A Lewisian Theory for Special Science Laws

Markus Schrenk, DPhil MA

DFG Research Fellow
Explanation | Causation | Dispositions | Laws

Philosophisches Seminar | Universität zu Köln
Richard-Strauss-Straße 2
50931 Köln
Germany

[e] markus.schrenk@uni-koeln.de
[w] http://www.clde.uni-koeln.de/schrenk

Abstract.

This paper explores whether it is possible to reformulate or re-interpret Lewis's theory of fundamental laws of nature—his "best system analysis"—in such a way that it becomes a useful *theory for special science laws*. One major step in this enterprise is to make plausible how law candidates within best system competitions can tolerate exceptions—this is crucial because we expect special science laws to be so called "*ceteris paribus* laws". I attempt to show how this is possible and also how we can thereby make the first step towards a solution for the infamous difficulties surrounding the troublesome *ceteris paribus* clause. The paper outlines the general ideas of the theory but also points out some of its difficulties and background assumptions.

1. Lewis's Original Theory.

David Lewis has offered an acclaimed analysis of laws of nature: suppose you knew everything and organised it as simply as possible in various competing deductive systems that mention perfectly natural properties only. A contingent generalisation is a law of nature if and only if it appears as an axiom or theorem in the one true deductive system that achieves a best combination of simplicity, strength, and fit (cf. (Lewis 1973: 73), (Lewis 1999: 41-43), (Lewis 1999: 233-44)). To have strength is to bear a great deal of informational content about the world; to be simple is to state everything in a concise way, not to be redundant, etc.; and to fit is (especially for the probabilistic laws) to accord, as much as possible, with the actual outcomes of world history.

Here are three examples for possible competing systems. We could have, (i), a gigantic lookup-table: for each space-time point the table lists the properties instantiated there. This would be a very strong but not a very simple system and hence probably lose against the others.[1] We could, (ii), have a single line: "all electrons have unit charge". This is a very simple but indeed very weak system for which it is not possible to win any competition. We could, (iii), have present day physics. If we are lucky it is not too bad a system when it comes to a convincing combination of strength, simplicity and fit. Yet, maybe it will be superseded at one point by some stronger, simpler, fitter arrangement. In any case, note that Lewis operates from the view point of an omniscient

[1] I ignore, for the sake of clarification, that the table would not list *generalisations* and so have not laws for, according to Lewis, laws are only the generalisations within the system.

being: “if you knew everything” (Lewis 1973: 73). So, even optimistically speaking, at best the ultimate future physics might come close to the real laws.

Lewis allows both axioms and also theorems of the winning system to be laws. The best system might, therefore, include laws of the special sciences—chemistry, biology, maybe psychology—if they follow as theorems. This comes close to a reductive account of special science laws: they derive from the more fundamental axioms. However, I do not want to follow this route in this paper. I would like to suggest a different, yet still Lewisian, non-reductionist path to define what special science laws are.[2]

Here is the basic idea. Run Lewisian best system competitions as usual but organise separate competitions for each special science: one competition for chemistry, one for biology, etc. depending on how far up you are willing to go.[3] In order to do so, at least one hurdle has to be taken: Lewis’s theory does not straightforwardly allow for laws with exceptions. Yet, especially the laws of non-fundamental laws like, say, chemistry or biology are said to be *ceteris paribus* laws, i.e., laws that are haunted by exceptions and therefore in need of proviso clauses.

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[2] A note on vocabulary: generalisations within systems that compete for the highest simplicity, strength and fit ranking are, of course, only law candidates and not laws. Only the competition’s winner contains the laws. Where no confusion can occur I might, for reasons of simplicity, use “laws” even if I should write “law candidate”.

[3] In fact, I will concentrate here on chemistry and biology for two reasons: I do not want to enter the debate on what counts still as science and what not. I believe that both biology and chemistry are uncontroversial candidates whereas it is not so clear where the cut off point: think of (neuro)-psychology, sociology, economics, etc. My second reason will only become clear later when I consider the accusation that the account given is too anthropocentric.

2. Exceptions to Laws?

The truth about such proviso clauses is, unfortunately, that they cause trouble: many philosophers claim that no good sense can be made of a statement like, for example, 'All Fs are Gs, *ceteris paribus'*. Such a phrase, so they say, is either tautologous like 'All Fs are Gs, unless not' or it stands for a proposition like 'All Fs which are also… are Gs' the gap of which we are unable to close. Now, one of the main suggestions of my paper is that if we make Lewis's theory fit for the special sciences we gain, *en passant*, a coherent interpretation of these *ceteris paribus* clauses. For this purpose I first have to modify Lewis's original theory of fundamental laws first so that exceptions to laws are admissible. I also have to show that the resulting exception ridden laws are fit for competition. This is the task for the following section.

Judging by some quotes it seems that, for Lewis, each and every exception would catapult an alleged law immediately out of the realm of candidates for lawhood:

> Few would deny that laws of nature, whatever else they might be, are at least exceptionless regularities. (Lewis 1986: xi)

> Admittedly, we do speak of defeasible laws, laws with exceptions, and so forth. But these, I take it, are rough-and-ready approximations to the real laws. There [sic!] real laws have no exceptions, and never had any chance of having any. (Lewis 1986: 125)

But this textual exegesis is incomplete. When considering Lewis's theory of counterfactual conditionals we get a different picture. The theory is couched in

terms of possible worlds and relies heavily on similarity relations between those worlds. Lewis does not, however, attribute a special status to the laws of nature in similarity considerations. While two worlds which have the same laws certainly have a good deal in common it is by no means a necessary condition for worlds to share laws in order to be judged similar.

> I could, if I wished, incorporate [a] special status of laws into my theory imposing the following constraint on the system of spheres: […] whenever the laws prevailing at i are violated at a world k but not at a world j, j is closer than k to i. This would mean that any violating of the laws of i, however slight, would outweigh any amount of difference from i in respect of particular states of affairs. I have not chosen to impose any such constraint. (Lewis 1973: 72-3)[4]

This is already a promising remark which loosens up the rigidity of laws. However, we are only half way on the path towards a notion of laws that allows for exceptions. This is because

> the violated laws are *not laws of the same world* where they are violated. […] I am using 'miracle' [i.e., violation of law; MAS] to express a relation between different worlds. A miracle at w_1, relative to w_0, is a violation at w_1 of the laws of w_0, which *are at best the almost-laws of* w_1. The laws of w_1 itself, if such there be, do not enter into it. (Lewis 1986: 44-45; my italics)

What we need, however, is a violation of laws *at home*, i.e., at w_0 itself. Here is a beginning:

> A localized violation is not the most serious sort of difference of law. The

[4] Later, in (Lewis 1979) he promotes the status of laws a little. However, having the same exceptionless laws is, though of first importance, still no *necessary* condition for similarity amongst worlds: “It is of the first importance to avoid big, widespread, diverse violation of law.” (Lewis 1979: 47)

> violated deterministic law has presumably not been replaced by a contrary law. Indeed, a version of the violated law, complicated and weakened by a clause to permit the one exception, may still be simple and strong enough to survive as a law. (Lewis 1973: 75; my italics)

Needless to say, it all depends on how extended the violation is: if it is temporally and spatially very limited, merely “a small, localized, inconspicuous miracle” (Lewis 1973: 75), then it is easy to imagine that the loss of simplicity, strength and fit we have to accept when we “complicate and weaken” the law by a clause, still does not affect the robustly best position of the system that includes that law. (We can imagine the *complicated and weakened* law to be noted down in the following way: $\forall u\ (Fu \wedge \neg @(x_0, y_0, z_0, t_0)u \supset Gu)$ where $\neg @(x_0, y_0, z_0, t_0)u$ means that object u is *not* where the “small, localized, inconspicuous miracle” happens.) No other system would thereby become a robustly better system. Therefore, the law status of a law, i.e., its membership in the best system, would be saved even if it has little exceptions.

The more laws in an alleged best system are affected by exceptions, or the more extended the space-time area is in which violations happen, the less likely it will be that this system is in fact the best or, indeed, that there is any such best system. Yet, about that fact we do not have to worry too much because it comes down to saying that the more messy the world is the less likely it is that it is law governed. This has never been subject to doubt.

This brings my assessment of Lewis's original best system to a conclusion. The answer to the question whether his theory can allow laws with exceptions is ‘Yes’.

3. Tailoring Lewis's Theory for the Special Sciences.

Now, if that works even for Lewis's original theory targeting fundamental laws then it should, in principle, also work for special science laws. I repeat the basic idea: accept law candidates as rivals in Lewisian best system competitions as usual but organise separate competitions for each non-fundamental science: one competition for chemistry, one for biology. It is necessary to separate the realms because otherwise biological systems would probably lose against their physical competitors. Each realm will provide its very own general statements, that is, law candidates. However, we cannot expect these special science systems to be as neat as the systems for the fundamental level (or, to be more cautious, as we expect the system for the fundamental laws to be). The best system for biology might contain law candidates about, for example, tigers and their stripes which have exceptions for albino tigers. The hope is that a system containing such law candidates can still win the best system competition (within biology, within chemistry) because it is unlikely that there are other, more advanced systems: no matter how hard we try there are no systems strong and simple enough with only strict regularities in biology and chemistry.

Running the competitions is not absolutely straightforward. There are (at least) two challenges. The first concerns the competition rules. We have to suppose that it is possible to delineate chemistry from physics and biology from chemistry to run individual contests for different sciences. Yet, the borderlines

between those sciences are blurred and so are the criteria for membership of laws in one as opposed to another science. Laws of one science might well purposefully quote properties from other sciences. Take, for example, the biological (or medical) rule that humans cannot survive much longer than ten days without water (H2O + certain isotonic salts). I therefore propose the following ordering mechanism:

> Subsume law L under science X if and only if (i) L quotes at least one property of science X and (ii) science X is highest up in the hierarchy of the sciences of which L quotes properties.

The law about humans and their need for water, for example, then qualifies clearly as biological law because being human is a biological property (and there is no further higher psychological or economical property). I have thereby reduced the problem of *law sorting* to the problem of property sorting and I am confident that the latter can be done (I come back to the issue of properties later).

Leaving the demarcation problem aside, I turn to the second challenge to the overall enterprise. I said that the special sciences are not blessed with the seamless generalisations the fundamental level will mostly deal with. Special science generalisations will most probably have exceptions and we need to spell out how these exceptions should be registered in special science law candidates. First note that the structure I have suggested for fundamental laws facing miracles, $\forall u\ (Fu \wedge \neg @(x_0, y_0, z_0, t_0)u \supset Gu)$, is not useful because the exceptions we have to expect in non-fundamental laws are rarely restricted to

certain space time regions.[5] Rather, they are often bound to certain individuals: take, for example, Bino the albino tiger who has no stripes. However, it seems possible to exclude those individuals in the antecedents just in the same way in which we exclude the small miracles in the case of fundamental laws. Yet, even if we accept this possibility a new twofold difficulty appears.

First, the exclusion lists of individuals in the antecedents of law candidates would most probably be unmanageably long. Also, many if not most exceptions are unknown to us. Therefore, second, we do not in fact find law statements of that kind in actual scientific practice. Rather, the lawlike statements we come across in chemistry, biology, etc. often bear (implicit) proviso clauses like ceteris paribus but they do not explicitly list exceptional cases. Hence, my suggestion to characterise non-fundamental laws via Lewis's idea plus lists of exceptions seems to distort not only what is the actual practice in science but also what is at all possible in scientific endeavour. How do we get from the armchair into the lab?

I will now show that there is actually no major problem. I even claim that we can solve some theoretical problems ceteris paribus clauses in law statements usually cause. This is a pleasant consequence of a Lewis system applied to the special sciences. For a start note that when dealing with Lewis systems we are always supposed to be operating from a heavenly or, at least, metaphysical perspective: "if we knew everything and organized it as simply as possible in a deductive system" (Lewis 1973: 73). To run the best system competition we can, so to speak, employ an omniscient being. She will have no problem

[5] However, there are such cases: black swans seem to be a phenomenon endemic to the space-time region called 'Australia'.

comparing systems including law candidates with long lists of exceptional individuals excluded in their antecedent. More importantly, she will have the complete world history in front of her eyes so that she should also know all exceptions to all regularities. In comparing systems she will, hopefully, come up with one robustly best system. If not, not: as with fundamental sciences, the world—or the aspects of the world we are dealing with—could be too messy to have any laws.

After her job has been done (with success I assume) we ask our divine helper to hand over the list of laws. However, and this is the fundamental clue which will help us to interpret proviso clauses, not without asking her to perform some cosmetic surgery on the candidate laws: delete all the exclusion phrases listing exceptional individuals from the laws' antecedents and attach, instead, the clause 'ceteris paribus' to these law statements. This cosmetic operation is less superficial than it might seem: first, it translates the lengthy law statements that have participated in the contest into the law statements typical for the special science: law statements with proviso clauses. Hence, we have arrived from the armchair into the lab. There is another positive aspect of this step. It seems to be a rather contingent matter which individuals are exceptions to non-fundamental laws (think of the albino tiger who has a gene defect caused by exposure to random x-rays). Hence, with the introduction of the ceteris paribus clause we remove the reference to contingent matters of fact from the law statement. There is an even greater benefit to be gained from the genesis of our laws: a theory of these ceteris paribus clauses. Let me explain.

4. A Theory for the *Ceteris Paribus* Clause.

The proviso clause serves as a reminder that the law, in its virgin form, listed exceptions in its antecedent when competing together with other laws for the best system status (balancing strength, simplicity, and fit ideally). That is, the proviso refers to, or, better, stands for the long exclusion list the original competing law statement incorporated. Also, and this is important to keep in mind, it reminds us of the fact that the original statement describes a good chunk of world history even though it excludes many individuals. It has precisely been selected (together with its peers) because of its strength. So, the present proposal is that the analysis or interpretation of provisos in proviso laws should be something along the following lines:

> "Fs are Gs, ceteris paribus" is a, say, biological law *iff*
>
> if we knew everything about living creatures and organised it as simply as possible in various competing deductive systems then "All Fs are Gs except for the individuals x, y, z, ..." (with all exceptions explicitly mentioned) would appear as an axiom or theorem in the one true deductive system (within biological systems) that achieves a best combination of simplicity, strength, and fit.

The novelty of this proposal is that it does not aim to define provisos solely in a law immanent way. Rather, provisos gain a holistic aspect transcending the isolated law: statements bearing provisos are abbreviations of those ideal statements (including the exceptions) which are part of the robustly best system. It is the membership in the best system that makes the proviso clause

acceptable. In a radical interpretation of this move a vice is turned into a virtue: the *ceteris paribus* tag can now be interpreted not as a weakening of a law but rather as a knighting of an only almost general statement that has the honour to be included in the best system. ‘Ravens are black’ is a mere factual and also false general statement. ‘Ravens are black, *ceteris paribus*’ shall, however, indicate both that there are exceptions but also that it is a law belonging to the best system to describe the biological world.[6]

Note that the theory is non-reductive. It treats the special sciences as grown up theories. Reduction or, at least, explanation of why certain laws are what they are by reference to some underlying mechanisms is, however, not forbidden. Looking at underlying mechanisms and applying some more fundamental sciences can especially help explaining exceptional cases.

This thought suggests a comparison to a theory of how to interpret provisos which has, justifiably, some fame in the literature on cp-laws: A proviso clause is, in the theory of Pietroski and Rey, a promise to the effect that if the application of a proviso law should fail a scientific explanation can be given of what went wrong. In their metaphorical words, Pietroski and Rey treat proviso clauses as

> 'cheques' written on the banks of independent theories” (Pietroski & Rey

[6] One might start to wonder at this point how regularities with many exceptions are to be distinguished from probabilistic laws. Shouldn’t we interpret “All Fs are Gs except for the individuals x, y, z, ...” as a probabilistic law of kind “P(G|F) = n%” rather than as “All Fs are Gs, ceteris paribus”? The criteria *simplicity*, *strength*, and *fit* will actually help to decide: a probabilistic law is simpler than a law listing exceptions (especially if there are many). When it comes to strength laws with exceptions win: they, unlike the probabilistic laws, tell us exactly where the consequent of the law is not instantiated. When it comes to fit, again the cp-law candidate is ahead because it, listing its exceptions, has 100% fit whereas the probabilistic law’s probability might divert from the actual frequency. For more on that matter see (Schrenk 2007: 89-90).

1995: 82).

> These cheques represent a 'promise' to the effect that all [exceptional] instances of the putative law in question can be explained by citing factors that are […] independent of that law. (Pietroski & Rey 1995: 89)[7]

However, in a paper entitled '*Ceteris paribus*, there is no Problem of Provisos' Earman and Roberts found a counterexample to Pietroski and Rey's promising account. They showed that 'All spheres conduct electricity' comes out as a *ceteris paribus* law in Pietroski and Rey's analysis. Let, in 'cp: $\forall x(Fx \rightarrow Gx)$', Fx mean 'x is spherical' and Gx 'x is electrically conductive'. Now, some fact explains why a certain x is not conductive, for example, because that x has a certain unfavourable molecular structure. Molecular structures are, however, explanatory independent from things being spherical and hence, we have an independent factor which explains $\neg Gx$.

> If Pietroski and Rey's proposal were correct, then it would follow that *ceteris paribus*, all spherical bodies conduct electricity. (Earman & Roberts 1999: 453)

> More generally, whenever any object's failure to exhibit property G can be explained by anything independent of whether the object exhibits property F, then Pietroski and Rey's proposal implies that *ceteris paribus*, anything with property F also has property G. (Earman & Roberts 1999: 453-4)

So, do we have to give up Pietroski and Rey's account? I think not and Earman and Roberts themselves point in the direction of where to look for a remedy. They claim that Pietroski and Rey's account fails

[7] A striking difference to my Lewisian approach is that Pietroski and Rey theory of laws and their provisos comes from a more epistemic rather than a metaphysical perspective.

> because [it] does not guarantee that A is in any way relevant to B, which surely must be the case if cp: (A → B) is a law of nature. Perhaps Pietroski and Rey's proposal could be modified to remedy this defect. But we do not see how to do this other than by requiring that the antecedent of the law be relevant to its consequent, in a previously understood sense of "relevant". (Earman & Roberts 1999: 453-4)

Now, if we merge Pietroski and Rey's theory with the idea of best system analyses for special sciences then counterexamples like Earman and Roberts' pseudo sphere-law cannot succeed anymore because they fail the precondition to be a member of the best system. The previously understood sense of being 'relevant' can be derived from membership in the best system.

This is so because the best system account explains why some absurd *ceteris paribus* laws that have been invented (independently of considerations relating to Pietroski and Rey's theory) to expose the difficulties proviso clauses pose do not count as laws: for example, "*Cp*, drinking milk kills". Although it is true that milk could kill if there's a dysfunction of someone's digestive system this is not the norm. Now, we can rely upon the quality of the system of laws which should, on the basis of the lack of strength and simplicity, not except the above weird law candidate but rather its complement: "*Cp*, drinking milk nurtures". That is, nonsense *ceteris paribus* laws are dropped because of the simplicity constraint: 'drinking milk kills' needs to list many more counterexamples than 'drinking milk nurtures' and is therefore far less simple.

5. Difficulties and Worries.

You might say that, at best, *ceteris paribus* clauses would be justified in the way I have endorsed if we had the best system available. Yet, neither are we omniscient nor can we expect any divine help. So, the question is whether the *ceteris paribus* clauses we attach to our actual law candidates are equally justified. I openly admit that this is a weak point in the overall idea but let me try to argue how one might be able to dissolve this worry. With a bit of luck, our system approximates the divine ideal but even if there is and always will be some gap between our and the best system there is a crucial structural similarity between them: simplicity and strength of a coherent whole are certainly virtues scientists strive for and present theories do, to a great extend, display these virtues. The hope is, then, that if, in the characterisation given above, we supplement “the system which best balances strength, simplicity, and fit” with “… that we currently have” the theory is still sound.

There is a further worry concerning the best system analysis applied to the special sciences. One could argue that, in a sense, anthropocentric parameters enter the picture and so make it questionable whether we are really dealing with “laws” that are objective enough: when we commission our divine helper to run the competition the aspects under which she had to view the world are chosen by human beings. That is, the division into chemistry and biology could be one that is tailored to human interests and human intellectual dispositions. The alleged laws, so the critique continues, would not be what we want laws to be:

the objective rules nature comes equipped with just by herself; they will have a human flavour.

To see how tough this challenge really is we have to look at an aspect of Lewis's competition rules I have not so far mentioned. Lewis demands that "the primitive vocabulary that appears in the axioms [of the competing systems; MAS] refer[s] only to perfectly natural properties" (Lewis 1999: 42). The reason for this move is, roughly, that if any language (containing absurd gruesome predicates) were allowed for the candidate systems then comparisons between these systems regarding their simplicity would be impossible because, for example, "a single system has different degrees of simplicity relative to different linguistic formulations" (Lewis 1999: 42); further reasons are given by Lewis on the same page). In other words, the competitions can not even start if biology and chemistry do not involve natural enough properties and are too anthropocentric. That is, if the challenge of anthropocentricity were correct the whole idea of a Lewisian analysis of special sciences would be jeopardised from the start.

I cannot provide an adequate answer to this challenge here but I can point in the direction where it might be available. Support for the claim that there are arguments that biology and chemistry indeed involve natural properties and so are not anthropocentric either can be found in scientific realism and modern essentialism. Theories like externalist semantics also rely heavily on the claim that biological and chemical kinds are natural kinds so I am at least not alone with my assumptions.

6. Summary.

I have, in this discussion note, introduced a way to characterise laws of non-fundamental sciences on the basis of Lewis's best system idea. I have claimed that this theory can provide a solution for the problems proviso clauses pose for law statements of these sciences. The core idea is to run best system competitions for each non-fundamental science. The laws that compete, exclude all their exceptions explicitly in their antecedent. When the best system is found, however, the exclusion clauses are replaced by a typical proviso clause (ceteris paribus, for example). In this way, the proviso neither means 'unless not' nor does it simply hide unexplained gaps. I have also pointed at possible solutions for various challenges to the idea of a Lewis inspired theory of special science (cp) laws.

8. References.

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