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Better Best Systems and the Issue of CP-Laws[1]

This paper combines two ideas: (i) That the Lewisian best system analysis of lawhood (BSA) can cope with laws that have exceptions (cf. Braddon-Mitchell 2001, Schrenk 2007). (ii) That a BSA can be executed not only on the mosaic of perfectly natural properties but also on any set of special science properties (cf., inter alia, Schrenk 2007 & 2008, Cohen & Callender 2009 & 2010). Bringing together (i) and (ii) results in an analysis of special science ceteris paribus laws.

Keywords: ceteris paribus, better best system, Lewis

(0) Introduction

Suppose not a benevolent god but an evil daemon created the world. That is, suppose everything is as orderly as we assume it is but that there are a couple of very tiny space time areas such that some of the seemingly universal regularities that hold good everywhere else in the universe are violated there. So, for example, at a location with the centre point <x, y, z, t> there's a sphere of a nano-meter diameter lasting for a nano-second such that Coulomb's force F_E does not equal $qQ/(4\pi\varepsilon_0 r^2)$, and so forth for some few other places and regularities. (We can imagine the effects of these gaps elsewhere to be erased.) Could and would an original Lewisian Best System Analysis (BSA) still deliver laws despite the fact that there are these exceptions?

Yes, it would, or so I will argue in the first section, (1), which concerns fundamental laws and Lewis's original system only. There, I rely on an idea which was first introduced by Braddon-Mitchell in his "Lossy Laws" (2001) but which has also been developed in (Schrenk 2007).

In the second section, (2), I will turn to non-fundamental laws and introduce my version of what has become known under the title of a "Better Best Systems Account" (BBSA) for the special sciences (Schrenk 2007, 2008); Cohen and Callender (2009, 2010); the apt name "BBSA" comes from Cohen and Callender).

I will show, third, (3), how the two ideas – laws with exceptions on the fundamental level and BBSAs for special sciences – can be combined to a theory of ceteris paribus laws in the special sciences.

A summary is in section (4).[2]

(1) Fundamental Laws with Exceptions

(1.1) Reminder of Lewis's Original System

Here is, first, a quick and rough reminder of Lewis's own best systems account: suppose you knew everything and you organised it as simply as possible in various competing deductive systems that contain only predicates which refer to perfectly natural properties. A true contingent generalisation is a law of nature if and only if it appears as an axiom or a theorem in the one deductive system that, amongst all the possible systems, achieves by far the best balance of simplicity, strength, and fit. 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; and fit, finally, concerns how likely the actual world is according to the system: the more likely the higher the fit (cf. Lewis 1973, 73ff; Lewis 1983a[1999], 41-43; Lewis 1994[1999], 233-244, Lewis summarises his view on 233f).

(1.2) Laws with Exceptions on the Fundamental Level[3]

Methodologically, physics searches for flawless regularities and every exception to a law-hypothesis is a strong incentive for the fundamental sciences to drop their initial conjecture and to formulate a new hypothesis in its stead. The belief in the uniformity of nature, here understood as its flawlessness, is at the heart of this scientific method.[4]

Yet, nature might not be kind to us, and less than perfect regularities could be the norm. Could we, in such an irregular world, nonetheless be justified to call some of the less than perfect regularities "laws"?[5] The odds stand against an affirmative answer but in what follows I will show that this is possible when we slightly amend Lewis's best system account. (Note that this is not the Better Best System suggestion yet. Here, we remain firmly on the fundamental level Lewis himself had in mind. The BBSA will be a further, second variation (section 2) along different lines.)

So, assume with Lewis, that the world is a vast four-dimensional mosaic of point size instantiations of perfectly natural properties and that there are many regular patterns in this mosaic. Yet, suppose we have one or some merely almost-exceptionless regularities like the one registered in 'All Fs are Gs' (etc.) which, at certain space-time points (which I later call "index"), fail, i.e., at such an index-location, an F is not a G. Suppose furthermore that this space-time location cannot be distinguished in kind, i.e., in further intrinsic properties[6] (except G, of course), from other places and times where the regularity does hold. This is to say, it is impossible to single out the exceptional case by means of a general description of the circumstances in which it occurs.[7]

Thus, define an index-regularity in the following way:

> (x, y, z, t) is an *ind*ividual *ex*ceptional space-time region[8] (an *index*) for regularity R (such as *all Fs are Gs* or $\forall u\ (Fu \supset Gu)$) iff R has an exception at (x, y, z, t) and there is at least one other space-time region (x', y', z', t') which is exactly alike in circumstances – that is, alike in intrinsic, non-relational properties – but where the regularity does not have an exception. An index-regularity is a regularity R which has at least one index somewhere sometime.

Of course you can, even with the singularity requirement in place, "strictify" the regularity statement in the following way: $\forall u\ (Fu \wedge \neg @(x_0, y_0, z_0, t_0)u \supset Gu)$ with '$\neg @(x_0, y_0, z_0, t_0)u$' abbreviating that the object *u* is not located at the truly individual exceptional space-time region (x_0, y_0, z_0, t_0).[9] You could even hide the reference to an individual space-time-point from the grammatical surface in creating a "general" predicate C: Cu iff u is not at (x_0, y_0, z_0, t_0). Yet, still, if one "neglects linguistic codifications, and looks instead at the classes of lawful and of outlawed events" (Lewis 1979: 55) then, clearly, the state of affairs the statement describes is a general pattern with one little singular non-general gap.[10]

On the basis of the definition of an index regularity we can now also say what an index law is: an index law is an index-regularity the respective statement of which figures in a best system as axiom or theorem.

Note that when encountering an index for a regularity (or a couple of indices), one might be tempted to formulate a probabilistic law (-candidate) instead of an index-law (-candidate).[11] Clearly, one should consider this option, too. However, it should not be the default decision to go for the probabilistic formulation. Whether we ultimately get a probabilistic law or an index law should rather depend holistically on which system comes out best. The one where we added the law candidate *as probabilistic* or the one where we added it *as index law*. It's all contingent upon coherence with the other (probabilistic/indexical) law candidates of the respective system, that is, upon the overall simplicity, strength, fit, and their balance. Note, however, that in isolation the probabilistic version is simpler (it needs not list all the exceptions) whereas the index version stronger (it says precisely what happens where).

Returning to Lewis, we might now wonder whether a world whose tapestry of perfectly natural properties has certain localised flaws could nonetheless be a world with Lewis-laws. The short answer is "yes"![12] and we find traces of it already in Lewis:

> I am using 'miracle' [i.e., violation of law] 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 and additions in square brackets)

What we need here, 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 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)

The last sentence is our clue. Needless to say, it all depends on how extended the violation is: if it is temporally and spatially very limited, merely "a small, localised, 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 (which we can imagine to be noted down in exactly the way suggested for strictified index-regularities above: $\forall u\ (Fu \wedge \neg @(x_0, y_0, z_0, t_0)u \supset Gu)$ where $\neg @(x_0, y_0, z_0, t_0)u$ means that object u is not where the "small, localised, 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 rescued even if the pattern it describes is gappy.

However, we surely must agree, 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 brings my assessment of Lewis's original best system to a conclusion. The answer to the question whether his theory, or a slight amendment thereof, can allow for laws with exceptions is positive.

That said, a note of clarification is in order. If we, as suggested in the Lewis quote above, do not focus on linguistic representation, and look instead at the classes of lawful and exceptional events (cf. Lewis 1979: 55) we can straightforwardly speak of patterns (laws) with flaws (exceptions) as I just did in my conclusion. Yet, turning to the respective *law statements* it depends on whether we register the patterns as, for example, "$\forall u\ (Fu \wedge \neg @(x_0, y_0, z_0, t_0)u \supset$

Gu)" or whether we write, despite the existing index, "$\forall u\,(Fu \supset Gu)$". The former is a *strict exceptionless statement* and only the latter statement can justifiably be said to *have an exception* (generously interpreted, that is, for literally it is simply false). Therefore, when I concluded above that we can allow for *laws with exceptions* I should have said more precisely: looking at the classes of lawful and of outlawed events (rather than at the linguistic codifications) we can allow for *laws with exceptions*.

Another crucial question is, of course, how statements like "$\forall u\,(Fu \wedge \neg @(x_0, y_0, z_0, t_0)u \supset Gu)$" stand in relation to the standard way of formulating *ceteris paribus laws*: "Cp, Fs are Gs". I will give an answer at the end of §3.2.[13]

(2) The Better Best System Analysis for Non-Fundamental Laws[14]

The ultimate goal of this paper is to present a theory for *ceteris paribus* laws *in the special sciences*. So far, an account in a Lewisian spirit has been given that handles exception-ridden laws *on the fundamental level* (if such there are). The next, independent step will be to extend Lewis's theory to non-fundamental laws. For this task I will initially ignore exceptions and the cp-issue. In section (3) both the theory developed here for special science laws and the strategy how to deal with exceptions from section (1) will be combined.

Lewis has his own view how to get from basic laws to the laws of higher sciences: since both axioms *and also theorems* of the winning system are to be called laws the best system might well include laws of the special sciences: chemistry, biology, maybe psychology, etc. Before the appropriate derivations can be made – special science theorems from fundamental axioms – special science vocabulary might have to be introduced via bridge principles and/or definitions (à la Nagel) in terms of the fundamental vocabulary that refers to perfectly natural properties only.[15] If at all successful then such a theory is reductive: special science properties and laws supervene on the fundamental properties and laws.

In (Schrenk 2007), I did not want to follow this route and I suggested a non-reductionist, yet, still Lewisian path to define what special science laws are. Independently, Cohen and Callender (2009)[16] developed a very similar theory for which they coined the apt name "Better Best Systems Account". Here's where our theories originated:

Lewis, before he added explicitly to his theory (Lewis 1983a[1999]: 42) that only predicates that refer to *perfectly natural properties* figure in his best system analysis, was a promiscuous nominalist who believed that there is no such thing as nature's joints: properties are just sets of things, any such sets of any such things. Some of them might be more relevant for us, and thus we have predicates[17] for them, but there is no objective fact of the matter as to which properties are more natural than others.

Then Lewis came to think that no satisfactory comparison of axiomatic systems regarding their strength, simplicity, fit and their balance is possible when these systems are phrased in different vocabularies. The language of the competing systems has to be the same and, thus, a pre-selection of predicates has to be made before best system analyses can be run. (The specific problems need not be discuss here (but see (Loewer 1996: 109); (Lewis 1999: 42); readers unfamiliar with these issues may think of Goodman's gruesome problems). Lewis made a radical step to accommodate the need for a pre-selection: he started believing that nature herself comes equipped with her own fundamental properties and kinds. Once this is assumed, the canonical step is to restrict the vocabulary of best system competitions to predicates that refer to these perfectly natural properties for, with the assumption of naturalness in place, a different restriction than that to the natural properties/predicates would, at best, yield someone else's laws, not *nature's*.

Things are different if we do not share Lewis's belief in perfectly natural properties. We still need to fix vocabularies before we conduct a best system competition if mother nature does not make the pre-selection for us. This gives us the freedom to make our own choices: we can start to consider any fixed set of properties we want for competition in best system challenges.

Indeed, as long as *some* vocabulary is held fixed (it does not have to be any special vocabulary) the problems alluded to above disappear.

In fact, we can even let run a multitude of best system competitions for different fixed vocabularies. As long as we keep separate these competitions (competition C_1 for systems written in vocabulary V_1, competition C_2 for systems written in vocabulary V_2, etc.) and do not attempt to make inter-vocabulary-systems comparisons no trouble results.

This is where Cohen & Callender's and my idea for laws in the special sciences starts: let separate Lewisian best system competitions be run almost as in the original but do that individually for each special science: one competition for chemistry, one for biology, etc. depending on how far up you are willing to go. In other words, first, compare internally axiomatic systems that are written in the language of physics, then, second and separately, axiomatic systems that are written in the language of chemistry, then third and separately, for biology, and so on.

Here's a handy metaphor for what has just been said abstractly[18]: on the basis of different property/predicate sets we commission several separate best system analyses from a divine, omniscient being who knows exactly where, past, present and future, the respective properties are instantiated. That is, while we know our properties and the sciences into which we wish to sort them, the omniscient being knows the respective mosaic of property instantiation. Being divine, she is also all powerful and can conduct a best system analysis in no time, that is, she can straight away see which axiomatic system describes a respective mosaic best along the parameters of simplicity, strength and fit. We can, thus, ask her, for example, to calculate what the best system is for the set of chemical predicates, or for biology, or economics, etc. These various best systems yield the respective laws of these special sciences.

Let me take stock. The first reason to opt for the better best system account was dictated by a flaw in the first version of Lewis's grand system: not anything goes regarding predicates/ properties; a vocabulary has to be fixed before best system competitions start. In a second step, Cohen & Callender and I[19] (et al.) diverged from Lewis in that we, contra him, did not assume the existence of perfectly natural properties which would, if they exist, be the canonical choice for vocabulary restrictions. In a non-reductionist spirit we chose to opt for a plurality of different fixed vocabularies which correspond to the predicates/properties of the separate special sciences.[20] (This is, we are returning, in some sense, to pre-1983a Lewis.)

I have a further reason to make that choice: having shown the possibility to amend Lewis's original idea for fundamental laws in such a way that it could account for fundamental laws with exceptions (see section 1) the hope is reasonable that that also works on the level of better best systems. I.e., I believe that combining the two amendments of Lewis's original theory – shifting it to higher level sciences *and* making it fit for exceptions – can yield a theory of special science *ceteris paribus* laws. This will be shown in section (3).

Before we go there, I feel that some worries one might have regarding BBSAs need to be dispelled. These challenges become visible when we have a closer look at the nature of the predicate sets for separate BBSAs. Here, we cannot discuss them exhaustively but I will try to target some of the concerns in this brief excursus.[21]

If nature does not dictate the sets of predicates are we, then, entirely free in our choices? Yet, if anything goes, don't the laws lose objectivity so that relativism results? Indeed, the BBSA idea allows, per se, that we best systematise any set of properties/predicates we like and, thus, proponents of the BBSA have to put up with some relativism. Note, however, two places where objectivity is firmly secured and, thus, a relativism to the degree of social construction of the laws or other worrisome anti-realistic features that would be very undesirable for a theory of lawhood are avoided:

(i) Nature, although she does not dictate the vocabulary, still dictates which discernible patterns can be seen through the lens of that vocabulary. That is, the concrete regularities that exist are factually and objectively given by nature.

(ii) We can assume (as Lewis does in (Lewis 1973: 73)) that, for any vocabulary set, the winners of BBSAs already objectively exist as abstract (Platonic) objects. In the language of our goddess metaphor from above: the omniscient, omnipotent helper has done the calculations for any possible vocabulary set already and, so, when we choose a vocabulary set to be systematised we pick the according best systems from what abstractly and objectively exists.

Next to the concrete objectivity of the regularities and the abstract objectivity of the best systems note, aside, that not any set of predicates will yield a best system. Some vocabularies will be so inapt to systematise the world (because there are no concrete regularities to be seen through their lenses, for example) that no winning system, far ahead of its competitors, will abstractly exist.[22]

Yet, it has to be openly confessed, that relativity of some sort remains. Suppose we focus on scientific vocabularies only.[23] Realistically, we will be confronted with alternative sets, even for one and the same science, which have very similar but not entirely matching predicate members. (Think, for example, of two or more competing, slightly diverging biological theories within the whole of biology.) Now assume that both sets deliver their very own best systems. Which one do we choose and, more pressing, which one has *the true* biological laws?

A BBSA proponent does, indeed, have to answer that, what the laws are, is relative to a vocabulary set. I.e., the laws have indices which indicate their system affiliation. There is no further absolute sense of lawhood.

A worry remains: could there be contradictions amongst the two exemplary envisaged biological winners? (I am assuming here that they share at least some vocabulary or that there are translation manuals.) For even if laws are relativised to their vocabulary sets this would be an undesirable outcome. Yet, we may trust that this is not possibility. For should the sets share some of their vocabulary and should they also each contain laws with that common vocabulary it is hard to see how they could be contradictory. This is so because these laws will have to be strong, i.e., they will have to trace the patterns in the world and, again, these patterns are objectively dictated by nature for both systems. If one contradicted the other, one of them wouldn't get things right and thus, for lack of strength, not belong to the system in the first place. In the words of the metaphor from above: seen through the shared lenses (vocabulary), nature will look the same for the two systems.

Now that we have dispelled some of the fears surrounding the BBSA's laissez-faire policy regarding vocabulary sets we can move on to the combination of the results of sections (1) and (2).

(3) Better Best System Laws with Exceptions

(3.1) Metaphysical Construction

We have available, from section (2), best system competitions also for sets of special science properties, that is, we have a theory for higher science laws. We also have a theory, from section (1), of how to deal with exceptions for fundamental laws: statements like $\forall u(Fu \wedge \neg @(x, y, z, t)u \supset Gu)$ might well figure in best systems if there should be exception ridden fundamental regularities in the mosaic of perfectly natural properties. Now we combine 1 & 2 and get a theory for special science cp-laws:[24]

Let competitions run on different property sets and allow for generalisations that exclude exceptional individuals from their antecedents. That is, instead of formulations with *indices*, i.e. exceptional space-time points, as in $\forall u(Fu \wedge \neg @(x, y, z, t)u \supset Gu)$, allow statements like "Tigers have black and orange stripes except for Siegfried and Roy, the albino tigers.", i.e. $\forall u (Fu \wedge u \neq siegfried \wedge u \neq roy \supset Gu)$ in systems for competition. (Of course, names like "siegfried" and "roy" are slightly problematic. See endnote 24 on that issue.)

Now, you might object that this is a far too complicated enterprise: one aspect of the problem of so called *ceteris paribus* laws is precisely that we cannot possibly know all these individual exceptions. This is actually why we use the *cp*-tag: “Fs are Gs, *cp*”. In ignorance of the exceptions there’s not much else we can do.

Yet, ignorance is not one of our issues. At this stage we are considering the metaphysics of laws, not their epistemology. To our goddess (that is, from a metaphysical point of view) the distributions of all tigers in the world and the distributions of their average and normal properties as much as deviant ones of individual tigers is readily available. That is, she can name[25] all tigers, including those that have and that lack features most of the others have.

You might further object: “All these individuals, and there are far too many in the special sciences, make the law candidates too complicated for a good system.” That might be so: even the best system might not be very good. In fact, if we compare actual biology to actual physics the number of exceptions in the former compared to the latter is immeasurably higher and, still, actual biological principles and laws describe fairly well what is going on in the living world.

Back to the abstract level of BBSAs we shall say that the absolute quality (whatever that would be!) of systems is not our measure. Rather, best system competitions are looking for the one that is by far outstanding amongst many systems. As long as there is a winner reasonably ahead of the others, the respective field of inquiry has laws (and be they exception ridden as we in fact expect them for the special sciences to be). If not, not, but also that outcome wouldn’t be disastrous: if the areas under concern are all too messy we would not expect them to be law governed anyway.

Here’s a problem one might see: keeping in mind that the winner has only to be by far better than competitors (while that might not be very good by a fictitious absolute standard), could it not be that some, most, or all laws of the winning system have more exceptions than positive instances? If so should we really count them as laws?[26] For a start, I do not think that most or all laws of a winning system could be of that kind for it is hard to see how it could be far ahead (especially in simplicity) of other systems, particularly the one where all these laws are reversed and, thus, have more positive instances than negative ones (from, for example, ‘All Fs except …

are Gs' to '… are not Gs'). Moreover, in such a messy world, the quality of any system must be fairly low so that it is hard to see how there could be one that is *by far* better.

(3.2) The Epistemic Scientific Side of Things

Just as in Lewis's original system, the exceptions-tolerating BBSA version (call it $BBSA_{cp}$) provides first an foremost the *metaphysics* of laws (here of special science cp-laws) and not their epistemology. That is, the human endeavour of how to find out the laws was not the central concern. This is reflected in the fact that actual human made special sciences do not have the resources to list all the exceptional cases in the antecedents of their law statements. Not being omniscient is one hurdle: we do not know all the exceptional cases; not being omnipotent is the other: we cannot write them down in statements and then best-systematise them.[27]

As we know, the way actual sciences (or at least philosophers' reconstruction of the sciences) deal with the problem is to attach the notorious cp-proviso clause to law candidates that have exceptions: "Tigers have black and orange stripes, cp." Two of the well known problems with this (pseudo-)solution are this: either such a statement is tautologous because the cp-clause stands secretly for "… unless not", or the cp-suffix is there to distract from the fact that the statement we actually attempt to make is gappy: "Tigers, except for Siegfried and … {here's a gap} ... and Roy, have black and orange stripes" (cf., for example, Lange 1993: 235).

Now, here's how the metaphysical $BBSA_{cp}$ account can help to circumvent these problems. To make plausible the solution I wish to offer, first recall what the relation used to be between the scientific laws of actual fundamental science and the laws of nature as Lewis envisaged them originally: the Schroedinger Equation for example, which is one of our best guesses of what the fundamental laws could be, is in fact a law of nature *iff* two things match: (i) the properties the Schroedinger Equation mentions (potential & kinetic energy, mass, etc.) are perfectly natural; (ii) the Schroedinger Equation has to belong to the axioms or theorems of the best system. These are the metaphysical facts that have to be true in order for Schroedinger to have really discovered a law.

What's the equivalent concerning the $BBSA_{cp}$ and actual special sciences? The actually used "Tigers have black and orange stripes, cp." is in fact a law *iff* two slightly more complicated conditions are satisfied: (i) the properties being a tiger, black, yellow, etc. are within a set of (mostly) biological properties that does yield a best system; (ii) "Tigers have black and orange stripes, except for the individual tigers: $tiger_1$, $tiger_2$, ... , $tiger_n$" belongs to the axioms or theorems of that best system. (More generally speaking, we are justified in writing 'cp, Fs are Gs' and calling it a law iff $\forall u\ (Fu \wedge \neg(u=a_1) \wedge \neg(u=a_2) \wedge \ldots \neg(u=a_n) \supset Gu)$ turns out to be an axiom within the respective BBSA.)[28]

Suffixing "cp" to one of our special science law candidates expresses the trust that the two conditions above are met. If, in short, a cp-candidate, completed by the omniscient being, is indeed a member of that best system the cp-clause makes the statement neither tautologous nor incomplete.[29]

(4) Summary

This paper's aim was to give a metaphysical account of ceteris paribus laws as they appear in the special sciences. For that purpose, it modified David Lewis's best system analyses of lawhood in two independent ways.

First, it showed how exceptions even to the fundamental laws of nature would be tolerable for the best system account. Second, it transferred Lewis's theory of fundamental laws to the realm of the special sciences. Combining the two independent adjustments a better best system theory of ceteris paribus laws in the special sciences resulted.

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[2] This paper revises and improves ideas of (Schrenk 2007 and 2008). The latter publications are now obsolete. I wish to thank three anonymous reviewers and also the editors, Matthias Unterhuber and Alexander Reutlinger, for their valuable suggestions how to advance the paper beyond the first draft they have commented.

[3] Section (1.2) refines and makes concise pp. 45-54 &77-86 of (Schrenk 2007).

[4] For a discussion cf. Earman 1978.

[5] By "irregular" is not meant "probabilistic". Endnote 10 shows how to distinguish cp-laws or laws with exceptions from probabilistic laws.

[6] Here, I have Lewis's specification of intrinsic properties in mind (cf. (Lewis 1983b) and (Lewis & Langton 1998).

[7] The non-generality requirement is there because if it were possible to add *general* exclusion clauses to the antecedent of the respective general statement ('All Fs *that are not also H* are Gs', for example) we would say that that general statement is the (exceptionless!) regularity we should consider.

[8] To signify a region I should write ($x_0+\Delta x$, $y_0+\Delta y$, $z_0+\Delta z$, $t_0+\Delta t$); for brevity I I stick to (x_0, y_0, z_0, t_0).

[9] That is, "@(x_0, y_0, z_0, t_0)u" is a one-place predicate that stands for being localized at the space-time point with coordinates <x_0, y_0, z_0, t_0>. One can easily create further such one-place predicates of the same form: "@(x_1, y_1, z_1, t_1)u", etc. for further space-time locations.

[10] More on reference to individuals: (Schrenk 2007: 48).

[11] The probabilistic law, by which I mean laws of the sort P(G|F)=r, would claim that, wherever you are, there is a chance r that Fs are Gs. The index law says instead that, except for the indices where the chance is 0, the probability is 1 to find Fs that are Gs. Cf. also (Schrenk 2007: 50) and (Reutlinger, this volume).

[12] The long answer is also "yes": (cf. Schrenk 2007: 76ff).

[13] David Braddon-Mitchell (Braddon-Mitchell 2001), who has his own version of Lewis laws with exceptions ("Lossy Laws") and who has greatly influenced my own thoughts on the topic, explicitly allows law statements to lie. That is, unlike me, he opts for recording the law as "∀u (Fu ⊃ Gu)" even if there is an exception at (x_0, y_0, z_0, t_0). For the consequences of this difference see (Schrenk 2007: 92ff). My interpretation is, for example, more in line with Lewis: "Take all deductive systems whose theorems are true… " (Lewis 1994, p. 231; my italics). For a valuable critical evaluation of both accounts see (Kowalenko 2011).

[14] Section (2) makes more precise Part 3 of (Schrenk 2008).

[15] In which relation bridge laws stand to the best system is not so clear in Lewis. Clearly, they cannot belong to competing systems from the start because of Lewis's vocabulary restriction to predicates that refer to perfectly natural properties.

[16] The BBSA style ideas can also be found in (Halpin 2003), (Taylor 1993: 97), (Roberts 1998), (Loewer 2007) and (Albert 2000). For discussions see (Frisch forthcoming), (Weslake forthcoming) and (Reutlinger and Backmann under review).

[17] I treat, here, properties innocently as the semantic values of predicates. Where no confusion can result I make smooth transitions from properties talk to predicates talk and vice versa.

[18] See (Schrenk 2008: 126). David Albert uses a similar "audience with god" metaphor (Albert unpublished: chapter 1) as, in fact, does David Lewis (1973: 74). Still, it might be important to underline again that the goddess metaphor is only there to highlight that we are operating from an omniscient, that is, metaphysical standpoint. No theism is implied. Omniscience of the whole mosaic is what Lewis assumed for his best system, too, so there is no difference here except for the one that the respective mosaics we look at come in different colours and tesserea sizes.

[19] I should say: I no longer assume that natural properties exist. In (Schrenk 2007) I did, now I am agnostic.

[20] It would be very interesting to engage in the question how BBSA laws for less than perfectly natural properties would compare to the non-fundamental laws an original Lewis BSA would generate (via bridge principles) if there were natural properties. This question can, however, not be targeted here.
Note also that the vocabulary choices are not as straightforward as I made it seem above. The reason is that many biological laws will also essentially refer to physical and/or chemical properties. Think of the bio-medical law that humans cannot survive much longer than ten days without water, i.e., H_2O + certain dissolved *isotonic salts*. I discuss this problem at length in (Schrenk Manuscript).

[21] For further challenges and how to meet them see (Schrenk Manuscript).

[22] I thank Alexander Reutlinger for helping me to disentangle these two types of objectivity.

[23] The vocabulary sets of the sciences suggest themselves as the canonical selections if the system winners are to be called "laws of nature". This to limits the abundance of useful vocabularies.

[24] While not being their central concern Cohen and Callender also have a view on cp-laws (cf. their 2009: 25-6; 2010: 433). As they explicitly say, what they have to contribute depends partially on existing accounts of what *cp*, when attached to a regularity statement, could mean (Cohen and Callender 2009: 25), and they are positive that acceptable solutions exist (they list some options, including Schrenk 2008). Once such a theory is in place, so they continue, BBSAs can easily cope with cp-regularities/laws. Their argument is, like mine, very similar to Braddon-Mitchell's. It says, in essence, that generalisations with exceptions can be subjected to best systematisations, checking strength and simplicity, just as this can be done with strict generalisations (ibid. 25-26). How Cohen and Callender's and my account differs thus depends entirely on which additional theory for the cp-clause they adopt. If mine, there is no difference at all.

[25] "Naming" in the sense of "singling them out". What she can't do is give them proper names that would then be mentioned in the exclusion clauses, for proper names do not belong to the scientific vocabulary we handed over. Yet, that is no major hurdle because the divine helper has the resources to pick out individuals simply as the space time worms they occupy and we can safely assume that space-time vocabulary is allowed in any science. (I wish to thank Jenann Ismael for the observation that proper names mustn't appear.)

[26] I thank an anonymous referee for pointing out this difficulty.

[27] My BBSAcp account shares with so called "completer accounts" (cf. Reutlinger et al. (2011: §5) that the antecedent of the respective law statements is expanded so that the statement is strictified, yet, it differs from those accounts in that the addenda are not general but individual (cf. the section about indices) and appended only under idealized conditions (omniscience) and not within scientific practice.

[28] Of course, nothing speaks against excluding at least some "exceptional" individuals from the antecedent of scientific law candidates (the ones we are certain of to be exceptions). Also, nothing counts against scientists trying to find a systematic account for the exceptions. The account here given is for those exception ridden laws for which this cannot be successfully done.

[29] How the BBSA ceteris paribus solution here offered can be paired with Pietroski and Rey's well known account of cp-laws (Pietroski and Rey 1995) is discussed in (Schrenk 2008). By such a maneuver a problem of the latter account is solved and the BBSA gains a valuable epistemic supplement.