Chapter 10
From Explanation to Knowledge

Abstract Building upon the insights of the previous chapter concerning the nature of explanation and its relation to understanding this chapter argues for a close connection between explanation and evidential support. That is to say, this chapter argues that the degree to which a given body of evidence supports believing that a particular proposition is true depends upon how well that proposition explains the evidence or is explained by the best explanation of that evidence. The upshot of this explanationist view of evidential support is that explanation is an integral component of epistemic justification. As a result of detailing this explanationist view of evidential support, this chapter offers a clear conception of when we should accept claims in science as well as an account of epistemic justification more generally. Thus, the chapter establishes a very close connection between scientific inference and the justification we might have for any of our beliefs.

In the previous chapter we explored the nature of explanation and its aim, understanding. We noted it is plausible that in order to have scientific understanding of a phenomenon (UP) it is necessary to have understanding of a particular theory, or theories (UT). One must understand a theory before she can use that theory to generate, and possibly even to truly understand, explanations (explanatory hypotheses) of phenomena.

Although the connection between UT, explanations, and UP is very important, a key component of scientific knowledge is missing. We need to have a grasp of what is required to know, or at least justifiedly believe (recall our discussion from Chap. 8 that justification may be what we really care about rather than knowledge), that the theories for which we have UT are true. After all, having UT, understanding how a theory, *T*, works and being able to generate possible explanations of a particular phenomenon from *T* will not help us to truly understand the phenomenon unless we know that *T* is true. For example, understanding my theory of gnomes and being able to use this theory to generate an explanation of why iron rusts (because gnomes love the taste of iron and their saliva causes rust, of course!) does not provide one with genuine understanding of why iron rusts. Why not? My theory about gnomes is simply not true. Even though you can generate "explanations" using my theory, you cannot gain understanding of the phenomena "explained" by those explanations. You need to know that the theory is true. This sort of knowledge is an important part

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of our scientific knowledge. But, how do we come to have this scientific knowledge? We will see in this chapter that such knowledge comes by way of explanatory inferences.[1] In this chapter we will also explore the connection between this sort of explanatory reasoning and the justification of our beliefs more generally.

10.1 Knowledge of Scientific Theories

When it comes to our knowledge of scientific theories part of the picture is quite mundane and unsurprising. Often we base our beliefs concerning which theories are true, at least in part, on observations. How do we gain knowledge of the observational data that we use to support these theories? Just like we gain knowledge of any other empirical facts about the world around us—through observation or by learning of the observations others have made. We use our senses either directly such as when we look outside our window to see if the dog is in the yard, or indirectly by using measuring instruments such as when we determine the temperature by looking at a thermometer or when we receive reports of someone else's observations of deviations in Uranus' orbit. We will discuss how our sensory experiences might be understood to support our observational beliefs below. For now it is sufficient to recognize that this piece of our scientific knowledge, knowledge of observations, is the same as any other knowledge we gain by using our five senses or via the testimony of others as to what they have observed.

The issue that is of interest to us is how we move from observations to knowledge of a particular scientific theory.[2] We tend to do so via a particular method of inference: inference to the best explanation (*IBE*).[3] In simplest terms the idea behind IBE is that explanatory virtues are a guide to truth. That is to say, "the explanation that would, if true, provide the deepest understanding is the explanation that is likeliest to be true" (Lipton 2004, p. 61). IBE is extremely widespread in the sciences. As Clark Glymour (1984, p. 173) aptly notes "One can find such arguments [inferences to the best explanation] in sociology, in psychometrics, in chemistry and astronomy, in the time of Copernicus, and in the most recent of our scientific journals." Here is an historical example to help illustrate the use of IBE in science:

[1] Similar considerations apply to our knowledge of the explanatory hypotheses generated from theories and our knowledge of laws of nature.

[2] Here we are concerned with the sort of knowledge that is gained in a particular scientific context—how a theorist can come to know that a particular theory is true. Later, in Chap. 15, we will discuss how one can gain scientific knowledge via testimony from others whether this is through studying the written works of others or being told directly about the theories and their claims, supporting evidence, and so on.

[3] IBE is sometimes referred to as "abduction". It is best to use separate terminology because there are good reasons for thinking IBE and abduction are not the same. See Hintikka (1998) and Minnameier (2004) for arguments to this effect.

> At the beginning of the nineteenth century, it was discovered that the orbit of Uranus, one of the seven planets known at the time, departed from the orbit as predicted on the basis of Isaac Newton's theory of universal gravitation and the auxiliary assumption that there were no further planets in the solar system. One possible explanation was, of course, that Newton's theory is false. Given its great empirical successes for (then) more than two centuries, that did not appear to be a very good explanation. Two astronomers, John Couch Adams and Urbain Leverrier, instead suggested (independently of each other but almost simultaneously) that there was an eighth, as yet undiscovered planet in the solar system; that, they thought, provided the best explanation of Uranus' deviating orbit. Not much later, this planet, which is now known as "Neptune," was discovered. (Douven 2011)

There are many other examples of IBE being used in the history of science. Copernicus' main argument in support of the heliocentric model of the solar system over the geocentric model of Ptolemaic theory was that his theory provided the best explanation of the observational data (Gauch 2012). Galileo's arguments in support of the Copernican view of the solar system were IBE arguments too (Pitt 1988). Joseph John Thomson's discovery of the electron was an IBE concerning the behavior of cathode rays (Achinstein 2001). Joseph Priestley's discovery of photosynthesis involved employing IBE (Matthews 2015). The reason that we are justified in accepting Einstein's Special Relativity instead of Lorentz's version of aether theory, which also fits the empirical data, is that the former is the best explanation of the data (Janssen 2002). There are several other instances in the history of science where IBE has been successfully employed, for example Antoine Lavoisier's argument against phlogiston theory in favor of the oxygen theory of combustion, Christiaan Huygens' argument in support of the wave theory of light, and, of course, Charles Darwin's argument in support of natural selection (Thagard 1978). As Darwin (1859/1962, p. 476) said about his theory, "it can hardly be supposed that a false theory would explain, in so satisfactory a manner as does the theory of natural selection, the several large classes of facts above specified. It has recently been objected that this is an unsafe method of arguing; but it is a method used in judging of the common events of life, and has often been used by the greatest natural philosophers." Isaac Newton seemed to support IBE as well. In his *Principia* Newton offered several rules for scientific reasoning. The very first rule of reasoning that he offered is an appeal to the sort of explanatory virtues used in IBE. "No more causes of natural things should be admitted than are both true and sufficient to explain their phenomena . . . For nature is simple and does not indulge in the luxury of superfluous causes" (Newton 1687/1999, p. 794). Clearly, Newton believed that simplicity is a very important factor in choosing which theory to accept. There are numerous additional examples of IBE employed both historically and currently in the sciences. The many instances where Ockham's razor (considerations of parsimony/simplicity) is employed to support one theory over another are all examples of IBE.[4] In fact, IBE is so pervasive in the sciences that Ernan McMullin (1992) refers to it as "the inference that makes science."

[4]See Sober (2015) for discussion of the many historical uses and defenses of Ockham's razor as a method of theory selection.

It is clear that IBE plays a major role in the sciences (Boyd 1981, 1984; Douven 2011; Harré 1986; Lipton 2004; McMullin 1992; Psillos 1999). It accounts for how we gain scientific knowledge of theories.[5] When a particular theory generates specific hypotheses that best explain a sufficiently large set of data and those explanations are sufficiently better than their rivals, we can infer that those hypotheses are true. When the best explanation of why a theory produces true hypotheses is that the theory is true, such as in cases where the hypotheses of the theory offer novel predictions, we can infer that the theory itself is true. This is how we gain knowledge of scientific theories. Of course, such knowledge is tentative in the sense that we may revise what we think about a particular theory in the light of new evidence or new rival theories. After all, additional evidence, or new rival theories, may make it so that the hypotheses provided by the original theory are no longer the best explanations, or the new rival may provide the same explanations as the original while providing additional explanatory hypotheses of even more data.

Now that we have had a glimpse of the pervasiveness of IBE in the sciences and we have seen that IBE is the common method by which we gain knowledge of scientific hypotheses and theories, it is worth exploring the structure of such inferences in more detail.[6] Here is the general structure of IBE:

> $F_1, F_2, \ldots, F_n$ are facts in need of explanation.
> Hypothesis H explains the F_i.
> No available competing hypotheses would explain the F_i as well as H does.
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> Therefore, H is true (Lycan 2002, p. 413).[7]

Something like this formulation seems to be what most people have in mind when they speak of IBE.

There are a number of points about the above formulation of IBE that need to be clarified. First, the line "$F_1, F_2, \ldots, F_n$ are facts in need of explanation" needs to be made clearer. Specifically, it is important to consider what counts as a "fact". For our purposes, facts are simply evidence we have and which is taken as given. For example, in a scientific setting the "facts" are typically the experimental observations that have been made.

Second, recall from the previous chapter that to say H explains F is to say that H (perhaps along with various other auxiliary hypotheses or further information) provides information about dependence relations which hold between various

[5]Despite its ubiquity in the sciences, some question the veracity of IBE. We will consider some of the primary objections that have been leveled at IBE in Chap. 14. We will see that these objections are not persuasive.

[6]Presumably, we come to have knowledge of laws of nature by either coming to know a theory of which they are a part or by inferring them from numerous known theories which are themselves best explained by the truth of the law. Hence, IBE is integral to this aspect of our scientific knowledge as well.

[7]Also, see Lycan (1988) for a similar, but different formulation. The primary difference is that Lycan's (1988) formulation has the conclusion that "[probably] H is true" instead of "H is true".

phenomena and F. For instance, the hypothesis that a baseball hit the window (H) explains the window's breaking (F) because, along with auxiliary information about windows and baseballs, H provides information about the dependence of F on other phenomena.

Third, it is important to note a distinction we glossed over in the previous chapter—the distinction between *actual* explanations and *potential* explanations. An actual explanation of a phenomenon is true. Potential explanations are such that they *would* provide understanding of the phenomenon to be explained *if* they were true. The explanations referred to in the above formulation should be understood as potential explanations. Thus, when making an inference to the best explanation one is inferring that the best potential explanation of F is the actual explanation of F.

Fourth, the line "No available competing hypotheses would explain the F_i as well as H does" contains two points that need clarification. One point is what is meant by "available" hypotheses. Admittedly, there are some difficult issues in trying to say when exactly an explanation is available to someone. For instance, it might be thought that for hypothesis H to be available to S, S must be consciously aware of H. Alternatively, one might think that H is available to S so long as S possesses the requisite concepts and cognitive abilities to understand H. Though giving precise availability conditions for an explanation is difficult, one thing seems indisputable; if S is consciously aware of H and she understands H (in the UT sense we explored in the previous chapter), then H is available to her. Plausibly, we might hold that S has H available anytime she has UT of H or she has UT of the theory from which she can generate H, even if she is not consciously aware of H at the moment. We will say a bit more about availability below.

Another point that needs to be clarified is what it means for hypotheses to be "competing". Competing hypotheses are simply contrary hypotheses which offer explanations of a fact or set of facts. On the one hand, the hypothesis that a baseball broke the window competes with the hypothesis that Piper broke the window by kicking it and then she placed a baseball by the window. At most one of these hypotheses is true. On the other hand, the hypothesis which purports to explain why ice melts in water by appealing to modern chemistry is not a competitor for the hypothesis which purports to explain this phenomenon by appealing to quantum mechanics. It is possible that both of these hypotheses are true. So, two hypotheses are competing when it comes to a particular claim just in case they disagree about that claim—when they cannot both be correct about the claim.

Fifth, it is important to understand what it means to say that no available hypothesis explains F *as well as* H does. This is essentially the claim that the explanation inferred to be true must be the *best* available explanation. Before continuing it is worth very briefly considering what might make one explanation better than another. A host of explanatory virtues have been identified and appealed to in various scientific contexts: empirical adequacy (actually explaining the data in question), various kinds of simplicity, explanatory power (the range of phenomena explained and/or how illuminating the explanation is), consistency with currently accepted theories, non-ad hocness, predictive power (making novel predictions),

and raising fewer unanswered questions are just a few.[8] In general, inferences to the best explanation involve evaluating the various available hypotheses in terms of their explanatory virtues and inferring that the most explanatory virtuous hypothesis is (likely) true. Peter Lipton (2004, p. 59) offers the following straightforward construal of what it means for something to be the best explanation: "we may characterize the best explanation as the one which would, if correct, be the most explanatory or provide the most understanding." So, according to Lipton, even if various competing hypotheses each explain all of the relevant facts, there can still be a best explanation among these competitors. The best explanation is the one that, if true, would provide the most understanding of the dependence relations of the phenomena to be explained.

Sixth, another key point which needs to be clarified is that the mere fact that a potential explanation is the best available explanation is not enough for the truth of the explanation to be inferred. The best must also be a good (enough) explanation of the phenomenon in question. That is to say, in order for an explanation to be legitimately inferred as true because it is the best available explanation the explanation needs to meet certain minimal standards.[9] Admittedly, it is a difficult task to make these minimal standards completely explicit. Nevertheless, for the current purposes an intuitive understanding should suffice. To help make the general idea clearer consider the following sort of example:

> Monte has three available explanations for a particular phenomenon, which has ten points of data that require explaining. H_1, H_2 and H_3 each individually explain one of these data points, but offer no explanation of the other nine.

Intuitively, in this example Monte should not infer that the best of the three explanations, H_1 say, is true because it does not sufficiently explain the relevant data. Alternatively, consider the following example:

> Martha has three available explanations for a particular phenomenon, which has ten points of data that require explaining. H_1, H_2 and H_3 each individually explain all ten of these data points.

Whichever explanation is best H_1, H_2 or H_3 clearly meets the standards of being a good (enough) explanation of the data. Certainly, there are difficult cases that lie between these two examples; however, the intuitive idea behind the restriction is

[8] See Beebe (2009), Lacey (2005), Lipton (2004), Longino (1990), Lycan (1988), Kuhn (1977), McAllister (1996), McMullin (1982), Quine and Ullian (1978), Thagard (1978), and Vogel (1990) for a sampling of the explanatory virtues that have been proposed in various scientific contexts and the literature on the nature of explanation. Some might question whether all of the virtues listed are distinct—for example, some claim that predictive power is what separates ad hoc theories from those that are not (Popper 1959; Psillos 1999). As a result, they might question whether predictive power and non-ad hocness are actually two virtues rather than one. Fortunately, for our purposes it is sufficient to simply have a grasp of what some of the most commonly cited explanatory virtues are.

[9] For more on this see Lipton (2004).

fairly clear. Thus, an important caveat for our understanding of IBE is that it is not enough to be the best available explanation; the inferred explanation must be the best available explanation, *and* it must be a sufficiently good explanation of the relevant data.

Now that we have a good handle on the nature of IBE it is worth briefly sketching a picture of our scientific knowledge. Inferring to the best explanation allows us to gain knowledge of explanatory hypotheses which are generated by our scientific theories on the basis of their explaining our observational data. From our knowledge of explanatory hypotheses we are able to infer that our scientific theories are true. If one then has UT of that theory, she can use the theory she knows to be true to construct (or at least appreciate) explanations of further phenomena. These explanations can in turn lead to her having UP of the phenomena in question. The exact process by which we gain knowledge of any particular theory is apt to be much more complex than what we have here, but we do have a good handle on how the various pieces of our puzzle fit together to yield scientific knowledge and understanding.

10.2 IBE Everywhere

In addition to being widely used in the sciences, inference to the best explanation is ubiquitously employed in everyday life. We use IBE to infer that a patient has a particular illness from the fact that she has particular symptoms. In fact, some claim that IBE is the primary method of medical diagnosis (Josephson and Josephson 1994).[10] IBE is used in agriculture to construct models which help increase crop yields (Gauch 1992, 2012). Many philosophers argue that we use IBE when we gain information via the testimony of others. Our explanatory reasoning is key to whether or not we trust the information we have been given by a testifier (Adler 1994; Fricker 1994; Harman 1965; Lipton 1998). Some claim that the use of IBE is relevant to our comprehension of language because it is required to even determine what speakers mean when they tell us things (Dascal 1979; Hobbs 2004). We use IBE so often in our lives many philosophers and psychologists claim that it may be "so routine and automatic that it easily goes unnoticed" (Douven 2011).

Explanatory reasoning more broadly, whether it occurs in explicit instances of IBE or implicit ones, is pervasive in our everyday lives. There are large amounts of cross-cultural research which suggests explanations are pervasive in "our activities from the most simple and mundane . . . to the most sophisticated and unusual"

[10]This claim is somewhat controversial because some think appeal to likelihood ratios alone may be the key to medical diagnosis. Although it is plausible that likelihood ratios can be important tools in medical diagnosis (see Grimes and Schulz 2005), it is not clear that even their use cannot be accounted for under the umbrella of IBE (see Chap. 12). For present purposes, it is enough to note that it has been claimed that IBE is the primary method of medical diagnosis, and this claim has some plausibility.

(Wilson and Keil 2000, p. 87). As William Brewer et al. (2000, p. 281) point out "when one is given an explanation of a phenomenon there appears to be a natural human tendency to evaluate the quality of the explanation." This tendency seems so natural that many think explanatory reasoning may be hard-wired into us. It may be that we are simply born equipped to engage in explanatory reasoning. Even if we are not born ready to engage in this sort of reasoning, it seems clear that the capabilities for explanatory reasoning appear very early in our development. Evidence suggests that infants may have "at least a rudimentary form of explanatory understanding" (Keil and Wilson 2000, p. 4). Brewer et al. (2000, p. 103) assert that their cognitive science research "suggests that, qualitatively, children show competence with most aspects of everyday explanations at an early age." Importantly, the "aspects of everyday explanations" which Brewer et al. refer to are what are typically understood as the sort of explanatory virtues we mentioned above, things like: consistency, explanatory power, simplicity, etc. Further support for the idea that children are competent at evaluating explanations comes from the work of Alison Gopnik (1998, p. 103), who claims that children have "powerful and flexible theory-formation abilities", which seems to suggest they are good at coming up with their own explanations. The empirical evidence clearly suggests that IBE is ubiquitous throughout our entire lives. It is so ubiquitous that it is not uncommon to think that IBE is a basic belief forming method for humans (Enoch and Schechter 2008).

Explanation, understanding, and knowledge all come together in IBE. IBE involves using our understanding of theories to generate explanations which are evaluated in terms of their explanatory virtues. The most virtuous explanation is inferred to be true (or at least likely to be true). Once we infer the truth of the best explanation of a given set of data we arrive at further understanding and knowledge of the phenomena it explains. This method of reasoning, IBE, is a powerful mode of arriving at knowledge in both science and our everyday lives.[11]

Given how integral IBE is to both our scientific and everyday reasoning, we have some reason to think that perhaps the way to understand what is required for a given body of evidence to justify believing a particular proposition (evidential support) is really a matter of explanatory relations. This is an insight that has been noted by many "explanationists" (those who understand epistemic justification to be a matter

[11]Despite its widespread use in science and everyday life, IBE is not without its critics. See van Fraassen (1989), Ladyman et al. (1997), Roche and Sober (2013), and Wray (2008). One of the lines of criticism many find particularly troubling is the claim that IBE leads to probabilistic incoherence. In other words, critics charge that IBE is inconsistent with accepted theories of probabilistic reasoning such as Bayesianism. For a survey of responses to objections to IBE see Douven (2011). For responses to the claim that IBE runs afoul of probabilistic reasoning see Lipton (2004), McCain and Poston (2014), McGrew (2003), Okasha (2000), Psillos (1999), and Weisberg (2009). Some (Huemer 2009; Poston 2014) even go so far as to argue that without IBE probabilistic reasoning, including Bayesian confirmation theory, straightforwardly falls prey to the skeptical problem of induction. We will explore criticisms of IBE as well as responses to those criticisms more fully in Chap. 14.

of explanatory considerations).[12] We will turn our attention to the prospects for such an explanationist account of evidential support now.

10.3 Explanatory Reasoning and Evidential Support

Consideration of IBE and explanatory reasoning more generally puts us in a position to answer a promissory note given in Chap. 5. We are now in a position to sketch an account of what it takes for a body of evidence to provide justification for believing a proposition (evidential support).[13] As we have noted, a plausible place to look for an account of evidential support is in our practices of explanatory reasoning. As Earl Conee and Richard Feldman (2008, p. 97) explain, explanationists hold that "fundamental epistemic principles are principles of best explanation." Here is a plausible way of spelling out evidential support in terms of explanatory considerations:

Explanationism

A person, S, with evidence *e* at time *t* is justified in believing *p* at *t* if and only if at *t* S has considered *p*, and:

(i) *p* is part of the best explanation available to S at *t* for why S has *e*

or

(ii) *p* is available to S as an explanatory consequence of the best explanation available to S at *t* for why S has *e*.[14]

It is worth very briefly explicating a few points about *Explanationism* before continuing.

First, when we discuss whether S is justified in believing that *p*, "S's evidence" should be understood to mean S's total evidence. This is important to keep in mind because making judgments about justification while construing *Explanationism* in terms of only part of S's evidence would have the obvious flaw of ignoring the potential justificatory impact of defeating evidence. For instance, the best explanation of why Jeff seems to see an elephant is that there is an elephant in his vicinity. However, the best explanation for why Jeff seems to see an elephant when he is on a commercial airline flight, has taken a medication which has the side-effect of causing elephant hallucinations, and several trustworthy companions are assuring him that there are no elephants around is that Jeff is suffering one of the side-effects of his medication and hallucinating an elephant. So, <there is an elephant in the vicinity> is the best explanation of part of Jeff's evidence, but it

[12] Conee and Feldman (2008), Goodman (1965, 1978), Harman (1973, 1986), Lycan (1988, 2012), McCain (2013, 2014), Moser (1989), Poston (2014), and Sellars (1963) each defend explanationist theories of justification.

[13] The account of evidential support that we will sketch, and the subsequent discussion of it, is based on the account defended in McCain (2013, 2014, 2015).

[14] McCain (2015, p. 339) This is also very similar to McCain's (2014) "*Ex-EJ*".

is not the best explanation when we consider all of the evidence that he has. This makes clear that it is very important to take account of the total evidence one has when determining whether a particular proposition is justified for her. For simplicity, the examples below only focus on a portion of S's evidence; however, it is assumed in the examples that S's total evidence does not include defeating evidence relevant to the proposition being discussed.

Second, in order for p to be part of the "best" explanation available to S at t it must be the case that there is no competing explanation with respect to p available to S at t which is as good of an explanation as, or better than, the best explanation of which p is a part. Importantly, this does not require S to have a unique best explanation available to her. It could be that S has two explanations available to her, H_1 and H_2. H_1 and H_2 are both equally good explanations of why S has the evidence that she does. Consequently, S could not justifiedly accept H_1 over H_2 or vice versa. In such a case S may still be justified in believing that p because it is part of both H_1 and H_2. If p is not a part of one of the two explanations, H_1 say, then p is not part of the best explanation available to S because there is an equally good explanation available to her which does not have p as a part—H_1 and H_2 are equally good after all. In order to be justified in believing that p there cannot be an explanation which does not contain p that is as good as the best explanation S has which contains p.

Relatedly, as we noted above with respect to IBE, the mere fact that a potential explanation is the best available explanation is not enough for the truth of that explanation to be inferred. The best must also be a good (enough) explanation of the phenomenon in question. Similar considerations apply to *Explanationism*. In order for S to be justified in believing that p it must not only be the best available explanation of S's evidence, it must also be a sufficiently good explanation of S's evidence.

Finally, it is important to say a bit about what it means for S to have an explanation available or have p available as an explanatory consequence of the best explanation available to S. The simplest way to explain what "available" means here is in similar terms to how we construed UT in the previous chapter. Recall, UT requires being able to use a theory to construct or to appreciate explanatory hypotheses. Similarly, we can roughly characterize when S has an explanation available as when she can construct that explanation or at least appreciate it as an account of why she has the evidence that she does without having to first gather additional evidence. Likewise, we can roughly characterize S's having p available as an explanatory consequence of the best explanation available to S as her being in a position to recognize that the best available explanation of her evidence would explain p significantly better than it would $\sim p$.[15]

[15]This approach is influenced by earlier explanationist views such as Harman (1973) where p is justified when it explains or is explained by one's evidence. Notably, the approach here does not say that p is justified when it is explained by one's evidence though. Rather, it holds that p is justified when it best explains S's evidence or when it would be explained by the best explanation of S's evidence. The difference here is subtle, but important.

Of course, we are glossing over many details that an epistemologist would require before accepting *Explanationism* as the correct account of evidential support. For our purposes though we do not need to go into all of these details. We are not attempting to defend a complete account of evidential support and epistemic justification here.[16] Instead, we are simply providing a sketch of how a plausible general account of evidential support and epistemic justification can be constructed from the sort of explanatory reasoning we engage in routinely in our everyday lives. In light of this we are better served by briefly considering how such an account might apply in a number of cases than delving into the minutia of *Explanationism*, or similar accounts.

10.3.1 Applying Explanationism

In order to appreciate the plausibility of our rough sketch of evidential support, it will be instructive to consider some cases to see how *Explanationism* fares when compared with our intuitive judgments.

Let us begin with a simple case of perceptual experience. Intuitively, in normal circumstances (when one does not have the sort of defeating evidence that he had above) Jeff's visual experience as of an elephant provides him with justification for believing <there is an elephant nearby>. *Explanationism* delivers this result. Part of the best explanation of why Jeff has an experience as of an elephant is that there is an elephant. It is exceedingly plausible that an ordinary person, like Jeff, would have the proposition <there is an elephant nearby> as part of the best explanation of his evidence (which includes his current visual experience as of an elephant). Furthermore, in normal situations Jeff will not have an equally good or better explanation of his experience, which fails to include the proposition <there is an elephant nearby>, available to him. Thus, according to *Explanationism*, Jeff is justified in believing that there is an elephant nearby in this case. This is the intuitively correct judgment for such a case.[17]

Explanationism also seems to work well in cases where the proposition we have justification for believing is a truth of reasoning. Consider this sort of situation, Florence considers the proposition <every second grade teacher is a teacher>. Plausibly, since Florence understands what this proposition means, she is justified

[16]For a full development and sustained defense of the sort of account of evidential support we are sketching here see McCain (2014).

[17]One might worry whether this proposition is really part of the best explanation of Jeff's evidence because of concerns having to do with external world skepticism (the view that we cannot know or have good reason to believe propositions about the world around us). There are good reasons for thinking the ordinary propositions that we believe are better explanations than their skeptical rivals. Detailing these reasons is outside of the scope of this chapter, but we will return to this issue in Chap. 11 when we discuss, and respond to, the threat that external world skepticism poses for our scientific knowledge.

in believing it to be true. How can we account for Florence's justification in this case? Presumably, when she reflects on this proposition and understands its content Florence has an experience. Likely, Florence has some sort of awareness of the proposition and of the relations which hold among the conceptual components of the proposition.[18] That is, she is aware that the predicate term "teacher" is contained in the subject term "second grade teacher". It is reasonable to think that in such a situation the truth of the proposition <every second grade teacher is a teacher> is part of the best explanation of Florence's awareness of the relations between the conceptual components of the proposition. After all, when the predicate term of a proposition is contained in the subject term, and the predicate term is affirmed of the subject, there is no way for the proposition to be false.[19] Again, *Explanationism* yields the intuitively correct judgment that Florence's belief is justified.

In both of the previous cases the person was not making an explicit inference. In this next kind of case the person is making an explicit, inductive inference. Bert is aware that all of the vast number of observed emeralds are green. Intuitively, his possession of this evidence puts Bert in a position to justifiedly infer that the next observed emerald will also be green.[20] Again, *Explanationism* yields the correct result. Plausibly, in such a case part of the best explanation available to Bert for his evidence concerning the vast number of observed emeralds is that all emeralds are green.[21] <The next observed emerald will be green> is better explained by the best explanation of Bert's evidence in this case than <the next observed emerald will not be green>. After all, <all emeralds are green> provides a very good explanation of the first proposition, but no explanation at all of the second. And so, <the next observed emerald will be green> is available to Bert as an explanatory consequence of the best explanation available to him for his evidence concerning the observed emeralds.

A more complex case of inductive inference arises when Bert has made many varied observations of some kind of object and most, but not all, of them have had a particular characteristic. Perhaps he has observed a large number of swans in a variety of situations, and the vast majority of observed swans are white, but Bert has seen a few black swans too. In such a case <all swans are white> is not part of the

[18] See Conee (1998) for an explanation and defense of this view. See Markie (2013) for criticism.

[19] One might worry about how a proposition like <every second grade teacher is a teacher> can explain any feature of someone's evidence. While it is true that <every second grade teacher is a teacher> cannot offer much by way of a *causal* explanation of Florence's evidence, explanation should not be restricted to causal explanations when it comes to *Explanationism*. The relevant notion of explanation here is the sort we appealed to in our working model in the previous chapter—it is a matter of providing information about dependency relations. It is not implausible to think that the truth of <every second grade teacher is a teacher> does help explain the dependency relation Florence finds herself aware of when she recognizes that the predicate term of this proposition is contained in the subject term.

[20] We can assume here that Bert knows there will be more emeralds observed in addition to those which have been observed so far.

[21] Whether this regularity is itself a law of nature or some other, perhaps contingent, regularity does not matter for the present purpose.

best available explanation of Bert's evidence. Instead, something like <most swans are white> is part of the best available explanation of Bert's evidence. Often in such cases we still think Bert would be justified in believing <the next observed swan will be white>, or more guardedly, <the next observed swan is likely to be white>. Of course, Bert is not as justified in believing either of these propositions in this case as he would be if all the swans he had observed had been white.[22]

Again, *Explanationism* yields the intuitive result in this sort of case. Bert is justified in believing <the next observed swan will be white> because the best explanation of his evidence, which includes <most swans are white>, better explains that proposition than its denial, namely, <the next observed swan will not be white>. The reason for this is that large probabilities explain better than smaller ones. That is to say, if we are considering two hypotheses and, for example, one hypothesis says that the probability of A occurring is X and the other hypothesis says that the probability of A occurring is less than X, although both hypotheses might offer potential explanations of A's occurrence, all other things being equal, the first hypothesis is a better explanation of A.[23] Likewise, if a particular hypothesis says that the probability of A occurring is X and the probability of B occurring is less than X, then, all other things being equal, the hypothesis provides a better explanation of A than it does of B. When we say, "most swans are white" we mean the probability of observing a swan that is white in a random sampling is X (in this case X is greater than 50%), and the probability of observing a swan that is not white is less than X. Hence, <most swans are white> would better explain <the next observed swan will be white> than it would explain <the next observed swan will not be white> because it offers a higher probability explanation of the first proposition than it does for the second. Thus, *Explanationism* coupled with the very plausible claim that large probabilities explain better than smaller ones yields the intuitively correct results in these sorts of cases of inductive inference.

We have seen that there is at least some plausibility to *Explanationism*. As we have already noted, much more would need to be said in order to provide a full elaboration and defense of this sort of account of evidential support and justification. Nonetheless, we have seen enough to recognize that such an account is a live option. Furthermore, we have now seen that it is not implausible to think that the very method we utilize to gain scientific knowledge can be extended to an account of how we gain the justification required for knowledge in general. The fact that IBE is widely used in most every area of science and the fact that we utilize the very same method, in admittedly a less precise fashion, in our everyday lives gives reason to think that there may be more unification to the sciences on a deep level than may be apparent at first. Additionally, consideration of explanationist accounts of evidential

[22] We are assuming that in this case Bert will be making his next observation of a swan from a random sample. Things would be different if he were making an observation from a sample he has reason to believe is biased in some way.

[23] For further articulation and defense of why large probabilities explain better than smaller ones see Strevens (2000).

support, such as *Explanationism*, suggest that scientific knowledge may not be a different kind of thing than general knowledge. If something like *Explanationism* is correct, there may differences between knowledge in everyday contexts and scientific knowledge in terms of precision and the amount of supporting evidence we require before we believe the known proposition, but the two do not differ in any deep, conceptual ways.

10.4 Conclusion

In this chapter we have considered how it is that we employ explanatory reasoning in order to come to have scientific knowledge—particularly, knowledge of theories and the hypotheses constructed from those theories. We also saw that there are grounds for thinking the sort of explanatory reasoning that is ubiquitous in science, IBE, also permeates our everyday lives. As a result of the extremely widespread use of IBE in our lives it is plausible that evidential support and epistemic justification themselves may be a matter of explanatory considerations. Although the evidence of the ubiquity of IBE and of the plausibility of an explanationist account of evidential support adduced here is far from complete, it does help us to better understand the nature of scientific knowledge and to appreciate its contiguity with knowledge in general. Both may be important for deepening our understanding of NOS.

We have now completed Part II of this book. In these two chapters we have narrowed our focus from the nature of knowledge in general to scientific knowledge in particular. Despite the fact that there are numerous points which are currently unsettled when it comes to the nature of scientific knowledge we have continued to develop a philosophical foundation for understanding NOS. By appreciating the various aspects of scientific knowledge and the debates which are still raging over various components we are in a position to better appreciate the components of scientific knowledge that enjoy widespread support and to understand the relevant issues that remain unsettled. This puts us in a position from which we can continue to deepen our understanding of NOS.

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