Gunk Mountains: A Puzzle

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Abstract

This note points out a conflict between some common intuitions about metaphysical possibility. On the one hand, it is appealing to deny that there are robust counterfactuals about how various physically impossible substances would interact with the matter that exists at our world. On the other hand, our intuitions about how concepts like MOUNTAIN apply at other metaphysically possible worlds seem to presuppose facts about 'solidity' which cash out in terms of these counterfactuals. I consider several simple attempts to resolve this conflict and note they all fall short.

1 Introduction

In this note I aim to point out a conflict between some common intuitions about metaphysical possibility.

In section 2, I will present the main puzzle, noting that three initially attractive ideas about metaphysical possibility are incompatible. On the one hand, it is appealing to deny that there are robust counterfactuals about how various physically impossible substances would interact with the matter that exists at our world. On the other hand, our intuitions about how concepts like MOUNTAIN would apply at other metaphysically possible worlds seem to presuppose facts about 'solidity' which cash out in terms of these counterfactuals. I consider several simple attempts to resolve this conflict and note they all fall short.

In section 3, I will provide further motivation for one of these intuitions. I note that a kind of cardinality problem which arises if we use appeals to intrinsic qualities of essences (or physically natural properties) to ground counterfactuals about how objects in metaphysically possible worlds very alien to one another would interact.

2 A Puzzle About Mountains

The core conflict of intuitions I want to point out is very simple. In [4] David Lewis introduces the idea of 'gunk', a kind of matter which is indefinitely divisible. We can use this notion to bring out a tension in common ways of thinking about metaphysical possibility as follows.

Intuition 1 It is metaphysically possible for there to be a mountain made of gunk in a world containing only gunk.

Intuition 2 If something isn't disposed to resist the motion of *our* hands, then it doesn't count as a mountain, e.g., a mountain shaped cloud doesn't qualify as a mountain.

Intuition 3 There is no fact about whether our hands (made of atoms) would be repelled by gunk existing at in an all gunk world.

The tension between these three premises is clear. Intuition 1 insists that there is a possible world containing a gunk mountain but Intuitions 2 and 3 imply that it can't be determinately true that the proposed world contains a gunk mountain.

To dramatize the difficulty of solving this puzzle, I will now consider some possible ways of responding to it. I will argue that significant sacrifice and/or philosophical work would be required to adopt any of them one.

I don't think premise 1 is particularly controversial, so let's begin by considering the costs of rejecting premise 2. I will argue that premise 2 is strongly motivated by intuitions about cases. Specifically, it's hard to deny that mountain shaped clouds in our world do not (literally) count as mountains[1], and we seem to need something like premise 2 to explain this fact.

One might say that being a mountain requires being disposed to resist the touch of (and otherwise play a mountain-role towards) some *possible agents*. But this doesn't seem strong enough to do the necessary work, as it seems conceivable that there could be cloudy agents who would be suitably repelled by the mountain-shaped clouds in our world. Nor can we say that it is a necessary condition for mountainhood that there there are some agents *in the world containing the purported mountain* who would be impeded by it. For, surely, there are possible worlds which don't contain anything we would recognize as an agent, but still contain mountains[2].

One might instead suggest that it is sufficient for a (suitably shaped etc.) object in a possible world w to count at as a mountain that it repel the bodies of agents living in w. Alternatively, one might say that what matters is whether (in some sense) most of the 'material' in w could pass through the supposed mountain. But we can counterexample these suggestions by considering a possible world closely mirroring our own, but with the addition of cloud people (or dark matter people) who ski on cloud (dark matter) mountains. Even if the cloud stuff in this world acts like a solid with respect to other cloud stuff, and even if there is more cloud stuff in this world than atomic stuff, it seems intuitively clear that as long as *our* hands would effortlessly pass through a mountain shaped

[1] We might speak metaphorically about mountains of coins which Scrooge McDuck can swim in or mountains of spices. But we would not count these when asking how many mountains the world contains.

[2] We also can't say that it's a necessary condition that all agents in the same world as the candidate mountain not be able to pass through it. For, it seems that the actual existence of ghostly agents who could pass through our mountains wouldn't prevent them for counting as mountains.

cloud, it wouldn't qualify as a mountain. So it looks like Intuition 2 can't be given up easily.

What about Intuition 3? One could also avoid paradox by rejecting Intuition 3 (i.e., maintaining that there *is* a definite fact of the matter about whether our hands would pass through some particular form of gunk) while accepting Intuitions 1 and 2.

To see how this approach runs into trouble, let's begin with a little unpacking. Intuition 2 plausibly says something with the following form: $\Box\forall$ x mountain(x) then 'were we to touch x, our hands would be repulsed by x'[3]. And in Lewissian terms, this amounts to something like: for any object o in a possible world, if o is a mountain, then the closest possible world w' (to the actual world) in which a counterpart of one our hands touches some counterpart of o, is one in which the mountain-counterpart repels the hand-counterpart.

Thus, accepting premises 1 and 2 (and thinking about metaphysical possibility in broadly Lewissian terms) plausibly requires us to say that there is *some* possible world w_0 containing a mountain-shaped chunk of gunk m_0 which is disposed resist our hands. And presumably, on pain of unprincipledness[4], we also want to say there's a similarly mountain-shaped chunk of gunk at some other (phenomenologically and structurally very similar[5]) possible world w_1, which

[3]One might instead say 'x is disposed to repel our hands' and say that the truth of this dispositional claim requires more than the the truth of the above counterfactual. For instance Lewis gives the following analysis in [5], and the related literature, " Something x is disposed at time t to give response r to stimulus s iff, for some intrinsic property B that x has at t, for some time t' after t, if x were to undergo stimulus s at time t and retain property B until t', s and x's having of B would jointly be an x-complete cause of x's giving response". I will ignore these further refinements because (so far as I can tell) they make no different to my argument.

[4]Intuitively, for any metaphysically possible all-gunk world containing a mountain which our hands are disposed to pass through, there must be another all gunk world which is just like the first world phenomenologically and 'structurally', but contains matter which is disposed to let our hands pass through.

[5]By saying that w_0 is phenomenologically and structurally similar to w_1 I mean that similar experiences are had by creatures within these two worlds, and that structural facts about how physically natural properties apply within them are similar i.e., even if different physically natural properties are instantiated in w_0 and w_1 the same Ramsey sentences saying that there are *some* physically natural properties which bear a certain relationship to one another and more observational properties (as considered in [6]) will be true in w_0 and w_1.

has the opposite disposition (i.e., is disposed to pass through our hands)[6].

Now, consider, the question: what grounds or explains the difference between all-gunk worlds which do and don't resist our hands. It is very natural (if not completely logically required) to think that there must be some intrinsic difference between gunk worlds w_0 and w_1 which explains why the mountain-shaped chunks of gunk found in possible world w_1 are disposed to interact with our hands so differently from those in w_0[7]. For, note that the scientifically useful and explanatory laws within each gunk world say nothing directly about disposition to interact with our kind of matter (after all, the physical laws of our world preclude gunk, and the laws of a gunk-only world preclude atoms). And (more generally) note that we cannot appeal to phenomenological facts about what experiences creatures in these gunk worlds have, or structural facts of how physical properties are instantiated in these worlds (for, by supposition, the phenomenological and structural facts about these worlds are identical).

It may seem that the obvious answer is to say that there are different essences (or fundamental physical properties) instantiated in w_0 and w_1, and that the different intrinsic nature ('quiddities') of these essences grounds and explains why similar mountain-shaped chunks of gunk in w_0 and w_1 are disposed to interact with our hands so differently. Positing such quiddities is already somewhat unpopular, in view of general reluctance to posit 'extra' metaphysical facts about the actual world which are in principle undetectable and scientifically redundant[8]. But, in the next section, I will show that a more concrete problem arises

[6]On the other hand, accepting premises 1 and 2 doesn't require us to say that all substances qualifying as gunk would resist our hands or that 'Our hands would be repelled by gunk' is definitely true. It's fine (and indeed independently plausible) to say that there are distinct types of gunk which would vs. wouldn't pass through our hands, and that the closest possible worlds where we touch gunk include ones with both varieties of gunk.

[7]In more Lewisian terms, there should be something about w_1 which (together with facts about the actual world) helps ground and explain the fact that possible worlds where (counterparts of) the peaks in w_1 repel (counterparts of) our hands are closer to the actual world than any worlds where counterparts of these peaks pass through our hands (if there are any of the latter type worlds). And, analogously, there should be something about w_0 which grounds and explains why the mountain-shaped peaks in w_0 have the converse disposition.

[8]For example Hawthorne writes, "The best case for thinking that the causal profile of a

(about how many such essences there are supposed to be) if we try to develop this solution in any principled way.

3 Essences to the Rescue?

Consider what I've called the traditional account of the difference between the all gunk world w_1 (whose peaks which would resist our hands) and the all gunk world w_0 (whose peaks would not) : saying they differ from one another in something like which essences (or physically fundamental properties) are instantiated in them[9]. On this picture, all metaphysically possible objects (or at least all fundamental objects like electrons and pieces of gunk) have an essence[10], which is shared by all counterparts of that object and helps ground the truth of counterfactuals regarding that object's interactions[11]. So, for example, a single essence e is instantiated by all electrons in the actual world. And the intrinsic nature of this essence helps ground/explain the fact that electrons are disposed to repel each other, combines with facts about the essence of (actual) protons to ground and explain why the electrons are disposed to be attracted to protons,

property exhausts its nature proceeds not via the thought 'Well otherwise we wouldn't know a whole lot of what we do know' but rather via the thought 'We don't need quidditative extras in order to make sense of the world.' Let us return to negative charge. All scientific knowledge about negative charge is knowledge about the causal role it plays. Science seems to offer no conception of negative charge as something over and above 'the thing that plays the charge role.' If there were a quiddity that were, so to speak, the role filler, it would not be something that science had any direct cognitive access to, except via the reference fixer 'the quiddity that actually plays the charge role.' Why invoke what you don't need? Unless certain logical considerations forced one to suppose that properties are individuated by something over and above their causal role, then why posit mysterious quiddities?"[2] Perhaps one could take the gunk mountain problem to point out a way in which (rather than logical considerations) natural language, core metaphysical possibility intuitions and non-arbitrariness considerations 'force' one to posit quidities.

[9]It seems intuitively plausible that w_1 and w_0 might otherwise 'look' exactly the same because they have exactly analogous physical laws governing how these fundamental physical properties interact with one another.

[10]We might instead say that they all instantiate a physically fundamental property which is shared by all counterparts in close possible worlds and behave as specified bwloq. Since nothing in the argument depends on this choice, so I will talk in terms of essences for the rest of this paper without loss of generality.

[11]So this essence somehow helps ensuring that the closest worlds where counterparts of the object are subjected to a certain treatment are ones in which a certain outcome obtains

and combines with facts about the essences of objects in other metaphysically possible worlds (including essences that can be instantiated in radically different all-gunk worlds) to ground/explain robust counterfactuals about how our electrons would interact with objects in these worlds, i.e., determine whether gunk with a certain essence could pass through atoms with some other essence.

And (on this picture) we account for the possibility of distinct all gunk worlds w_0 and w_1 (while avoiding treating our world as special) by positing a range of different essences. We posit multiple atom-type essences, which differ from another in how they ground dispositions to interact with objects that have other essences, e.g., different types of gunk. And we posit multiple gunk-type essences, which function analogously. So we have a kind of abundance or plenitude of different essences (in what follows, I will assume that no essence e_i can play both the gunk and the atom roles, i.e., no essence is both gunk type and atom type[12]). But now we can ask: how many (and what different kinds of) essences are there supposed to be? And here trouble arises.

To see why, note that it's not enough to say that there could be objects with atom-type essences *in some world* which are disposed to pass through some objects with gunk-type essences. What we need to vindicate the truth of premise 1 and 2 (and thereby solve the paradox above) is for *our* atoms to be disposed to pass through peaks of gunk in some possible worlds.

So, instead, we want a stronger principle which guarantees the existences of essences witnessing a range of different ways to interact with certain *specific other essences* like the essences realized by electrons in the actual world (but

[12]As will become clear, the paradoxical argument below only really requires us to suppose that there are some two disjoint (but not necessarily exhaustive) categories into which essences can be sorted on the basis of some property which intuitive . So, for example, rather than gunk type essences and atom type essences, in the argument below we could instead talk about self-attracting (i.e., essences e such that for any two objects o_1 and o_2 instantiating e o_1 will tend to attract o_2) and self repelling essences, or essences that require having other other objects with the same as proper part (and so, necessarily satisfying some of the the gunk axioms) vs. essences that forbid this (as perhaps the essences of actual electrons do).

doesn't privilege our essences). Informally this principle seems to let us reason to the existence of infinitely many different gunk-type and atom-type essences as follows.

- There is at least one atom-type essence, namely the essence had by electrons in the actual world. Call this essence @. There are two incompatible ways which an object with a gunk type essence can interact with objects instantiating another essence: resisting it and not resisting it.

- Therefore there are at least two distinct gunk type essences (call them $y_1 y_2$), such that $R(@, y_1) \wedge \neg R(@, y_2)$ if R stands for 'is disposed to resist'.

- Therefore there are actually at least four distinct types atom type essences corresponding to different possible relationships to these witnesses y_1 and y_2. One kind is already instantiated by @ and we can choose witnesses x_2, x_3, x_4 for the other four combinatorial possibilities so that we have: $R(@, y_1) \wedge \neg R(@, y_2)$, $R(x_2, y_1) \wedge R(x_2, y_2)$, $\neg R(x_3, y_1) \wedge R(x_3, y_2)$,$\neg R(x_4, y_1) \wedge \neg R(x_4, y_2)$.

- Therefore there are actually at least eight distinct kinds of gunk type essences corresponding to different possible relationships to $@, x_2, x_3, x_4$ only 2 of which we have considered before (when we divide up our original typology of kinds of gunk according to their dispositions to interact with various other kinds of atoms $x_2, \ldots x_4$) we can chose witnesses for the rest $y_3 \ldots y_8$.

So it seems we should accept that there are at least a countable infinity of different types of gunk (aka essences which can play the gunk role) and a countable infinity of different types of atoms (aka essences which can play the atoms role). Now in itself, such perhaps this profusion of different essences is so bad. But the things get worse. For the underlying intuition that let us

infer the existence of multiple types of gunk is would seem to be most naturally formulated something like as follows.

- **Full Plenitude Principle**: For any set S of essences playing the gunk (atom) role and function f from S to a set of possible interaction dispositions (e.g., to resist interpenetration, both disappear, both explode), there is an essence e playing the atom (gunk) role such that e has interaction disposition $f(i)$ with any $i \in S$

But this yields a contradiction. If the different types of gunk have cardinality α, then this principle implies that the atoms must have cardinality 2^α. For there must be different types of atoms corresponding to all possible combinations of interaction dispositions toward each gunk essence. But then applying this principle again to the distinct types of atoms tells us that that there must be $2^{2^\alpha} \neq \alpha$ types of gunk. Contradiction[13]

Now obviously we can weaken the above Full Plenitude Principle by limiting the size of the sets of essences considered to be $<$ some cardinality κ. Of these options, perhaps $\kappa = \omega$ is most attractive (i.e., the saying that the above plenitude principle only holds for finite sets of essences). But even this can seems rather unprincipled.

Alternately one can try to avoid this cardinality problem by metaphysically privileging the actual world, as follows. One could say that all objects at other possible worlds definitely have (or lack) a property like "solidity" which grounds definite counterfactual facts about their disposition to repel or pass through the stuff that makes up the actual world, but then *deny* that that there are analogously well defined facts about how objects at *arbitrary* pairs of possible

[13]Note that this cardinality problem for *essences* is different from Forrest and Armstrong's cardinality problem for *possible worlds* and Kaplan's cardinality problem for *propositions* which Lewis considers in 2.2 and 2.3 of [7], and not fixed by just endorsing the constraints what propositions it is metaphysically possible to express and when (so to speak) some collection of possible worlds can be combined to form a larger one which Lewis advocates there.

worlds would be disposed to interact with one another. However, adopting this view involves some bullet biting. We must reject some intuitive verdicts about the truth conditions of people's use of "mountain" at macroscopically identical words made of some non-gunk-type substance different than our fundamental particles. For it would seem that *their* claims about the possibility of a gunk "mountain" in an all gunk world could not be (definitely) true, because (we would be conceding that) there are no definite counterfactuals relating *their* hands to mountain-shaped things in other metaphysically possible worlds[14].

4 Conclusion

In this note I have tried to draw attention to a conflict between various common intuitions about metaphysical possibility. I've noted that our intuitions suggest that being a mountain requires having certain robust dispositions to interact with actual human bodies in certain ways and also that it would be possible for there to be mountains made of radically different fundamental substances that our familiar mountains are made of (e.g., gunk). However, it can be hard to see how there could be such robust counterfactual facts about how substances from radically different possible worlds (such as the fundamental particles in our world and gunk) would interact.

I won't discuss possible solutions to this puzzle here. But I do think studying it is important, because the considerations above suggest that some commonly used assumptions for reasoning about metaphysical possibility may be wrong.

[14] Another strategy for rejecting premise 3, while avoiding this problem, would be to say that the existence of a single possible world can somehow ground the truth of two incompatible claims about metaphysical possibility (specifically: both the possibility of there being gunk which would resist our hand and gunk which wouldn't resist our hands), just as David Lewis holds a single possible world can witness the possibility of my being one twin or another[7]. Perhaps if one does this, one can avoid the idea that there must two different gunk-type essences whose different natures explain the difference between two different all gunk worlds, and thus cut proliferation problems off even earlier. But it is, at best, extremely unclear how this proposal could be developed – even from a technical point of view.

It is also interesting to note that if Intuition 2 is correct, then plausibly many more concepts will turn out to involve a kind of 'implicit rigidified reference' to the actual world than had been previously thought. Here's what I mean. It's long been thought/recognized that 'water' apply to what is chemically similar to the watery stuff around here (as Kripke famously argued in [3]). But if you accept my arguments for Intuition 2 above then it appears that 'mountain' (and presumably many other such macroscopic-object terms) will apply only to things that would resist the bodily stuff around here. In Chalmers' vocabulary, many more things will be 'twin earthable' than had previously been thought[15]

References

[1] David J. Chalmers. *Constructing the World*. Oxford University Press UK, 2012.

[2] John Hawthorne. Causal structuralism. In James Tomberlin, editor, *Metaphysics*, pages 361–78. Blackwell, 2002.

[3] Saul Kripke. *Naming and Necessity*. Blackwell, 1972.

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[5] David Lewis. Finkish dispositions. *Philosophical Quarterly*, 47(187):143–158, 1997.

[6] David Lewis. Ramseyan humility. In David Braddon-Mitchell and Robert Nola, editors, *Conceptual Analysis and Philosophical Naturalism*, pages 203–222. MIT Press, 2009.

[15] As Chalmers puts it, "an expression E is Twin-Earthable if there can be a nondeferential utterances of E for which there is a possible corresponding utterance by a twin speaker with a different extension. So 'water' is Twin-Earthable since a nondeferential utterance of 'water' by Oscar (on Earth) may refer to H_2O while a corresponding nondeferential utterance by his twin Twin Oscar (on Twin Earth) may refer to XYZ. By contrast, 'zero' is not Twin-Earthable: while Burge's arguments suggest that twins in different linguistic communities might use 'zero' with different extensions, this requires that the utterances be deferential." [1].

[7] David K. Lewis. *On the Plurality of Worlds*. Blackwell Publishers, 1986.