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Darren Bradley

Philosophy Department, Leeds University, Leeds, UK

ABSTRACT
Sober and Elgin defend the claim that there are a priori causal laws in biology. Lange and Rosenberg take issue with this on Humean grounds, among others. I will argue that Sober and Elgin don't go far enough – *there are* a priori *causal laws in many sciences*. Furthermore, I will argue that this thesis is compatible with a Humean metaphysics and an empiricist epistemology.

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1. Introduction

Sober (2011) and Elgin and Sober (Forthcoming) defend the claim that there are a priori causal laws in biology – specifically, laws saying that fitter traits will probably increase in frequency. Lange and Rosenberg (2011) take issue with this on Humean grounds, among others. I will argue that Sober and Elgin don't go far enough – *there are* a priori *causal laws in many sciences*. Furthermore, I will argue that this thesis is compatible with a Humean metaphysics and an empiricist epistemology.

The starting point will be a discussion of how mental explanations work according to David Lewis's functionalism. Moving from functional terms, to functional properties, to functional laws, reveals that these functional laws have several strange features – including that they look a priori, necessary and trivial. I will argue that none of these features is problematic. But they do reveal that there are significant differences between functional laws and fundamental laws.

CONTACT Darren Bradley d.j.bradley@leeds.ac.uk

Section 2 explains what functional laws are and Section 3 explains the various ways in which they might be thought problematic. Section 4 explains how these apparent problems either disappear upon scrutiny or should be embraced. Section 5 concludes.

2. Functional laws

My aim is to defend a position that applies to all functional terms, so it is useful to start in the area that is most closely associated with functionalism – philosophy of mind, and specifically with Lewis's version of functionalism.

In 'Psychophysical and Theoretical Identifications' Lewis raises 'a familiar problem about mental explanations. How can my behaviour be explained by an explanans consisting of nothing but particular-fact premises about my present state of mind? Where are the covering laws?' 257

Lewis doesn't give an example, but he has in mind something like the following. My reaching for an umbrella can be explained by my present state of mind – my desire to stay dry (combined with my belief that the umbrella will keep me dry plus the usual *ceteris paribus* details, such as having no strong conflicting desires). The purported explanation, in simplified form, looks like this:

Explanans: Desire to stay dry.

Explanandum: Reaching for umbrella.

The problem is that this seems to be a good explanation even though there is nothing linking the explanans with the explanandum. The explanans states one fact, and the explanandum states another – there is no link, such as a law of nature, connecting them. The problem is obvious if we accept the classical view that explanations require a law of nature linking the two sets of facts.[1] But even if we don't demand a law of nature, there must be *some* connection between the two sets of facts.[2]

The connection falls out of Lewis's functional account of theoretical terms. The term 'desire' is defined as referring to states that cause their objects (i.e. the objects of desire) under the right conditions (we'll put the relevant beliefs and other *ceteris paribus* conditions in here under 'right conditions'). For example, 'a desire to keep dry' refers to whatever state causes dry-keeping behavior under the right conditions:

[1]Hempel and Oppenheim (1948).

[2]For example, Schaffer (ms) has a broad view of explanation, on which explanations can be causal, logical or metaphysical. In all three cases, explanation has a tripartite structure – a basis, a link and a result. In our example above, there is a basis (the desire), there is a result (reaching for an umbrella) but there is no link – there is nothing connecting the desire with the reaching for an umbrella.

[Functional definition] 'The desire to stay dry' = 'the state that causes dry-keeping behaviour (under the right conditions)'.

This leads to the following principle:

[M] If something is the referent of 'the desire to stay dry' then it causes dry-keeping behaviour (under the right conditions.[3])

We can now infer that:

[*] If something is a desire to keep dry then it causes dry-keeping behaviour (under the right conditions).

This inference from [M] to [*] requires only a move from the meta-language to the object language.

And [*] gives us a link from the explanans to the explanandum – from the desire to the behavior. Furthermore, we can see why this link did not need to be made explicit in the explanation above. The link is *implicit* in the term 'desire'.

Our question is whether [*] a *law*. There are various worries here, some of which are the topic of this paper. But I want to set aside a couple of familiar objections which I will not be concerned with. For example, some argue that laws cannot contain *ceteris paribus* conditions like 'under the right conditions'.[4] Others argue that laws must refer to universals, and perhaps desires are not universals.[5] But these are not the issues at stake in the debate between Sober & Elgin and Lange & Rosenberg. The issues here are specific to laws involving *functional* terms. So let's tentatively call [*] a law and see which problems emerge.

3. Problems

Let's have a closer look at the law we are invoking, [*], in a more general form, and leaving the *ceteris paribus* clause implicit:

[Des] The desire that p causes p.

In ordinary language, this law looks unproblematic. But we saw that according to functionalism, 'the desire that p' is analyzed as 'the state that causes p':

[Functional definition generalized] 'The desire that p' = 'the state that causes p',

So the law, Des, can be more perspicuously stated as:

[3]Notice this is the second time the 'right conditions' appears in M. It is implicit in 'the desire to stay dry' which is defined as 'the state that causes dry-keeping behaviour (under the *right conditions*)'. Then the 'right conditions' appear explicitly at the end of M. This latter appearance is needed to ensure that the antecedent causes the consequent e.g. where an agent desires to stay dry but doesn't believe any actions would achieve this, the desire does not cause dry-keeping behaviour. Thanks to a referee for raising this.

[4]Davidson (1970).

[5]Armstrong (1983).

[Des'] The state that causes p causes p.

Now the problem is obvious. Let's separate five challenges to Des' as a purported law of nature:

(1) The law is a priori i.e. can be justifiably believed independently of any empirical evidence. The idea that we might discover laws without making any investigation into the world is absurd.
(2) The law is necessary. This conflicts with the Humean dictum that there are no necessary connections between distinct existences.
(3) The law is not explanatory. It is a triviality, and so cannot explain.
(4) The law is not causally explanatory. Even granting that it is causal in some sense, the law does not cite the causally relevant properties.
(5) The law overdetermines. The neural state that realizes the desire causes p. Any further causes, such as the desire, would overdetermine the effect, and widespread overdetermination is implausible.

The same challenges apply to other laws stated using functional terms. Here are two other examples. If something is a mousetrap, then it causes the containment of mice; thus there is a law connecting mousetraps with mouse containments, and calling something 'a mousetrap' invokes this law. Similarly, if something is a currency, then it is used as a medium of exchange; thus there is a law connecting currency with exchanges, and calling something 'currency' invokes this law. This example from economics brings out the breadth of the problem – many higher-level sciences use functional terms.

Returning finally to the debate between Sober & Elgin and Lange & Rosenberg, function lies at the core of the concept of fitness, which plays a crucial role in most accounts of evolutionary biology. Unfortunately there is a no uncontroversial definition of fitness. Rather than trying to adjudicate between them, I will work with one, as I think the issues I discuss will apply to any other concept of fitness. Let's say that trait A is fitter than trait B if and only if organisms with A are expected to have more offspring than organisms with trait B.[6] If we make various simplifying assumptions, such as the traits being heritable, plus *ceteris paribus* conditions, we arrive at the following law:

[P] If trait A is fitter than trait B in a population, then A will probably increase in frequency.[7]

Substituting in the functional definition of 'fitter', P can be more perspicuously stated as P':

[6]Among other qualifications, we are suppressing, fitness is really relative to an environment. See Rosenberg and Bouchard (2015) for some of the other complications.
[7]My formulation is simpler than those of Sober, Elgin, Lange & Rosenberg but I think the qualifications they add can be left implicit.

[P′] If organisms with A are expected to have more offspring than organisms with trait B, then A will probably increase in frequency.

And this seems to have all the same problems as [Des′]. Sober (2011) argues that P is an a priori causal law. Lange and Rosenberg (2011) object, applying a number of the 1–5 objections. Elgin and Sober (2014) reply, mainly defending the claim the P is causal.[8]

I will argue that of those of 1–5 that are true, none are problematic.[9,10]

4. Solutions

4.1. The law is a priori

Let's distinguish between statements that are committed to the instantiation of the properties (or existence of the objects) they purport to refer to, and those that don't. Call the former existentially committing. For example, it is natural to interpret the following as existentially committing:

(Exist) Token event C causes token event E.

It looks like there needs to be something for C and E to refer to, in order for the sentence to be true. By contrast, there is no similar commitment when we use the subjunctive and explicitly hedge for the instantiation of the properties:

(Non-exist) Property q would cause property p, if such properties were instantiated.

Non-exist can be true, even if p and q are not instantiated. It would be implausible for a priori laws to be existentially committing. So we should state Des and Des′ as the following subjunctive conditional:

[Des-hedged] The property of desiring p would cause property p, if such properties were instantiated.[11]

I agree that this law is a priori, but not problematically so. We are not committed to any mysterious knowledge of the world. We know merely from

[8]Sober and Elgin give less trivial examples too, but I want to focus on the most problematic law, and argue that it is still causal.

[9]It's worth mentioning that although the problem is put in terms of functional terms, it is really the presence of dispositional terms that generates all the problems. I take it a dispositional term is defined in terms of its causes and effects; a functional term is too, but also requires a lower-level realizer. So a dispositional term that is not a functional term will refer to a bare disposition (McKitrick 2003). The problems look slightly different for bare dispositions. First, the overdetermination problem goes away, as there is no realizer to compete with the higher-level property. Second, the necessity problem is worse, as bare dispositions are plausibly fundamental properties. Humeans claim fundamentals are recombinable. Thus, Humeans must deny the existence of bare dispositions.

[10]For related arguments focused on the philosophy of mind, see Bradley (2013).

[11]This roughly corresponds to a Carnap-sentence; the unhedged sentence roughly corresponds to a Ramsey-sentence (see Schilpp 1963).

understanding the term 'desire' that the law is true. P can be understood in the same way, as a subjunctive conditional, hedged for the instantiation of the properties.

Sober (2011) made the required distinctions. He distinguished three types of causal claim – 'e1 caused e2'; 'e1 actually promoted e2'; and 'e1 would promote e2' – and only claimed the last was a priori, as only the last avoids commitment to the existence of e1 and e2.

4.2. The law is necessary

The issue here is whether the law violates Hume's dictum that there are no necessary connections between distinct existences. It does not. Lewis (1994) was explicit that his functionalism does not conflict with Humeanism, explaining the point as follows:

> We have no necessary connections between distinct [existences[12]] of course; the necessity is verbal. The state itself could have failed to occupy its causal role, but would thereby have failed to deserve its mental name …
>
> At some point … weird tales of folk psychology that habitually offend against the principles of folk psychology stop making sense; because at some point the offending states lose all claim to their folk-psychological names. 417–418

For example, the property that realizes my desire to stay dry – some neural property – could have failed to cause my picking up the umbrella (even under the right conditions), but then it would not have been a desire to stay dry.

The only necessary connections here are between non-distinct existences. There is a necessary connection between the desire to stay dry and the picking up of the umbrella; and these are not distinct, as the desire is characterized in terms of behaviors such as picking up the umbrella. By contrast, the neural state is distinct from picking up the umbrella, and there is no necessary connection between the two. The neural state could have had different effects (but then would not have been the desire to stay dry).

Similarly, the property that realizes trait A's being fitter than trait B could have failed to cause an increase in frequency, but then it would not have been an instance of relative fitness. The realizing state is distinct from the increase in frequency; the fitness is not distinct from the increase in frequency. There is a necessary connection only between the latter two.

In both cases, the lower-level laws connecting the realizer with the effects are contingent; the higher-level laws connecting the functional property with its effects are necessary.

[12]Lewis writes 'essences'. I'm not sure if this was a slip; but I don't think this Humean principle is best expressed with the vexed notion of essences.

The underlying issue here is that the principle of recombination the Humean is committed to – roughly that any combination of properties across space and time is possible[13] – does not apply to *all* properties. It is only the fundamental properties that can be recombined, so we should not expect that properties such as desiring p or being fitter than B are combinable with any and all other properties.[14,15]

4.3. The law is not explanatory

Consider my reaching for an umbrella, and the purported explanation that I desired to stay dry. Is this explanatory? I think so, but the details depend on your theory of explanation.

Let's start with the simple view that an explanation is an argument to the effect that the phenomenon to be explained was to be expected given certain explanatory facts.[16] (For now we don't put any further restrictions on what it takes to be an explanation e.g. describing the causal history. We'll add this restriction in the next section.) According to this theory, desires can explain. We just need the dry-keeping behavior to be expected given the facts about beliefs and desires, and we saw above that it will be. Similarly, the increase in frequency is to be expected given the facts about fitness.

One might object that even if the criteria for being an explanation are technically satisfied, the resulting explanation is too trivial to be satisfactory, and so cannot provide an account of the explanatory power of P. The problem is that the explanation effectively says: trait A increased in frequency because it was expected to increase in frequency.

One response is to deny that P is as explanatory as it looks.[17] A less concessive response is to point out that we are using toy examples involving simple definitions of fitness and desire. Using more realistic definitions would make explicit the other causal connections that fitness and desire will have. For example, we might add that desiring p can be caused by positive past experiences of p. And we might require that fitter traits increase in frequency due to ecological interactions that produce systematic differences in reproductive success. Thus, desire and fitness can both be identified as nodes in a complex causal network. Laws containing these fuller definitions will not look as trivial as P'.

[13]Armstrong (1997).
[14]Thus, Humeans need not be troubled by Bird's (2001) claim that necessarily, salt dissolves in water.
[15]Lewis 1986a, 88. Of course, there is considerable controversy about which properties are distinct, and which can be recombined (see Wilson 2010).
[16]e.g. van Fraassen (1980).
[17]See Beatty 1981, Thompson 1989 Brandon 1990 and Lloyd 1994.

A different objection to the explanatoriness of the law is that citing the desire or the fitness leaves out relevant lower-level facts, for example, details about the neural structure of the brain, and so is not fully explanatory.

In response, it's true that details are left out of the explanation, but no explanation gives every detail. As Sober and Elgin point out, 'all causal statements omit some causal fact or other that is explanatorily important' (168).

The objection might be pressed that an explanation in terms of the lower-level properties – perhaps describing the neural structure – would be *better*. The explanation in terms of lower-level properties includes more details, details that might explain the underlying mechanism.

Let's concede that the lower-level explanation might be better sometimes. But other times an explanation in terms of lower-level properties is worse, as it mentions *irrelevant* details. For example, the best explanation of why a conductor is annoyed might be that someone coughed; to add that Bob coughed is to add irrelevant and misleading details.[18] Similarly, we normally don't care about the neural structure of other people; we care about their beliefs and desires. So an explanation of behavior in terms of neural states would contain irrelevant details. Similarly, we might want to know whether the change in the frequency of a trait was due to natural selection, as opposed to a freak event, or artificial selection. Again, lower-level details would be irrelevant.

However, some deny the simple theory of explanation we have been using. One of the main challenges is from those who add that explanations must cite causally relevant properties,[19] and that higher-level properties are not causally relevant. This introduces the concept of causation, which brings us to the next worry.

4.4. The law is not causally explanatory

One might deny that higher-level properties are explanatory on the grounds that only the lower-level explanation gives the *causally relevant* properties. L&R seem to take this line:

> We acknowledge that there are philosophically innocuous a priori causal statements … However, it is difficult to see how these a priori … statements could figure in *causal* explanations. 593 (Italics original)

The worry seems to be that the higher-level properties don't cause the effect. Whether they do will depend on your theory of causation.

[18]Compare Putnam (1975), Jackson and Pettit (1990), Sober (1999).
[19]'To explain an event is to provide some information about its causal history' (Lewis 1986a, 217).

Theories of causation can be usefully divided into two categories – probability theories and process theories.[20] On probability theories, causing is making more likely[21]; on process views, causing is physical producing.[22] Let's take each in turn. I will argue that on either approach, the law can be causally explanatory.

Assuming the probability theory – that causing is making more likely – higher-level properties can clearly be causally relevant. For example, the umbrella-reaching would have had a lower probability in the absence of the desire, so the desire is causally relevant. Similarly, if A had not been fitter than B then an increase in A's frequency would have been less probable. Again, A's fitness comes out causally relevant.

Process views are less discussed than probability views, but the underlying idea is that there is some physical connection between cause and effect, such as an energy flow. Can functional properties generate such a physical connection? I see no reason why a functional property can't generate a physical connection. For example, the desire is located in the brain, and energy can flow from the brain, to the muscles, and then on to the umbrella as it gets picked up.[23]

Still, one way to develop the process view is to hold that the *real* causal process only happens at the micro-level, and this would result in higher-level properties not being causally efficacious. We'll consider this austere metaphysical picture in the next section.

4.5 The law overdetermines

Let's grant that my neural properties caused the reaching. If my desire also caused the reaching, the reaching is overdetermined. That seems to be bothering L&R, who argue that sleep cannot be caused by the property of having a property that causes sleep:

> To argue that the second-order property was causally active threatens to require us to accord causal relevance to C's instantiating a third-order property, and a fourth, and so on. Accordingly, we suggest that what it is about C that gives it the power to bring about E is its involving the ingestion of a substance with a certain intrinsic, non-dispositional, natural property involving opium's chemical structure. The properties of C that are causally relevant to E, then, do not include C's involving the ingestion of a substance possessing the second-order property of being soporific. 594–595

L&R don't spell out what's wrong with second, third, or fourth-order properties being causally active. But a natural worry is that with all these

[20]Schaffer (2014).
[21]e.g. Davidson 1970, Hitchcock 2001, Lewis 1986b and 2000, Woodward 2003
[22]e.g. Dowe 1992 and 2000, Ducasse 1926, Kistler 1998, Russell 1948, Salmon 1984 and 1998.
[23]See McKitrick (2005) for a related defense of the causal relevance of dispositions.

extra causes, the effect is problematically *overdetermined*. A paradigm overdetermination case is that of two baseballs hitting a window at the same time, in which case the breaking of the window is overdetermined. The coincidence required in this example indicates that this kind of overdetermination must be unusual. So it seems that any theory that posits widespread overdetermination must be wrong.

A version of this argument has been hugely influential in the philosophy of mind. Kim (1973, 1998) has famously used overdetermination worries to argue that mental higher-level properties are not causally efficacious.[24]

But if we don't countenance *mental* higher-level properties as causes, it is difficult to stop there. First, the overdetermination argument can be extended to any higher-level properties, which can be found in many higher-level sciences, not just psychology. Every science other than physics will deal in epiphenomenal properties.[25]

Second, the overdetermination argument can be extended to objects – the window was broken by both the baseball and the molecules in the baseball.[26] These extensions of Kim's argument push us toward the view that the only objects, and the only causes, that exist are those at the lowest level of science i.e. particle physics, or whatever will replace it. On this view, desires, beliefs, fitness, organisms and rocks do not exist / are not instantiated. I have some sympathy for such an austere metaphysics, but I doubt L&R, nor many others, will wish to follow the argument to this conclusion.[27]

A more palatable conclusion is to accept overdetermination. Overdetermination seems problematic in typical examples, such as where two baseballs break a window. These cases require a coincidence, and it is implausible to believe that such coincidences happen all the time. But the overdetermination of, say, a higher-level property and its realizer are not like this. It is no coincidence that both the higher level and intrinsic properties are instantiated in the same object – the two properties are intimately connected. Spelling out the exact nature of this intimate connection remains a vexed issue. But Schaffer (2003) and Sider (2003) have offered compelling arguments that overdetermination is everywhere, and is unproblematic. If so, there is no problem with the realizer and the higher-level property both being causally relevant.

[24]Shapiro and Sober (2007) discuss the overdetermination case and argue that mental and physical causes don't constitute overdetermination in the relevant sense.

[25]See Marras (2000), Bontly (2001) and Block (2003). The move from psychology to other sciences might be denied, but an argument would be needed. Although the literature focuses on psychology rather than other higher-level sciences, this seems to me a historical accident.

[26]Merricks (2001).

[27]Furthermore, those who accept this austere metaphysics do not have to say that the causal claims of the higher-level sciences are false. Instead, they can say that the claims are grounded in the fundamental metaphysics, and that therefore utterances of 'desires cause behaviour' are true.

Thus, trait A being fitter than trait B causes the increase in frequency, and so does the lower-level property that realizes trait A being fitter than trait B. It is no coincidence that both these properties are instantiated together, so there is nothing problematic about this type of overdetermination.

5. Conclusion

To sum up, I have generalized and defended Sober and Elgin's claim that there are a priori causal laws in evolutionary biology – I think there are a priori causal laws in many sciences that posit higher-level properties. This view has consequences that might seem surprising, and which have not been widely acknowledged in the literature. But I have argued that these consequences follow from countenancing functional properties. Rather than showing what is wrong with functional properties, they lead us to a better understanding of what functional properties involve.

Why are these consequences relatively unfamiliar? My hunch is that these consequences of functional laws have been overlooked because the literature has focused on the question of whether there *are any* functional laws (or higher-level laws).[28] Those arguing against have generally tried to show that functional laws are to be ruled out in some principled way e.g. as being *ceteris paribus*, or not fundamental. These arguments would, in a sense, rule out functional laws on principle, as opposed to the *reductio* strategy of granting that there are functional laws and showing they have unacceptable consequences. Only the latter strategy would bring out the consequences we have been discussing. On the other hand, those defending the existence of functional laws have often tried to minimize the difference between functional and fundamental laws, in order to show that the former are as worthy of being laws as the latter. But this strategy risks overlooking the important differences between them.[29]

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[28]e.g. Davidson (1970), Roberts (2004).

[29]There is a further question of whether there are laws that are both non-fundamental and non-functional. Such laws would seem to require emergent properties i.e. properties of non-fundamental entities that they have in virtue of the lower-level properties of their constituents, but which are not a priori/conceptually entailed by those lower-level properties. I take it the evidence is against the existence of such properties.

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