the exchanges contain stereotypical explanation keywords such as "because," "cause," or even "explain." Moreover, our desire to make sense of an exchange frequently involves inventing suitable contexts. The alleged explanations *sans* projectable regularities take advantage of the hidden contexts. Once we bring to light the examples' deceptive qualities, their *prima facie* plausibility dissolves. At the end of the next

section, I will return to the Aronson-like argument and offer a deeper response.

3.4 Why should explanations contain projectable regularities

In a surprisingly anti-positivist essay, Carnap echoes similar sentiments concerning the centrality of laws in explanations.⁶ He argues that the traditional positivist hostility towards why-questions was mainly due to their rejection of introducing metaphysical entities to shoulder the entire explanatory work. Thus, Hans Driesch's introduction of entelechy to explain regeneration in sea urchins is unacceptable for the whole enterprise contains no new laws and no novel insight into the phenomena in question that was not accounted for by already existing general laws not involving entelechy. For Carnap, the positing of a new agent is not sufficient for explanatory purpose, one must also provide the corresponding laws indicating the appropriate nomic relationships of the new agent.⁷

⁶ Carnap (1966).

⁷ The presence of law is a plausible criterion demarcating science from pseudo-science. What makes creationism, for example, not a science is that it either contains no law at all or if it does, it merely mimics those of evolutionary biology. Likewise, I suspect our feeling that

But why should laws be indispensable in an explanation? As I mentioned in the first chapter, to have something explained is to gain a particular kind of knowledge, specifically, a kind of knowledge that grants us an understanding of the way the world is. Naturally, one wonders why we so strongly desire this particular kind of knowledge, among all things we can know, and place it among the paragons of epistemic gains? The answer has to do with our belief that learning about projectable regularities is the most secure (though not necessarily the most effective) way to increase our control over our surroundings. We desire explanations precisely because they give us projectable regularities that substantiate our predictions. Without some metaphysical groundings (e.g., projectable regularities or causal connections), we have no reason to have confidence in our predictions. All the constant conjunctions in the world may be no more than cosmic coincidences. As Ruben argues, past conjunctions have projective force only because we posit causal connection. He writes,

"God did it" explains little has to do with the fact that the alleged explanation contains no projectable regularities. Putting forth an explanation without projectable regularity is like giving an insincere apology (e.g., one that expresses no regrets): one has gone through the motion without undertaking the essential tasks. See Lange (1999) for a thorough analysis of the indispensability of law in science.

Consider again the case of every person's yawning being followed by his sneezing. Suppose I knew by a complete enumeration that this has been true in the past. But if it is a true generalization, it is true for the future, and if past instances are to provide me with grounds for believing that future yawnings will be followed by sneezing, I must be presupposing some causal tie, whether direct or indirect, between yawning and sneezing in the past, observed instances. If the instances of a constant conjunction generalization provide me with evidence for the truth of the generalization, then I cannot consistently take the constant conjunction generalization to be non-causal in character.⁸

Ruben's causal connection is but a particular instance of our projectable regularity. Prediction is an important activity that both scientists and laymen engage in every day. If I am right about the centrality of projectable regularities in justifying predictions and explanations being vehicles through which projectable regularities are introduced, then clearly we should expect explanations to be strategically important and valuable in our attempt to maneuver in the world. Having said all this, we need not deny the possibility that learning some other non-nomic regularities can be more effective at altering our environment. There are plenty of examples of non-realistic instrumental laws that clearly provide a superb means of making highly accurate predictions. However, projectable regularities are superior in that we believe they alone

⁸ Ruben (1982)

give us reasons to have confidence in our predictions. This last point is obvious because as long as we accept the distinction between accidental vs. projectable regularities, by definition we are committed to the conclusion that only the latter regularities are susceptible to confirmation and thus substantiate predictions. All the constant conjunctions in the past need not give us any ground to believe that the next instance will conform to the past regularity.

Let us summarize what has been said so far. Explanations (in our ordinary understanding of them) essentially contain projectable regularities. We offer three reasons for this claim. They are:

- (1) The failure of past attempts to explicate the explanatory connection in terms of relations that are metaphysically weaker (e.g., not projectable) than projectable regularities;
- (2) the generalizing nature of explanations; and,
- (3) the fact that subsumptions under brute or non-projectable regularities do not necessarily explain.

In chapter one, I argued that explanations are about revisions of the inquirer's beliefs. Here, we begin to see how the inquirer should adjust her beliefs: to explain *P* relative to the inquirer's epistemic corpus is to connect *P*

to her beliefs via an appropriate projectable regularity. If the selection of the appropriate connection is an objective matter, then it follows that the revision is itself objective. Hence, the worry that an epistemic theory of explanation is hopelessly relativistic is unwarranted. I will return to this theme shortly.

Before we continue, let us return to Aronson's alleged examples of explanations without projectable regularities. It is certainly the case that we often speak naturally about A explaining B without obviously referring to any regularities (projectable or otherwise). This fact, however, poses no serious problems to our view. Our analysis of explanation involves as much rational reconstruction as exploration. Explanations, as I point out in this section, are tremendously useful things and they are useful in virtue of the fact that they reveal projectable regularities. And with these regularities, we can better manage our positions in the world. We are owed from those, like Aronson, who argue that explanations include no projectable regularities, an account as to why we want explanations in the first place. As I have argued, in most cases the counter-examples are not answers to explanation-seeking why-questions. Instead, they perform different functions; for example, the assignment of moral

responsibility as in "Why was my car dented?" The type of explanations that interests us is the type that helps us improve our position in the world by bringing forth projectable regularities that assist us in making predictions for instance.

3.5 Explaining via projectable regularities

Now that we have established the indispensability of projectable regularities in explanations, we need to say more about what it means to explain via projectable regularities. The account that I am advancing here resonates with many of the philosophical intuitions behind Hempel's covering-law model. Unlike Hempel, however, my view does not dilute nomic connections into strictly logical ones (of the deductive and inductive sorts). In this respect, we have good reason to believe that our account is immune to the traditional problems raised against Hempel's model that take advantage of the explanatory "looseness" of logical connections (e.g., the asymmetry problem). The price we pay, however, can be potentially steep. Although the positivists' avoidance of metaphysical "funny business" bordered on the obsessive, they had nonetheless very good reasons to shun robust nomic connections. The traditional Humean problem of rationally

establishing the existence of unobservable nomic connections within empirically sanctioned means has not gone away. Indeed, Goodman's new riddle of induction has merely demonstrated the magnitude of the problem. In order to lend some plausibility to our projectable model and define the scope of the project, I propose that we delineate three different levels of possible problems and outline the strategy for responding to them.

Firstly, there are "super-global" problems that attack the very possibility or coherence of there being any projectable predicates (or more to our point, projectable regularities). Goodman's riddle is a good illustration of a super-global problem. Secondly, there are the "global" problems such as whether explanations essentially contain projectable regularities. These problems take it for granted that there are projectable regularities but question the role they play in an explanation. Scriven's attack on Hempel's covering-law model is a paradigmatic example of a global problem. The previous sections of the present chapter and the examination of various models of explanation in the last chapter are intended to respond to global objections. Finally, one might attack our account on a "local" or technical level by demanding that the mechanics of the model be filled out. What are the

conditions of adequacy? How well does the account capture our intuitions? The symmetry and the irrelevancy problems are examples of local objections (which, of course, have ramifications on the global level).

The tripartite division presented here is analogous to the division between meta-ethics, normative ethics and applied ethics. In discussing an issue in, for instance, medical ethics, one takes certain normative considerations for granted (e.g., the idea that we have moral rights). Likewise, in constructing an adequate normative theory, one puts aside known meta-ethical problems (e.g., whether there is a factual difference between right and wrong) and assumes a meta-ethical position for the purpose at hand. Just as it would be silly to wait for meta-ethical consensus before determining whether euthanasia is permissible, it would be equally counter-productive to insist that one solve the super-global problems first before working on an adequate model of explanation. For the purpose of our project, we make an "upward" assumption and help ourselves to the supposition that projectable regularities are not impossible; thus, we focus primarily on the local problems.

It is worth noting that one way to avoid venturing into the metaphysical mess altogether is to claim that our

goal here is no more than to engage in a kind of rational reconstruction. To be more precise, we are giving an analysis of our *commonsensical* concept of explanation. If it turns out to be the case that projectable regularities are neither metaphysically possible nor epistemically within reach, then so much the worse for our commonsensical understanding of explanation. Indeed, van Fraassen is among few philosophers who recognize the intimate connection between metaphysically rich nomic connections and explanations. His attack against metaphysics centers on the significance of the role played by the traditional concept of explanation. According to van Fraassen, the targets of the empiricist critique are

...forms of metaphysics that (a) give absolute primacy to demands for explanation and (b) are satisfied with explanations-by-postulate, that is, explanations that postulate the reality of certain entities or aspects of the world not already evident in experience.⁹

For better or for worse, the fortune of explanation is inherently tied to the reality of projectable regularities. If you reject projectable regularities or for that matter any notions of necessitation (like van Fraassen does), then your theory of explanation will be an error-theory. I suspect we do not need to make this strong concession yet

⁹ Van Fraassen (2002), p. 37

since the jury is still out in terms of whether or not an empiricist-friendly notion of projectable regularity is possible.

Let us take stock of what we have determined so far. The object of an explanation, as I argued in the first chapter, is an ordered-pair $\langle O, B \rangle$ consisting of some of the inquirer's beliefs together with the observation in question. Furthermore, we also determined that a proper explanation always contains a projectable regularity and that in demanding an explanation, an inquirer seeks to connect the explanandum with her other beliefs vis-à-vis the appropriate regularity.

With these things in mind, we define an adequate explanation as:

$\langle O, B \rangle$ is explained for S if and only if among S 's beliefs, there exists a true belief that O was brought about by some antecedent conditions together with at least one projectable regularity the type of which is specified by B .

The first thing we need to notice is that the definition is not given in terms of the traditional schema "A explains B if and only if..." The reason is that explanation, like any epistemic activities, primarily concerns the epistemic achievement of the agent. The traditional schema fails to

reflect this point.¹⁰ Suppose we want to analyze the concept "understanding." Presumably, we want to know under what conditions an agent understands a certain thing (say, a proposition). The bi-conditional would look something like this: *S* understands that *p* if and only if... It consists of a relation between the object of understanding and the "understander." Likewise, for explanation, we want an analysis that tells us what conditions must be satisfied in order for the inquirer to stand in an explanatory relation to the object of the explanation. Unfortunately, in our case, "*S* explains $\langle O, B \rangle$ " gives us the wrong analysandum since we are not interested in what someone must do in order to explain but rather what must have happened to the inquirer for her to qualify as someone who

¹⁰ It might be possible to translate our definition into the traditional schema. An examination of belief-justification shows us how. Typically, *S*'s belief that *p* is justified just in case, for instance, it stands in the appropriate relation to *S*'s other beliefs. The schema "Belief *p* is justified for *S* if and only if..." is essentially equivalent to "Belief *q* justifies belief *p* for *S* just in case..." The key is that belief-justification is presupposed to be a relation between beliefs in the analysandum of the second definition while it is stated as part of the analysans in the first. Similarly, we can translate our definition into "Belief *X* explains belief *Y* for inquirer *S* just in case..." Frequently, among the various things that constitute an explanation the selection of the explanation in a given case is pragmatically determined. It might be the citation of the projectable regularity, it might be the relevant antecedent conditions or it might even be corrections of false presuppositions that gave rise to the demand for the explanation in the first place. To that extent, putting the analysis in terms of the schema "*A* explains *B* for *S* if and only if..." masks the pragmatic element in the selection to the explanans by implying that *A* is necessarily the explanation.

has received an explanation. Hence, the definition is put into passive voice.

We will examine two examples to clarify the definition:

Example one: The soap bubble

Suppose Sam wants to know why soap bubbles are created when he washes his dishes: first they expand in volume and then they contract. We figure out what it is about the observation that Sam wants to have explained by learning more about Sam's beliefs. Sam tells us that the observation strikes him as puzzling because he believes that there were no external forces acting on the bubbles and in general, things do not change size unless some external force is acting on them. This "given" clause tells us what kind of explanation the inquirer is looking for. An appropriate explanation, in the case, would be a set of instructions telling him how to change his beliefs so that the observation ceases to be anomalous. For instance, we point out that contrary to his beliefs, there is an external force acting on the bubbles. Since Sam washes his dishes with hot water, the water that comprises the bubbles' walls heats up the air inside the bubble. The air expands and in turn the bubbles expand. As the water and the air cool down, the bubbles shrink. By

demonstrating how the facts in this case satisfy gas laws, we show that the observation occurred as a result of some objective regularity.

Example two: The outbreak of World War One

An inquirer wants to know why World War One began given the fact that telegraphs allowed national leaders to communicate easily, thus increasing the chance of defusing international crises via diplomatic means. We might answer the inquirer by pointing out that other war-inducing factors were also at work. The emergence of military planning as a science gave military outcomes an air of necessity and certainty. The familial closeness among the heads of the major nations turned personal competitions into international rivalries. Once all the factors are recognized, the balance tipped heavily in favor of a major international conflict. The key to this explanation is that we must establish that the outbreak of World War One was a result of certain social and political regularities and the corresponding conditions of the time. Indeed, whether these regularities exist in politics is a point of contention among political scientists but our ambivalence provides further evidence for the view that explanations contain projectable regularities. Historical explanations are suspicious precisely because we have reason to doubt

the existence of any projectable regularities in politics or history.

Although we appeal to regularities and antecedent conditions in explaining something, our account differs significantly from Hempel's. First of all, we relativize explanations to specific inquirers and we treat explanations as epistemic achievements of the inquirers. Hempel would find these characterizations as entirely unacceptable. Moreover, our account permits the explaining of highly improbable occurrences. Recall that for Hempel, Inductive-Statistical explanations are only possible for explananda that are rendered highly probable relative to some antecedent conditions and probabilistic laws. Here we agree with Peter Railton that if a probable explanandum (i.e., an explanandum that happened as a matter of indeterministic chance) is explainable, then this fact should be blind to whether the explanandum was likely to occur or not.¹¹ In other words, if we can explain why a random roulette ball lands on a black slot (99% chance), we should likewise be able to explain why the ball lands on a red slot (1% chance). Again, to explain $\langle O, B \rangle$ to S we need to show that it occurred as a result of some projectable

¹¹ Railton (1978)

regularity together with certain antecedent facts. A highly improbable observation can result from a projectable regularity too. When the roulette ball lands on the improbable red slot, it lands there *as a result of* a genuine random distribution of a particular set-up, exactly as it does when it lands on a black slot.

Suppose we can only obtain a certain rare material by harvesting it through a chemical reaction. Unfortunately, the reaction produces mostly useless waste but once in a while, it produces the desired material. Suppose further that what comes out of a given reaction is genuinely random. How would we explain to an inquirer who wants to know why the waste product was produced? The inquirer is puzzled by our inefficient method of production. We point out to her that the only way to obtain the desired material is to take advantage of the chemical reaction in question and that most of the time, we get junk. Analogously, if she wants to know why the desired material was produced, we inform her that once in a while (if we are lucky enough!) the chemical reaction produces the material we want. Both of these explanations, of course, appeal to the same set of antecedent facts and the same projectable regularities. But this should not strike us as surprising. After all, to say that *O* is random is to say that there is nothing we can

do and nothing we can add in order to bring about one outcome as opposed to the other once the antecedent conditions obtain. In explaining to the inquirer, we demonstrate to her that the observation is connected to her understanding of the world via a universal regularity.

For Railton, an explanation of an improbable occurrence consists of a deductive argument with statistical laws and particular facts as premises and the probability of the explanandum as the conclusion. In addition, there is an addendum stating that the explanandum did in fact occur. Together they form a deductive-nomological-probabilistic (D-N-P) explanation. The schema is as follows:

Explanandum: Ge, t_0 : e 's having property G at time t_0 .

- (1) A theoretical derivation of a probabilistic law of the form (2).
- (2) $(t) (x) [Fx, t \rightarrow P(Gx, t) = r]$
- (3) Fe, t_0
- (4) $P(Ge, t_0) = r$
- (5) (Ge, t_0)

(2) and (3) constitute the premises of a deductive argument for (4). (5) indicates that the explanandum did in fact occur. Aside from the criticism that Railton does not treat explanation epistemically, there is another serious problem with his account. Even with the addition of (5), there is no indication that the explanandum did occur as a

result of the statistical law and the antecedent conditions. A D-N-P explanation takes probabilistic laws and antecedent conditions to be sufficient conditions in bringing about the explanandum; however, they are not necessary. Therefore, it is possible that the explanandum occurred for reasons other than the "probabilistic mechanisms" that Railton takes to be the heart of a probabilistic explanation. One way out of this dilemma is to tag on a *ceteris paribus* condition and Railton hints at this solution at several places. However, *ceteris paribus* clauses are notoriously difficult to define and to defend in a non-question begging manner. Rather than relying on *ceteris paribus*, our account accepts the efficacy (not necessarily causal) of projectable regularities and requires that an explanation must show that the observation is a result of these regularities. We will return to this issue shortly when we discuss some of the potential problems with our view.

One consequence of our definition is that there are no formal requirements for the explanans. As long as the explanans projectably connects the inquirer's observation to her beliefs, it can be a sentence identifying the connection, a set of instructions that restructure the inquirer's beliefs, an argument, or even a work of art.

In some cases, a correction of the inquirer's presupposition suffices for an explanation while in other cases the correction dismisses the inquiry but does not answer it. For instance, take an inquirer who wants to know why an iron bar expands when heated. Imagine that she finds the observation puzzling because she falsely believes that iron is not a metal while she rightly believes that all metal expands when heated. Our explanation might amount to just a correction of her false belief that iron is not a metal. However, a correction of a false belief concerning the occurrence of an observation can never be an explanation. Thus, suppose that Mary wonders why witches fly on broomsticks. Although our answer "There are no witches" stops the inquiry, it is clearly not an explanation of why witches fly on broomsticks. In general, a correction of a presupposition that is part of the inquirer's beliefs (*B*) can be (part of) an adequate explanation while a correction of a presupposition that is part of the observation (*O*) cannot.

Notice that the question-approach to explanation as favored by Achinstein, Bromberger and van Fraassen cannot easily accommodate this last point. The question-approach takes a proper explanation to be one that adequately answers the corresponding explanation-seeking why-question.

A correction of the presuppositions of a why-question shows that the initial question was technically ill formed. A correction of presupposition is not an answer to the question; instead, it literally denies the legitimacy of the question. Nonetheless, ordinary explanations often involve such corrections and our view can account for this fact.

There are a number of serious concerns that must be addressed in order to make plausible the concept of explaining by demonstrating the efficacy of projectable regularities and I will discuss them in turn.

First of all, what does it mean to say that the explanandum was a result of a projectable regularity and some antecedent conditions? For Hempel's D-N explanations, the problem is solved by construing nomic sentences as universal sentences. The law "All F's are G's" is translated as $\forall x(Fx \supset Gx)$ where " $\supset$ " is the material conditional. An explanandum Ga came about via $\forall x(Fx \supset Gx)$ just in case Fa and the universal sentence deductively entail Ga . As we have pointed out earlier, for Hempel a law is a true universal sentence that does not contain any references to spatio-temporal locations and is used as a scientific law. The problem with Hempel's attempt to explicate nomic necessity is that whatever nomic force

there exists in "All *F*'s are *G*'s" has been substituted by deductive necessity. Not only does this substitution move require justification, it is likely to be the source of many problems that plague Hempel's view. In light of these difficulties, it would be wise to resist the temptation to analyze projectable force in terms of simple logical notions (like deductive entailments and inductive support).

Another widely regarded approach is to view laws in terms of subjunctive conditionals and analyze subjunctive conditionals in terms of possible worlds. So, "All *F*'s are *G*'s" really says that if something were an *F* then it would be a *G*.¹² Moreover, the latter conditional entails no more than how possible worlds are distributed (e.g., all the accessible possible worlds contain *F*'s that are *G*'s). There are a number of difficulties with this analysis of

¹² One main reason why subjunctive conditional analysis of law appears attractive to many philosophers is that it seems to handle the problem of noninstantiated law nicely (Curd and Cover (1998), p. 881). For example, a corollary of Newton's first law of motion says that a body with no external force acting on it either remains at rest or moves along a straight line at a fixed velocity. Since it is likely that no object in the universe is free from external forces, we can conclude that no object ever instantiates the principle. If laws are just brute regularities in the universe, then the absence of any such regularity entails that Newton's law is not a law. A subjunctive conditional account avoids the problem by pointing out that if there were an object with no external force acting on it, it would behave accordingly. Likewise, there are functional laws with values that never obtain. For example, the ideal gas law ($PV = nRT$) ranges over infinite number of values with only finitely many of them ever realizing. Again, the subjunctive account solves the problem by implying that if there were such a value, it would act in accordance to the law.

onomic laws. As Mellor argues, there are laws that entail values that are physically impossible (hence, inaccessible from the actual world).¹³ Take the nomic relationship between the temperature and pressure of water vapor. The functional law entails that there is a value for the pressure of water vapor at the significantly high temperature at which water vapor would decompose. There are no accessible possible worlds (i.e., those that share our physical laws) that contain such instances. Yet, functional laws with physically impossible values are commonly accepted.

There is, however, a more fundamental problem with cashing out the modal quality of a nomic relation in terms of possible world distribution. For starters, we want to say that it is no mere accident that the possible worlds are distributed in a given manner. Remember that we believe that mere constant conjunctions (even if they are stable transtemporally) are not necessarily laws. Here the problem has been moved to the possible world realm. Mere distribution of worlds cannot be the source of modality. To say so is to reverse the conceptual priority: the worlds are distributed as such because there is a modal fact and

¹³ From his "Necessities and Universals in Natural Laws" in Mellor (1980)

not the other way around. As Kripke has argued, possible world talk is just a picturesque way of understanding possibility and necessity. They ought not to be analyses of modal notions.¹⁴

I am inclined to believe that no reductive account of projectable force is possible. The argument parallels Moore's critique of naturalistic analyses of moral concepts. For any proposed reductive account of modality, one can always meaningfully ask if it is possible that the explicans is but a coincidence. Thus, for example, suppose we say that the nomic necessity of all *F*'s are *G*'s derives from the fact that in all possible worlds (where *F*'s exist) if something is an *F*, it is also a *G*. But of course, it might just be a mere transworld coincidence that there are no worlds in which there is an *F* that is not also a *G*. If we argue, however, that there is some necessity to the distribution of the possible worlds (as David Lewis does), then the concepts "necessity" and "possibility" remain unanalyzed. Although this response is too quick to dismiss all reductive analyses of projectable properties, it gives us some reason to be pessimistic about the approach.

¹⁴ Kripke (1980)

One attractive feature of the reductive approach is that it captures the Humean intuition that however hard one contemplates the relations between things, one cannot discover the nomic connections between them. Discovery of nomic relation is clearly an *a posteriori* activity. And it is often assumed that *a posteriori* truths are contingent; hence, the reductive approach attempts to capture the contingency and in turn the *a posterioricity* of modality by appealing to what *is* (not must, not can be) the case. Kripke's and Putnam's analyses of natural kind terms, nonetheless, show that although identification of nomic laws is an empirical matter, it does not follow that laws are contingent. Putnam's classic twin-earth example is supposed to show that if water is H_2O , then water is necessarily H_2O . The necessity derives from certain conceptual facts about reference-fixing; namely, we fix the reference of a term by identifying it with the "stuff" in question. If the baptizing is successful, then the connection between the term and its underlying nature becomes a metaphysically necessary truth.

Tyler Burge has further argued that the direct-reference analysis can be extended to non-natural kind terms including "an artifact terms, an ordinary natural kind word, a color adjective, a social role term, a term

for historical style, an abstract noun, an action verb, a physical movement verb, or any of various other sort of words."¹⁵ Development of reference-fixing as the basis of the modality of law promises to capture the richness of projectable regularities while appealing to the least amount of metaphysical notions. Moreover, it undercuts the assumed contingency of laws and the motivation for a reductive approach. The "bring about" of an observation by a projectable regularity, I believe, can best be cashed out along this approach. In explaining something, we must show that it occurred as a result of a projectable regularity. An analogy here helps clarify the "as a result of" relation. Take the game of chess. The rule of the bishop dictates that it moves diagonally. If the bishop is to make a legal move, it *must* move diagonally. Suppose someone wants to know why the bishop moves diagonally. Depending on her beliefs, it might suffice to point out that there is a rule dictating that the bishop must move diagonally. We know that the bishop must move *as a result* of the rule of the bishop. If the rule were to change, the possible moves of a given bishop also change. The relationship between the rule and the actual movement of a

¹⁵ Burge (1979) as reprinted in Harnish (1994), p. 400.

bishop is surely non-causal. Moreover, we are inclined to say that the relationship is also not analytic since it involves a token event. Thus, some philosophers have concluded that the relationship, for want of a better term, is metaphysical.

For our purpose, all we need is the intuition that events in the world occur in relation to one another and these relations dictate what combinations are possible. Our aim is to demonstrate a conceptual connection between explanation and projectable regularity. And we will leave the determination of what constitutes a projectable regularity an opened question. Our theory simply says this: *explanations explain in virtue of connecting the explanandum-observation with the inquirer's beliefs via a projectable regularity.* The only analysis that it rules out is one that rejects the modal nature of projectable regularities altogether. The ultimate nature of the projectable force (e.g., whether it be explicated in terms of non-nomic concepts) and in some respects even its reality are irrelevant.

A far more serious problem with our projectable account is the apparent gap between the presence of projectable regularities and what actually happens; in other words, how can we be sure that the observation is a

result of the regularity and not some other forces? The standard irrelevancy problem illustrates the gap nicely. Suppose we want to explain why Jonathan is not pregnant and suppose Jonathan has been taking birth-control pills. The fact that Jonathan is not pregnant seems to be subsumed under two different projectable regularities: that men do not become pregnant and that individuals who take birth-control pills are unlikely to become pregnant. Surely, we explain why Jonathan is not pregnant by the fact that he is a man and not by the fact that he has been taking birth-control pills.

The gap is further widened when we consider probabilistic laws that are explanatory. Suppose Peter took a 99% effective poison but instead of dying from the poison, he died of a rare case of simultaneous heart failure that had nothing to do with the poison. Although there is a projectable regularity between taking the poison and dying, it would be a mistake to explain why Peter died on the basis of this connection. After all, that is not what happened.

Hempel recognizes the apparent gap between a projectable regularity and the explanandum in his discussion of the necessity to supplement any explanation with what he calls a "proviso." Hempel argues that no

matter how complete our theoretical knowledge is, we cannot deduce (in an explanatory manner) the explanandum on the basis of laws and antecedent conditions alone.¹⁶ For all deductive nomological explanations, we have to assume that no other relevant factors are at play. As an example, imagine we want to provide a covering-law explanation of why one end of magnet *M* points to the North Pole while being suspended by a thin wire. Suppose there is a law stating that all magnets point to the North Pole when suspended by thin wires and that *M* satisfies the conditions. For Hempel, the antecedent conditions and the nomic connection explain the explanandum only if there are no other factors influencing the direction of the magnet. If, for example, there is an additional thin wire attached to one end of the magnet pulling it to one direction, then the presence of the trick wire explains why *M* is aligned to the north. Without the additional "proviso" indicating that no causal interference take place, the deduction would not be explanatory.

We should notice that Hempelian provisoes go further than auxiliary hypotheses of the Quine-Duhem thesis. While the Quine-Duhem thesis states that theories entail

¹⁶ Hempel (1988)

observations only when conjoined with some *theoretical* auxiliary assumptions, Hempel's provisoes are "localized" in that they are about making particular *non-theoretical* assumptions. So, for Quine and Duhem, in deducing an astronomical observation on the basis of, say, Kepler's laws, we must assume that the laws of optics are correct. For Hempel, the issue is far more severe. We not only assume other auxiliary theories, we also assume that there are no smudges on the lens or that the telescope is pointed to the right direction, etc. No complete theoretical account will ever contain these localized particularities (since they are not theoretical claims). Thus, no theory in principle can ever deduce an observation (and explanation) without the help of provisoes.

The main difficulty with the proviso solution to the gap problem is that it can potentially rob Hempel's covering-law analysis of its very philosophical motivation. Hempel's project attempts to provide an account of explanation that appeals to notions that are modally no stronger than logical necessity. If his modified account tells us that

X is an explanation if and only if *X* satisfies the D-N criteria and it is in fact the case that the explanans brought about the explanandum,

then one is left wondering why the D-N criteria play any role at all? Isn't the second condition appealing to a metaphysical notion "brought about" that Hempel was trying to avoid in the first place?

The gap between the explanandum and the projectable regularity, I believe, cannot be closed in any straightforward empirical manner and this result should not surprise us. As I argued earlier, the projectable regularity that exists essentially in any explanation is a modal notion. Its actual "modal efficacy" cannot be determined or confirmed through any empirically sanctioned methods (e.g., via direct observation).¹⁷ And as the Quine-Duhem thesis and Hempel's proviso argument show, we cannot conclusively falsify the presence of a projectable regularity when the explanandum does not occur. Without the apparent ability to confirm or disconfirm the projectable regularity, explanations with genuine modal components seem to be beyond the reach of any empiricists.

I am inclined to think that the situation is not so dire. First of all, we need to be clear about the exact

¹⁷ Karl Popper was masterful at making a case against confirmation. Some of the problems he raised still pose, in my opinion, serious obstacles against any sensible conception of confirmation.

nature of the gap and the alleged problem that it raises.

The argument seems to be roughly the following:

- (1) For any proposed projectable regularity, it plays a role in an explanation only if it is what actually brought about the occurrence of the explanandum.
- (2) However, we have no way to tell if the projectable regularity in fact was responsible for the explanandum or was screened off by some other facts. We have no way to tell if a projectable regularity plays a role in an explanation.

Since explanation is an epistemic activity, this objection (if sound) would be fatal in that even if projectable regularities are metaphysically real, explanations cannot meaningfully contain them. The proper way to respond to the objection is to reject premise (2). Premise (2) sets the standard of evidential support unreasonably high. It tells us that the only acceptable method of determining the efficacy of a projectable regularity is a deductive argument guaranteeing the truth of the conclusion. When we offer an explanation, we submit a projectable regularity that we believe is that which brought about the explanandum. Determining the acceptability of the proposed explanation is akin to the determination of any alleged facts (modal or otherwise) within a holistic approach. Projectable regularities cannot be confirmed or disconfirmed in isolation. Their reality can only be established as part of a complete method of understanding

and maneuvering in the world. Once we recognize this holistic nature of our beliefs (both theoretical and observational), the gap problem becomes far less threatening. Take the poison example. The claim that Peter died of a rare heart disorder "screens off" the poison regularity because explaining his death on the basis of his heart failure is superior to the poison explanation. We observe, in an autopsy, that the poison has not done its job and that Peter had a heart failure, etc. The projectable regularity "all (or most) people suffering from a spontaneous heart failure die" fits the evidence at hand far better. The poison regularity seems like the wrong explanation because there is a much better one available. Once we take away the facts about his heart condition, then all of a sudden the poison explanation becomes more plausible. The gap problem points out no more than the fact that some explanations are better than others but this fact squares perfectly well with our view.

The pregnancy example, on the other hand, requires a slightly different treatment. Why is the explanation that Jonathan has been taking the birth control pills so terrible? One obvious reason is that the regularity accompanying the explanation (i.e., anyone who takes birth control pills will likely not become pregnant) is not a law

at all. The domain of the law is too broad to be useful. More accurately, we say that the birth control pill is effective for individuals who are likely to become pregnant if they are not taking the pill (e.g., women of a certain age group, of a certain biological dispositions, etc.). We need such a narrow law because we want to identify the exact size of the domain whose members are affected by the pill. To expand the domain unnecessarily is to defeat the purpose of the law. The problem with the birth control pill example lies not with the essentially projectable nature of explanations but with the regularity involved. We once again see the importance of the modal nature of projectable regularity in an explanation. The regularity "all persons taking the birth control pill will not become pregnant" is extensionally correct but it fails to be a law for it does not capture the proper nomic relation; thus, it offers no explanatory force. I do not have a full account of what makes something a law but it suffices for our response to note that the regularity used to generate the problem is intuitively neither a law nor a projectable regularity; hence, it is not an objection to an account of explanation that requires projectable regularities.

It is important to distinguish the class of examples we are discussing from a somewhat different breed. Some

philosophers claim that there can be multiple explanations for the same explanandum. They claim, for instance, that we can explain the movement of someone's arm on the basis of neurological facts or on the basis of the agent's desires and beliefs (which might or might not supervene on neurology). The gap problem differs from these sorts of cases in that the former does not claim that there is more than one explanation for a given explanandum; rather, it merely states that we have no way to confirm the efficacy of a projectable regularity.

In any case, I believe the so-called multiple explanation phenomenon is seriously misguided because alleged examples all trade on an ambiguity that results from failing to consider the epistemic parts of the explanandum. As I argued before, explananda always contain epistemic facts about the inquirer and the manner in which the inquirer finds the phenomenon in need of an explanation. In typical examples of multiple explanations, the explananda are entirely devoid of these indispensable epistemic facts. Once the missing elements are added, there are no actual examples of multiple explanations. Take the case of trying to explain why Sam moved his arm. In order to determine the proper explanation, we need to know what it is about Sam's moving his arm that the

inquirer wants to have explained. Perhaps it is because the inquirer believes that individuals move their limbs as an attempt to satisfy some intentional goals. If this is right, then the answer "Sam wanted to shoo away the rabid squirrel" might do the trick. Alternatively, it might be the case that the inquirer is interested in how mechanically an arm is moved, in which case a detailed neurological explanation is called for. Both examples contain respectively different explananda, and as such they are not multiple explanations of the same explanandum. A nice consequence of our analysis is that since multiple explanations are often taken to be grounds for reduction or translation of "levels," if there are no multiple explanations, then the need for reduction becomes less pressing. My point here is not to offer a complete argument against the possibility of multiple explanations for the same explanandum. Rather, I want to point out that when we come across alleged examples of multiple explanation phenomenon, we have to be mindful of the essential epistemic elements of explananda. In many cases, as we have seen, once the beliefs of the inquirer are specified, we do not have multiple explanations for the same explanandum after all.

The multiple explanation phenomenon, however, illustrates the close relationship between an inquirer's body of beliefs *B* and the appropriate projectable regularity for an explanation. In identifying the explanandum as a disconnection between some specific *B* and *O*, the inquirer tells us the kind of projectable regularity or the kind of explanation she has in mind. For example, suppose the inquirer witnesses a car accident and wants to know why the victim is bleeding so badly. Imagine that she tells us that given the fact that only a minor artery is severed, the rate of blood loss should not be this high. By contrasting the observation with these beliefs, she tells us that she is interested in a medical explanation (i.e., an explanation that appeals to medical regularities). For a different inquirer, the observation might be contrasted with the beliefs that the victim should not have been seriously hurt since she only broke through the front windshield and flying through the front windshield does not cause serious injuries. In this case, we might appeal to some properties of glass and the principle of inertia to point out that the significantly violent force was exerted on the victim. The dynamic of the selection of the proper projectable regularity is an important issue but it falls outside of our current scope.

A more developed theory of the pragmatics of explanation will have to undertake this difficult task.

There are essentially two related questions that we must answer in determining the adequacy of an explanation:

- (1) Does the projectable regularity in question exist?
- (2) If the regularity in question exists in general, did the projectable regularity (together with the corresponding antecedent conditions) bring about the observation in this particular case?

These two questions are related in that the answer to question (2) partially depends on our answer to question (1). However, it is useful to maintain the distinction so that we can accommodate the notion of a potential explanation. Something is a potential explanation just in case it answers "yes" to only one of the two questions. An explanation that answers "yes" to question (2) but not to question (1) says that a projectable regularity would explain for someone if the regularity did exist.

Explanations that appeal to supernatural forces, pseudo-scientific principles, and false theories are prime examples of this kind of potential explanations. The history of science is filled with these examples.

Alternatively, a projectable regularity might be real

without being an explanation for the observation because there it failed to necessitate the observation in the particular episode. Finally, we can speak of hypothetical epistemic situations in which something would explain $\langle O, B \rangle$ if there were an actual inquirer who has those beliefs. This last category is particularly useful in consideration of the explanatory power of a theory or a projectable regularity because it allows us to consider non-actual cases. Explanatory power of a theory is just its disposition to explain and dispositions range over hypothetical cases.

Whether or not a projectable regularity brought about the explanandum depends entirely on our other beliefs. Does the projectable regularity proposed accord with known evidence? Does it fit well with other projectable regularities that we believe exist? In addressing the gap problem, we see how determination of projectable efficacy (i.e., the answer to question (2)) is a holistic matter. Contrast this view with the pre-proviso Hempelian covering-law account. For Hempel, the satisfaction of the nomic relationship between the antecedent conditions and the explanandum is essentially an *a priori* syntactical matter. Once the two relata are formalized, whether or not they form a nomic connection depends on there *being* a true

universal statement generalizing them. There is no talk of empirically determining if the antecedent conditions and the explanandum are related in actuality.

There is an additional worry, however. One might argue that if an observation is explained by showing how it is connected to the inquirer's belief via a projectable regularity, then why should it not also explain its contrapositive. Take the classic raven example. If a particular bird being a raven together with the law all ravens are black explain for an inquirer why the bird is black, why shouldn't the same law necessitate and in turn explain the fact that all non-black things are non-black (e.g., why a red shoe is red)? Surely, the argument continues, the fact that a red shoe is not black is not explained by the fact that all ravens are black.

This argument conflates two different issues. Whether or not the law all A 's are B 's brings about a $\sim B$ that is a $\sim A$ is a metaphysical issue concerning the nature of law. There are regularities like $F=ma$ that support this inference. If an object having force F is a result of its mass m and its acceleration a (together with $F=ma$), then certainly something's not having m and a (together with $F=ma$) necessitates why it does not have F . Other cases, however, are less supportive of this inference. For

example, individuals who suffer from sickle-cell anemia are immune to malaria. When we come across an individual who is immune to malaria and also has sickle-cell anemia, his immunity is a result of this medical regularity. It would be wrong, however, to conclude that it also brings about why my computer is black. It appears that laws often have very specific and focused domains of application. The reason is because laws and projectable regularities are not isolated true generalizations; instead, they form a total theoretical picture of the world for us. We believe, given the available evidence, that sickle-cell anemia has nothing to do with the color of my computer. As such, we narrow the domain of the regularity to "make room" for other regularities and theoretical beliefs that we have. In this respect, we believe all ravens are black has nothing metaphysically to do with the redness of a given shoe; hence, it does not factor into an explanation of the latter.

Might it be the case that a biological law can explain the redness of a shoe? Some philosophers would perhaps argue that since "red shoe" is not a biological concept, it does not belong to the domain of biology; thus, it cannot fall under the nomic jurisdiction of a biological law. I am inclined to think that this response is too quick.

After all, why should "red shoe" not be a part of the standard biological vocabulary? Nevertheless, we can remain agnostic on this issue and say that as a matter of fact, red shoe is not part of our current biology and leave open the possibility that perhaps with enough evidence, we would say that the redness of a shoe is explained by the fact that all ravens are black. The domain of a science expands and contracts in light of new evidence. The existence of new projectable regularities between entities that once belonged to disparate fields represents an expansion of the domain. Whether the introduction of a new type of entity into a science (e.g., adding red shoe to biology) leads to a new autonomous type or an eventual reduction to the old concepts depends heavily on the criteria of theoretical taxonomy; i.e., what is an admissible new theoretical category for a given science.

In addition to presupposing a controversial metaphysical view about projectable regularities, the raven objection also fails to take seriously the epistemic nature of explanation. In asking for an explanation for $\langle O, B \rangle$, an inquirer tells us two things. She tells us the observation that is in question and the beliefs relative to which the observation possesses an explanatory problem. The beliefs tell us what kind of explanation she wants. The redness of

a shoe does not get explained in and of itself. It is an object of an explanation only when it is relativized against some body of beliefs. All ravens are black can only explain why a shoe is red if it is the regularity by which the redness of the shoe is necessitated and the regularity that connects the observation to the inquirer's beliefs. We have already raised some doubts concerning the first part. The raven objection fails also to consider the beliefs of the inquirer. A projectable regularity cannot automatically explain the complement of an observation even if we assume that the regularity metaphysically brings it about. The reason is that there is a distinction between necessitation and explanation. Necessitation is a metaphysical notion that is independent of any inquirer while explanation is always inquirer-relative. In explaining something, we need to know what it is that the inquirer finds puzzling. The complement of an observation *O* might not be in need of an explanation. Moreover, even if the inquirer finds it puzzling, it might be puzzling relative to a different set of beliefs and hence needing a different kind of explanation.

The holistic nature of our attempts to satisfy the projectable condition highlights the centrality of explanation in our theoretical reasoning. The very *raison*

d'être of explanation is the offering of a projectable regularity. What is valuable about explanations is not that they are true but that they are an integral part through which we propose projectable regularities. A version of inference to the best explanation accords nicely with our view. As Gilbert Harmon suggests, inference to the best explanation takes us "from the fact that a certain hypothesis would explain the evidence, to the truth of that hypothesis."¹⁸ In giving an explanation, one says that a particular projectable regularity is that which brought about the explanandum and that the projectable regularity is real. As more diverse phenomena are explainable via the proposed projectable regularity, the regularity gains plausibility until we decide that the projectable regularity is confirmed enough to be considered real. One might wonder why it should be that a supposed regularity's frequent manifestation should contribute to its reality. The reason, I believe, has to do with our (only) method of ascertaining an entity's objectivity. Robert Nozick, for instance, suggests that one mark of an objective fact is that it is

...accessible from different angles. Access to it can be repeated by the same sense (sight, touch, etc.) at

¹⁸ Harmon (1965)

different times; it can be repeated by different sense of the same observer, and also by different observers. Different laboratories can replicate the phenomenon. What can be experienced only at one instant by one sense modality of one observer is indistinguishable from random noise and does not (securely) count as an objective fact.¹⁹

Repeated manifestation of a projectable regularity under diverse conditions shows that we have an objective regularity.²⁰ Explanatory power of a regularity does not give us grounds to infer its objective reality; rather, approachability from different angles is what we mean by objectivity. In this respect, we differ from the traditional argument for realism such as Putnam's miracle argument in that for our account, no justification of the inferential relationship between explanation and truth is necessary.²¹

If my analysis is correct, there is a constant interplay between answering questions (1) and (2). As we accumulate instances of (2), (1) becomes more plausible. Because of the continual dynamics of answering questions

¹⁹ Nozick (2001)

²⁰ See Betterman (2002) for a wonderful presentation of asymptotic reasoning; i.e., the isolation of patterns exhibited in distinct types of systems.

²¹ The miracle argument claims that the best explanation for the success of science is to attribute reality to the unobservable terms which are parts of our scientific theory of the world. If these entities do not exist, then the success of science would amount to an amazing coincidence (i.e., a miracle).

(1) and (2), the acceptance of an explanation is a matter of degree. We choose to accept a certain explanation because the truth of the regularity is either confirmed or highly plausible and also because posited regularity as that which brought about the explanandum best coheres with our other beliefs. Our analysis captures the intuition that before Einstein, Newtonian physics did explain (to a certain degree) the nature of celestial bodies. The reason is not only that for a limited domain Newton's laws appear true (or at least extensionally correct); instead, given theoretical understandings before Einstein, it was reasonable to accept Newton's nomic regularities as objectively real. It would have been rational for them to revise their beliefs in order to form a worldview constructed on the basis of Newtonian physics even though in hindsight, Newton's laws are strictly speaking not true.

The definition of explanatory adequacy that we proposed explains the importance of explanation in theoretical reasoning. In searching for an adequate explanation, we are engaging in theoretical reasoning. And as long as theoretical reasoning is an integral part of our formulation of a worldview, the search for adequate explanations will continue to play a significant role in this pursuit. It is no wonder that philosophers like van

Fraassen who reject the importance and possibility of theoretical reasoning find explanation to be a peripheral activity.

3.6 Conclusion

Twentieth-century philosophy can be seen as a progression of ever-widening holism. It was Frege who argued that only within the context of a sentence do words have meaning; thus, their truth-values can only be determined when they are embedded in sentences. Quine, taking meaning holism further, argued that beliefs must be judged as inter-related elements of a logically consistent web. No belief in isolation is falsifiable; rather, the entire web of beliefs is subjected to the tribunal of senses. Our account of explanation says that explanations are parts of a large theoretical enterprise. Explanations ought to be evaluated in terms of the success of our overall theoretical reasoning.

Too often the object of an investigation is sliced into smaller conceptual projects in an attempt to provide greater clarity, sometimes at the cost of overall comprehension. So it is in the study of theory acceptance that we find distinct topics such as confirmation, prediction, unification, falsification and, of course,

explanation. Each of these topics is supposed to be a manageable autonomous entity the understanding of which will be part of a grander exploration of the nature of theoretical reasoning. This approach, however, makes a substantive assumption. It presupposes that one can meaningfully ask for necessary and sufficient conditions for an explanation without considering its connection with other theoretical activities. Just as the function of a wheel can only be evaluated in relation to the other components of a cart, an isolated analysis of the nature of explanation would miss the very purpose of explanation; i.e. its interconnectedness to other areas of theoretical reasoning.

Explanations are about the changing of beliefs to form a more accurate picture of the world including its perceived projectable necessities. If we know that no projectable regularities are possible, then I doubt we will continue to offer explanations and regard them as important things to know. In chapter one, I argued that the central worry with an epistemic theory of explanation is that it seems to render explanation a matter of psychology. What eases one person's puzzlement might do nothing for the next. An epistemic theory of explanation is, as Musgrave claims, hopelessly relativistic. Seeing explanation as a

key part of theoretical reasoning shows that the selection of a proper explanation is no less objective than scientific reasoning is. There is clearly a great deal of reflective equilibrium none of which promises to deliver the true picture of the world. But, amidst the phenomenal prison, theoretical reasoning is not only objective enough but it is perhaps all that we can ever have.

Chapter Four: Some Consequences of the Projectable Model

4.1 Introduction

In this final chapter, I wish to examine some consequences of our model of explanation. Specifically, I will look at how it relates to our earlier discussion of the context sensitivity of explanation and also how it handles Peter Achinstein's challenge that there cannot be a model of explanation. In addition, we will look at the relationship between our model and Kitcher's unification in addition to some further applications of our model in normative ethics.

4.2 Context sensitivity

Explanations are sought in order to resolve a certain dissonance between the epistemic corpus of the inquirer and an observation. Relative to different epistemic backgrounds, a particular observation can warrant different (kinds of) explanations. Thus, it makes little sense to ask for certain explanations in contexts with no transparent epistemic conflicts.

Analogously, the selection of the proper explanation is also context-sensitive. An adequate explanation requires that the proposed projectable regularity fits well

with other preexisting and well-confirmed beliefs. A result of this condition is that an explanation that would be proper within one context might be entirely unsatisfactory in another (even in cases where the explanandum is the same in both contexts). For example, it might be perfectly acceptable in many contexts to explain why we have not been able to build a perpetual motion machine by demonstrating that it violates the first law of thermodynamics. Such an explanation would not only be unavailable to a pre-scientific community but, as long as the community holds onto beliefs that are contrary to the laws of thermodynamics, it would be unacceptable even if we were to tell them about the laws. In other words, explanations explain in virtue of placing the observation within a projectable regularity that exists within a broader theoretical background. Without the appropriate background, there is no evidence that the projectable regularity in fact brings about the observation.

All this context sensitivity might sound highly relativistic. It is important that we do not draw this superficial and erroneous conclusion. An adequate explanation entails that the projectable regularity must be real. Its reality must be both objective and mind-independent. Therefore, although one can believe that

certain phenomena are explained, one might be wrong. All explanations are provisional upon the reality of the projectable regularity. However nicely an explanation fits within one's background beliefs, if it contains purported projectable regularities, then it is not an adequate explanation.

A successful model of explanation must recognize the epistemic nature of explanation while avoiding the degeneration into relativism or anything goes. Our account achieves the first part by taking into consideration the inquirer's epistemic background and shows how the explanandum fits in a projectable fashion. The requirement that only real projectable regularities explain provides the necessary objectivity. Drinking a bottle of whiskey, contrary to Musgrave, would not be considered an explanation even though the initial perplexity is removed. In addition, there is clearly no explanatory "privileged access" in the sense that one can easily be mistaken as to whether something has been explained. Both the reality of a projectable regularity and the evidential support for its efficacy in a particular explanation are open to errors.

Those who are attracted to the non-epistemic analysis of explanation (e.g., causal models) might have reasons for rethinking their sympathy. The *prima facie* appeal of non-

epistemic models primarily rests on the allegedly relativistic nature of epistemic models. Indeed, Hempel argues persuasively against "familiarity" analyses of explanations that attempt to define explanatory adequacy on the basis of reducing the unfamiliar (the explanandum) to the familiar (the explanans).¹ As he points out, some of the best explanations we have often do the opposite. Furthermore, what seems familiar to one person might not appear so to another; familiarity defined epistemically is far too subjective to be of use for an objective science. But, once we realize that epistemic models are not necessarily relativistic, this fact undercuts the very motivation to reduce an explanation - a clearly epistemic concept - to a non-epistemic one. From a strategic point of view, reductive models face two major hurdles. First, an advocate of a reductive model must establish why the reduction of a primarily epistemic concept to a non-epistemic one is warranted. Second, the advocate must provide at the minimum a plausible sketch of the target theory. Our epistemic model not only provides explanatory objectivity but it also circumvents the need to address these two fundamental issues.

¹ Hempel (1965), p. 430

4.3 Achinstein's objection

Peter Achinstein argues that any adequate model of explanation must satisfy two requirements: the *a priori* requirement and the No-Entailment-by-Singular-Sentence (NES) requirement. The idea behind the *a priori* requirement is that "a model of explanation should require that sufficient information be incorporated into the explanans that it becomes an *a priori* question whether the explanans, if true, would correctly explain the explanandum."² Potential explanations can only exist for models that satisfy the *a priori* requirement. Although Achinstein does not put it this way, I believe that the *a priori* requirement seems appropriate because he correctly treats the explanation relation as an epistemic relation (akin to other epistemic relation like confirmation). Whether *E* confirms *H*, for example, should be an *a priori* matter and *E* confirms *H* if and only if they satisfy the confirmation relation and *E* is true. Analogously, we should be able to judge the explanatory power of a theory hypothetically; i.e., what would it explain if it were true. Such a judgment is presumably an *a priori* process.

² Achinstein (1983), p. 162

The NES requirement is necessary because it bars analyses of explanations that are not illuminating. It says that "...no singular sentence in the explanans (no sentence describing *particular* events), and no conjunction of such sentences, can entail the explanandum."³ Therefore, in explaining why this metal expanded, the sentence "This metal expanded" cannot be part of the explanans since it alone entails the explanans. It also precludes pseudo-explanatory concepts like "cause," "because," "on account of" from occurring in the explanans. Without it, we permit the following kind of analysis of explanation:

X explains why p if and only if X is the reason for why p.

The right-hand side of the bi-conditional, Achinstein argues, tells us next to nothing about the nature of "to explain."

According to Achinstein, no model of explanation satisfies both the *a priori* requirement and the NES requirement. Hempel's covering-law model, for example, satisfies NES but because of the irrelevancy objection, we cannot determine if the explanans is in fact relevant to the explanandum without some empirical information. We can of course solve Hempel's problem by supplementing it with a

³ Ibid, p. 159

kind of proviso suggested by Hempel himself indicating that the explanans is relevant. The problem then becomes one of violating NES. Achinstein further argues that all of the major models of explanation, including the causal model, Salmon's S-R model, and van Fraassen's question model, violate the *a priori* requirement in order to satisfy the NES requirement. Thus, he concludes, no model of explanation can be acceptable.

How seriously should we take his argument? We can certainly challenge his two requirements. These requirements, however, follow straightforwardly from taking explanation as an epistemic concept. Thus, if we take seriously my earlier argument for the essentially epistemic nature of explanation, Achinstein poses a legitimate challenge. The *a priori* requirement, for example, is reasonable precisely because we want to inject some objectivity into explanation. To deny it amounts to saying that even if we have all the information for the explanans, it still does not guarantee that it explains the explanandum. What else can matter once we have amassed all the relevant facts (e.g., antecedent conditions, causal connections, laws, etc.)? The familiarity model that Hempel rejects epitomizes the danger of violating the *a priori* requirement.

The model that we propose satisfies both of Achinstein's requirements. Recall that our model $\langle O, B \rangle$ is explained for S just in case S rightly believes that O was brought about by a projectable regularity specified by B . By "rightly believe," we mean that both the regularity is real and that it was efficacious in bring about the observation. At first blush, it appears that our model violates NES because it contains "bring about." However, we have to notice that the object of our explanation is $\langle O, B \rangle$ and the explanatory account that tells the inquirer how to adjust her beliefs cannot logically or analytically entail $\langle O, B \rangle$. No explanans according to our analysis entails that an inquirer S would find an observation puzzling relative to her beliefs. Any explanatory account including ours of course pragmatically presupposes an explanandum but the relationship between them is not as strong as logical entailment.

Our model also satisfies the *a priori* condition. Again, we explain by subsuming the explanandum within a certain real projectable regularity. The determination of the proper projectable regularity depends on seeing how it fares against other hypotheses, broadly specified by the inquirer's beliefs. Once all the relevant empirical facts have been gathered, the comparison itself is an *a priori*

matter. This follows clearly from the underdeterminacy thesis of theoretical reasoning. In a nutshell, the thesis claims that no amount of evidence can ever deductively entail a theoretical claim (e.g., the efficacy of a projectable regularity). Thus, we have to appeal to non-evidential and often non-empirical considerations like plausibility (condition on the evidence) and coherence. Both of these latter conditions are determined independent of the complete evidence for the projectable regularity. And this is so even if we hold the view that theory selection is guided by pragmatic considerations (like simplicity or usefulness relative to a given goal). Once the pragmatic consideration is included in the totality of evidence, a hypothesis' ability to satisfy the consideration is again a conceptual matter. In either case, theory acceptance is an *a priori* matter.

4.4 Kitcher's unification view

Philip Kitcher advocates the view that the key to explanatory adequacy rests on the explanans' ability to unify diverse phenomena under a single argument pattern.⁴ As he puts it, "a theory unifies our beliefs when it

⁴ Kitcher (1981) as reprinted in Pitts (1988). Kitcher has recently abandoned the unification approach.

provides one (or more generally, a few) pattern(s) of argument which can be used in the derivation of a large number of sections."⁵ Although the details of his account are complex, the general philosophical motivation behind it is simple. Citing Newtonian dynamic corpuscularianism and Darwin's evolutionary theory as his examples, Kitcher argues that the explanatory power of a theory is its unifying power which "is achieved by generating a large number of accepted sentences as the conclusions of acceptable arguments which instantiate a few, stringent patterns."⁶ In other words, the greater number of accepted sentences we can derive from the fewest patterns increases the explanatory power of a theory. Simplicity is explanatory power.

A number of philosophers have raised technical objections against Kitcher's model but I believe that there exists a more fundamental difficulty with Kitcher's model. If we are to believe that explanation grants us real knowledge of the world, then unification can only be the right path if the world really consists of a few patterns. Indeed, Kitcher's explanation of why his model confers

⁵ Pitts (1988), p. 173.

⁶ Ibid, p. 177

understanding demonstrates the gulf that exists between unification and real knowledge of the world. He says,

[b]y using a few patterns of argument in the derivation of many beliefs we minimize the number of types of premises we must take as underived. That is, we reduce, in so far as possible, the number of types of facts we must accept as brute.⁷

No doubt we make some cognitive gains by reducing the number of types of brute facts but such reduction amounts to mere psychological ease unless the argument patterns offered are real. A false theory can reduce brute facts by positing certain argument patterns but surely accepting a false theory is the antithesis of yielding understanding.

There is, however, something intuitively appealing about Kitcher's unification view but it does not lie in his claim that explanatory power is unification. Instead, the appearance of an argument pattern in a number of diverse phenomena establishes the *prima facie* objectivity of the pattern. And Kitcher's patterns are essentially our projectable regularities. Therefore, unification does not grant explanatory power; rather, unification establishes the ubiquitous presence of certain projectable regularities that are necessary for explanations. Unification itself is only an indicator of the objectivity of a projectable

⁷ Ibid, p. 184

regularity and not the source of explanatory power. In this respect, Kitcher's analyses of Newton and Darwin are dead on. The explanatory power of these theories is heightened by the presence of their respective projectable regularities in ever-increasing domains of phenomena. The more we witness them in different circumstances, the more we are inclined to believe they are real.

4.5 Normative ethics as ethical explanations

The construction of normative theories usually begins by identifying strong moral intuitions and then proceeds to use them as evidence for a theory. The relationship between moral intuition and normative theory is of particular interest. Judy Thomson, for example, argues that normative theories must explain object-level moral judgments. She writes,

At the heart of every moral theory there lie what we might call explanatory moral judgments, which explicitly say that such and such is good or bad, right or wrong, other things being equal good or bad, other things being equal right or wrong, and so on, because it has feature F—for example, "Capital punishment is wrong because it is intentional killing of those who constitute no threat to others".⁸

Why should it be the case that normative theories have this explanatory component? Why is it not sufficient that we

⁸ Thomson (1990), p. 30

have a hodgepodge set of object-level moral judgments? The reason is that we do not merely want to have true moral beliefs, we want to know how to evaluate new moral beliefs, how to convince one another when we have false moral beliefs and how to predict the moral status of certain novel acts. In essence, we want to engage in moral behavior. None of this is possible if we only know existing object-level moral judgments. We need a theory that tells us why object-level judgments have the moral statuses that they do. An explanation of object-level moral judgments brings out projectable regularities that become the backbone of a moral theory. It is in this sense that the explanatory component is necessary for the construction of a normative theory.

Our projectable model of explanation captures Thomson's intuition in two ways. First, it explains why an explanatory account of object-level moral judgments is important for normative ethics. Second, because of the loose concept of projectable regularity, our account provides a natural model of explanation in ethics. We can explain object-level ethical facts by showing how they (conceptually) are necessitated by ethical principles (i.e., ethical projectable regularities). This uniform treatment of explanation across different domains gives us

further reasons to believe that we have reached a fundamental analysis of what makes an explanation an explanation.

4.6 Conclusion

The considerations in this chapter are meant to provide further evidence for and reasons to subscribe to our view of explanation. A number of important issues remain open. Most pressing is the need to explicate the notion of a projectable regularity. We have outlined the characteristics of a projectable regularity but we have not explained how observations result from them. Moreover, the details of the selection of a proper projectable regularity are also unfortunately vague. Sharpening them, however, entails providing an explicit account of theory selection. We can say a few more words concerning the interplay between the inquirer's epistemic background and what she believes is the appropriate regularity needed for a proper explanation. Recall that an explanandum consists of some inquirer's beliefs together with an observation. In general, projectable regularities like laws contain a class of irrelevant perturbations. For instance, suppose all individuals who suffer from sickle cell anemia are immune to malaria is a projectable regularity. The regularity

tells us that the color of an individual's eyes, the size of his feet, his geographic location and his preferences in ice cream flavors do not alter his immunity to malaria if he has sickle cell anemia. By specifying that the explanandum relative to an epistemic body, the inquirer in fact says "given such-and-such, why O?" The given-clause indicates what she believes are the irrelevant perturbations; thus, she communicates to her interlocutor what kind of explanation she is seeking (e.g., irrelevant perturbations that exclude biological facts that are likely relevant signals her interests in a biological explanation). Recall Garfinkel's remarks on contrastive explanations in the first chapter. In this respect, we do justice to Hempel's claim that in explaining something, we must specify what it is about the event that needs explaining.

Investigation into the nature of explanation, as I have argued, has largely ignored the role explanations play in an overall understanding of the world. Rarely do philosophers step back and ask the deeper question "Why do we need or have explanations in the first place?" Our analysis suggests that explanation is part of an epistemic activity of proposing and confirming the existence of projectable regularities. These regularities afford us the

highest degree of confidence in making predictions. Projecting claims beyond the observed is such a widespread and critical part of our epistemology. Indeed, the Holy Grail of epistemology is to know about things that we have not observed.

For those who remain turned off by the heavily metaphysical flavor of our account, it is worthwhile to reconsider van Fraassen's rejection of naïve empiricism. The lesson we should learn from empiricism is that there is no privileged methodology (not even empiricism itself) and thus, there is no *a priori* rejection of certain worldviews. All we have are stances or ways of life that we can adopt. It might be that the only common ground that we all share is the desire to maneuver in the world successfully. If so, then let us abandon the dogmatic rejection of metaphysics and allow pragmatic considerations be the ultimate arbitrator of stance-acceptance. Empiricism might turn out to be the best thing that has ever happened to metaphysics.

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