NATURALNESS AND GROUNDS

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There has been some recent interest in a structural relation of metaphysical determination and dependence, one that corresponds to talk of "in virtue of" and "grounds".[1] This *grounding relation* provides order to the layers of reality by mapping the relations of dependence between entities. In what follows, I show that this grounding relation can do some new work for the friends of grounds. Namely, a relation of *comparative naturalness* is definable, one that is suited to play certain theoretical roles akin to those devised by David Lewis in his "New Work for a Theory of Universals".[2] In what follows, I outline certain aspects of the naturalness package provided by Lewis (§1), contesting one key element, and, then, in §2, draw a picture, starting with the grounding relation, that seems to provide an adequate alternative to the Lewisian package. Finally, in §3, I draw out some consequences of the system developed in §2, with particular focus on key similarities and differences from the package sketched in §1.

1. The Package

Lewis considers properties to be classes of *possibilia*, sets of their instances, this- worldly and other- worldly alike.[3] Properties are *abundant*, this makes them *undiscriminating:*

> Any class of things, be it ever so gerrymandered and miscellaneous and indescribable in thought and language, and be it ever so superfluous in characterizing the world, is nevertheless a property. [...] Any two things share infinitely many properties, and fail to share infinitely many others.[4]

There is, however, another, *sparse*, conception of properties:

> Sharing of them makes for qualitative similarity, they carve at the joints, they are intrinsic, they are highly specific, the sets of their instances are *ipso facto* not entirely miscellaneous, there are only

[1]Cf. Schaffer (2009), Rosen (2010), Fine (2010, *forthcoming*), Audi (*forthcoming*), Correia (2010).
[2]Lewis (1983).
[3]Lewis (1986, 50). As such, relations are to be considered properties of tuples of things: sets of $n-$tuples of *possibilia*.
[4]Lewis (1983, 12-13).

> just enough of them to characterize things completely and without redundancy.[5]

Thus, in his (1983), Lewis showed that the insight had by Armstrong (1978*a,b*)–that a distinction should be drawn between genuine and non-genuine features–could be had independent of the dialectic over predication within which it was buried. Properties are well suited to play the role Armstrong required of universals, once one distinguishes the élite minority, the *natural* properties. The resulting package Lewis presented was powerful in that once *naturalness* was isolated, it became clear that it could do much additional work.

My main focus will be on three important aspects of the Lewisian package. First, while the abundant properties are well suited to function as semantic values generally, the natural properties are importantly independent and upstream from the use of language. That is just to say: (1) they are *independent* in that there are certain structural features of reality, certain joints in nature at the most fundamental level that they serve to mark, and (2) they are *upstream* insofar as once these features have been marked, they may then play an active role in the fixation of the content of our attitudes and the semantic values of our expressions over and above the role played by the abundant properties. Finally, membership in this élite group is not an all or nothing affair. Naturalness comes by degree, the features marked can be more or less genuine.

I call these aspects of the Lewis package *joint-carving*, *magnetism*, and *length,* respectively. The first role that natural properties are fit to play, that of carving nature at its joints, can be defined as follows:[6]

Joint-carving: The more natural a property is, the less things that have it can resemble things that lack it.

This serves to render the gruesome and gerrymandered properties less natural than their world-cutting counterparts. For example, there is less resemblance between the green and blue things than between the grue and bleen things along at least one significant dimension: with respect to color, some grue things will resemble some bleen things more than they will resemble other grue things, and *vice versa.* Further, after attaching this notion of objective similarity and difference to the natural properties, they can then serve a role in combating the skepticism of Putnam (1980), Davidson (1979), and Kripke (1982). We may dub this role *magnetism*:

Magnetism: The more natural a property is, the easier it is to refer to, *ceritus paribus.*

Once we have joint-carving in hand, we have a proper explanation of why we mean *plus* by '+' rather than *quus*; what constitutes the semantic glue that sticks our

[5]Lewis (1986, 60).
[6]I borrow the following definitions from Dorr and Hawthorne (2011).

words onto their referents, rather than some seemingly equally acceptable permutation thereof.[7]

Some properties are more natural than others, and less natural than others still:

> Probably it would be best to say that the distinction between natural properties and others admits of degree. Some few properties are *perfectly* natural. Others, even though they may be somewhat disjunctive or extrinsic, are at least somewhat natural in a derivative way, to the extent that they can be reached by not-too-complicated chains of definability from the perfectly natural properties.[8]

Thus, we must develop some method of comparison between properties. This leads to the criterion of *length*:

Length: The more natural a property is, the simpler its definition in terms of perfectly natural properties.

The rough idea is this: define a formal language[9] that admits only the perfectly natural properties as predicates. Any given property may be represented in this language. The *relative naturalness* of a property will then be tied to the syntactic complexity of its representation. The idea is that the further from the perfectly natural properties, the longer the chain of definability. This is similar to the notion of *real definition*. The language of perfectly natural properties will provide a privileged language: a basis upon which the more complex properties may be defined. *Grue* will then be less natural than *green*, for whatever the representation of *green* in terms of perfectly natural properties, the representation of *grue* will contain that of *green* as a disjunct.

Given that both JOINT-CARVING and MAGNETISM are defined in terms of a degree determiner, the notion of comparative naturalness introduced by LENGTH is a key element of the Lewisian package. It is unfortunate that not more was said about it. Several authors have called this criteria for determining relative naturalness into question,[10] and I now raise one additional question. I use the problem here developed to draw out some similarities and differences between the conception of comparative naturalness generated by LENGTH and that which I develop in §2.

I need two additional assumptions made by Lewis. First, *supervenience*:

Supervenience: Fundamental properties figure in a minimal basis on which all else supervenes.

This links possible worlds based on their patterns of instantiated fundamental properties. Second, I will need a bridging assumption:

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[7]Note that Lewis would most likely rather talk in terms of the assignment of content to attitudes, allowing for resolution in this domain to resolve the problems in the linguistic domain, but for the purposes of these particular problems, no difference is made by choice of direction.
[8]Lewis (1986, 61).
[9]For Lewis, most likely a first-order language that admits of plural quantification.
[10]Cf. Sider (1995), Schaffer (2004) for representative examples.

Link: The fundamental properties are all and only the perfectly natural properties.

Finally, we need *alien* properties. A property is *alien* to a world just when it is uninstantiated at that world. Since Lewis allows worlds with different supervenience bases than the actual world, by SUPERVENIENCE and LINK he allows alien perfectly natural properties.

Now, say that a property P is *multiply realizable* just when it has multiple possible supervenience bases. Say that $\mathcal{P}_w$ is the supervenience base at w for P–the set of instantiated perfectly natural properties at w upon which P supervenes. To say that P is multiply realizable is then to say that there is some possible $\mathcal{P}_w$ that differs from $\mathcal{P}_@$.[11] My argument purports to show that any multiply realizable property will have an infinite LENGTH. Take the class of multiply realizable properties $\mathbb{P}$. For each property $P \in \mathbb{P}$, an equivalence relation can be defined over the pluriverse corresponding to the different possible $\mathcal{P}_w$ of P. Say $w_1 \sim_P w_2$ just in case $\mathcal{P}_{w_1} = \mathcal{P}_{w_2}$. It seems plausible that there will be an *infinite* number of partitions in $\sim_P$, for if P has at least one possible supervenience base that differs from its actual supervenience base, there is no principled reason to limit the ways in which these supervenience bases could differ. If this possibility is granted, however, then we have a problem. Defining P in the language of perfectly natural properties will require an infinitary disjunction. Each disjunct will correspond to the sentence that represents the instantiated perfectly natural properties in a specific cell of $\sim_P$. This will be so for every property in $\mathbb{P}$. LENGTH is too coarse grained to draw distinctions between the multiply realizable properties.

How might Lewis respond? The first move that comes to mind would be an increase in the expressive power of the language: allow quantification into predicate position. One might think that existential closure over the predicates in each disjunct might allow for simplification. This move would help only if it reduced the infinitary nature of the definition. Unfortunately, carrying out this reduction requires an assumption which should be rejected. That is, there would have to be a $1-1$ correspondence between the actually instantiated perfectly natural properties and the alien properties in each partition of $\sim_P$. One would have to connect each actually instantiated property with a unique set of alien properties that are its possible realizations across partitions. It is by no means clear that this kind of identification is possible. A single actually instantiated property might in some cases be realized by several alien properties, in other cases none. If we allow an infinite number of possible variations of this sort, we have then done nothing to reduce the definitional length of our multiply realizable properties.

[11]There is some world w that differs from the actual world in instantiated perfectly natural properties, and the properties upon which P supervenes at w differ from the properties upon which P supervenes at the actual world.

In the face of this difficulty, one might then consider plural quantification over the predicates in his language of perfectly natural properties. This would allow for reduction of the length of our multiply realized properties, but with an equally problematic consequence. If we allow one to say that in effect there are some Ps such that x is instantiated by the Ps, then the shortest definition of any non-perfectly natural property will have a length of one, we simply quantify over the plurality of natural properties that instantiate it at any given world. Again, Lewis's method becomes too coarse grained to draw the distinctions required. Intuitively, what we would like is a definition of comparative naturalness that allows us to say that the gruesome properties are less natural than their joint cutting counterparts, allowing for a story to be told about the magnetism of reference, that does not immediately go haywire as soon as cases of higher level properties are considered. In the following section I show how the *grounding relation* provides the resources required to define a notion of comparative naturalness better suited to our intuitions about naturalness. I then, in §3, go on to show how this model satisfies the criterions of JOINT-CARVING and MAGNETISM, drawing out some structural differences between it and the Lewis package on the way.

2. Grounding

Structure has increasingly become a prominent consideration in metaphysics.[12] Eschewing modal analysis as too coarse grained,[13] some have suggested that if we take for granted that reality contains some intrinsic structure, then some headway might be made. A relation that maps this structure may be defined, providing an analysis of metaphysical dependence. One would then seek to generate principles governing the relation that maps this structure. Some relevant principles, as laid out in Rosen (2010), which will be required to construct and evaluate a relation of comparative naturalness, will now be covered. Characterization of the grounding relation will come in three steps. First, I define some general notation and structural principles. Next, some principles governing interaction with basic logical relations will be covered, and, finally, more complex interaction related to reduction and real definition will be considered. This will provide the basis from which a relation of comparative naturalness will be derived.

I will be following Rosen (2010) in considering the grounding relation as one that holds between facts.[14] Facts are to be considered structured entities, along the same lines as Russellian propositions, and I take $[p]$ to stand for *the fact that* p. I thus write the grounding relation as $[p] \leftarrow [q]$, which stands for *the fact that* p *is grounded*

[12]Cf. Sider (*forthcoming*) for a master argument.
[13]Cf. Fine (1994).
[14]Cf. Fine (*forthcoming*) and Correia (2010) for alternate proposals, which hold that the grounding is a relation between sentences.

in the fact that q. Since plural grounds are possible, it will be perspicuous to at times represent the relation as holding between a fact and a set of facts: $[p] \leftarrow \Gamma$.

The most uncontroversial structural principle regarding grounds is that it is *asymmetric*: if $[p]$ grounds $[q]$, then it is not the case that $[q]$ grounds $[p]$. From this it follows that the grounding relation is *irreflexive*: it is not the case that $[p]$ grounds $[p]$. Generally:

Asymmetry: if $[p] \leftarrow [q], \Gamma$, then not $[q] \leftarrow [p], \Delta$
Irreflexivity: not $[p] \leftarrow [p], \Gamma$

There is further reason to believe that the relation is not *connected*, as it seems fairly clear that some facts are irrelevant to the grounding of others, which provides credence for the denial of *monotonicity*:

Non-monotonic: if $[p] \leftarrow \Gamma$, then not $[p] \leftarrow [q], \Gamma$

These principles characterize the relation that some would call *immediate grounds.*[15] It is an open question as to whether this relation is *well-founded*, as we want to leave open the possibility of infinite chains of descent, rather than assume that there is some ground level of basic facts. Further, as the relation stands, it does not rule out *cycles*, it could be that $[p] \leftarrow [q] \leftarrow \ldots \leftarrow [p]$. Given the adversity to reflexivity, one might consider the relation *acyclical*. Many take the relation to be *transitive,* or, at least, take the *transitive closure* of the *immediate grounds* relation to be the more general notion. At certain points in what follows, however, the transitive closure will prove to be too strong for our purposes. So we will from this point forward assume that the relation of *immediate grounds* is *acyclic*, and henceforth consider the *grounding relation* to be the transitive closure of the *immediate grounds* relation.

When considering the grounding relation, Rosen posits the following principle connecting grounding to metaphysical necessity:

Entailment: If $[p] \leftarrow \Gamma$, then $\Box(\bigwedge \Gamma \supset p)$

This is a strong principle, and one that does not obviously hold for the immediate grounds relation. Three additional principles follow from ENTAILMENT, however, that do hold of the immediate grounds relation:

($\vee$): If p is true, then $[p \vee q] \leftarrow [p]$.
($\wedge$): If $p \wedge q$ is true, then $[p \wedge q] \leftarrow [p], [q]$.
($\exists$): If $\varphi(a)$ is true, then $[\exists x \varphi x] \leftarrow [\varphi a]$.

These three principles characterize the easy cases of logical relations, and, further, it is quite plausible that they hold of the immediate grounds relation as well.[16] From this we can see that disjunctions are grounded in their true disjuncts, conjunctions grounded in their conjuncts, and existential facts grounded in their instances.

[15]Cf. Fine (2010).
[16]There are some interesting questions related to the principles governing universal facts, but I will be bracketing those issues here, as they do not bear directly on my concerns.

Next, let us consider the link between the grounding relation and reduction. The grounding relation is an explanatory relation, and reduction, as conceived here, is a metaphysical matter. That is to say, reduction is a relation between propositions corresponding to the *real* definitions of the items in question. This gives us the following rough connection:

GR: If p reduces to q and p is true, then $[p] \leftarrow [q]$.

We can provide for reduction as a relation among propositions by introducing the following notation:

Reduction: For all $x, y, \ldots$, $\langle Rxy \ldots \rangle \Leftarrow \langle \varphi xy \ldots \rangle$

Where the angle brackets introduce names for propositions with the corresponding structure,[17] and φ is a complex that does not have R as a constituent. This allows a better specification of the grounding-reduction link:

Grounding-Reduction: If $\langle p \rangle$ is true and $\langle p \rangle \Leftarrow \langle q \rangle$, then $[p] \leftarrow [q]$

Note that given the nature of the grounding relation, holding this link requires the rejection of the following principle:

Reduction$_=$: If $\langle p \rangle \Leftarrow \langle q \rangle$, then $\langle p \rangle = \langle q \rangle$

That is, we must reject the identity of the reducible to that reduced. This would be a problem if we were working with course grained propositions, as the set of worlds where p is true *just is* the set of worlds where q is true, but given the additional structure we have built into our model, we do not have this problem.

Additionally, we can provide a specification of real definition directly. We will want a tighter connection for real definition than we have for reduction, as reduction is a contingent matter. We can specify this with Fine's notion of essential truth:

Grounding-R$_{df}$: $R =_{df} \varphi$ iff $\Box_R \forall xy \ldots (Rxy \ldots \supset ([Rxy \ldots] \leftarrow [\varphi xy \ldots]))$[18]

What it is for φ to define R is for it to be necessary that in virtue of the nature of R, facts about φ ground facts about R.

Considering our immediate grounds relation, it seems obvious that the grounding-reduction link fails. This is because the right-hand-side of a reduction or real definition will be cast in the most basic terms. If a comparably high-level property P reduces to a basic property ϕ, then it is conceivable that there is a sequence of reductive steps between P and ϕ. By the transitivity of the grounding relation, then we have that ϕ grounds P, but it could be that ϕ grounds ψ, ψ grounds P, P reduces to ψ, and ψ further reduces to ϕ. In this case ϕ is the most basic reduction of P, and ϕ grounds P given transitivity, but P has the immediate grounds of ψ, and really immediately reduces to ψ, which in turn reduces to ϕ. This more fine-grained structure is flattened by the transitive closure of the immediate grounds

[17] We are assuming here that propositions, like facts, are structured entities.

[18] Gideon Rosen suggested this connection in his lectures on David Lewis at the *International Summer School in Cognitive Science and Semantics: David Lewis on Language and Mind, 2011.*

relation. We can fix this problem in the following way. First, introduce a relation of *immediate reduction*:

Immediate Reduction: $\langle p \rangle \Lleftarrow \langle q \rangle$ iff
1: $\langle p \rangle \Leftarrow \langle q \rangle$, and
2: there is no $\langle r \rangle$ s.t. $\langle p \rangle \Leftarrow \langle r \rangle$ and $\langle r \rangle \Leftarrow \langle q \rangle$

Finally, introduce the notion of a *basic reduction*:

Basic Reduction: $\langle q \rangle$ is a *basic reduction* of $\langle p \rangle$ iff
1: $\langle p \rangle \Lleftarrow \ldots \Lleftarrow \langle q \rangle$, and
2: there is no $\langle r \rangle$ s.t. $\langle q \rangle \Lleftarrow \langle r \rangle$

With these two definitions, we can introduce an immediate grounds-immediate reduction link in the same manner as before, and the notion of basic reduction captures the kind of final reductive level aimed at when capturing the real definition of a property or relation. With these definitions in hand, we can now move to the derivation of a *comparative naturalness* metric.

At first pass, the structure of our immediate grounds relation lends itself to being considered something like a *forest.* In our case, an oriented acyclic graph, all of whose connected components are *rooted trees,* ordered *toward* the root. Our trees, however, will not be, strictly speaking, disjoint. If there exists a basic level of stuff, the facts corresponding to this level will be the leaves of every tree. Every tree will grow out of the same basic stuff. This structure, however, allows for the measurement of the *height* of a node, the longest downward path to a leaf from that node.[19] We can then define a function, h, over the facts, where $h([p])$ is the measure of the height of $[p]$'s immediate grounding tree.[20]

We now have a new way to define natural properties and relations. As an example, we could define a property/relation as *perfectly natural* just in case the height of some fact involving it is zero:

PN: P is *perfectly natural* iff
1: there is some $[\ldots P \ldots]$ that involves P,[21] and
2: $h([\ldots P \ldots]) = 0$

This is not exactly right, however, for different facts involving P will have different heights. When measuring naturalness, should we take the height of the tallest tree involving P or the shortest? If we take the possibility of infinite grounding chains seriously, taking the height of the tallest tree will threaten to trivialize our measure, so it would seem that the best option would be to consider the shortest P involving

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[19]The height of a *root*, then will correspond to the height of a tree.
[20]At this point, it does not matter whether we define height as a measure of the *immediate* grounding relation or its transitive closure, but it will turn out to be important in what follows.
[21]I will from this point forward treat $[\ldots P \ldots]$ as short for a fact that involves the property P.

grounding tree.[22] With this in mind, we can now define a partial order, $\geqslant$, over the properties corresponding to *comparative naturalness*:[23]

CN: $P \geqslant Q$ just in case:
- **1:** $h([\ldots P \ldots]) \leq h([\ldots Q \ldots])$,
- **2:** there is no $[\ldots P \ldots]^*$ s.t. $h([\ldots P \ldots]^*) < h([\ldots P \ldots])$, and
- **3:** there is no $[\ldots Q \ldots]^*$ s.t. $h([\ldots Q \ldots]^*) < h([\ldots Q \ldots])$

Here we can read $P \geqslant Q$ as that P is at least as natural as Q. A property, φ, then, is *perfectly natural* just in case, for any ψ, if $\psi \geqslant \varphi$, then $\varphi \geqslant \psi$. We have thus partially ordered the properties according to the height of the shortest trees in which they are involved. Those at the bottom level of this order are perfectly natural, with the rest decreasing in naturalness as you move through the levels. What is now left is to investigate the consequences of this choice of ordering and its comparison with the Lewis metric.

3. Consequences and Comparison

The first point to note, when considering our new measure, is that *logically complex properties are always less natural than the atoms which ground their real definition*. Take, for example, the property C. C's real definition is constituted by the conjunction of the properties φ and ψ. That is, $C =_{df} \varphi \wedge \psi$. By our real definition link, any facts involving C will be grounded in facts involving $\varphi \wedge \psi$, which will, by ($\wedge$), be grounded in facts involving φ and facts involving ψ:

$$[Cxy \ldots] \leftarrow [\varphi xy \ldots \wedge \psi xy \ldots] \leftarrow [\varphi xy \ldots], [\psi xy \ldots]$$

We can see, then, that whichever of φ or ψ has the taller grounding tree, C's grounding tree will be at least taller by two.[24] Thus, C will be strictly less natural than both φ and ψ, as it is strictly less natural than their conjunction. This provides the following two consequences: (1) gruesome properties will always be strictly less natural than their joint-carving counterparts, and (2) the conjunction of two perfectly natural properties will be strictly less natural than its conjuncts. The first of these consequences is welcome, the second can be called into question.

To see that gruesome properties will always be strictly less natural than their joint carving counterparts, one simply observes that given the apparatus of real definition, a gruesome property will always have a logically complex definition.

[22]Here it is important that we construct this metric with the *immediate grounds* relation. If we were considering the transitive closure, then the shortest tree of any given fact would have a height of at most one.

[23]I leave the order as partial in order to allow for the possibility of properties that are not involved in any facts. These properties would, strictly speaking, be incomparable to the rest, simply *unnatural*.

[24]We must qualify with *at least* due to the fact that our real definition link holds only for the transitive closure of the immediate grounding relation, we do not know at what level in the immediate grounds tree the real definition of C will appear, only that it will appear at some level.

Grue is defined as a disjunction of *green* and *blue*, *quaddition* in terms of *addition* and some constant function, etc.. In each of these cases, the *definiens* will always be strictly more natural than the *definiendum,* by our real definition link and, in these cases, principle ($\vee$). As a corollary, we have an answer to the permutation arguments over which our principle MAGNETISM is concerned. For example, take a language $\mathcal{L}$ and let $f_{\mathcal{L}}$ be a permutation of $\mathcal{L}$'s domain of quantification. We can now define a relation of *crazy-reference*$_{\mathcal{L}}$. For any given names $\mathbf{N}, \ldots$, if $\mathbf{N}$ refers to some a in the domain of quantification, let it *crazy-refer* to $f_{\mathcal{L}}(a)$. For any given predicate $\mathbf{P}, \ldots$, if $\mathbf{P}$ refers to the property P, then let it *crazy-refer* to the property Q, where Q applies to some object a just in case P applies to some b where $f_{\mathcal{L}}(b) = a$. Note, however, that our definition of the properties required to define *crazy-reference* require in their *definiens* the properties involved in the original reference relation. They are a specific kind of gerrymander. As such, by our real definition link, we will have that facts involving crazy reference will be grounded in facts involving regular reference. And, therefore, the standard reference relation will be strictly more natural than the permuted *crazy-reference* relation.

The second consequence mentioned constitutes a substantive claim regarding what it is to *carve at the joints.* A claim that would distinguish the friends of grounds from some of their contemporaries.[25] The picture of the joints painted by our current story is one that lacks any logical structure. The joints correspond to just the basic properties and relations, and, as such, any logical construction out of these properties and relations will lose some joint-carving qualities. This picture differs from that in Sider (*forthcoming*), for example, wherein he posits a metaphysically basic language with a full logical vocabulary. On his view, the joints in nature are closed under the metaphysically fundamental logical operations. If, for example, conjunction were metaphysically fundamental, then conjoining two fundamental properties would be equally fundamental. Performing operations on things inside the joints with other things inside the joints will not take you outside of the joints. If one wanted to adopt this conception of joint-carving, then any operator considered fundamental would not required a corresponding grounding principle, as metaphysical dependence would ground out in logically complex properties. Taking conjunction as an example: if the lowest level properties and relations contained conjunctive properties, then the real definition of higher level properties would consist in disjunctions of joint-carving conjunctions. Our grounding relation would only require tracing of the true disjuncts down to the joint-carving conjunctions whose truth fundamentally grounds the higher-level properties.

I leave open the preceding possibility, but, given our current construction, nature's joints are to be considered maximally discriminating. We can see what it is to be maximally discriminating through an example: consider a world containing

[25]Most notably, Sider (*forthcoming*) and Cian Dorr in conversation.

only three properties, P, Q, and ϕ, where $\phi =_{df} P \wedge Q$, and P and Q are perfectly natural. Now take an entity, a, instantiating only the property P: a will resemble the things instantiating $P \wedge Q$ just as much as those instantiating $P \wedge \neg Q$, but will bear no relations of resemblance to those things instantiating $\neg P \wedge Q$. Similarly for any entities instantiating only Q, *mutatis mutandis.* Suppose, however, that we have an entity, b, which instantiates ϕ: b will perfectly resemble other things that instantiate both P and Q, but it will also resemble the $P \wedge \neg Q$ things just as much as the $\neg P \wedge Q$ things. Generally, the things that have ϕ resemble *more* things that lack ϕ than the things that have just P or just Q. As the things that have just P or just Q bear *no* relations of resemblance to things that lack their respective property. As such, these things are *more discriminating* than the ϕ things. This fits perfectly well with our definition of *joint-carving* provided in §1: the P things and Q things resemble less things that lack their respective properties than the ϕ things.

A further consequence of our current metric locates a point of departure from the metric generated by LENGTH. Consider a high-level property, P, with an immediate reduction chain of length n and a basic reduction that is a logical complex of perfectly natural properties. Now, according to the Lewis metric, our property P would have a naturalness value defined in terms of the syntactic complexity of the sentence corresponding to Ps basic reduction in the language of perfectly natural properties. Suppose the complexity value associated with this measure is l. Now, given the reduction link and rules for the connectives, the property P will, according to the grounding metric, have a naturalness value of at least $n+m$, where n is the length of the immediate reduction chain and m corresponds to the logical complexity of the basic reduction, according to the rules for grounding logically complex statements.[26] It is fairly clear, however, that we can find cases where $n + m \neq l$. As such, the grounding metric and the lewis metric are distinct, in that the grounding metric takes into account several dimensions that the lewis metric ignores. Additionally, the grounding metric does not discriminate, in terms of naturalness, between logically complex yet reductively basic properties and logically simple yet reductively high-level properties.

Will we have Lewis's problem when measuring multiply realizable properties? It is doubtful. Take the infinitary disjunction previously considered. This disjunction will be grounded in its true disjunct, which will in turn be grounded in whatever way is required by its logical/reductive complexity. Unless there is reason to think that each disjunct is itself infinitary, then we have a potentially finite grounding tree. Potentially because nothing we have said rules out the possibility of infinite

[26]One thing we can note here is that $m \leq l$. How m corresponds to l depends on how one measures syntactic complexity. It seems clear, however, that m will not be greater than l, as m will have an upper bound equal to the number of connectives in the basic reduction of P, and l will have this value only if one counts just the connectives.

length grounding trees. But there is no reason to think that, bracketing this general possibility, we will have any particular problems with multiple realization. There is, however, one potential problem in the area. Consider the disjunction of a perfectly natural property and a gruesome property, where the perfectly natural property is the true disjunct. On our current metric, this property will be just as natural as our conjunction of two perfectly natural properties. Some might consider this an odd result. In order to resolve this potential problem, one might first consider moving from a measure based on shortest tree height to one based on tallest tree height, which would shift the evaluation to the tree made true by the gruesome property. But in this case, if we are still open to the possibility of infinite grounding trees, we do have a serious problem. As it is quite plausible that the tallest tree for any given property is infinite in length. A second potential solution here might be a move to the view of joint-carving where the joints are logically closed in certain respects. For while the disjunctive property would still be fairly natural, it would not be as natural as many logically complex joint-carving properties. A final possibility might be to tell a story about negation that would allow one to drop the disjunction clause in favor of negation and conjunction, as this would conceivably shift the height of trees involving disjunctions. At the moment, I have no such story, and, as this paper is largely exploratory, I leave this problem open.

4. Conclusion

To conclude, we have seen that the distinction between abundant and sparse properties lends itself to a conception developed by Lewis: that some properties are more natural than others. Naturalness is a powerful conception in that it is apt to play certain roles such as describing the joints in nature and fixing the content of thought and language. One problem with Lewis's original conception, however, is that the measure of comparative naturalness originally devised is inadequate to its task. I have here explored how the grounding relation might provide certain resources to allow for a better analysis of the basic idea that some properties are more natural than others. In particular, I have shown how a comparative naturalness relation might be defined over the properties given these resources, and then considered three consequences of this definition. First, the relation renders logically complex properties less natural than logically simpler properties, *ceritus paribus*. This was seen to provide intuitive results regarding gruesome, gerrymandered properties, allowing for the magnetization of reference, but it also marks a substantive point regarding the carving of natures joints, which could be contested. Additionally, the metric does not distinguish between logically simple, high level properties and logically complex, low level properties. This feature was shown to be capable of generating different results than the Lewis metric, in certain cases.

Finally, the metric does not fall victim to the same problems as the lewis metric, but it may have some problems of its own.

Word count: 5320

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