

Explanation, Abstraction, and Difference-Making

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The riches of Marc Lange's *Because Without Cause* cannot be surveyed, let alone subjected to critical examination, in a few thousand words. Suffice it to say that anyone interested in scientific explanation, mathematical explanation, metaphysical explanation, or explanation in general should spend some quality time with this book: beautiful examples, penetrating philosophical insights, and wise remarks abound.

In the spirit of a book symposium, I will demonstrate my respect for the work by concerted critique. That will necessitate a narrowness that I hope will not misrepresent the book to readers. I only wish I could have commented, both admiringly and critically, on Lange's handling of dimensional and (purely) mathematical explanation, to name two topics in particular. But I will say nothing about either, rather focusing on what, in the context of the contemporary philosophy of explanation in science, appear to be the most controversial claims of the book. These concern certain limits on the scope of causal explanation in science.

That some scientific explanation is non-causal is not especially controversial. In my book *Depth*, for example, I diagnose the explanation of laws of nature—even causal laws—as an instance of metaphysical explanation (§7.62), in the simplest cases showing that the law is identical to or constituted by a certain mechanism.

Lange's principal provocation is to argue that much event explanation in

science is non-causal; thus, in this piece, I will focus on event explanations. A happy consequence of this focus is to make it easy to see what constitutes, for any of the explanations in question, the “underlying causal process”—a crucial notion for Lange. A less happy consequence is the exclusion of many of Lange’s most thought-provoking examples. I can only reiterate my advice to philosophers of explanation to read this book all the way through.

Driving Lange’s diagnosis of event explanations as causal or otherwise is a dichotomy between “constraints on the underlying causal process” and “descriptions of the underlying causal process”. An explanation may specify either or both. What makes an explanation non-causal is its omitting the latter, that is, its citing only constraints and the singular facts in virtue of which those constraints apply to the process in question.

The paradigm of non-causal explanation, for Lange, is the explanation why “Mother” (presumably some cold-war era spymaster) failed to divide 23 strawberries evenly among her three “children”. The explanation of this failure, which we can regard as a particular event—a particular instance of non-even division that occurred on some particular day, with say Karla getting 9 strawberries, Smiley 8, etc.—is simply that 23 is not evenly divisible by 3. This mathematical fact puts a constraint on the causal process of division, as a consequence of which the division, however exactly it panned out, was bound to be non-even. That’s all that need be said to complete the explanation; nothing about the underlying causal process of division, the actual doling out of the strawberries, need be specified. So the explanation is non-causal. (It is essential, note, that the explanandum is not the endpoint of the division in all its specificity—9 for Karla and so on—but rather a coarse-grained fact about the endpoint, that however it came out it did not constitute an even division.)

I want to put some pressure on the divide between constraints on and descriptions of the underlying process. Is there really a qualitative distinction to be found here? After all, isn’t it a fact about the underlying process that it was subject to certain constraints? How is such a fact explanatorily different from

other facts about the process that are the bread and butter of causal explanation, such as its starting out with certain initial conditions and proceeding in a certain way?

Think of a ball rolling down a spiral track. Surely a model of the ball's progress from top to bottom describes the underlying causal process. But it can be thought of entirely in terms of constraints. Given its energy, the ball could not leap off or otherwise depart from the track; given gravity, it could not stay in place; thus, the constraints on the causal process are responsible for, and explain, its taking the path that it does.

What philosophically important difference is there between the explanation of the non-even division of the strawberries and the explanation of the ball's trajectory? Think of them as specifying facts about the underlying causal process sufficient for it to produce the explanandum event, or think of them as specifying constraints on the underlying process sufficient to do the same. It makes no difference. Certainly, it does not result in a dramatic shift of explanatory form, from causal to non-causal.

Lange resists this attempt at explanatory lumping, claiming that while descriptions have their explanatory power "by virtue of supplying ... information about the world's network of causal relations" (p. xvi), constraints, even if they do supply such information, have their power by "constraining what there could be" (p. 19).¹ More helpfully, Lange writes that constraints "apply to causal processes, but not in virtue of their being causal processes. Rather, they apply in the same way to all aspects of the world, whether causal or not. Indeed, they would apply in the same way even if the world contained no causal network at all" (p. xvi).

This looks, at first blush, to distinguish the principles at work in the strawberry and the spiral cases. The strawberry principle, that 23 is not evenly divisible by 3, is about natural numbers not causal processes. As such it

1. Similar formulations occur in a number of places in the book. There is, as best I can tell, no canonical presentation of the idea, so I choose the first and one of the simplest.

constrains anything with a numerical character: not only causal processes, and indeed, not only processes.

But the spiral explanation contains much mathematics, too. If we regard these mathematical principles in isolation, they concern mathematical objects such as the space of real numbers, not causal processes, and as such they constrain anything with the appropriate mathematical structure. Inspect the way that the mathematics is used in spiral explanation, however: its job is to capture an aspect of the relevant causal process. In isolation it is about the real numbers, but in context it is about the physical constraints operating on the ball as it rolls down the track. I say the same thing about the strawberry affair: that 23 is not a multiple of 3 is a purely mathematical fact, to be sure, but in the context of the explanation of Mother's uneven apportionment, it is telling us something about a causal process—and it derives its explanatory power from its doing so.

What the strawberry constraint tells us is, of course, highly abstract. Could this be what pushes Lange to regard its explanatory power as non-causal? There is much to be learned from pursuing this idea.

Whereas the spiral explanation specifies a particular trajectory by which the ball arrived at its endpoint, the strawberry explanation says nothing about “trajectories”—nothing about the means that Mother used to dole out the strawberries (spoon? catapult? parcel post?) or the way in which she arrived at the final allocation.

I do not see this as grounds for a qualitative distinction, however. In the great enterprise of scientific explanation, causal processes are described at every conceivable level of abstraction. There is no bright line, beyond which process descriptions become so abstract that they entirely lose their causal luster.

To illustrate this point, consider an example that I think Lange gets suggestively wrong. It is a simple case of equilibrium explanation that has been much discussed in the literature on non-causal explanation, beginning with

Elliott Sober (1983). A steel ball bearing is released somewhere on the inner lip of a salad bowl. It rolls around the bowl for a while, eventually coming to a standstill at the bowl's center.

How should the ball's final position be explained? Sober rightly asserts that the most satisfying explanation of the position will say nothing specific about the ball's trajectory: it will specify neither the ball's release point nor the path that it takes on its way to its resting place. Rather, it will specify some general physical principles—gravitation, the dissipation of energy through friction—which in concert with the shape of the bowl and the simple fact of the ball's being released somewhere, are sufficient to imply that the middle of the bowl is the one and only stable equilibrium state for the ball, and so sufficient to imply the explanandum. Because there is no specification of the trajectory, Sober claims that this is a non-causal explanation.

Lange disagrees: it is true that the equilibrium explanation does not specify the actual causal process leading to the explanandum, he says, but it is sufficient for an explanation to qualify as causal that it describe possible causal processes leading to the explanandum—that it describe “what the causes would have been like under certain conditions that extend significantly beyond the actual ones” (p. 15). The bowl explanation does precisely this: it models, in a certain sense, every pathway that the ball might have taken, rather than specifying a particular pathway.

To hold, as Lange does, that the equilibrium explanation works by supplying information about possible but non-actual processes resulting in the explanandum, is I believe a serious misunderstanding; further, by encouraging the thought that explanatory information about an actual causal process always specifies a particular causal pathway (and so that explanations that do not specify pathways do their work in part by supplying information about possible but non-actual processes), this misunderstanding leads directly to the conclusion that the strawberry explanation is non-causal. Let me sketch an alternative view.

Like Lange, I hold that a causal event explanation describes certain features of the underlying causal process that resulted in the occurrence of the explanandum. More specifically, it describes those aspects of the underlying process that *made a difference* to its generating the explanandum event as opposed to some alternative. The point on the bowl's lip at which the ball was released does not make a difference: a ball released anywhere on the lip would end up at the bottom of the bowl. The convex shape of the bowl and the action of gravitation do make a difference. In general, the difference-makers are those facts about the causal network that are required to derive the occurrence of the explanandum, while the non-difference-makers are those that are incidental to such a derivation.²

A causal explanation always tells us about the actual underlying causal process. But it tells us only what we have to know in order to see that the process was going to generate the explanandum. Anything else is explanatorily irrelevant. In cases where a few high-level facts about the process are sufficient to generate the explanandum, a causal explanation will be rather abstract, as in the case of the ball in the bowl. As a consequence of this abstraction—indeed, as a consequence of any abstraction whatsoever—the explanatory model (i.e., the description) will be instantiated not only by the actual causal process but by many possible yet non-actual processes. In the bowl scenario, the explanation will be instantiated by every process in which a ball is released somewhere on the lip. Many writers—and Lange in particular is apparently one—have understood this representation of possible but non-actual processes to be the essence of the explanation's power. This is quite wrong. It is merely a side effect of abstraction, of saying less than everything that could be said. The explanation's power subsists solely in what it says about the actual causal process, and in particular, in its specification of the difference-making properties of that process.

2. Many subtleties attending to this formulation are tackled in Strevens (2008), or for a brief treatment, Strevens (2004).

The bowl explanation, then, derives its explanatory power from its description of the actual underlying process in just the same way as does the spiral explanation. That Lange does not acknowledge this fact strikes me as deeply significant. He is systematically misreading abstract causal explanations, failing to recognize what they have in common with detailed causal explanations in virtue of which they are manifestations of a single, unified explanatory practice: picking out difference-making properties of actual causal networks.

I recommend that the strawberry explanation be assimilated to this same picture. It is a description of the actual process by which Mother divided up the fruit in question. But because there are only a few high-level difference-makers for the non-evenness of the division, it picks out only a few high-level properties of the process: that a division is attempted, that individual fruits are not further divided. As such it is even more abstract than an explanation that, say, accounts for the particular allocation (9 to Karla etc.), which will specify something about Mother's thought processes but presumably little or nothing about her techniques for ensuring that the strawberries reach their intended destinations. Both explanations, however, operate according to the same principles and with the same ends, though one describes a particular train of thought and the other does not. One has more causal detail than the other, but both are causal for precisely the same reason.

How might Lange respond, attempting to preserve a distinction between these two strawberry scenarios?

He frequently remarks that explanations such as the uneven strawberry distribution model have a level of necessity that is far higher than nomological necessity: they apply to many scenarios in which the actual laws of nature do not hold. In Newtonian worlds, even in Aristotelian worlds, Mother fails to divide evenly. This is not, however, a special feature of the strawberry case. Any model that abstracts from the actual laws of nature will have broader-than-nomological modality. The ball in the bowl explanation, for example, requires gravitation, but it does not require inverse-square-law gravitation.

In other words: the force of gravity is a difference-maker for the ball's final resting place, but the precise form of the force is not. Consequently, this form will be omitted like all non-difference-makers from the explanatory model, and so the model will be instantiated by nomologically impossible worlds: worlds with gravity that operates according to a law different from ours, such as those where it falls off with the inverse cube of distance. The less the degree to which particular aspects of the laws of nature make a difference to some explanandum, the less the corresponding explanatory model will say about those laws, and so the wider the modal scope of the model. The strawberry model has very wide scope, but compared to other causal explanations the difference is one of degree rather than of kind.

The casual reader might get the impression from Lange's calling the strawberry explanation a "distinctively mathematical" explanation that the strawberry model differs from the rest in having maximal scope, that is, as holding in all metaphysically possible worlds (and indeed, even those metaphysically impossible worlds where 23 is not a multiple of 3). But the model does not—as Lange himself is happy to allow—have quite so wide a scope. It tells us, for example, that a division process was going on, which rules out possible worlds where no such process occurs. (Some contingent facts about the biological integrity of strawberries are surely also essential to the model.) In short: the strawberry model has very broad, but not maximal, modal scope—compared to other causal models, a difference in quantity rather than quality.

A rather different attempt to do justice to Lange's thought would point to the fact that, in the strawberry explanation as opposed to the spiral explanation or even the bowl explanation, the mathematics seems to be doing all the hard work. Not all the work, mind—see the previous paragraph—but all the really illuminating work. I suspect this is what lies behind Lange's characterization of the strawberry case as "distinctively mathematical explanation".

I am sympathetic. There is a class of interesting and important explanations in science in which our grasp of a mathematical fact is the key to

understanding. In Strevens (2018) I argue that the function of mathematical insight in such cases is to show us why some properties of the underlying causal network are difference-makers and others are not. These explanations are distinctly mathematical, then (as opposed to *distinctively* mathematical), but also unquestionably causal. Indeed, unless you see that they are constructed with the aim of pinpointing causal difference-makers, you will not grasp the role of the mathematics in conveying understanding.

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Let me follow with some related comments about Lange's notion of "really statistical" explanation.

Suppose I toss 10 fair coins 50 times apiece. The frequency of heads in each series of 50 tosses will tend to be about 50%. There is of course a probabilistic explanation of this. It is a causal explanation that draws on the properties of tosses of a fair coin in virtue of which the probability of heads is one-half; by citing these properties, it specifies the explanatorily relevant properties of the underlying causal process that in each 50-toss series produced the one-half frequency (Strevens 2008, Part Four).

Now take the coin that produced the greatest number of heads (considerably more than 50%, let's assume). Toss it 50 times more. Most likely it will produce fewer heads than the first time around. That outcome—not the number or frequency of heads, but simply the fact that there were fewer in the second round—is to be explained as "reversion toward the mean". In brief: the overproduction of heads in the first set of 50 tosses was merely a matter of chance, and so is quite unlikely to be repeated, at least to the same degree, in a second 50-toss run. Lange claims that such explanations, which he terms "really statistical", are not causal.

I demur. Reversion toward the mean is to be explained, like a 50% frequency, by citing the properties of the underlying causal process. The relevant properties are fewer when explaining reversion than when explaining the frequency. The value of the probability, in particular, matters for the frequency

but not for reversion—a feature that Lange emphasizes is crucial for the reversion explanation’s “really statistical” status (p. 192). I see this, however, as a difference in degree of abstraction rather than in mode of explanation. Omitting the value of the probability from the explanation, as the reversion explanation does, makes the description of the underlying process more abstract, but it does not transform it into a qualitatively different beast.

Lange’s view of the matter is quite different. The reversion explanation, he claims, does not turn on the underlying causal process at all: its foundation is the existence of a certain physical probability (or “chance”) distribution, conceived independently of any causal underpinning. The standard explanation of a 50% frequency of heads, by contrast, cites not only the distribution but the causal process that underlies the distribution.

Let me allow (while cocking an ontological eyebrow) that the distribution and the process are sufficiently distinct that the one can be invoked for explanatory purposes without invoking the other. Then a frequency explanation that calls upon the process and thereby the distribution is indeed, I suppose, qualitatively different from a reversion explanation that calls upon the distribution only. But presumably there is a parallel pair: a frequency explanation that calls upon the distribution only and a reversion explanation that calls upon the process in addition. So there appears to be no basis here for asserting that the characteristic reversion explanation is qualitatively different from the characteristic frequency explanation.

One clue to Lange’s thinking is his view that a really statistical explanation is not “deepened” by giving causal information about the underlying process, for the same reasons that the ball in the bowl explanation is not deepened by giving information about the ball’s specific trajectory (p. 426n3). Could it be, then, that while causal information tends to deepen a frequency explanation, it fails to deepen a reversion explanation? That would provide a rationale for holding, as Lange does, that reversion but not frequency explanations tend to be “really statistical”.

But the claim about a lack of deepening in the case of reversion is, I think, false, as is the analogy between reversion and the ball in the bowl. The reason that details of trajectory do not enhance the ball in the bowl explanation is that the ball's specific trajectory makes no difference to its final position; the aspects of the causal process underlying reversion to the mean that are responsible for the relevant features of the probability distribution, by contrast, do make a difference to reversion.

Sometimes, it is true, grasping that a phenomenon is a case of reversion even without attending to underlying causes is exceptionally illuminating. But as in the case of distinctly mathematical explanation, that is because in so grasping, we see that certain factors are not among the difference-makers—in the case of reversion, typically that there was no relevant change in the underlying probability distribution. Such insights are a boon to understanding only because scientific event explanation is always a matter of grasping the difference-making aspects, and only the difference-making aspects, of the underlying causal network.

References

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