Brit. J. Phil. Sci. (2008), 481–497

Explanatory Inquiry and the Need for Explanation

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ABSTRACT

Explanatory inquiry characteristically begins with a certain puzzlement about the world. But why do certain situations elicit our puzzlement (or curiosity) while others leave us, in some epistemically relevant sense, cold? Moreover, what exactly is involved in the move from a state of puzzlement to a state where one's puzzlement is satisfied? In this paper I try to answer both of these questions. I also suggest ways in which our account of scientific rationality might benefit from having a better sense of the *kind* of epistemic goal we are trying to realize, when we engage in our explanatory inquiries.

1 *Two Senses*
2 *The Need for Explanation*
3 *An Example*
4 *Proto-understanding*
5 *Conclusion*

Explanatory inquiry characteristically begins with a certain puzzlement about the world. As Jonathan Lear, commenting on Aristotle's interest in scientific knowledge (or *epistêmê*), aptly notes:

> it is a remarkable fact about us that we cannot simply observe phenomena: we want to know *why* they occur. We can imagine beings who simply watched the sun set and the moon rise in the heavens: they might come to expect regular transitions, but they would lack curiosity as to why the changes occur. We are not like that. The heavenly motions cry out (*to us*) for explanation. (Lear [1988], p. 3)

I take it that the same puzzlement that drove Aristotle's interest in scientific knowledge continues to drive inquirers today. Not just the heavens, but the tides, the photoelectric effect, Brownian motion, and so on, cry out (*to us*!) for explanation.

But Lear also seems right about the following point: we can, apparently, imagine beings who share many of our beliefs about the world and yet fail to

doi:10.1093/bjps/axn021

be puzzled by it. So what exactly is it that accounts for *our* puzzlement? What inspires *our* explanatory inquiries? To suggest, as Lear suggests, that it is our native curiosity that inspires our inquiries helps to illuminate these questions. But in another way it only postpones them. For again we can ask: In virtue of what do certain situations elicit our *curiosity*? What is it that distinguishes those situations that elicit our curiosity from those that leave us, in some epistemically relevant sense, cold?

In this paper I will try to address these issues by focusing on two basic questions. The first we have seen already in passing; since it will recur throughout the paper, it will be helpful to refer to it simply as **Q1**, as follows:

> **Q1**: What is it *in virtue of which* a situation stands in need of explanation for someone?[1]

The second question builds on the first. We can refer to it simply as **Q2**:

> **Q2**: Given that a situation stands in need of explanation for someone, what does it take, from an epistemic point of view, to *satisfy* that need?

Another way to think of **Q2** is as follows: What is it that, when things go well, takes someone from having a need for explanation to having satisfied that need? Or again: what kind of epistemic gain is involved, exactly, in moving from the one state to the other?

Our main questions, **Q1** and **Q2**, obviously complement one another. Thus it is natural to think that if we can accurately identify why a situation stands in need of explanation, we will then be in a very good position to identify what is involved in the satisfaction of that need. A good answer to **Q2** would also have wide-ranging implications. For one thing, a good answer would help to give us a better sense of the sort of epistemic payoff that we expect from a good explanation. For another, if we think of scientific rationality in goal-directed terms—in other words, if we think that an activity is scientifically rational just to the extent that it helps bring about the goals of science[2] —then the project of giving an account of scientific rationality would almost certainly benefit from having a better sense of the *kind* of epistemic goal we are trying to realize, when we engage in our explanatory inquiries.

For our purposes, however, it will be the first question, **Q1**, that will occupy the bulk of our attention. And the hope is that if we can identify a good answer

[1] Along with Menzies ([1989]), I will start off by using the notion of a 'situation' in a fairly expansive and commonsensical way, so that it is broad enough to encompass the range of categories that are usually thought to stand in need of explanation, such as events, states of affairs, facts, and so on (cf. Menzies [2004]). In Section 3 I will then refine this idea.

[2] See, for example, Paul Thagard ([2004]): 'In general, rationality requires reasoning strategies that are effective for accomplishing goals, so discussion of the rationality of science must consider what science is supposed to accomplish' (p. 364).

to *that* question, then our further questions, especially **Q2**, will in turn become that much easier to answer.

1 Two Senses

One reason why answering **Q1** has proven difficult is that there are two quite different ways in which a situation might stand in need (or fail to stand in need) of explanation for someone. We might characterize the first of these needs as *practical* and the second as *epistemic*.

The practical need for explanation is fairly straightforward. In this sense, whether or not a situation stands in need of explanation for you will depend on whether you deem it worth the bother, in some all-things-considered sense. Thus my leaky roof will stand in need of explanation for me but not for you in virtue of the fact that although the well-being of my roof is prudentially valuable to me, this is (let's suppose) far from true for you.

But there is another sense in which a situation might seem to stand in need of explanation for someone, one that considers things from a more purely *epistemic* point of view. As Carl Hempel ([1965]) points out in the opening paragraph of 'Aspects of Scientific Explanation', in addition to the obvious practical incentives we have for wanting to explain our environment, we also seem to have a distinctively intellectual desire to make sense of the world, a desire rooted in our

> *sheer intellectual curiosity*, in [our] deep and persistent desire to know and to understand [ourselves] and [our] world. So strong, indeed, is this urge that in the absence of more reliable knowledge, myths are often invoked to fill the gap. (Hempel [1965], p. 333; my emphasis)

In his *Progress and Its Problems*, Larry Laudan reiterates this point:

> If a sound justification for most scientific activity is going to be found, it will eventually come perhaps from a recognition that *man's sense of curiosity about the world* is every bit as compelling as his need for clothing and food. Everything we know about cultural anthropology points to this ubiquity, even among 'primitive' cultures barely surviving at subsistence levels, of elaborate doctrines about how and why the universe works. (Laudan [1977], p. 225; my emphasis)[3]

[3] The claim is common in more recent authors as well. Roger White ([2004]), for example, likewise connects our interest in why-questions with our natural curiosity: 'In asking a why-question we are seeking to satisfy a peculiar kind of curiosity; we are seeking *understanding* and trying to *make sense* of things' (p. 2). Philip Kitcher ([2004]) also emphasizes the importance of curiosity: 'When we view a completely pragmatic account of the sciences as inadequate, I think we're responding to this (almost?) universal sense of human curiosity' (p. 216).

According to both Hempel and Laudan, then, in addition to the practical incentives we have for wanting to explain our environment, we also seem to have a purely intellectual or epistemic interest in understanding the world around us, one flowing from our natural curiosity. Building on their common appeal to curiosity, we might therefore say that the sign that a situation stands in need of explanation, *from a purely epistemic point of view*, is that it is capable of eliciting our curiosity.

To say that a situation's ability to elicit our curiosity is a 'sign' that it stands in need of explanation for us, of course, does not yet tell us what it is, in virtue of which a situation stands in need of explanation. What it does do, however, is offer a new and potentially more tractable way of posing our first question, **Q1**. We might therefore think of the following 'curiosity-oriented' question as a variant of our original 'need for explanation' question, as follows:

> **Q1***: In virtue of what do certain situations elicit our curiosity?

What this variant of our first question reminds us is that some situations seem to elicit our curiosity and others fail to elicit our curiosity. What is it, then, that accounts for the difference?

2 The Need for Explanation

Even when they are sensitive to the significance of these questions, for the most part philosophers of science have not tended to address either **Q1** or its variants head on.[4] After noting that the notion of an 'empirical problem' is easier to illustrate than to define, for example, Laudan offers the following proposal: 'Generally, anything about the natural world which strikes us as odd, or otherwise in need of explanation, constitutes an empirical problem' (Laudan [1977], pp. 14–5). As Laudan would likely acknowledge, however, suggestions along these lines do not take us very far. Thus if we take Laudan's reference to the 'oddness' of a situation to mean something like the 'puzzlingness' of a situation, then we are left with an essentially circular account: a situation would be in need of explanation on this view (hence puzzling) in virtue of its

[4] Sylvain Bromberger, especially in his ([1962/1992]) and ([1971/1992]), is in some ways a notable exception to this claim. According to Bromberger, a question puzzles us—in his words, we are in a 'p-predicament' with respect to that question—when (roughly) we can think of no candidate answers to the question. While my view seems consistent with this description of puzzlement, it has a different focus: I am more interested in the general question how we should construe the epistemic circumstances in virtue of which a question puzzles us, hence leaves us at a loss for candidate answers, in the first place (in other words, **Q1**). Likewise, Kuhn, famously, talks a great deal about 'puzzles' in *The Structure of Scientific Revolutions* ([1996]), but he does not seem particularly interested in identifying the *source* of the puzzlement. Instead, he says things along the following lines, 'Though intrinsic value is no criterion for a puzzle, the assured existence of a solution is' (p. 37). Again, however, this does not seem a good response to our first question, concerning the need for explanation in the first place.

puzzlingness. Presumably, Laudan must have had something different in mind by the expression 'odd', but as far as I can see he does not explore the question further.

To the extent that philosophers of science *have* attempted to address **Q1** head on, at any rate, one answer has been particularly prominent: namely, that a situation stands in need of explanation for someone in virtue of the fact that, from the person's point of view, the situation strikes him or her as *unexpected* or *surprising*.[5] The basic problem with accounts of this sort, however, is that there seem to be countless situations that strike as entirely *un*surprising, or that in some sense we fully expect, and yet nonetheless stand in need of explanation for us. Thus, for example, the squeaking wheel on my bicycle might be painfully familiar to me as well as entirely expected, yet for all that it will presumably be something that stands in need of explanation for me (cf. Lipton [2004], p. 26).[6]

Rather than attempting to revive the surprisingness account, I therefore will attempt to develop a new approach to **Q1** in what follows. Or, more accurately, I will try to develop a new approach that attempts to build on an insight originally proposed by Robert Nozick some 25 years ago. According to Nozick:

> I am tempted to say that explanation locates something in actuality, showing its actual connections with other things, while *understanding* locates it in a network of possibility, showing the connections it would have to other nonactual things or processes. (Explanation increases understanding too, since the actual connections it exhibits are also possible.) Recall how illuminating it can be to place something, something actual even, in a typology or a two-by-two matrix, how salient is the insight gained through locating it in that network of alternative possibilities. (Nozick [1981], p. 12)

What is particularly important here, I submit, is the connection that Nozick draws between our attempts to understand the world—to satisfy our needs for explanation—and the notion of a 'network of alternative possibilities'. In light of this connection, moreover, what I want to suggest in the remainder of this

[5] See, for example, Peirce ([1908/1968], p. 143) and (Hempel [1965], p. 429).

[6] To this an advocate of the 'surprisingness' model might be able to reply to the squeaking bicycle example by appealing to a notion along the lines of '*ur*-surprisingness'—in other words, a notion of surprisingness which measures how likely one would have taken the situation to be *before* one first learned of the situation. Still, it is not clear that a satisfying answer to **Q1** can be developed along these lines. Suppose that I only happen to be familiar with tree leaves that are green; then at some point I notice that they can change colors (in the autumn, for example), and become gold, orange, and so on. It then seems that the goldness of the leaves might elicit my curiosity—and that would fit the surprisingness model (broadly construed) quite well. Once I become aware that things might be otherwise, however, it also seems that the *greenness* of the leaves might elicit my curiosity. In the midst of summer, I might therefore ask: 'Why are the leaves green (rather than gold etc.)?' It is difficult to see a way to make this latter question work on the surprisingness model, however, even with the 'ur-surprisingness' refinement, for it does not seem to be the case that there was any sensible measure of ur-surprisingness with respect to the greenness of the leaves.

paper is that our attempts to explain the world are necessarily informed by the network of possibility that we bring to bear on the world. More directly, what I want to suggest is that *the need for explanation arises for us in the first place only because we view the world in terms of this network of possibility*.

Brian Skyrms, for one, has proposed a similar framework in more formal terms as follows:

> Let $\{S_i\}$ be an exhaustive set of mutually exclusive possible states of the system of which S^* is a member.... Degrees of explanatory power are relevant to the force with which the explanation resolves the puzzlement: why S^* rather than something else? (Skyrms [1980], pp. 140–1)

Although Skyrms does not explicitly make the connection to our need for explanation, it is easy enough to do some reverse engineering here. Suppose, for example, we accept Skyrms's suggestion that our 'puzzlement' is resolved to the extent that we can identify the factor or factors that help to discriminate among the various possibilities that are in some sense 'live' relative to S^*. If so, then it is natural to think that the reason why S^* stood in need of explanation for someone in the first place is in virtue of the person's sense that there were various alternative ways that the system might have been, various alternative states it might have assumed. If Skyrms and Nozick are right, moreover, then in many important cases where we experience a need for explanation, the need is elicited—alternatively, our curiosity is elicited—by our sense that (in some way) the situation might have been otherwise.

Before we continue with this suggestion, at this point it will help to clarify an important ambiguity that has recurred throughout the paper: thus, I have sometimes used expressions such as 'various ways the situation might have been' and sometimes (as in our discussion of Skyrms a moment ago) expressions such as 'various ways the system might have been'. But these expressions seem to mean different things. For example, we can easily imagine things like 'systems' (or maybe 'substances') being otherwise, but what does it mean for a situation to be otherwise? If a 'situation' is anything like what metaphysicians think of as an 'event', then at the very least it is controversial whether an event can survive a change among its constituent parts. For example, if Smith delivers his lecture on modality two months later than originally planned, does this qualify as the same event as the originally planned lecture, or as something altogether new? Opinions divide sharply here, and it is no easy matter to decide which view we should prefer.[7]

To my mind, however, the best way to sidestep these difficulties, as well as to shed further light on our question, is by drawing attention to the fact that the sorts of situations we have been considering all along are quite finely

[7] For overviews of these debates, see (Simons [2003]; and Collins, Hall, and Paul [2004], Section 4).

structured. Suppose, for example, we come to learn some fact: say, that A is F (perhaps, that the tides are low). The reason why this fact seems to stand in need of explanation for us, I now want to suggest, is because of our sense that the 'subject' of this fact, A, in some sense might have been otherwise: in other words, because of our sense that in some way A might have been (say) G. What elicits our curiosity with respect to the fact that A is F, accordingly, is not simply our registering of the fact that A is F,[8] but rather our registering of the fact that A is F *along with* our sense that things might have been otherwise: here, that A might have been G. It is therefore this whole conglomerate—both our belief that A is F *and* our belief (or sense) that A might have been G—that plausibly elicits our curiosity.[9]

Borrowing from the work of Alan Garfinkel ([1981]) and Peter Lipton ([2004]), we can think of the one possibility, A is F, as *the fact*, and the other possibility, A is G, as *the foil*.[10] On this way of looking at things, it will therefore be the combination of fact and foil that together constitute a 'situation' for us. Although it will continue to be useful to talk of 'situations' in what follows, however, according to the proposal on offer here the important thing to bear in mind is that the sort of situation that elicits our curiosity seems to be a composite thing—again, a thing that consists of a fact along with at least one foil.

Combining these clarifications with our previous discussion, on this proposal two preliminary answers to our questions, **Q1** and **Q2**, naturally fall out. Regarding **Q1**, we now have reason to think that what elicits our curiosity with respect to a situation is *our desire to figure out why the fact rather than the foil obtained*. This then invites the following answer with respect to **Q2**: that the way to satisfy this need is to identify what it is that the difference between the fact and the foil depends on.

By appealing to an example from the recent popular literature on string theory, in Section 3 I will try to clarify this proposal in three ways. First, by showing how the need for explanation is deeply shaped by the network of possibility we bring to bear on the world. Second, by illustrating what is

[8] This might be exactly the kind of thing that Lear's imagined creatures, which we encountered in the opening paragraph, are capable of registering.

[9] Presumably, other beliefs would need to be added here: for example, the belief that it is not the case that A is G. (If 'belief' strikes some as too strong, or too overt, we could speak instead in less overt terms, along the lines of 'convictions'.) It is also worth noting that when a situation strikes us as irreducibly chancy—say, one involving the radioactive decay of a sample of radon, where we observe the radon to decay at one time while yet believing that it might have decayed at a slightly different one—our sense of curiosity is apparently *not* elicited. Or, perhaps better, to the extent that our curiosity *is* elicited by the question of why the time of decay is one way rather than another, this is because we suppose that there is something here that apparently makes the difference between one alternative rather than another—something over and against irreducible chance. (For insightful criticism of the very idea of irreducible chance, see Schaffer [2007].)

[10] van Fraassen ([1980], Chapter 5) offers another well-known account along these lines.

typically involved in the move from a need for explanation to the apparent satisfaction of that need. Finally, by showing how the network of possibility that we bring to bear on the world is importantly structured by our theoretical commitments, including, among other things, our commitments (or beliefs) about nature and its capacities.

3 An Example

The example I have in mind comes from Brian Greene's ([1999]) popular defense of string theory as a potential 'theory of everything'. As Greene notes, throughout the second half of the 20th century researchers seemed to uncover new elementary particles by the day: no longer just electrons and protons, but suddenly quarks, muons, neutrinos, taus, and so on. What amazed particle physicists was not simply the fact that these strange things existed, however, but that their properties were so oddly diverse. As Greene writes, a host of curiosity-driven 'why questions' quickly piled up.

> Why are there so many fundamental particles, especially when it seems that the great majority of things in the world around us need only electrons, up-quarks, and down-quarks? Why are there three families? Why not one family or two families or any other number? Why do the particles have a seemingly random spread of masses—why, for instance, does the tau weigh about 3,520 times as much as an electron? Why does the top quark weigh about 40,200 times as much as the up quark? These are strange, seemingly random numbers. Did they occur by chance, by some divine choice, or is there a comprehensible scientific explanation for these fundamental features of the universe? (Greene [1999], pp. 9–10)

According to Greene, there is thus something about these particles, over and above the mere fact that they exist, that eludes understanding and stands in need of explanation. But what is it, exactly? What is so puzzling or peculiar about the fact that the tau particle (say) weighs 3,520 times as much as the electron?

Despite what Greene himself suggests, the problem does not seem to be the 'seeming randomness' of the properties. Suppose that the mass ratios among the elementary particles were much simpler (to our minds at least) than the actual values Greene cites: for example, suppose the particles stood in mass ratios of 1:2 or 1:3 rather than in ratios of 1:3,520 or 1:40,200. Although these alternative ratios seem (again, to our minds) much less random than the ratios that actually hold, it should be clear that these too can be considered in need of explanation. Suppose the tau weighed three times the mass of the electron—that is, that the two stood in a 1:3 ratio. The fact that *this* simple ratio held rather than some other simple ratio would still presumably be capable of eliciting our curiosity. For that matter, the fact that this *simple* ratio rather than

some other, more complex ratio held would likewise still seem to stand in need of explanation.

If Greene's argument succeeds in convincing us that there is something that stands in need of explanation about the properties of these fundamental particles, the problem must therefore be more basic than that the properties bear certain less-than-simple relationships to one another. Building on the proposal sketched in the previous section, what I therefore want to suggest instead is that the real source of the need for explanation in this case can instead be traced to our awareness that other things of this kind—specifically, other elementary particles—have different masses, so in order to understand why the tau has the particular mass it does rather than another mass that—as an instance of this kind—it might have had, we need to know what it is that differentiates the tau from other elementary particles. More briefly, we want to know what the difference between the tau's mass and the masses of the other elementary particles depends on.

Consider a comparison. If you believe that the corn stalks in a certain field can range in mature height between 6 feet and 8 feet, then presumably the fact that one stalk is (say) 7 feet will be something that might elicit your curiosity. Why is it 7 feet and not 8? Or 7 feet and not 6? In order to satisfy this need for explanation, you will therefore need to identify what it is that accounts for the difference between the stalk's being 7 feet high rather than 6 feet or 8 feet high. Perhaps what makes the difference is that the fertilizer was distributed unevenly throughout the field, or perhaps pests inhibited the growth of some stalks but not others. Whatever it might be, to satisfy your curiosity you will need to identify the factor (or factors) that seem to make a difference here.

It is also important to see that, given our usual beliefs about corn, it would be very odd indeed to be puzzled about (say) why the corn is 7 feet high rather than 7,000 feet high—even though in some broadly logical sense it seems possible for the stalk to be 7,000 feet high. If this is right, however, then the kind of modality that is most relevant to the 'other ways things might have been' clause is often not a broadly logical (or perhaps metaphysical) brand of modality. Rather, the possibilities that are relevant to us are instead often tied to our sense of what sort of capacities a thing has, relative to the *kind* of thing it is.[11] Arguably, then, the reason why Greene seems to be successful in making us think that something like the mass of the tau stands in need of explanation is not simply because he has moved us to believe that in some broadly logical sense the mass of the tau might have been different, but rather because he has reminded us

[11] This suggestion therefore bears strong similarities to Nancy Cartwright's ([1989], [1999]) view that our attempt to explain the natural world is grounded in our knowledge of natures and their capacities. As she writes: 'Our basic knowledge—knowledge of capacities—is typically about natures and what they produce' ([1999], p. 80).

that other things of this very kind—other elementary particles—have different masses, an observation that prompts us to wonder what it is that distinguishes one instance of this kind from another instance of this kind.[12]

I will have more to say in the following section about how our network of possibility often incorporates these richer senses of modality (richer, at least, than broadly logical possibility). For now, we would be better off turning to the next important feature of Greene's discussion: namely, Greene's proposal for how our puzzlement about these particles might be *resolved*—how, in other words, our need for explanation might be *satisfied*, once it has been elicited. It is here, according to Greene, that the merits of string theory are particularly evident because (on his view) string theory *is* able to point to something that might make the difference between the various possibilities that seem alive to us, relative to the focal fact. In particular, he argues that elementary particles have the particular masses and charges they happen to have because they are constituted by vanishingly tiny strings whose resonance patterns determine why the particles have masses and charges with certain values rather than others. As he puts it: 'Here's the central fact: Just as the different vibrational patterns of a violin string give rise to different musical notes, the different vibrational patterns of a fundamental string give rise to different masses and force charges' (p. 143).

One might reasonably ask, in passing, how this qualifies as a step towards a theory of *everything*.[13] But the important point for our purposes is that if Greene is right that the difference between the masses and charges of the elementary particles depends on the oscillation patterns of the strings that constitute the particles, then he has at least helped us to understand this much: namely, why the elementary particles have *these* mass and charge values rather than the masses and charges that, by our lights (and apparently in virtue of the kind of thing they are), they in some sense might have had.

Again, it is worth focusing on Greene's discussion for at least three reasons. First, because the discussion shows in the concrete how certain situations seem to stand in need of explanation for us; what's more, it helps

[12] The notion of a 'kind' of thing also helps to shed light on how even situations that incorporate *necessary* truths—especially, situations where the subject of the situation apparently could *not* have been otherwise—might stand in need of explanation for us. For example, it seems to make sense to ask a question like 'Why is $2 + 3 = 5$ a necessary rather than contingent proposition?' (plausible answer: because it holds in all possible worlds rather than just in some) even though $2 + 3 = 5$ could not have been contingent. On my view, the reason why it makes sense to ask a question of this sort is because the subject of the situation—the proposition $2 + 3 = 5$—is a particular *kind* of thing—namely, a proposition—that *is* capable of being otherwise: namely, qua proposition it is capable of being either necessary or contingent.

[13] After all, even if string theory is correct and all matter is made of the same stuff—tiny oscillating strings—then there still seems to be plenty of room to wonder why strings of a certain sort, the ones that constitute tau particles for instance, vibrate according to pattern X while others vibrate according to pattern Y.

to clarify the central epistemic mechanism—our sense of the alternative possibilities that in some sense might have obtained—that prompts our puzzlement and inspires our inquiries in the first place. Second, it suggests the sort of solution that would potentially *satisfy* our need for explanation—roughly, the identification of the factor or factors that help to determine why one possibility holds rather than another. Finally, it illustrates the way in which our network of possibility is often structured in ways that are modally quite rich—at least, richer than something like broadly logical possibility can capture.

4 Proto-understanding

In order to make better sense of this crucial connection between our sense of possibility and the need for explanation, it will now help to introduce one final piece of terminology: the notion of *proto-understanding*. By an agent's proto-understanding, I mean an agent's convictions *about* the sorts of possibilities that are live or relevant, relative to the situation in question.[14] The notion of proto-understanding can therefore be thought of as a further specification of Nozick's notion of a 'network of possibility'; it is something like a person's 'modal sense' of the various alternatives that might have obtained, relative to the fact in question.

Thinking of a person's proto-understanding as a kind of 'modal sense' helps to remind us once again that there are several different varieties of modality on offer, some stronger than others. So which is most relevant to the need for explanation? To focus our thoughts, we can begin by trying to imagine what the world might be like for someone such as the person David Hume calls 'Adam'—that is, someone newly arrived on earth with 'perfect rational faculties' (Hume's words) but otherwise without any experience of the world ([1748/1963], Section IV, part I). For Adam, unlike for us, the sorts of possibilities (or foils) that are live, relative to his experience of the world, would seem to be all of the alternatives that are *logically* possible, relative to this experience. So, for instance, if Adam were to observe a brick shatter a window, then the sorts of possibilities that would be live, relative to the window's shattering, would be very different from the possibilities that are (presumably) live for us. Thus, by Adam's lights, the window might very well have disappeared into a puff of smoke upon contact with the brick, or perhaps turned into a frog, or perhaps started speaking Spanish.

But now notice: if Adam's possibility space—his proto-understanding—is structured in this way, then he will presumably have reason to be *puzzled*

[14] Although he argues for the point in a different way, Michael Scriven ([1962]) seems to offer a similar proposal: '[T]he request for an explanation presupposes that something is understood, and a complete answer is one that relates the object of inquiry to the realm of understanding in some comprehensible and appropriate way. What this way is varies from subject matter to subject matter. . .; but the logical function of explanation. . . is the same in each field' (p. 202).

about why one of these alternatives obtained rather than the other. Why *did* the window shatter rather than disappear in a puff of smoke? Or shatter rather than turn into a frog? That one of these possibilities rather than another obtained will thus stand in need of explanation for Adam; his curiosity will, apparently, naturally be elicited.

So much for Adam—what about for *us*? What I want to suggest now is that, as we become better acquainted with the world, our network of possibility, and hence the sorts of possibilities that we take to be live relative to a given fact, commonly changes over time. As our network of possibility changes, moreover, the sorts of situations that manage to elicit our curiosity will likewise change. In particular, some situations will cease to elicit our curiosity because we will no longer feel that the 'foil' constituent of the situation is relevant. On the other hand, when the range of alternatives that we take to be possible increases—that is, when the range of foils we take to be relevant increases—some new puzzles will arise for us.

Consider, by way of illustration, the following variation of our earlier example. Suppose that standing alongside Adam, two other observers likewise watch the brick collide with the window, shattering it. One of the additional observers, Stan, has fairly conventional 21st century beliefs about the world, while the final observer, Harry, believes (as a result of being raised by a community of delusional J. K. Rowling fans) that the world is full of objects with magical powers and capacities. Suppose further that we pose some of the same questions to Stan and Harry that we previously considered with respect to Adam: for example, questions such as '*Why did the window shatter rather than turn into a frog*?' and '*Why did the window shatter rather than disappear in a puff of smoke*?'

Focusing first on Stan (the normal one), one important point to notice is that if asked a question such as 'Why did the window shatter rather than turn into a frog?', his answer will presumably *not* be: 'Because it was struck by a brick'. Rather, his answer will either be something along the lines of 'Because windows can't turn into frogs. That isn't possible', or perhaps 'Why ask a ridiculous thing like that?' In other words, rather than answering the question Stan will reject one of the question's presuppositions: that the window is capable of turning into a frog. The 'situation' at issue here—namely, that the window shattered (the fact) rather than turned into a frog (the foil)—will therefore fail to elicit his curiosity because he does not take the 'turning into a frog' possibility to be a relevant alternative to the window's shattering.

A further important thing to notice (and we will return to this point in the final section) is that in ruling out this alternative Stan has presumably made no direct progress on figuring out why the window shattered; in pointing out that it was not possible for the window to turn into a frog, it is not as if he took a step closer towards identifying the factors that made a difference between the window's shattering and remaining intact. Instead, what he has done is

marked out a boundary within which the difference-making question can even be asked.

Turning now to our third observer, Harry, we can imagine not only that given his unusual beliefs the 'frog' question will elicit his curiosity but moreover that he might answer the question in a number of ways, depending on the particulars of his beliefs about the window and its capacities. For instance, he might reply that because the window is capable of turning into any number of things (including a frog), what happens after the window is struck by the brick will depend on the enchantment that has been placed on the brick. Perhaps, for example, he believes (based on his community's testimony) that if the brick has been sprinkled with newt's oil, the window will shatter rather than turn into a frog, and that this particular brick *has* been sprinkled with newt's oil. If so, he will identify the sprinkling with newt's oil as the thing that makes the difference between the shattering and the turning into a frog, and he will thereby take himself to understand why the window shattered rather than turned into a frog on this basis.

The point that bears emphasizing, in any case, is that there are always at least two ways to respond to a 'Why this rather than that?' question: either (a) by claiming that at least one of the alternatives is impossible (i.e., by rejecting one of the question's presuppositions), or (b) by trying to identify what the difference between these alternatives depends on. Moreover, whether one answers with response (a) or response (b) will often depend on the theoretical commitments[15] one brings to the world.[16]

5 Conclusion

Summing up, in response to the first question with which we began, **Q1**, I have suggested that a situation stands in need of explanation for someone in virtue

[15] At least if one understands theory will a small 't' (as it were), so that it includes beliefs about kinds and their capacities, for example.

[16] It might be objected that claiming that a situation stands in need of explanation for someone in large part in virtue of their background convictions about the sorts of possibility that are alive, relative to the fact in question, will lead to an implausibly *individualistic* account of explanation, or perhaps to an overly psychological account (whatever exactly that charge amounts to). But while this view does imply that the need for explanation is relative to background beliefs, nothing about this view requires an implausibly individualistic account. For one thing, so long as one of our primary sources of knowledge continues to be the testimony of others, and so long as science continues to be a paradigmatically social and open form of inquiry, then the testimony of others will surely inform an individual's beliefs about those alternatives which are possible and those which are not, thus on occasion leading to something like a 'shared sense' of what is possible and what is not. It is also worth briefly mentioning research that suggests a more hard-wired source of shared proto-understanding: for example, Baillargeon, Kotovsky, and Needham ([1995]) report that when four-month-old infants are shown a released block that remains suspended in the air without any visible means of support (in fact, it is supported from behind in a way invisible to the children), the infants look reliably longer at the suspended block than at blocks which fall to the ground when released. From our earliest days, therefore, we seem to take heavy looking objects (for example) to be the kinds of things that *should* fall when dropped. When they remain suspended in midair, our sense of how such things should behave is upended.

of the person's sense that there are various alternative ways the subject of the situation (a system, say, or a substance that constitutes the 'A' in a fact such as A is F) might have been. It is thus not the obtaining of a given fact *per se*, but instead the larger situation—the larger possibility space consisting of both fact and foil—that stands in need, or fails to stand in need, of explanation for someone. This then naturally suggested an answer to our second question, **Q2**: namely, that the way to satisfy the need for explanation is to identify the factor or factors that make a difference to these alternatives; alternatively, to identify the factors that help to determine which of the alternatives is in fact realized.

In closing I would like to turn more speculative for a moment and consider how these conclusions might help to shed light on two further questions: first, concerning the connection between the need for explanation and the sense of surprisingness that Peirce and Hempel appealed to earlier; second, concerning the connection between our proposal and the nature of scientific progress and scientific rationality more generally. To my mind, in fact, the two points are (perhaps unexpectedly) closely related.

With respect to the first point, and keeping the importance of the notion of proto-understanding firmly in mind, we are now finally in a position to say something about why so many philosophers of science (to say nothing of scientists themselves) associate the need to explain a situation with something like the surprisingness or unexpectedness of a situation. Thus, if we have been correct so far, the reason why a situation—a particular conglomerate of fact and foil—stands in need of explanation for someone is often in virtue of the person's sense that alternatives other than the fact might have obtained: we want to know why A is F rather than G etc. It is quite possible, however, to imagine that the fact that is actually observed to obtain—say, that A is F—would antecedently have been *excluded* by the rest of what the person believes; moreover, the person antecedently would have guessed that some other possibility would have obtained.

But this seems to raise a quite different, and quite special, set of issues than the ones we have been considering so far. For although in some sense the reason why the situation in this case will stand in need of explanation for someone will still be because the person takes it to be the case that A is F and not A is G, the fact that A is F was in some sense *excluded* by the person's proto-understanding means either that some aspect of the person's proto-understanding was mistaken or (alternatively) that the situation was misconstrued in some way. In such a case, the puzzlement felt will then be of quite a different sort than the puzzlement we feel with respect to a question such as why the tides are sometimes high, sometimes low. When we observe an alternative that we antecedently would have ruled out, our sense of the sort of alternatives that were possible—the various ways the world might have been—has been

damaged, and (again) as a result our sense of what was possible either needs to be changed or some extenuating circumstances need to be identified.

In what remains of this paper I will not attempt to say anything further about the distinctiveness of this kind of puzzlement. Instead, the main point I want to emphasize here is that it is only by thinking of the need for explanation in terms of a network of possibility that the various forms of puzzlement we have identified can be properly distinguished and understood: in the one case, a need for explanation that arises from our desire to identify the factor or factors that made the difference among the various possibilities that by our light might have obtained; in the other case, a need for explanation that arises because the network of possibility through which we view the world has been upset or called into question.

Turning finally to the connection between our results and the nature of scientific progress, it would likewise seem to follow that scientific inquiry makes progress—or, more neutrally, just *develops*—in at least two distinct senses. In the first and most obvious sense, scientific progress occurs when a particular need for explanation has been satisfied: more exactly, when someone succeeds in identifying the factor or factors that (apparently) make the difference between the possibilities in question. This is the sense of progress in which we begin with a puzzling situation and we move, through experiment and inquiry, towards an apparent resolution of the puzzle.

There is a second sense of progress, however, in which (roughly speaking) our proto-understanding, or the network of possibility in terms of which we address the world, gradually becomes more and more adequate to the way the world actually is. In particular, it becomes more adequate *both* the more we appreciate that certain alternatives are in fact *beyond* the bounds of possibility (e.g., certain 'magical' possibilities of the sort Adam entertained), as well as the more we recognize that certain possibilities are *within* the bounds of possibility. In this second way, the proto-understanding in terms of which we experience the world would, optimistically, be approximating ever more closely the various ways the world actually might be.

Acknowledgements

Thanks to Robert Audi, Michael DePaul, John Greco, Peter Lipton, Henk de Regt, Jaegwon Kim, Ernest Sosa, Fritz Warfield, and the referee for BJPS for very helpful comments on earlier versions of this paper. An earlier version of Sections 1 and 2 appeared in (Grimm [2007]).

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