# *Comparing apples with oranges*

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Which is the more important cause of IQ, nature or nurture? Were the deaths of Iraqi children due more to Saddam's regime or to international sanctions? Was the penetrating attack or the stout defence more responsible for the football team's victory? Comparisons of causal efficacy are ubiquitous in the practice of science and indeed everyday life but it turns out that furnishing a good account of the notion is a surprisingly delicate task, and moreover one also almost wholly neglected in the philosophical literature.[1] In this paper I focus on just one aspect of that task – one relevant to all of the above examples, but to my knowledge nowhere yet addressed satisfactorily – namely, comparing the efficacies of two causes that work in apparently incommensurable ways. Contrary to common opinion I shall argue that, to be comparable, it is neither necessary nor sufficient that two causes also be commensurable.

## *1. The issue of commensurability*

We should start by filling in some necessary preliminaries. By causal 'efficacy' or 'strength' I have in mind the quantity of effect for which a cause is responsible. For example, if I kick a ball softly I can measure the efficacy of that kick by the resultant acceleration of the ball. If I kick the ball hard, by contrast, the ball will accelerate by much more, and it is this larger acceleration that shows that the hard kick had a greater efficacy than the soft one. I shall gloss over the extensive technicalities a full definition of causal efficacy involves,[2] since for my purposes all that will be necessary is the somewhat intuitive version of the notion sketched above. Note also that the focus of this paper is *not* the venerable project of defining causation in the first place. Instead, I shall assume always that – as is common in practical problems – all parties antecedently agree on what causes are present, and the question at hand is rather those causes' relative strengths.

Consider – which of genes or environment was more responsible for the height of an individual plant? Biologists have been taught to regard this type of question as meaningless. The reason is that both genes and environment are necessary inputs for a plant to achieve any quantity of

[1] Rare exceptions include Good 1961, Miller 1987, Sober 1988, Sober et al. 1992, Pearl 2000 and Spirtes et al. 2000.

[2] For details, see Northcott 2004.

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height at all, which makes it seem impossible to assign either factor a greater importance than the other. Perhaps it would be better to describe any such comparisons as *trivial* rather than meaningless – once given the presence of the other, the addition of either genes or environment will each score 'full' causal efficacy in the sense of leading to a full plant rather than none at all. But still, even on this reasoning, neither factor could ever be assigned a greater strength than the other. Sober (1988) attributes the root of the problem to the *incommensurability*[3] of genes and environment. For instance, does switching from one plant breed to another represent a greater or lesser change than switching from one fertilizer to another? There is no general answer because there is no common natural unit we can use to equate one chunk of genetic cause with one chunk of environmental cause. By contrast, if comparing the causal efficacies of, say, gravity and electricity on the motion of a Newtonian particle, the problem seems to go away since the strength of each can now be compared readily using common units of force. Likewise, if comparing the strength of my push on a rock with yours, again there seems to be a common natural unit for comparing our two efforts.

The same issue crops up in many places. For example, a long-running debate in the philosophy of biology concerns the relative importance in evolution of various factors – selection, genetic drift, migration, rate of mutation, and so on. But are these different factors even commensurable? If not, their relative importance (it is claimed) would not be well defined. Matthen and Ariew (2002: 68), for instance, complain that 'there is no common currency in which to compare the contributions of [these] different evolutionary "forces".'

Lewontin (1974: 402) illustrates the general point vividly:

> If two men lay bricks to build a wall, we may quite fairly measure their contributions by counting the number laid by each; but if one mixes the mortar and the other lays the bricks, it would be absurd to measure their relative quantitative contributions by measuring the volumes of bricks and of mortar.

Accordingly Sober (1988: 312), speaking for many, offers the following conjecture:

> For it to make sense to ask what (or how much) a cause contributes to an effect, the various causes must be commensurable in the way they produce their effects.

But despite its apparent reasonableness this conjecture is wrong.

[3] Note from the start that this paper's sense of commensurability is at issue even in cases where the causes themselves are already agreed on, and has nothing to do with the *ontological* sense of commensurability made famous by Kuhn and others.

## 2. *Commensurability versus separability*

All causes are 'commensurable' if they impact on the same effect. But the claim at issue here is that they need also to be commensurable in the *way* that they impact on it. Thus although the bricklayer and mortar-mixer each contribute to the same final effect (i.e. the wall), the reason the strengths of their contributions are not comparable is seen to be because they contribute in, as it were, incommensurable currencies. There are many causes in the world that are incommensurable in this second sense, so if the conjecture really were true it would represent a serious limitation on, for instance, our ability to compare the impacts of different causal interventions. That is, many choices of intervention are between incommensurable instruments; must we declare all such instruments' efficacies incomparable?

True enough, there does seem to be something which distinguishes cases like genes-environment with trivial causal efficacies from those like gravity-electricity with interesting ones. I believe the important factor though is not commensurability; rather, it is marked by what I shall label *separability*. By this term I do not mean merely that two causes are distinguishable (although that too is necessary); rather I mean that their *effects* are (potentially) distinguishable. The key structural feature is whether at least one of the causes is individually sufficient to produce any quantity of the effect of interest. For example, genes and environment are easily individuated but neither without the other could have produced any quantity of the final effect at all, and this property is symmetric. In our terminology the two are not separable, and it makes no sense awarding them different causal efficacies. If, on the other hand – as with gravity, electricity and the Newtonian particle – each cause *is* individually sufficient to produce some effect, i.e. we do have separability, then (and only then) may each be deemed individually responsible for different particular quantities of that effect and hence their efficacies indeed be deemed to differ.[4]

Note that often this whole issue applies, as it were, only to absolute, not to relative, causal efficacies. For example, which is more important for producing speech, my brain for thinking of the words or my vocal chords for generating the physical sound? Clearly, both are necessary for producing any speech at all and so in our sense are inseparable. Accordingly, each must be awarded the same absolute causal efficacy. But comparing my vocal chords when healthy to when they are hoarse, it may

[4] Sober (1988) gives a thought-example of genes and environment each contributing 'height particles' to a plant, and claims that this would enable non-trivial comparisons of causal strength by creating commensurability of genetic and environmental effects. But my view is that these height particles could only achieve that goal in so far as they led to separable impacts on the plant's final height. Their commensurability is irrelevant.

well be that my power of speech is a little bit greater – thereby yielding a positive but small strength for healthy relative to hoarse vocal chords. Comparing my powers of speech before and after a major stroke, on the other hand, it may be that the difference is now enormous, indicating a much larger strength for the healthy brain relative to the stroke-damaged one. Thus sometimes relative efficacies may be interestingly comparable even when the absolute ones are not.

To summarize so far: our interest lies in what determines whether, in our terminology, a comparison of causal efficacies is trivial. Now, in the Newtonian particle example we have both commensurability and separability, and we get non-trivial comparisons. In the genes-environment example, by contrast, we have neither commensurability nor separability and the comparisons *are* trivial. So neither of these cases is really decisive, since of course they are both consistent with either of commensurability or separability being the key factor. To illustrate that it is indeed separability that matters I shall present two further examples, this time with the two factors diverging.

### 3. *Two further examples*

Our first new example will be a case where the causes are commensurable but inseparable. Imagine a primordial soup in the early history of the Earth, in which there are two chemicals that can react to synthesize some complex organic compound but that will only do so given a certain activation energy. Imagine further that there are two thunder-clouds passing overhead, a large one and a small one. Suppose that a lightning bolt from the large cloud is more energetic than one from the small one, but still not energetic enough to trigger the reaction in the primordial soup on its own. Therefore of course neither is a bolt from the small cloud. However, if the two lightning bolts strike simultaneously then (let us suppose) the combined energy of the two together does go past the activation threshold and the chemical reaction will be triggered. In other words, for this effect the two bolts are individually insufficient but jointly sufficient. Assume finally that the two bolts then do indeed strike simultaneously and that the chemical reaction is indeed triggered; what is each bolt's causal efficacy?

The two lightning bolts are surely commensurable if anything is – they are, after all, two examples of exactly the same phenomenon. But their impacts, *with respect to this effect*, are nevertheless inseparable. Individually, neither triggers the chemical reaction; jointly they do. Therefore, defining their causal efficacies in the usual way by how much they produce of the effect we are interested in, we have to conclude that individually each bolt has zero efficacy while together they have full efficacy. This of

course is exactly the same situation as in our genes-environment example: on their own, neither genes nor environment can produce any plant while together they produce a full plant. The important point is that commensurability plus inseparability has yielded a case of trivial causal strengths. All the strengths here will be either zero or maximal, and there is no way of saying that the causal efficacy of one bolt is any different from that of the other.

Note particularly that this analysis holds even though we have specified that one bolt is the bigger of the two. Intuitively of course one might assume that the bigger bolt should, as it were, be assigned more of the credit. It is this intuition, perhaps, that motivates an emphasis on commensurability in the first place – since the energies of the two lightning bolts can be directly compared (i.e. are commensurable), *therefore* differential causal efficacies can be assigned. But I believe such reasoning to be incorrect. Remember, the specific effect we are concerned with here is the chemical reaction, and this is dichotomous – it either occurs or it does not. To be sure, when considering how efficacious they are at producing *other* effects, for instance inducing voltage in a wire, then of course the two lightning bolts may well have different causal strengths. But when considering our particular effect of triggering the chemical reaction, because of the activation energy threshold I do not see how assigning different efficacies can be justified. In our *particular* example, that is, the comparison of causal efficacies must surely be trivial, even though our two causes are commensurable, and even though their comparison is not trivial in *other* examples.[5]

Turn now to the last category of example, this time the other way round from before: namely, with separability but not commensurability. This last example will demonstrate that commensurability, as well as being insufficient for non-trivial comparability, is also unnecessary. Suppose I am taking my dog for a walk on a windy heath and he gets interested in a ball lying in the grass a long way from me. I want him to come back to me, so call out to him. Assume that hearing or seeing my call induces him indeed to move back to me. Now suppose that at exactly the same moment an especially huge gust of wind blows up. Suppose further that, being only a small dog, this huge gust physically blows him back towards me, independently of any voluntary motion of his. So we now have two independent causes – namely the dog's reaction to my call and the physical gust of wind – each producing the same effect, namely the dog's movement closer to me. Which cause is the stronger?

[5] Observe that the two bolts' separability, our marker for non-trivial comparability, itself varies correspondingly with choice of effect.

I think we can answer that straightforwardly. The definition of the wind's efficacy is how much the dog moves given the gust of wind compared to if there had been none. And similarly, the efficacy of my call is given by how much the dog moves compared to if I had not called. This straightforwardness is a direct result of the easy separability of the two causes' effects. The two efficacies could perfectly conceivably differ from each other and in that respect the case is clearly analogous to our Newtonian particle example. But unlike electricity and gravitation in the Newtonian case, the two causes here do *not* seem to be commensurable. My call presumably stimulates some reaction in the dog's brain, and thence voluntary movement. The gust of wind, in contrast, bypasses such mechanisms completely and simply physically pushes the dog's body. How could we define one unit of wind gust and equate it to one unit of call? The two are like Lewontin's bricks and mortar, and there is no analogue to the common role of force in the Newtonian particle case. But despite this lack of commensurability, non-trivial comparisons of causal efficacy are clearly still possible.

## 4. *Conclusion*

It is perhaps easy to think – and as we have seen often *has* been thought – that the key to comparability of causal efficacies lies in those causes being commensurable. But I conclude that this is a mistake, and that the critical factor is actually not commensurability at all but rather that the impacts of the causes are separable.

Just what significance then should we ever attach to commensurability? Perhaps (my own view) it merely makes comparison of causal efficacies particularly obvious and easy sometimes. Moreover, upon closer inspection some claimed instances of it seem to be more mirage than reality. Electricity and gravity were supposedly commensurable via the common unit of force, for example, but could that force in turn ever be measured *except* via a common effect such as the Newtonian particle's acceleration? If not, such cases collapse to the trivial 'commensurability' common to all two causes of the same effect, and the second sense of commensurability – referring instead to the *way* two causes bring about their effects – seems to melt away.

Maybe then our final conclusion should be a different one. It seems to me that people already compare the strengths of incommensurable causes all the time in everyday life. For example, which is the quickest route home – left to avoid the multiple traffic lights, or right to avoid the roadworks? Outside of physics, similar remarks surely apply to much of science too. For example, which is the most effective way to speed up a particular chemical reaction – further heating the reagents, or adding a catalyst? So

in dispensing with commensurability, perhaps we are merely enabling philosophical analysis to catch up with existing (and correct) human wisdom. All this time, we've all been comparing apples with oranges already.

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