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1 August 2019

Penultimate draft. To appear in The Routledge Handbook of Metaphysical Grounding, Michael J. Raven (ed.). Please cite published version.

3.3 Infinite Descent

1. Introduction

Once one accepts that certain things metaphysically depend upon, or are metaphysically explained by, other things, it is natural to begin to wonder whether these chains of dependence or explanation must come to an end. This essay surveys the work that has been done on this issue—the issue of grounding and infinite descent. I frame the discussion around two questions:

> **Question 1.** What is infinite descent of ground?
> **Question 2.** Is infinite descent of ground possible?

In addressing the second question, I will consider a number of arguments that have been made for and against the possibility of infinite descent of ground. When relevant, I connect the discussion to two important views about the way reality can be structured by grounding: metaphysical foundationalism and metaphysical infinitism. The third view, metaphysical coherentism, countenances cyclic grounding chains. Due to limitations on space, I will not discuss this view in what follows, though I will have cause to briefly discuss cyclic chains. For further discussion of coherentism, see the section "Partial Order".

Before I begin, I must introduce certain definitions and principles that will make it possible to state the central questions, and the answers to them, more precisely. I take full grounding as primitive, at least provisionally, and assume that it is a relation that holds between a single entity on the one hand and one or more entities on the other. I express full grounding claims as instances of the schema

> x is fully grounded by Γ,

where 'x', 'y', and 'z' are singular variables and 'Γ' and 'Δ' are plural ones.[1] Each ranges over the entities in the domain of the grounding relation, whatever they may be. To simplify the formulation of various claims, I assume a plural variable can be assigned to no objects. While many authors restrict the grounding relation to facts, others (e.g., Schaffer 2009: 375–76) are more liberal about the sorts of things that may stand in the grounding relation. I frame the following discussion in a way that is neutral between the two sorts of view. I define partial grounding in the standard way.

> **Partial Grounding.** x is *partially grounded* by $y =_{df}$ there are Γ such that y is among Γ and x is fully grounded by Γ.[2]

I'll say that x is *properly* partially grounded by y if and only if x is partially, but not fully, grounded by y.

Full grounding is generally thought to be governed minimally by the following two axioms.

> **Full Irreflexivity.** x is not fully grounded by x, Γ.

> **Full Cut.** If x is fully grounded by y, Γ and y is fully grounded by Δ, then x is fully grounded by Γ, Δ.[3]

These two axioms together entail that full and partial grounding are asymmetric, and that partial grounding is irreflexive.

> **Full Asymmetry.** If x is fully grounded by y, Γ, then y is not fully grounded by x, Δ.

Partial Asymmetry. If *x* is partially grounded by *y*, then *y* is not partially grounded by *x*.

Partial Irreflexivity. Nothing is partially grounded by itself.

And Full Cut on its own entails the following more familiar transitivity principles usually thought to govern full and partial grounding.

Full Transitivity. If *x* is fully grounded by *y* and *y* is fully grounded by *z*, then *x* is fully grounded by *z*.

Partial Transitivity. If *x* is partially grounded by *y* and *y* is partially grounded by *z*, then *x* is partially grounded by *z*.

Thus these axioms ensure that partial grounding is a strict partial order—i.e., an irreflexive and transitive (and thus asymmetric) relation.

It will be helpful to have available the notion of a grounding structure.

Grounding Structures. Γ form a *grounding structure* $=_{df}$ there are *x* and *y* among Γ such that *x* is partially grounded by *y*.

It will also be helpful to have available the notion of a grounding chain.

Grounding Chains. Γ form a *grounding chain* $=_{df}$ (i) Γ form a grounding structure and (ii) for every *x* and *y* among Γ, either *x* is partially grounded by *y*, *y* is partially grounded by *x*, or $x = y$.

With these definitions and principles in hand, we are ready to address the two questions above, beginning with Question 1: What is infinite descent?

2. What Is Infinite Descent of Ground?

What is infinite descent of ground? The most straightforward, and, I think, the best answer to this question is that it is something that is exhibited by any grounding structure which contains a grounding chain that has no end, i.e., that is such that one can move along it from node to node in a "downward", or *groundward*, direction (i.e., in the direction of a ground) forever. In other words, infinite descent of ground is what is exhibited by any grounding structure which contains an *infinitely descending grounding chain*. But what is an infinitely descending grounding chain? The characterization I just provided is rather imprecise. Here is a more precise one:

> **Infinitely Descending Grounding Chains.** Γ form an *infinitely descending grounding chain* $=_{df}$ (i) Γ form a grounding chain and (ii) for every x among Γ, there exists a y among Γ such that x is partially grounded by y. (See Rabin and Rabern 2016: 371.)

Any node you pick in an infinitely descending grounding chain will have a ground in the groundward direction in the chain, as with C_1 in figure 1 below.

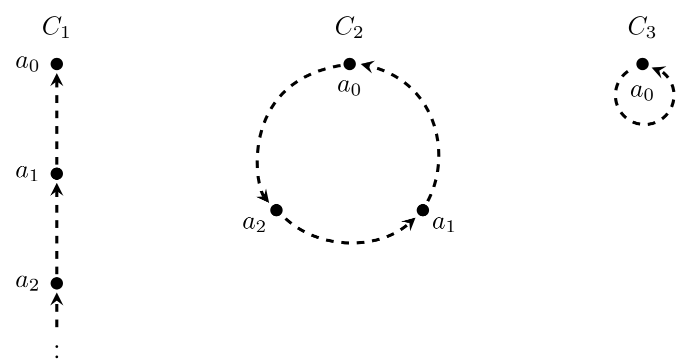

Figure 1. Nodes represent the relata of grounding. A directed dashed line running to a node x from a node y indicates that x is partially grounded by y. The only other grounding claims that are assumed to hold are those entailed by Full Cut.

For the purposes of the following discussion, I assume that the above definition captures the notion of an infinitely descending grounding chain, and thus the notion of ground-theoretic infinite descent more generally.

It is an interesting question whether a cyclic chain would count as exhibiting infinite descent. One way to allow for the possibility of cyclic grounding chains is by denying Partial

Transitivity, since one can avoid violations of Partial Irreflexivity so long as nothing immediately grounds itself. But the definition of grounding chains I gave in the previous section presupposes the the truth of Partial Transitivity. It would not count the distinct entities a_0, a_1, and a_2 as forming a grounding chain if a_0 is grounded by a_1 and a_1 is grounded by a_2 but a_0 is not grounded by a_2. This is because a_0 and a_2 are distinct and yet neither is grounded by the other. Thus one must modify the definition of grounding chains to work in contexts in which Partial Transitivity is not assumed to be true. The most straightforward way to do so is as follows.

> **Grounding Chains (Revised).** Γ form a *grounding chain* $=_{df}$ (i) Γ form a grounding structure and (ii) for every *x* and *y* among Γ, either *x* is partially grounded⁺ by *y*, *y* is partially grounded⁺ by *x*, or $x = y$,

where partial grounding⁺ is the transitive closure of partial grounding on its domain, and where

> **Transitive Closure of Partial Grounding.** The transitive closure of partial grounding on a set *S* is the smallest relation *R* such that, for any *x*, *y*, and *z* in *S*, (i) if *x* is partially grounded by *y*, then *x R*'s *y*, and (ii) if *x R*'s *y* and *y R*'s *z* then *x R*'s *z*.

Given this revised definition of chains, cyclic grounding chains can be defined as follows.

> **Cyclic Grounding Chains.** Γ form a *cyclic grounding chain* $=_{df}$ (i) Γ form a grounding chain and (ii) the transitive closure of partial grounding on {Γ} is reflexive (i.e., everything in {Γ} is partially grounded by itself),

where {Γ} is the set of exactly those things among Γ.

As it happens, the definition of infinitely descending chains I gave at the beginning of this section counts cyclic chains as such, given this definition of cyclic chains (and the revised definition of grounding chains). For any non-cyclic infinite descending chain, any node in it will always have a (partial) ground distinct from itself in the chain (as with C_1). For any cyclic chain, any node in it will also have at least one ground in the chain. But whether that ground is distinct from that node will depend on how grounding is axiomatized. Anyone who countenances cyclic chains will deny that partial grounding is a strict partial order, since it's being so rules out such chains. But one can allow for cyclic chains by rejecting either Partial Transitivity or Partial Irreflexivity. If, partial grounding is antitransitive on C_2 (i.e., it is not the case that, for any x, y, and z in C_2, if x is partially grounded by y and y is partially grounded by z, then x is partially grounded by z), then every ground of every node in C_2 will be distinct from it. This case presupposes the falsity of Partial Transitivity. If partial grounding is transitive on C_2, however, each of its nodes will be one of its own grounds. And, of course, if the chain consists of just a single node (as with C_3), that node will be one of its own grounds. These latter two cases presuppose the falsity of Partial Irreflexivity.

Allowing cyclic chains to be infinitely descending ones does not do injustice to the notion of infinite descent, as one might expect. There is a perfectly natural sense in which a cycle of ground involves infinite descent. Indeed, the ways I've informally characterized infinite descent, at the beginning of this chapter and at the beginning of this section, already count cyclic chains as doing so. Cyclic chains do not come to an end. Moreover, one can move groundward from node to node in a cyclic chain forever. Ricki Bliss and Graham Priest (2017: 67 and 2018: 9) seem sympathetic to this more liberal sense of the terms "infinite descent" and "infinitely descending grounding chains". Interesting as it is, I will not investigate the possibility of cyclic infinite descent in what follows, as space permits me only to focus on the possibility of the non-cyclic variety. I will henceforth assume that grounding is axiomatized as I have axiomatized it in section 1, so that partial grounding is a strict partial order. For further discussion of the possibility of cyclic chains, see the section "Partial Order".

3. Is Infinite Descent of Ground Possible?

I now move on to Question 2. Is infinite descent of ground possible? Given the definition above, this question can be understood as: Are infinitely descending grounding chains possible? Surprisingly, proponents of the two major views about how reality is structured by grounding, according to which grounding is a strict partial order—metaphysical foundationalism and metaphysical infinitism—both seem to answer 'yes' to this question. But a closer investigation of these views reveals a nearby question, on the answer to which there is the expected disagreement between them. In order to explain these two points, I will first characterize these two views about how reality is structured by grounding, beginning with an informal statement of metaphysical foundationalism.

> **Metaphysical Foundationalism (Preliminary).** There must be a bottom layer of fundamental entities, which ground all other entities.[4]

One typical way to define fundamentality is as follows.

> **Fundamentality.** x is *fundamental* $=_{df}$ nothing partially grounds x.[5]

Something is non-fundamental just in case it is not fundamental (i.e., it is grounded by something). With fundamentality characterized in this way, foundationalism has seen a number of advocates. Jacek Brzozowski (2008), Ross Cameron (2008), Kit Fine (2010: 105), Jonathan Schaffer (2010: 37 and 62 and 2016: 95), and Karen Bennett (2011) have all endorsed or defended the view. But the view is endemic outside the grounding literature as well. Many a complaint about a view resulting in a vicious regress can plausibly be traced to a tacit foundationalist picture of the world.

The above characterization of foundationalism is admittedly imprecise. The view is most often stated by adding an axiom to the standard axiomatization for grounding, which I provided in section 1. While this axiom has come to be referred to as a "well-foundedness axiom for grounding", and to the condition it imposes as "well-foundedness", the most plausible formulation of it is not an instance of the standard mathematical definition of a well-founded relation. For this reason, it is perhaps better to refer to the axiom, and to the condition it imposes, differently. In what follows, I refer to it as a "well-*grounded*ness axiom for grounding", and to the condition it imposes as "well-*grounded*ness". As noted by Scott Dixon (2016) and Gabriel Rabin and Brian Rabern (2016), there are several potential candidates one might adopt as one's well-groundedness axiom for grounding. Four of the most plausible candidates are:

> **No Infinitely Descending Chains.** There are no infinitely descending chains.
>
> **No Maximal Infinitely Descending Chains.** There are no maximal infinitely descending chains.
>
> **No Weakly Maximal Infinitely Descending Chains.** There are no weakly maximal infinitely descending chains.
>
> **Full Foundations.** For every non-fundamental entity x, there are some fundamental entities Γ (where there is at least one x among Γ) such that x is fully grounded by Γ.

The notions of maximal chains and weakly maximal chains can be defined as follows.

> **Maximal Grounding Chains.** Γ form a *maximal grounding chain* $=_{df}$ (i) Γ form a grounding chain and (ii) nothing partially grounds every x among Γ.
>
> **Weakly Maximal Grounding Chains.** Γ form a *weakly maximal grounding chain* $=_{df}$ (i) Γ form a grounding chain and (ii) there are no Δ that fully ground every x among any final segment Γ,

where

Final Segments. Δ form a *final segment* of Γ $=_{df}$ (i) Γ form a grounding chain, (ii) there is an x among Δ, (iii) Δ are among Γ, and (iv) every x among Γ, but not among Δ, is partially grounded by every y among Δ.

A final segment of the infinitely descending chain C_1, depicted in figure 1 above, for example, will be any chain formed by $a_n, a_{n+1}, a_{n+2}, \ldots$ for any $n \geq 0$.

The notions of maximal chains and weakly maximal chains are not entirely straightforward, so I'll illustrate them by making reference to the grounding structures depicted in the figure below.[6]

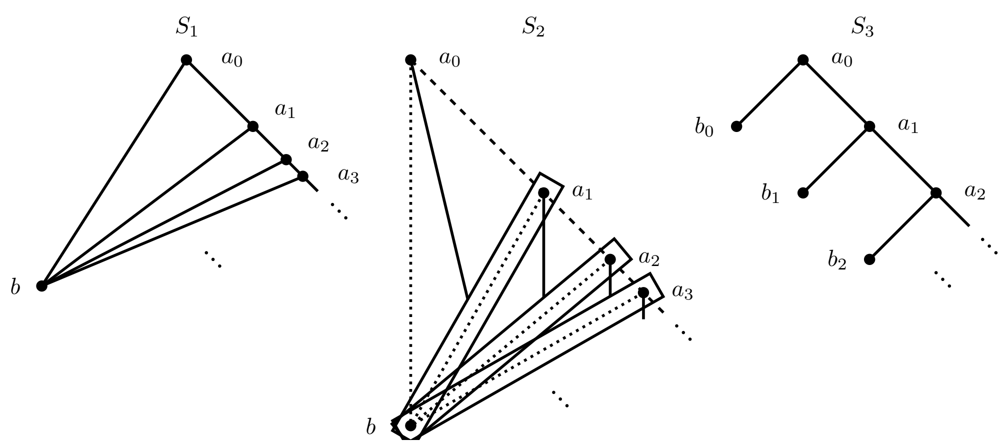

Figure 2. A solid/dashed/dotted line running in a downward direction from a node x to another node y indicates that x is fully/partially/properly partially grounded by y. A solid line connecting a node x to a solid box enclosing nodes $y_1, y_2, \ldots$ indicates that x is fully grounded by $y_1, y_2, \ldots$

In S_1, the chain $a_0, a_1, \ldots, b$ is maximal, since there is nothing that partially grounds each of the things in it. It is also weakly maximal, since there is nothing that *fully* grounds each of the things in it. (If a chain is maximal, then it is weakly maximal, since, if there is nothing that partially grounds everything in a chain, then there are no things that fully ground everything in it.) The chain consisting of just the *a*s is neither maximal nor weakly maximal, since there is something (namely, *b*) that fully (and so partially) grounds each of the *a*s. Similarly, in S_2, the chain a_0, a_1, …, *b* is maximal (and weakly maximal), again, since there is nothing that partially grounds (and so nothing that fully grounds) each of the things in it. And the chain consisting of just the *a*s isn't maximal, since *b* partially grounds everything in it. But it *is* weakly maximal, since no things *fully* ground everything in any final segment of it. In S_3, the chain consisting of the *a*s is maximal, since there isn't anything that partially grounds each of the things in it (and so it is weakly maximal also).

Of the four most plausible candidate well-groundedness axioms mentioned above, Dixon and Rabin and Rabern note that Full Foundations (or an equivalent of it) is the most plausible. They provide considerations in support of it, in the form of grounding structures which intuitively should be considered acceptable by foundationalist lights, but which are ruled out by some of the other contenders, and structures which intuitively should *not* be acceptable by foundationalist lights, but are allowed by some of them. S_1 and S_3, for example, should be considered acceptable by foundationalist lights. Following Schaffer (2010: 37), Dixon (2016: 447) notes that one of the motivations for foundationalism is to validate the idea that the derivative (the non-fundamental) must have its source in, or acquire its being from, the non-derivative (the fundamental). In S_1, there is something non-derivative, namely *b*, which fully grounds every derivative thing in it. *b* might be God, who has decided to create an infinitely descending chain of dependent entities. Each thing in that chain would be dependent on God as well as on those things groundward relative to it in the chain.[7] In S_3, while there is no *single* non-derivative thing which fully grounds every derivative thing, each derivative thing in it is fully grounded by *some* non-derivative thing or other (a_i is fully grounded by, for example, b_i for each

$i \in \{0, 1, \ldots\}$). An infinitely disjunctive fact, $[p_0 \vee (p_1 \vee (p_2 \vee \ldots))]$, each disjunct of which is true and expresses a fundamental fact, might be seen as an example of this sort of structure. Each disjunctive subformula, $[p_i \vee (p_{i+1} \vee (p_{i+2} \vee \ldots))]$, would be fully grounded by the fundamental $[p_i]$, while also being fully grounded by the non-fundamental $[p_{i+1} \vee (p_{i+2} \vee (p_{i+3} \vee \ldots))]$.[8] Neither is true of S_2. While each derivative thing is *partially* grounded by b, not all (indeed, none) is *fully* grounded by it or by any other non-derivative thing. It is fully grounded only by b together with something non-derivative (a_i is fully grounded by, for example, b, a_{i+1} for each $i \in \{0, 1, \ldots\}$).[9]

Of the contenders, Full Foundations is unique in that it does not make the wrong determination about any of these grounding structures. No Infinitely Descending Chains incorrectly rules out S_1 and S_3. (It is this candidate which is equivalent to an instance of the standard mathematical definition of a well-founded relation.) No Maximal Infinitely Descending Chains incorrectly allows for S_2 and incorrectly rules out S_3. And No Weakly Maximal Infinitely Descending Chains incorrectly rules out S_3. Only Full Foundations allows for S_1 and S_3, but rules out S_2. Dixon and Rabin and Rabern conclude on this basis that Full Foundations is the correct well-groundedness axiom. Henceforth, when I use the phrase "well-grounded", I have Full Foundations in mind.

If Dixon and Rabin and Rabern are right, metaphysical foundationalism can be more precisely characterized as follows.

> **Metaphysical Foundationalism (Final).** For every non-fundamental entity x, there are some fundamental entities Γ (where there is at least one x among Γ) such that x is fully grounded by Γ.[10]

(Presumably, many foundationalists will take this thesis to hold necessarily.) However, as Dixon and Rabin and Rabern note, and as should be clear from the preceding discussion, there are infinitely descending grounding chains that satisfy Full Foundations, i.e., every (non-fundamental) entity in them is fully grounded by some fundamental entities or others. S_1 and S_3 both contain examples of such chains. So it would appear that infinitely descending grounding chains are possible *even by foundationalist lights*.

But what of infinitely descending chains that are *not* well-grounded? That is, what about infinitely descending chains which contain entities which are *not* fully grounded by any fundamental entities? Are they possible? This is the more philosophically interesting question, and the question about which there is the expected disagreement between metaphysical foundationalism and infinitism. The foundationalist says 'no', while the infinitist says 'yes'. For the purposes of this discussion, metaphysical infinitism can be formulated as follows.

> **Minimal Metaphysical Infinitism.** There is at least one infinitely descending grounding chain, at least one entity in which fails to be fully grounded by any fundamental entity or entities.

Metaphysical infinitism is often stated in much stronger terms. Perhaps most notably, Matteo Morganti's (2014 and 2015) argument for metaphysical infinitism (to be discussed in more detail later) can plausibly be construed as supporting the idea that *every* entity in the domain of grounding sits atop an infinitely descending grounding chain, and perhaps even that this is *necessarily* so, despite the fact that Morganti himself (*Ibid.*: 233) characterizes the view very minimally, as I have done above. (Naomi Thompson (2016: 41) calls the former view "strong infinitism", and calls minimal infinitism "weak infinitism".) In any case, however the infinitist characterizes her view, any plausible statement of it will at least entail the minimal version of it stated above. And that is enough to set it apart from foundationalism, as any view that entails that thesis allows for the possibility of non-well-grounded infinitely descending grounding chains.

It would appear, then, that the interesting question is not whether infinite descent *simpliciter* is possible, but whether *non-well-grounded* infinite descent is possible. Proponents of foundationalism and infinitism both answer 'yes' to the former question. It is the latter question which sets them apart, as foundationalists answer 'no' while infinitists answer 'yes'.

Question 2 (Revised). Is *non-well-grounded* infinite descent of ground possible?

We turn our attention to this question. I will not take a stand on the answer to this question in this article. Instead, I will survey a number of arguments for answering this question 'no' (section 4) and 'yes' (section 5).

4. Non-Well-Grounded Infinite Descent Is Not Possible

Many have expressed support for the idea that grounding is well-grounded, and hence that non-well-grounded infinite descent is not possible. Perhaps a greater number still have assumed its truth, for example, as a premise, sometimes explicit, sometimes implicit, in a regress argument against some view or other. See, for example, Brzozowski 2008: 199--201, Fine 2010: 105, Schaffer 2010: 61--65, Bennett 2011: 30, and Dixon 2018: §5. In short, the view that non-well-grounded infinite descent of ground is not possible, often under the guise of foundationalism, has, deserved or not, enjoyed a profusion of adherents compared to its rivals. Perhaps for this very reason, arguments for foundationalism have been difficult to come by. The few that there are come in the form of arguments for foundationalism. In this section, I will look at three of the most prominent recent discussions in favor of foundationalism which, among all others, most deserve to be called “arguments”.

Perhaps the best-known and most familiar of these are *inheritance arguments*. This sort of argument is deployed by Schaffer (2010: 37 and 62 and 2016: 95), who traces it back to Leibniz and Aristotle. (See the first chapter of this volume for more on grounding in the history of philosophy.) A version of the argument can be put as follows. Reality (or being or existence) is a quality that every entity in the domain of grounding must have in full measure, and it is a quality that can be transmitted from one such entity to another only by grounding. In particular, such an entity *x* has the relevant quality in full measure if and only if either (i) *x* is fundamental or (ii) *x* is fully grounded by some entities, each of which has that quality in full measure. Were every non-fundamental entity *x* not necessarily fully grounded by some fundamental entities or others, then *x* could not have the quality in full measure. After all, as Schaffer says,

> One cannot be rich merely by having a limitless sequence of debtors, each borrowing from the one before. There must actually be a *source* of money somewhere. Likewise something cannot be real merely by having a limitless sequence of ancestors, each claiming reality from its parents. There must actually be a source of reality somewhere. Just as wealth endlessly borrowed is never achieved, so reality endlessly dependent is never realized. (Schaffer 2016: 95, ital. orig.)

But every non-fundamental entity *must* have the quality in full measure (since *every* entity in the domain of grounding must). So, every non-fundamental entity must be fully grounded by some some fundamental entities or others. Of course, independent reasons need to be given for Full Irreflexivity and Full Cut for a full defense of foundationalism, as it is usually formulated. But the inheritance argument does a lot of heavy lifting for the view.

Another important argument for foundationalism is due to Cameron (2008). He argues for it on pragmatic grounds. Other things being equal, he says, we should avoid theories which posit infinitely descending chains of explanatory relations such as grounding if we have an alternative theory available which provides a unified explanation of the relevant phenomena. This effectively puts foundationalism at an advantage over infinitism in any context where such a theory exists. Consider some set of phenomena, P, consisting of some facts which we wish to explain. Suppose there are two theories, T_1 and T_2, such that T_1 provides a full explanation of each element of P by a single fundamental entity f, while T_2 does so by an infinitely descending chain of facts $f_1, f_2, \ldots$ Many will agree that T_1 is preferable to T_2. And Cameron's criterion yields this result—a result that is friendly to foundationalism. Further, Cameron's criterion may, or a slightly stronger version of it would, yield a foundationalism-friendly result even when there are a countably infinite number of facts in P, g_1, g_2, …, and a theory, T_3, which explains each element of P with another element of P, so that the elements of P form an infinitely descending grounding chain. Depending on how heavily we prefer unified explanations to non-unified ones, we can employ a criterion like Cameron's that will justify our choosing T_1 over T_3, even though it posits a fact that T_3 does not. This would be because it posits a *unified* explanation of the phenomena we would like to explain, whereas T_3 does not.

A final argument for foundationalism that is worth noting is due to Bliss (2019). Once each dependent (non-fundamental) entity that exists has been provided with a full explanation, one might think that there is still something that needs to be explained. Such a situation is, after all, compatible with a model in which Full Foundations is false. Suppose, for example, that every entity is fully grounded by some entities or others, but they are not all fully grounded by some *fundamental* entities or others. (Perhaps all that exists is an infinitely descending chain of full grounds.) After considering and rejecting several possibilities, Bliss concludes that what needs to be explained is why there are any dependent entities *whatsoever*, i.e., why there are some dependent entities, rather than none. This, Bliss argues, can only be explained by positing independent (fundamental) entities. This is due, according to Bliss, to the *externality assumption*: "no dependent entity can explain why there are any dependent entities whatsoever" (*Ibid.*: 11). Moreover, Bliss thinks that this assumption is defensible, since she takes it to be plausible that one cannot explain why there are any members of a substantial kind *whatsoever* by invoking only members of that kind, even if that explanation goes on forever—a view inspired by Stephen Maitzen (2013: 260).

To be sure, these arguments for foundationalism can be criticized. See Bliss 2013: 407–08, Bohn 2018: 170, and Trogdon 2018 for objections to the inheritance argument. And while this is not an objection to Cameron's theory-choice argument *per se*, several have noted that it isn't strong enough to ensure that foundationalism holds necessarily (see Cameron 2008: 12--13, Morganti 2014: 240, Bliss 2018: 76, and Trogdon 2018: 182). Moreover, it isn't even strong enough to ensure that foundationalism should be preferred to infinitism when the only foundationalist alternative to infinitism posits non-unified explanations of the relevant phenomena. I know of no one who has yet taken issue with Bliss's argument, but one might wonder whether dependent entities form a substantial kind. In any case, whatever one might think of these three arguments, they constitute the most compelling strategies that have been deployed in recent years in attempts to show that there is no non-well-grounded infinite descent. But what of considerations *in favor of* non-well-grounded infinite descent? This is the question to which I will turn next.

5. Non-Well-Grounded Infinite Descent Is Possible

Arguments for non-well-grounded infinite descent of ground are a bit more numerous. They often come in the form of defenses of metaphysical infinitism. But even these arguments are rarely direct arguments for the *necessary* or even *actual* existence of non-well-grounded infinitely descending chains. As I suggested above, foundationalism has enjoyed a dialectical advantage in the debate, and so arguments for alternative views are often intended merely to defend an alleged theretofore unappreciated viability or possibility of non-well-grounded infinitely descending grounding chains. This advantage may also explain why arguments for non-well-grounded infinite descent are more numerous than those against.

Schaffer (2003) and Tuomas Tahko (2014) argue that infinitely descending chains are possible if the descent is “boring” or “repetitive”, i.e., if the structure repeats itself in a certain sense.

> There is no *novelty* in the structure after a certain point. … The boring part of the structure that repeats infinitely could be of any length, as long as it starts anew eventually. (Tahko 2014: 261, ital. orig.)

Schaffer and Tahko speak of the boring part of a boring infinitely descending structure as a fundamental supervenience base. Once one has determined the laws of just one of the segments which repeat in this base, there is no more interesting scientific work to be done (see Schaffer 2003: 512).[11] Schaffer thinks that there is something to be said for boring infinite descent. He argues that a picture on which everything supervenes on a boring infinitely descending supervenience base is better off, evidentially, than foundationalism (*Ibid.*: 510--11). The latter is, he says, committed to a particle-based theory of fundamental entities. But the claim that everything ultimately decomposes to particles, Schaffer thinks, is an article of faith, not supported by empirical evidence (*Ibid.*: 504--05). The former, on the other hand, merely postulates a fundamental supervenience base containing infinite descending chains of dependence. So it is compatible with, for example, a pure field theory, which postulates fundamental entities which are infinitely divisible.[12] Tahko (2014: §4) adds to Schaffer's case for the possibility of boring infinite descent, citing a model of the structure of quarks and leptons which is consistent with the relevant observational data.

Another important argument in favor of non-well-grounded infinite descent is due to Morganti (2014 and 2015). He thinks that grounding may be understood in a way analogous to the way Peter Klein (e.g., 2007) conceives of justification. Reality (or being or existence) isn't *transferred* from grounds to grounded. Instead, it *emerges* from one (or more) infinite chains which descend from a given entity. Morganti thinks that this move is, in the case of a metaphysical dependence relation like grounding, at least as plausible as, if not more so than it is in the case of an epistemic dependence relation like justification. This is because metaphysical infinitism appears to be immune from the objection that haunts the epistemological infinitist: that an epistemic agent, with limited cognitive resources, could never hold in her mind all the beliefs (an infinite number of them!) which, according to the account, allegedly justify a given belief only together. But the relata of the metaphysical dependence relationships Morganti has in mind (presumably facts, or something like facts) exist whether or not there is anyone around who is capable of representing them. As I mentioned at the end of section 3, while Morganti's goal is merely to argue for the *possibility* of infinite descent, his argument can be naturally construed as supporting the idea that, *necessarily*, *every* entity in the domain of grounding sits atop an infinitely descending grounding chain. This is because the emergence model of reality can naturally be taken to be exclusive: reality can *only* emerge; it *cannot* be transferred in full measure. If so, then something can have reality in full measure *only* if it sits atop an infinitely descending grounding chain. And given that everything *must* have reality in full measure, this would mean the emergence view holds necessarily. See Lubrano 2018 for a challenge to emergence-based infinitism.

Michael Raven (2016) develops a view according to which an entity may be fundamental without being foundational. Note, however, that he uses these terms differently than I have been using them. For Raven, an entity is foundational just in case it is fundamental, in the way I defined fundamentality above (i.e., as something that is ungrounded). A fundamental entity, for him, however, is an entity that is *ineliminable*, in the sense that "reality cannot be completely described without it" (*Ibid.*: 609). To get the idea across, Raven provides the following examples of an (comparatively plausibly) ineliminable fact and an eliminable fact, respectively.

(E) Electron e^- is negatively charged.
(F) FEMA is a federal agency.

He thinks that one can also evaluate the *constituents* of facts for eliminability. Of the constituents of (E) and (F), e^- and the property *being negatively charged* are more plausibly ineliminable than FEMA and the property *being a federal agency*. What is important in connection with the present discussion is that Raven's view allows one to make out a conception of fundamentality even if every grounding chain is not well-grounded. The materiality of a gunky object, *a*, for example, can be understood as fundamental, even though every grounding chain which the fact that *a* is gunky sits atop is infinitely descending and not well-grounded. Its materiality is grounded in the materiality of its left and right parts, the materiality of each of which is grounded in *its* left and right parts, and so on. Materiality is ineliminable from these series of explanations, and thus it is fundamental on Raven's account. So, while Raven does not directly argue for the possibility of non-well-grounded infinitely descending chains, he removes an obstacle one might envisage for infinitist views according to which every grounding chain is not well-grounded: they preclude the existence of fundamental entities, and one might have independent reason to think that such entities exist.[13]

Two final arguments for non-well-grounded infinite descent are due to Einar Duenger Bohn (2018). He argues first that the metaphysical possibility of gunky and junky objects, along with the truth of at least one of the following two theses, entails that non-well-grounded infinitely descending chains are possible.

> **Parts Ground Wholes.** Necessarily, for any *x* and *y*, if *x* is a proper part of *y*, then *y* is partially grounded by *x*.
> **Wholes Ground Parts.** Necessarily, for any *x* and *y*, if *x* is a proper part of *y*, then *x* is partially grounded by *y*.

(A gunky object is one which has a proper part, and is such that each of its proper parts has a proper part, while a junky object is one that is a proper part of something, and is such that everything it is a proper part of is a proper part of something.) Bohn then provides some considerations to the effect that the actual world might be both gunky and junky (what he calls "hunky"), in which case metaphysical foundationalism would *actually* be false. Bohn deploys a second argument against any view that posits any fundamental facts (e.g., foundationalism), by arguing that it cannot answer the question of why they exist, and (he presumes) there must be such a reason. This presumption is given by what he calls "the metaphysical principle of sufficient reason":

Metaphysical Principle of Sufficient Reason (MPSR). Every fact has a metaphysical explanation.

Bohn thinks that even if the MPSR isn't true, it is better to avoid violating it without good reason. Since views about the metaphysical structure of reality exist which satisfy the principle, then, he thinks, all else being equal between them and foundationalism, they should be preferred to foundationalism. For more on grounding and the principle of sufficient reason, see the section "Principle of Sufficient Reason".

6. Concluding Remarks

Infinite descent of ground is what is exhibited by any infinitely descending chains of ground. The question of whether infinite descent, so understood, is possible has an easy answer, assuming that metaphysical foundationalism is best captured by the addition of the most plausible well-groundedness axiom for grounding, Full Foundations, to the standard axiomatization for grounding consisting of Full Irreflexivity and Full Cut. That answer is 'yes', whether one is a metaphysical foundationalist or infinitist. But answering the nearby question of whether *non-well-grounded* infinite descent is possible is not nearly so easy. I surveyed some of the most compelling considerations for answering this question 'yes' and 'no'. I leave it to the reader to decide which is the best way to answer it.

Notes

[1] I therefore take the view that the fundamental notion of grounding is expressed by a predicate rather than an operator. Despite this, what is said below can be recast in operationalist terms. For further discussion of the predicate-operator debate, see the Introduction and the section "Granularity". Also, I have in mind Fine's (2012a) and (2012b) notion of strict ground, as opposed to weak ground. It is the former of which, after all, that is supposed to capture the explanatory notion at issue.

[2] See Rosen 2010: 115, Audi 2012: 698, Fine 2012a: 50, and Raven 2013: 194 for endorsements of this definition. I should note that, despite its wide-ranging acceptance, this definition is not completely free from controversy. Some have argued that a partial ground of something need not be among some things which fully ground it. See, for example, Leuenberger ms. I ignore this issue in what follows.

[3] This principle is not quite strong enough to do everything a cut principle for full grounding should do, though it is sufficient for my purpose here. See deRosset 2014: 720 for a completely adequate principle, which is derivable in Fine's (2012a and 2012b) system as well.

[4] For other informal characterizations of foundationalism, see, for example, Schaffer 2010: 37, Bliss 2014: 245, 2018: 76, and 2019: 359, Raven 2015: 323, Brzozowski 2016: 59, Thompson 2016: 40, Barnes 2018: 65, Morganti 2018: 257, Rabin 2018: 38, and Tahko 2018: 240.

[5] Not everyone accepts this definition of fundamentality, but it will serve my purpose for the time being. I will have cause to discuss an alternative conception of fundamentality in what follows. I also ignore the distinction between being ungrounded and being zero-grounded, which could complicate a definition of fundamentality. See Fine 2012a: 47–48. See the section "Fundamentality" for further discussion of how to conceive of fundamentality.

[6] A chain is maximal iff it has no (partial) lower bound, and is weakly maximal iff it has no full lower bound. This is the terminology used by Rabin and Rabern (2016: 372).

[7] For other potential examples of this sort of structure, see Bliss 2013: 416 and 2014: fn. 9, Dixon 2016: §4, and Rabin and Rabern 2016: §4.1.

[8] This example is from Dixon 2016: §7 and Rabin and Rabern 2016: 355--56. While Litland (2016: §5) raises concerns about its plausibility, it is one of the most straightforward ways at least to give the reader a sense of the sort of examples that might exhibit this structure. For other examples of this sort of structure, see Litland 2016 and Dixon 2016: §7.

[9] See Dixon 2016: §6 and Rabin and Rabern 2016: 372 for further discussion of this sort of structure.

[10] While many foundationalists will presumably endorse Full Irreflexivity and Full Cut in addition, it is not obvious that foundationalism requires the truth of these two axioms. Views which allow for cyclic grounding chains, as long as every non-fundamental entity is fully grounded by a plurality of fundamental entities, and views in which Full Cut is false, but in which every non-fundamental entity is related to a plurality of fundamental entities by the closure of full grounding under Full Cut on its domain, may well count as foundationalist. For the sake of brevity, I set such views aside here, and focus only on views which validate both axioms. Analogous remarks apply to my formulation of metaphysical infinitism below.

[11] A Pascalian worlds-within-worlds situation might be an example of this, according to which each particle in the universe comprises a micro-universe, each particle of which comprises yet another micro-universe, and so on (see Schaffer 2003: 505). It might be enough that each embedded universe has the same natural laws as each of the others. Even if the worlds differ radically otherwise (i.e., different events occur in them), this may be enough to constitute boring infinite descent. Such a world may be the setting of the adventure described in Hasse 1936.

[12] Fine (2009: 174--75) discusses a similar example of boring infinite descent, exemplified by the Thalean view that everything is composed of water conjoined with the Aristotelian view that water is infinitely divisible. See also Fine 2001: 27.

[13] Raven's characterization of fundamentality as ineliminability can be operative in, for example, Rosen's (2018: 157) characterization of metaethical non-naturalism, which appears to allow for infinitely descending chains of normative facts. Raven can regard normativity as fundamental—a natural, perhaps even essential, thesis for a non-naturalist to endorse—even if there are no ungrounded normative facts.

Related Topics

See the section "Partial Order" for more on cyclic chains and coherentism. See the section "Fundamentality" for more on arguments for an against the existence of infinitely descending chains of ground (in the form of arguments for and against fundamentality). For more on the connection between grounding and the principle of sufficient reason, see the section "Principle of Sufficient Reason".

Further Reading

Dixon, T. S. (2016). What is the well-foundedness of grounding? *Mind* 125, pp. 439–68. (For a comprehensive look at the most plausible well-groundedness axioms, and extensive argumentation for Full Foundations.)

Litland, J. E. (2016). An infinitely descending chain of ground without a lower bound. *Philosophical Studies* 173, pp. 1361–69. (For an example of a chain like S_3 (figure 2 above) that, Litland argues, is more plausible than those discussed in Dixon 2016 and Rabin and Rabern 2016.)

Rabin, G. O. and B. Rabern (2016). Well-founding grounding grounding. *Journal of Philosophical Logic* 45, pp. 349–379. (For a comprehensive look at the most plausible well-groundedness axioms, and the connection between well-groundedness and the meta-grounding debate.)

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