# No foundations for metaphysical coherentism

**Ralf Busse[1]**

## Abstract

Recently, metaphysical coherentism has been propounded as an alternative to metaphysical foundationalism and infinitism. The view replaces the picture of reality as a hierarchy of levels with that of a network of objects or facts standing in symmetric or, more generally, cyclic relations of metaphysical dependence. This paper defends the orthodox picture of a well-founded hierarchy against the claimed superiority of coherentism. First, it will be argued that alleged theoretical advantages of coherentism do not hold up to scrutiny. Secondly, examples that are claimed to support coherentism are either misdescribed as involving metaphysical interdependence, or foundationalist treatments fare at least as good and often better than coherentist interpretations. Thirdly, a similar diagnosis applies to a recently proposed coherentist interpretation of quantum entanglement. The more general diagnosis is that claims of metaphysical dependence are convincing only if there is a detailed account of how one item metaphysically explains another. While foundationalists can resort to various specific explanatory relations, coherentism seems to be incapable of providing detailed explanations.

## 1 Introduction

Recently, metaphysical coherentism has been propounded as a superior alternative to two existing views about the structure of metaphysical dependence, metaphysical foundationalism and infinitism. Consider metaphysical grounding, which is standardly construed as a non-causal, but objective explanatory relationship between

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✉ Ralf Busse
rbusse@uni-mainz.de

[1] Department of Philosophy, Johannes Gutenberg-Universität, Mainz D-55099, Germany

facts. Foundationalism draws a "picture according to which reality is hierarchically arranged with chains of [facts] ordered by [irreflexive, asymmetric and transitive] relations of ground […] terminating in something fundamental" (Bliss & Priest, 2018b: 1). While infinitism merely dismisses the fundament, coherentism denies that grounding is a strict partial order at all. It embraces symmetric grounding structures, so that facts can be, and often are, metaphysically interdependent, as well as larger cycles of grounding.[1] The hierarchy is replaced by a network of interdependent facts.

Regarding a pre-theoretical notion of ontological dependence, which she distinguishes from "theoretical gizmos […] like grounding" (2018: 67–68), E. Barnes (2018: 53–55; 61–62) argues that we have reason to keep our notion of dependence "neutral across various ontologies", some of which involve symmetric dependence. However, maybe it is only on a liberal use of "dependence" that reciprocity appears possible.[2] In support of a better control of the target notion, I will focus on the two established hyperintensional kinds of metaphysical dependence, grounding and (neo-Aristotelian) essence.

N. Thompson (2018) defends the radical view that all facts of reality are metaphysically interdependent with each other. I will not construe coherentism in this strong sense (cf. Bliss & Priest, 2018b: 30). My interest is in the question whether the orthodox picture of a well-founded hierarchy is severely flawed and whether the correct picture of reality as a whole or of important areas of it is that of a network. I will therefore continue to confront foundationalism and coherentism with each other (sidelining infinitism for the purpose of this paper). What I call foundationalism is a combination of two core theses: first, a *hierarchy thesis* to the effect that metaphysical dependence relations allow for no circular instances, i.e., neither a tight circle in which an item depends on itself nor a circle in with two items reciprocally depend on each other nor larger cyclic structures in which a chain of dependence runs in a circle[3]; secondly, a *fundamentality thesis* to the effect that any dependent item ultimately depends on some independent item(s) (cf. theses 1 and 2 in Bliss & Priest, 2018b: 2; see their 2018b: 6 and Wigglesworth, 2018: 219–220 for various construals of the fundamentality thesis). When coherentists challenge orthodoxy by their network account, they clearly have in mind a view that combines at least those two theses. In the discussion of theoretical motivations for coherentism, the fundamentality thesis will be in focus, though in close connection with the non-cyclicity thesis. For

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[1] Symmetric dependence is a tight species of cyclic dependence. See Fine (1995a: 65–66) on essence.

[2] K. Fine's sophisticated work on essence and ground proved to be particularly helpful in assessing coherentism. Following Fine (2001, 2012), I prefer a construal of grounding as an operation expressed by a sentential operator. In this paper, however, I will mostly treat grounding as a relation between facts. Fine (2012: 52–53) distinguishes weak from strict (full) ground and is inclined to think of the former, which is not asymmetric, as more fundamental. His reasons seem more technical than substantive, though. He explicitly thinks of grounding as a "constitutive form of determination" (2012: 37). Fine (2015: 297) emphasises the "noncircularity" of essence and ground and holds that "essentialist *IS*", a relation defined by both notions, "is most plausibly regarded as asymmetric", since it is both determinative and constitutive.

[3] The standard way of banning circles is by assuming dependence to be irreflexive, symmetric and transitive. However, I do not wish to include transitivity in the core characterisation of foundationalism, because it has been challenged by J. Schaffer, a main defender of a founded hierarchy (cf. Bliss & Priest, 2018b: 15).

coherentists seek to avoid the foundationalist's basis of independent items precisely by embracing symmetric or, more generally, cyclic dependences. In the discussion of alleged examples from metaphysics and the sciences in favour of coherentism, the hierarchy thesis will be in focus, because the examples are intended to support the possibility of reciprocal dependence. Even here, however, the fundamentality thesis will play a role, because some of the examples concern the most basic level of metaphysics and science. In principle, I am undogmatic about potential examples of reciprocal or cyclic dependence. However, regarding all those alleged examples from the literature, I will argue that no reasons emerge for assuming irresolvable symmetric relations of ground or essence, so that asymmetry of dependence can and plausibly should be maintained.

Foundationalism is clearly the orthodox view of grounding. One may wonder whether it makes sense regarding essence as well. It plausibly does, at least if one holds with K. Fine (1994) that an item is essential to another just in case it features in the latter's real definition. For example, assume that 2 essentially succeeds 1 in the natural numbers series in that the real definition of 2 is being the result of applying the successor function to 1. First, it then makes sense to say that 2 constitutively depends on its relation to 1. Essence thereby qualifies as one form of metaphysical dependence alongside grounding, as is also suggested by Fine's (1995b) proposal to define ontological dependence in terms of essence. Secondly, it is then plausible to impose foundationalist constraints on essence. Chains of relations of essentiality must not run in irresolvable[4] circles, on pain of a circularity of definition that, plausibly, would be vicious. And on pain of a plausibly vicious regress of definitions, all such chains must terminate in a fundament of items that do not in turn depend in the way of essence on other items, i.e., items that have no non-trivial essences.[5] At the most, such a basic item could perhaps be said to essentially be *it*. But it has no real definition in terms of other items. In this way, the two core theses of foundationalism make sense and are indeed rather plausible for essence, too.

It is a difficult and contested issue how ground and essence are related. I will not rely on any specific account, but let me briefly indicate the approach I find attractive. On this view, grounding relations and relations of essence fit into a unified picture by being two aspects or factors of real definitions. For suitable $p$, $q$, and $r$, consider the fact $f$ that $(p \wedge q) \vee (p \wedge r)$. The idea is that the real definition of this logically complex fact[6] consists in a complete account of how the fact can be constituted. Fact $f$ can *either* be constituted by disjoining the given fact $(p \wedge q)$ with $(p \wedge r)$, and in this specific way be grounded by $(p \wedge q)$, *or* it can be constituted by disjoining the given fact $(p \wedge r)$ with $(p \wedge q)$, and in this specific way be grounded by $(p \wedge r)$, or

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[4]  See Fine (1995a: 65) for a requirement of non-circularity on essence. For resolvable circles, see the construal of (superficial) reciprocal essence in terms of relational essence in Sect. 3.3.

[5]  Cf. J. Lowe's (2006: 138) circularity/regress objection to strong monistic dispositional essentialism. This is the view that the essences of all natural properties consist in nothing more than dispositions regarding other such properties. See Busse (2021) for a critique of A. Bird's (2007: ch. 6) structuralist response to Lowe, and Busse (2020) for a principled critique of structuralism in foundational metaphysics.

[6]  This example concerns what is called "representational" and not "worldly" dependence (cf. Correia & Skiles, 2019: 656). It is my view that both kinds of dependence can be embraced, depending on whether the relata are construed as more coarse- or more fine-grained.

both. The (potential) facts $(p \wedge q)$ and $(p \wedge r)$ are, in turn, constituted by conjoining $p$ with $q$ or $p$ with $r$, and in this specific way grounded by the facts $p$, $q$ or the facts $p$, $r$, respectively. Thus, $(p \wedge q)$ as well as $(p \wedge r)$ can be full immediate grounds of $f$, $p$ and $q$ as well as $p$ and $r$ jointly are potential mediate full grounds of $f$, and $p$ is a partial mediate ground of $f$. At the same time, however, $p$ is (mediately) essential to $f$. For $p$ is required as a mediate partial ground on all possible ways for $f$ to be constituted, either based on $p$, $q$ or on $p$, $r$. Roughly, the idea is that while grounding facts reflect how a target item *can* be constituted, facts of essence reflect how an item *must* be constituted.[7] On this view, foundationalism about grounding and about essence are closely related by being two aspects of foundationalism regarding real definition.[8]

My aim is not to refute coherentism. Instead, this paper is mainly defensive. When grounding and neo-Aristotelian essence were introduced, I think we caught on to notions that were intuitively asymmetric due to their link to explanation or definition, their distinctness from modal relationships such as supervenience and *de re* necessity, and motivating examples, such as that conjunctions ground in their conjuncts and containing Socrates is essential to {Socrates}. The question is whether there are convincing reasons for revising this original hierarchic understanding. The worry is that we lose track of both notions once we soften them by giving up their non-cyclicity.

With this background, this paper argues that the advantages of coherentism presented in the literature are more spurious than real. Section 2 criticises theoretical arguments for coherentism, focussing on the claimed avoidance of "brute facts". Section 3 argues that coherentist treatments of important examples from the literature result from ambiguity, are merely superficial, or fail to be substantial, while the examples can at least as well and sometimes much more convincingly be accounted for in foundationalist terms. Section 4 argues that a recent coherentist interpretation of quantum entanglement suffers from those same three problems of superficiality, ambiguity, and insubstantiality and that a foundationalist treatment seems both feasible and preferable. Section 5 concludes that the claimed advantages of coherentism do not hold up to scrutiny and that coherentism rather seems to be at a disadvantage because it systematically fails to offer accounts of *how in detail* one item metaphysically depends on another.

## 2 Theoretical issues: brute facts and (dis)analogies with epistemological coherentism

In this section, I will discuss, in close connection, an important intuition pump underlying metaphysical coherentism and a claimed theoretical advantage of the view: its assumed analogy to epistemological coherentism, and its alleged avoidance of "brute facts". Another claimed theoretical advantage, the view's alleged accommodation of

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[7] The view seeks to combine insights from Fine (2015) and Correia and Skiles (2019). It resembles Fine's (1995a: 67–69) distinction between how an item *can* and how it *must* be defined, which he presents as a distinction of two notions of essence.

[8] Here and at numerous other points in Sects. 1–3 and 5, I am indebted to a diligent anonymous reviewer, who demanded clarifications of many basic and specific issues.

holistic explanation in metaphysics, will be dealt with in Sect. 3.2 by means of the example of living organisms.

Thompson (2018: 116–117) claims that coherentism can avoid the brute facts of foundationalism. While foundationalism rests its hierarchy on ungrounded facts, each fact in a thorough coherentist network would be grounded. One wonders, however, why exactly it would be a good thing to provide every fact with a ground in a coherentist network.

R. Bliss and G. Priest (2018b: 20) diagnose a tension within foundationalism, which coherentism may be praised for avoiding: the search for fundamentalia is motivated by an appeal to a principle of sufficient reason, but then the view lacks reasons for the fundamentalia. But as we can learn from D. Lewis (1983: 20), foundationalism only demands an *account* of every apparent phenomenon. An account can consist in either eliminating the phenomenon or providing a metaphysical analysis of it or accepting it as fundamental. Alternatively, coherentists could insist on a universal principle of sufficient reason. But no such exceptionless *verité de raison* is common ground in the debate, nor has it independently been established. The initial idea seems to be that according to coherentism, every fact has a metaphysical explanation. But maybe this sounds better than it is. *Prima facie*, circular explanations are at least as bad as explanations that terminate in final facts. A child going on asking "Why?" (Dasgupta, 2016: 282–283) may be unsatisfied with a closing answer "And that's just a fact". But she is likely to feel cheated by a circular answer. Coherentists need to tell us the explanatory surplus value of symmetric or cyclic grounding in comparison to terminating grounding chains: exactly what desirable explanatory achievement do they claim coherent structures can deliver that a founded hierarchy fails to provide?

Metaphysical coherentism derives its original motivation from an assumed analogy with epistemological coherentism (Bliss & Priest, 2018b: 3; Thompson, 2018: Sect. 4; Barnes, 2018: 65; Calosi & Morganti, 2021: 883). Let us try to take this analogy seriously, as far as it reaches, but also highlight crucial disanalogies. The alternative theories of epistemic justification are typically introduced starting with Agrippa's trilemma (Williams, 1999: 38–43): chains of justification between beliefs either stop at "dogmatic" beliefs or run in circles or to infinity. Epistemological foundationalists take the first horn, coherentists choose the second. The sceptical trilemma, however, deems all three options as equally problematic, because it is difficult to see how on any of them justification of any belief could come about. In epistemology, the role of relational chains of justification is to constitute, or help to constitute, a status of justifiedness of beliefs. This is a monadic status of particular beliefs, which is desirable if it is acknowledged that justification (justifiedness) is a necessary condition for knowledge. Foundationalists feed in that status at the level of basic beliefs. Basic beliefs are claimed to have justifiedness by correctly reflecting pre-conceptual perceptual states, by reliably co-varying with external facts, or by default. Coherentists contend that the status of justifiedness of beliefs arises solely from the pervasive mutual support within one's belief system.

A crucial *dis*analogy between the metaphysical and the epistemological case crops up. In metaphysics, it is no consensus at all that facts should have an absolute status of grounded-ness or explained-ness. Foundationalists do not maintain that facts that are not grounded by other facts receive a monadic property of grounded-ness

in some other way. It would be an ambitious contention on the coherentist side that such a monadic status makes sense, that all facts must have it, and that it arises from cyclic grounding relations. Even in the epistemological case, there is a sense in which coherentism is the more ambitious theory. For the view assumes monadic justified-ness to emerge from justificatory relations alone.[9] Coherent networks of justificatory relations between beliefs are claimed to generate the epistemological surplus value of absolute justifiedness of beliefs. By analogy, to deliver on their promise of avoiding brute facts, it does not suffice for metaphysical coherentists to point out that on their view, every fact is the target of *relations* of grounding. Instead, they need to establish an explanatory surplus value of their grounding network: some desirable *absolute* status of grounded-ness that arises from the cycles of grounding relations.

Regarding any given piece of purported knowledge, we can ask "How is it justi-fied?" Regarding a given fact, we can ask "How is it grounded?" But the two ques-tions have a different structure and context. The epistemic question asks how the belief's monadic justifiedness comes about. Assuming an orthodox view of knowl-edge, it must have that status to be knowledge. What we cannot presuppose is that this status has an analysis in terms of justificatory relations to other beliefs, since foundationalists hold that basic beliefs have justifiedness without such relations. The metaphysical question, by contrast, has a consensual relational analysis: for a fact to be grounded is for it to stand in grounding relations to other facts. But it cannot be presupposed that all facts are grounded. For foundationalists assume facts that are not grounded by other facts and also deny them a monadic status of grounded-ness they receive in some other way.

Thus, it would be rather misleading to present the assumed analogy as follows: in epistemology, the issue is how beliefs can be inferentially justified, i.e., justified on the basis of inferential connections; similarly, in metaphysics, the issue is how facts can be explained on the basis of grounding. "Justified on the basis of inferen-tial connections" is ambiguous. It can simply mean that a belief is inferentially sup-ported by other beliefs, whether these supporting beliefs are absolutely justified or not. Then, by analogy, "explained on the basis of grounding" means that a fact has a ground. The foundationalist holds that facts are explained on the basis of grounding by ultimately being grounded by facts that have (and need) no grounds but are just facts. So far, the coherentist has failed to explain what should be wrong with such ungrounded basic facts: why exactly is having grounding run in circles better than letting grounding chains terminate in items that are just facts? Alternatively, "justified on the basis of inferential connections" can mean that a belief acquires an absolute status of justifiedness by being inferentially supported by other beliefs, so that the subject in question is within her epistemic rights to hold that belief. For the episte-mological foundationalist, this requires that the target belief is ultimately supported by basic beliefs that have that absolute status independently of inferential support, say, due to observation. Then, by analogy, "explained on the basis of grounding" would mean that facts acquire an absolute status of metaphysical explained-ness by being grounded by other facts. In the foundationalist framework, this would require that all other facts have such a status by being grounded by fundamental facts that

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[9] Hence the attempt by coherentists to assign observational beliefs a special role after all.

have an absolute status of explained-ness without being grounded by other facts. But this a typical foundationalist rejects. For her, the basic facts are just that, facts. So at this point the analogy breaks down. On this second reading, the coherentist needs to show that such an absolute status of metaphysical explained-ness makes sense, that it is desirable, and that it can be delivered by coherentism but not by foundationalism.

Coherentists may take up that latter challenge by trying to identify a desirable monadic property of facts and to argue that they and only they can account for this property. That desirable property could be a status that constitutes an ultimately satisfactory answer to metaphysical *why*-questions or brings us closer to such answers. (Cf. Dasgupta, 2016: 382–383 and the rather different notion of a completely satisfactory explanation in Bliss & Priest, 2018b: 20–23.) Such answers, it seems, orthodox foundationalism cannot provide, as it leaves the fundamentalia unexplained. Plausibly, a clear success in providing ultimately satisfactory explanatory answers would count in favour of a position. The question is what this could mean and how grounding cycles should help with providing such answers. To put the problem in simple terms: If, in accordance with foundationalism, $p$ is just a fact and $p$ grounds $q$, are then all legitimate *why*-questions concerning $p$ and $q$ answered? No, because one may ask why $p$ is a fact rather than $p'$, which grounds $q'$ instead of $q$. If, in accordance with coherentism, $p$ grounds $q$ and $q$ grounds $p$, are *then* all legitimate *why*-questions answered? No, because one can still ask why $p$ and $q$ are facts rather than $p'$ and $q'$, with $p'$ grounding $q'$ and $q'$ grounding $p'$. The fact-hood of the relata in a coherentist network must be assumed in addition to the structure of the grounding network, no less than the fact-hood of the foundationalist's basis must be assumed in addition to the hierarchic grounding structure.

More accurately, let facts be true propositions. Arguably, the foundationalist then needs to assume grounding relations between propositions and in addition feed in the truth of the basic propositions for a hierarchy of facts to ensue. The point of the claimed avoidance of brute facts could be that coherentism only needs to assume a network of grounding relations and not to additionally feed in truth. In this context, grounding ought to be construed as non-factive. For if grounding entails the truth of the relata propositions, then the foundationalist does not need to *add* truth to grounding relations any more than the coherentist. Grounding is here analogous to epistemic support between beliefs, which is neutral regarding the beliefs being true or false and regarding their being justified or unjustified in the monadic, absolute sense. It may be called a relation of metaphysical support between potential facts. We might understand the non-factive notion of ground as a natural extension of the factive one (Fine, 2012: 50), maybe by saying that a non-factive ground *would* ground the groundee in the factive sense if it were an actual fact (Fine, 2016: 5–6), or else understand it independently, just as we understand entailment between falsehoods.

Coherentism could be held to avoid brute facts because the network of grounding relations between those propositions that are in fact true already suffices to determine the actual truth of those propositions. Truth would supervene on the network of grounding, or metaphysical support. But suppose that network is captured by a long open formula: $x$ grounds $y$, and $y$ grounds $z$, etc. It is very plausible that there are isomorphic pluralities of propositions containing some falsehoods that satisfy the same formula just as well. This apple is crimson; this fact grounds the apple's being

red. But the apple might have been grass-green instead; this merely potential fact (non-factively) grounds the apple's being green. Hence it is very implausible that actual truth is determined by the actual network of non-factive grounding relations. (Compare: The elements of a set of logically equivalent propositions mutually entail each other but may all be false. In what way is mutual grounding different?) To arrive at a world of facts, coherentism needs to assume the actual truth of the propositions in its network in addition to their explanatory interrelatedness, just as foundationalism needs to add the actual truth of basic propositions.

Maybe it is not quite the truth or fact-hood of the relata that emerges solely from the network of grounding relations but a certain explanatory status. Important conceptions of explanation assume that explanation entails necessitation. According to the deductive-nomological model, the explanans logically entails the explanandum. According to most views, metaphysical grounding is both explanatory (see Thompson, 2018: Sect. 5 on identity vs. tracking) and necessitating (for dissenters see Bliss & Priest, 2018b: 28 n.).[10] The contention could be that the network of grounding relations between the actual facts endows those facts with a monadic status of explainedness by necessitating them (and by holding by necessity itself). But we just saw that the network of non-factive grounding fails to necessitate the facts in the network.

What could coherentists say instead? An idea might be that the actual facts are not quite necessitated by the network of grounding relations but are only endowed with objective tendencies to be facts, in analogy perhaps to different degrees of absolute justification constituted by coherent networks of justificatory relations. First, however, alternative pluralities of potential facts satisfying the very same network would be endowed with the very same tendencies to be actual facts. The metaphysical question would still arise of why those are the real facts rather than these. No ultimately satisfactory answer to metaphysical *why*-questions would be achieved, nor would we have come noticeably closer to such an answer. Secondly, coherentists would owe us a metaphysical account both of what objective tendencies of propositions to be facts should be in the first place and of how exactly such tendencies result from coherent grounding networks.

To sum up: Suppose avoiding brute facts merely means that every fact is the target of a grounding relationship. Then we lack an independent reason why integrating all facts in grounding cycles should be advantageous per se over terminating chains, because no explanatory surplus value of the cycles has been highlighted. Assume, on the other hand, that the point of avoiding brute facts is that grounding cycles bring us closer to ultimately satisfactory answers to metaphysical *why*-questions, such as why *this* system of facts obtains rather than *that* isomorphic system. Then coherentism so far provides nothing more than that promise, and the prospects for delivering on it look dim. It would now be the coherentist's task to explain what explanatory surplus value they wish to claim for their view and how it is achieved by grounding networks.

Note that the foundationalist's brute facts are proper targets of answerable *why*-questions in a broader sense. Assuming the method of inference to the best explanation, fundamental physics tells us *why we ought to believe* in certain facts pertaining to fundamental particles or fields. Given that ultimately satisfactory metaphysical

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[10] See Wilsch (2021) for the view that explanatory phenomena are essentially sources of necessity.

explanations are so hard to come by, it may prove rational to content ourselves with that epistemic offering of reasons for belief and diagnose the desire for ultimate metaphysical explanations to be an overproduction of our otherwise sane impulse to ask *why*.

In order to appreciate the difficulty of supplying ultimate metaphysical explanations, an *excursus* on a detailed proposal by a foundationalist is instructive. Like foundationalism in general, Sh. Dasgupta's (2016) *rationalism* maintains that every fact is either ungrounded or ultimately grounded in ungrounded facts. According to rationalism, however, those basic facts are not "brute", as "fundamentalism" has it, but are "autonomous" by not even being apt for being grounded, so that legitimate metaphysical *why*-questions stop at the basis. Dasgupta's paradigm for autonomous facts comprises nominal definitions and conceptual truths. If a concept just is defined in a certain way or a truth holds due to the concepts involved, it seems inadmissible to ask for a further ground. Real definitions are presented as close to that paradigm, and close to real definitions are facts of neo-Aristotelian essence. Therefore, "facts about the essences of things" are offered as the autonomous "rock bottom" of reality (2016: 400).

Dasgupta rejects the objection "that rationalism is such a very strange view that fundamentalism is the default view" (2016: 401). For, he argues, both variants of foundationalism are committed to a "strong universal claim" (2016: 411), either that all grounding chains terminate in autonomous facts or that they terminate in a certain type of brute facts. However, to account for the fact that only a small selection of what is apparently possible is actually the case, Dasgupta relies on facts of essential existence of a strong kind. Such "Anselmian" facts about an object entail (maybe given certain conditions) the actual existence of the object. His example is the potential fact that it is essential to a certain substantival spacetime manifold (the actual one) satisfying the equations of general relativity both to exist and to have a particular curved geometry (2016: 398). He dismisses the "appearance of bruteness" (2016: 400–401) of Anselmian facts by pointing out that existence is not assumed to flow from the concept of a thing, but from its essence. For the sake of argument, let us grant the autonomy of conceptual definitions and truths and of non-Anselmian facts of essence.[11] Still, the question arises whether Dasgupta has not overdrawn his notion of autonomy, motivated by those paradigm cases as it is, by relying on Anselmian facts of essential existence.

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[11] I find the idea of autonomous facts attractive. I lean towards the view, however, that the better candidates for autonomy are specific facts about how items are or can be constituted – perhaps the complete detailed real definitions in the sense adumbrated in the introduction. For example, the unspecific fact that {Socrates} is (somehow) grounded in Socrates may be grounded, *via* abstraction, in the specific fact that {Socrates} results by applying set-abstraction to Socrates. And the fact that containing Socrates is (somehow) essential to {Socrates} is grounded in the specific fact that applying set-abstraction to Socrates is the only way for the singleton to be constituted. This idea that unspecific facts of ground and essence are grounded in specific facts about constitution is similar at least in spirit to Glazier's (2022: Sect. 3) origin proposal and Raven's (2012, see p. 1060 for the example of {Socrates}) generative approach. However, I consider constitution not to be a "worldly" process but a "transcendent" affair (see Raven 2012: 1055–1057 for the distinction). To be sure, it is only simple transcendent facts that need no grounds. A conjunction of two such facts is certainly grounded in those two facts (cf. the worry in Raven 2012: 1057).

He defends such facts by the example of a particular table being essentially such that it exists if certain particles are arranged table-wise. However, the conditional essence attributed by this fact specifies a mere transfer both of existence and a "tably" form from given parts to a certain whole. If a thing is nothing more than a derivative entity grounded in certain parts, it may perhaps be essential to that thing to exist as a table if the parts are arranged table-wise. An alleged fact that it is essential to a certain *chair* to exist if certain parts are arranged *table*-wise would hardly be acceptable in the same way. When essence is read as necessity (relativised to a source), this latter fact states a necessary connection between distinct entities that does invite the legitimate question of why that connection should obtain. If the answer is that it obtains without further grounds, the connection would appear to be brute, not autonomous. Even more so, the assumption of a fact that actual spacetime essentially exists, unconditionally, with its exact actual curved geometry does provoke the perfectly legitimate question of why, in the metaphysical sense, such a fact obtains. The answer that it simply does would appear to present the fact as brute, comparable to a brute fact of necessary existence. Such an answer would not help to defend the assumed fact's autonomy. For the question does arise of why that Anselmian fact obtains rather than a fact of essential existence concerning an alternative spacetime. It does not suffice to insist that the fact is one of essence and hence autonomous (cf. Dasgupta, 2016: 400). For the puzzle is precisely how such a seemingly substantive fact of existence can be anything like a real definition and hence an autonomous fact of essence. After all, no "rather than"-question arises concerning facts of essence closer to the paradigm of conceptual definitions and truths. There is no question of why {Socrates} is essentially the set formed from Socrates rather than {Aristotle} essentially being the set formed from Aristotle. Every set has a real definition in terms of its members.

In sum, Dasgupta's rationalism is burdened with a serious tension. He owes us an explanation of how facts of essence can be close enough to the paradigm of conceptual definitions and truths to qualify as autonomous and at the same time be sufficiently unlike that paradigm to allow for the required strong facts of essential existence, which have no acceptable analogue in the conceptual realm. No comparable tension burdens the fundamentalist view that at some level reality simply is the way it is, in itself and independently of any specific representational perspective (cf. Fine, 2001: 25). Nor need any tension burden specific views, such as that fundamental reality consists in perfectly natural features being distributed over simple particulars. The view that ultimate reality autonomously defines itself into existence seems very strange indeed, so that the assumption of brute facts does suggest itself as default [12]. (*End of excursus.*)

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[12] Fundamentalists can perhaps imitate one aspect of rationalism. I find the view plausible that the possible modes for a fact to be grounded are fixed by a fact of essence concerning that fact. For example, it is due to the nature of disjunction that the options for $p \vee q$ to be grounded is by $p$, $q$, or both. Brute facts have no natures that fix their possible modes of being grounded. In this way, they are not even apt for being grounded.

## 3 Problems with examples: superficiality, ambiguity, and insubstantiality

### 3.1 The demand of accounts of *how* one item metaphysically explains another

Beyond alleged theoretic advantages, coherentism is advertised as making sense of certain examples of metaphysical dependence that foundationalism cannot describe properly. Defending orthodoxy against the coherentist challenge, my primary job will be to offer accounts of paradigmatic examples from the literature in a foundationalist framework. This suffices to deny the contention that they can be accommodated for only by assuming reciprocal essence or ground.

However, coherentists may not be satisfied, because they can still claim their accounts to be better. To rebut this claim of superiority, different examples require different treatments. Some phenomena can be shown to be simply misdescribed as involving a specifically metaphysical co-dependence of the grounding or essence variety by offering a more accurate description (Sect. 3.2 on physical quantities and living organisms). In other cases, an interpretation in terms of reciprocal dependence may be superficially alright, but a more fine-grained and therefore more adequate description accords with foundationalism (first part of Sect. 3.3 on mathematical structuralism).

Finally, there are certain contentious, in part structuralist ontological views that may suggest a coherentist interpretation. Here the question arises under what conditions an interpretation in terms of essence or ground is satisfactory. Essence and ground are standardly viewed either as explanatory notions themselves or as intimately linked to specifically metaphysical explanation. However, typically, we are not content with a mere claim *that* one item explains another. We demand a more specific account of *how* the explanation works. Typically, a mere application of the abstract, general notions of essence and grounding is unsatisfactory, and a specification of those relations for the concrete case is called for. When those hyperintensional notions were originally established, this requirement of specification was acknowledged and was a central part of their defence. Neo-Aristotelian essence was crucially defended as linked to a notion of real definition (Fine, 1994). Evidently, it is a doubtful move to simply claim, in abstract terms, that one item has a real definition in terms of some other without specifying how, *in concreto*, it is defined. For example, {Socrates} is defined as the set that has Socrates as its sole member, and mathematicians and philosophers offer very detailed stories about how a suitable notion of iterative set formation is to be understood. Similarly, grounding has been introduced as a particularly tight relationship of explanation. Fine (2012: 39) argued that by suitably completing their explanantia, scientific explanations can be turned into perfectly gapless explanations, which he took to be paradigmatic examples of metaphysical grounding. In this way, detailedness and transparency were assumed to even increase when we turn from scientific to grounding explanations.[13] Extant theo-

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[13] In the sciences, we are hardly satisfied with abstract claims that one phenomenon causes or explains another. We demand and typically receive detailed accounts, for example, of how smoking can cause cancer and of how the $H_2O$ structure explains the boiling of water (for a sketch, see Levine, 1993: 129).

ries of the "impure" logic of ground (e.g., Fine, 2012: 58–74) contain specific, comprehensible accounts of *how* logically complex truths are grounded by other truths. In his seminal paper, G. Rosen (2010) took pains to not merely claim grounding relations but make them specific and transparent, for example by offering an account of *how* determinate properties ground their determinables (2010: 126−30; see also the illustrative examples in Bliss & Trogdon, 2021, Sect. 1.4).

Some particular grounding relations may be opaque to us. Maybe we have reasons for thinking that use facts ground semantic facts and brain states ground qualia without being able to say how the grounding works. In these cases, the opaqueness is explained by our cognitive limitations and our peculiar first-person access to qualia. (To be sure, anti-reductionists take such cognitive opacities to be reasons for denying that the target phenomena are grounded.) However, in the examples that follow neither complexity nor a first-person access seems to be the problem. We may therefore demand that the accounts offered by foundationalism and coherentism not remain mere blanket claims of relations of essence or ground. Instead, they need to be so specific as to make it comprehensible *how* one item metaphysically explains another. For one of the ontological views under consideration I will argue that such a detailed account is available in principle to the foundationalist, while no detailed coherentist account is within sight (second part of Sect. 3.3 on mathematical structuralism). For the remaining two views, an imaginable foundationalist interpretation is at least not worse than the coherentist one, but both approaches fail to supply comprehensible detailed interpretations, which suggests that the very views in question are in trouble (Sect. 3.4 on states of affairs and moderate spacetime structuralism).

### 3.2 Ambiguity: physical quantities, organisms, and holistic explanation

Some alleged exemplary cases for reciprocal metaphysical dependence suffer from a problem of *ambiguity*: the appearance of interdependence in the sense of grounding or essence results from an ambiguity in the term "dependence"; the real structure is either a reciprocal relatedness of some other, undisputed kind or different kinds of dependence in different directions.

Thompson (2016: 47; 2018: 110) urges that the fact that a body's mass is equal to its volume multiplied by its density, $m = \rho \cdot V$ (more sophisticatedly, mass equals the integral of local densities over a volume), means that "the three parameters are interrelated" and that this ought to be construed as mutual partial grounding: mass partially grounds density, and density partially grounds mass. Clearly, the interconnection expressed as $m = \rho \cdot V$ seems stronger than mere nomic interrelatedness, which we find, for example, between gravitational mass, distance, and gravity. Some metaphysical relationship seems to be involved. However, Fine (2001: 11) once used the cyclic supervenience among mass, volume, and density precisely in order to distinguish strong supervenience, which in some cases holds symmetrically, from asymmetric grounding. The natural view would be that the real definition of density is mass per volume, and that, correspondingly, a body's density grounds in its mass and volume, or alternatively that the real definition of mass is density times volume, and

that, correspondingly, a body's mass grounds in its density and volume.[14] Both real definitions would render the formula metaphysically necessary. But on this natural view, either mass is the more basic quantity and density derives from it, or mass derives from a more basic quantity of density; but not both.[15] Alternatively, the three quantities may jointly ground in some underlying phenomenon (Wien, 1901 suggested electrodynamics), again in accord with foundationalism. In sum, a reading of m=ρ·V as mutual grounding may perhaps be plausible at first sight. But such an interpretation does not hold up to scrutiny, because it is hard to see any evidence from science for interpreting the correlation in that way. The coherentist interpretation seems to mistake a metaphysically necessary interrelatedness that stems either from a one-sided dependence or from a joint groundedness for reciprocal grounding.

As another example, Thompson urges that "the fact the organism […] has a properly functioning circularity systems depends on the fact that the heart pumps blood around the body", but at the same time "the fact that the heart pumps blood […] depends on the fact that the organism […] has a properly functioning circularity systems" (2018: 111; cf. 2016: 48). Arguably, the organism's circularity system including the pumping of the heart metaphysically depends on the heart in the sense of partial grounding: what the heart does is partially constitutive of the circularity system as a whole in that particular body. Yet the reverse claim that this complete system is also (partially) constitutive of the working of the heart is not plausible. What is true is only that the functioning of the heart is *causally*, not metaphysically, dependent on the proper functioning of the *rest* of the circularity system, i.e., the arteries and veins etc. without the heart. In a sufficiently broad sense of causation, the functioning of the body minus the heart also causally depends on that of the heart: if the heart stopped, the other organs would soon cease to do their job. So *cum grano salis*, whole and part may be viewed as causally, but not as metaphysically interdependent.

Organisms are also paradigm examples of holistic explanation, which according to some coherentists requires an account in terms of metaphysical interdependence (Barnes, 2018: 65; cf. Thompson, 2018: 119–123). However, we just saw that organisms are no instances of holistic explanation in the sense that the whole organism is *metaphysically* explanatory of its parts, which, in turn, are constitutive of the whole. According to a plausible model of holistic explanation, a reciprocal dependence between different items results in an explanation of a whole comprising those items. Lewis's account of social conventions (1975: 164–166) may serve as a paradigm. The temporal and modal stability of a convention in a population, say, of driving on the right is explained by a pattern of interdependencies between the members of the population, say, that Ann drives on the right because she believes that Ben does, and vice versa. Here, however, the "because" expressing the underlying interdependencies is causal. The question is whether there are convincing examples in which

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[14] Cf. the view of grounding and essence as aspects of real definition adumbrated in the introduction. Here, however, I only rely on the plausible principle that if the real definition of F is the conjunction of G and H, then a particular thing's being F is grounded by its being G and its being H.

[15] Maybe our *concepts* of mass, density and volume are co-constituted by accepting "m=ρ·V". Then it is a collective requirement on those concepts that their instances are correlated accordingly (cf. Section 3.3 on relational essence). However, the constitution of concepts of quantities ought to be distinguished from real definitions of the quantities themselves.

a whole is metaphysically explained by genuinely metaphysical interdependencies between its parts.

Again, living organisms are no such examples. One accounts for the life of an organism by highlighting the intact mutual *causal* interaction between its organs. Metaphysical dependence plays a role, because the causal interaction between the organs is what constitutes the organism's life. A property of the whole organism is metaphysically explained, quite plausibly in the sense of asymmetric grounding, by causal interactions among its parts. This view takes the "holistic" property of being alive seriously, but presents it as grounded in causal interactions of the parts (see Fine's, 2001: 15 distinction between grounding and a "strict notion of reduction"). It is, of course, not the job of metaphysics but of biology to specify the extremely complicated causal interactions underlying life. Still, it is hard to see where genuinely metaphysical interdependence ought to play an indispensable role in a holistic explanation such as that of life. Note that we are here concerned with specifically metaphysical explanation. Biology also aims at genetic accounts of how organisms phylogenetically came and ontogenetically come into being. Such causal explanations ought to be distinguished from a constitutive explanation of life.

Neo-Aristotelians in the philosophy of biology (see Simpson, 2023 for an opinionated introduction) may object that it is only true at a purely physiological level that all we have is causal interdependence. They may argue that as an organ, the heart metaphysically depends on the kidneys and other organs and even on the whole living organism after all, and vice versa. However, foundationalists can admit a loaded conception of organs and organisms, according to which it is essential to them to be functionally interrelated and integrated. As we shall see in the following Sect. 3.3 and again in Sect. 4.2 (see the discussion of an essential interrelatedness of *qua*-objects), such essential interrelatedness is more adequately described as collective or relational essence rather than reciprocal dependence. For example, the heart and the kidneys can be collectively such that it is essential to them that those organs suitably interact with each other. Relational essence is in accord with foundationalism.

In sum, it is hard to see exactly what holistic explanatory structure it should be that demonstrably obtains within organisms and involves reciprocal metaphysical dependences that foundationalism cannot accommodate.

### 3.3 Superficiality: mathematical structuralism

For certain exemplary cases, a description in terms of metaphysical interdependence is only *superficially* correct, while a deeper analysis reveals a different dependence structure compatible with foundationalism.

As Barnes (2018: 59–60) points out, mathematical structuralists think of mathematical objects such as numbers as nodes, positions or places in a mathematical structure, maintaining that each place depends on all the other places in the structure. For a structuralist, in contrast to more "successive" accounts of the numbers series, being the predecessor of two is no less essential to one than being the successor of zero. Since two also depends on one as its predecessor, the two numbers would appear to mutually depend on one another.

Fine ([1995a](#): 65–66; 1995b: 282–284), who developed the underlying account of ontological dependence in terms of neo-Aristotelian essence, allows for reciprocal essence and dependence, but only under a liberal, "consequential" notion of essence. Facts of consequential essence result by logical entailment from underlying facts of "constitutive" essence.[16] However, "[i]t seems very reasonable that reciprocal essences should be forbidden under the constitutive account; for how else could a noncircular account of the essences of things be given?" (1995a: 65) What gives rise to (cf. p. 66) reciprocal essences in the consequential sense is collective or relational essence in the more profound constitutive sense. It is a constitutive relational fact of essence about Watson and Holmes that they are together, in that order, such that the first admires the second.[17] When we use an indexed box to express essence, this fact of constitutive essence is of the form $\Box_{a,\,b}\mathrm{R}ab$. From this relational fact it can be inferred that, in the consequential sense, both $\Box_a\mathrm{R}ab$ and $\Box_b\mathrm{R}ab$, i.e., it is essential to Watson to admire Holmes and essential to Holmes to be admired by Watson. (See also the discussion of an essential relatedness of *qua*-objects in Sect. [4.2](#).)

The situation becomes more perspicuous with a predicational notation for essence, which Fine ([1995a](#): 55) is inclined to regard as fundamental though less convenient. With an indexed essence operator "E" followed by a predicate, the relational fact is written as $\mathsf{E}_{a,b}\mathrm{R}$: $a$ and $b$ are essentially such that the former is R to the latter; cf. the notation "$\mathrm{L}t_1t_2\ldots t_n\mathrm{P}$" in Fine ([1995a](#): 69 n. 1). Here, the expression specifying the two objects' essence, predicate "R", involves no reference to either $a$ or $b$. The collective essence of both fictional characters is specified purely relationally, without singular reference, so that neither character depends on the other. The two consequentialist facts of essence arising from this underlying relational fact are $\mathsf{E}_a\lambda x\mathrm{R}xb$ and $\mathsf{E}_b\lambda x\mathrm{R}ax$: it is essential to $a$ to be R-related to $b$, and it is essential to $b$ that $a$ is R-related to it. It is only in those derivative facts that $b$ features in the essential profile of $a$ and $a$ in that of $b$. In this liberal sense, structuralists may well maintain that the number one is essentially related to two as its successor and that two is essentially related to one as its predecessor. But those reciprocal facts of essence arise from the underlying relational fact of constitutive essence that one and two are essentially such that the latter is the successor of the former.[18]

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[16] Fine considers constitutive essence more basic; an essential property in this sense "is not had in virtue of being a consequence of some more basic essential properties" (1995a: 57). His doubts about that basic notion (1995a: 58) are more methodological than substantively metaphysical. See Koslicki ([2012](#)).

[17] This is a fact about the fictional characters, which are co-established by Doyle's stories. From within the fiction, one may well say that Watson as a person need not admire Holmes.

[18] Wigglesworth ([2018](#)) discusses mathematical structures under the perspective of grounding. He makes it clear (220–225) that Ø. Linnebo's "weak dependence" amounts to two objects having the same concrete system(s) as a common ground for their individuation, which reveals a joint dependence on that ground instead of interdependence. Wigglesworth himself relies on a notion of the identity of an object, which amounts to one of essence (227). Graph-theoretically, an object's essence is the collection of edges in which it is involved (230). However, involving particular nodes as their relata, edges are token relations. So in effect object $a$'s essential properties are of the form *being R to object b*. Reciprocal dependencies between nodes in graphs established on this basis are compatible with the above diagnosis that on a deeper analysis, those interdependencies stem from facts of relational essence to the effect that $a$ and $b$ together are essentially R. Ultimately, grounding only obtains between the complete structure and its objects.

In this way, an analysis free of profound reciprocal dependence between objects in mathematical structuralism is available. There are reasons for thinking that this is also the better analysis than a coherentist one that stops with reciprocal dependence. For the Finean account above is based on the more fine-grained and structurally richer view of essence. Reciprocal dependence seems inevitable only if one insists that all facts of essence attribute a monadic property to a single object, as in $E_a \lambda x R x b$ and $E_b \lambda x R a x$. It is an acknowledged major achievement of modern logic, however, that it systematically deals with *n*-adic predications alongside unary predication. Once relational constitutive essence is admitted, the perspicuous Finean analysis suggests itself, and the apparent need of profound reciprocal dependence dissolves.

This is not the end of the story, though. For it would be unsatisfactory for foundationalists to simply assume that a certain kind of objects have relational essences. A thoroughly foundationalist account is desirable of how those objects "come by" such essences. Otherwise the worry might be that relational essences are enough of essential interconnectedness to threaten foundationalism. The challenge is not that foundationalists provide metaphysical grounds from reality for facts that assign relational essences to mathematical objects. There may be something to Dasgupta's (2016; see the excursus in Sect. 2 above) contention that facts of essence have and need no grounds but hold autonomously. Still, foundationalists who seek to do justice to structuralism ought to provide a more detailed account of how mathematical objects are constituted in such a way that, as a result, they have certain relational constitutive essences. The truly autonomous facts could be those facts about how in detail items are constituted, and facts of essence could flow from them. The general problem is not specific to foundationalism. Even if facts of essence or constitution are autonomous, not every assumed such fact need to be a real fact. Some assumed facts of essence may not make sense, or be unacceptable because the assumption leads to contradiction, such as the assumption of a set that essentially has all and only the non-self-membered sets as its members. Any assumed fact of essence ought to be made plausible by a detailed account of how an item with that constitutive essence is constituted.

The natural approach regarding mathematics would be St. Shapiro's (1997, 2008) view that complete mathematical "[s]tructures are prior to places" (1997: 9), in the sense of metaphysical priority (Shapiro, 2008: 301). However, he also writes that a structure is "a whole consisting of, or constituted by, its places and its relations" (2008: 303). Coherentists could interpret those two claims as expressing a reciprocal metaphysical dependence between structures and their places. Shapiro's own view, by contrast, seems to be that places are constituents of structures by being mere derivative aspects of structures, so that structures are strictly prior to them after all and can fix the relational essences of places (cf. his statement 2008: 301 that mathematical objects *are constituted by* structures and the paragraph 2008: 302–303). Let me try to sketch a foundationalist account in this spirit and point out its main merit.

The idea is that structures are complex relations and that mathematical objects are the reified "endpoints" of those relations. Suppose an axiomatic system postulates a structure of three objects satisfying the formula "*xRy* and *yRz*" (cf. Shapiro, 2008: 302). The formula expresses a complex three-place way for things to be related. By a first step of reifying abstraction, we gain the complex relation that holds between

some things just in case they are related in the way expressed by the formula. The proposal says that this abstracted entity is the structure defined by the axiomatic system.[19] In a second step, we can reify the relation's capability of obtaining between things by saying that the relation features three "points of contact", with which objects can be connected to state that they stand in the relation. More generally, every *n*-adic relation yields exactly *n* contact points. To connect the contact points of our relation to three things is tantamount to stating that those things are related in the manner from which the relation is abstracted. It is only this second reifying abstraction that yields the relation's three contact points. These are the objects "in" the structure, or so the proposal.[20] These objects are nothing more than second-order abstractions from a given relational way for things to. They cannot be constituted in any alternative way, nor are they anything in themselves independently of the two-step abstraction. It is therefore plausible that they have a relational essence that mirrors the underlying way to be related.

According to this line-up, a mathematical structure is ontologically prior to its objects, as it derives directly by abstracting a relation from a complex manner for things to be related. The particular objects "in" the structure are derivative on the structure, as they result only by a second operation of abstraction that reifies the relation's capability of holding between things into contact points.

This outline of a proposal illustrates the main advantage of a foundationalist account of objects in mathematical structures. At no point does the sketch rely on generic notions of metaphysical dependence such as essence or grounding. Even a sceptic about those abstract notions could understand and accept the two specific reifying operations of abstraction of relations and abstraction of contact points. In this way, the proposal does not merely claim *that* structures are metaphysically explained by ways of being related defined by axiomatic systems and *that* mathematical objects are metaphysically explained by those structures. It offers a specific account of *how* mathematical structures and their objects are explanatorily derived: by two successive specific reifying operations that are comprehensible even without a general theory of grounding. Those operations are general in their own way. Yet they are much more specific than a generic notion of grounding of which they are plausible species, alongside other specific operations such as the constitution of wholes from parts, set abstraction, the formation of logically complex truths from constituent truths, reifying abstraction of propositions from sentential contents, etc.[21] However, the two abstraction operations are evidently directed and asymmetric, in accord with foundationalism.

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[19] Since the relation derives from a complex way of things to be related, it can be viewed as a pattern or structural universal (Shapiro, 1997: 84–85). Contrary to Shapiro (2008: 304–307), however, it does not have monadic universals representing objects among its constituents.

[20] Infinite and symmetric (Shapiro, 2008) structures may be captured by irreducible plural reference to contact points. It must also be shown that the contact points of mathematical structures instantiate themselves the very relation from which they are abstracted. Contact points would withstand Fine's (2000: 16–17) objections to "positionalism": they do not belong to the world's "fundamental furniture", and symmetric relations are handled by plural reference.

[21] I am here construing grounding as applying to items of different categories, not only to facts.

I fail to see how a comparably specific account of how structures and their objects are explained could be provided in a coherentist fashion. For what might a competing coherentist account of objects in structures be like? What kind of a symmetric relation between structures and objects could coherentists assume? A recently discussed symmetric notion is generalised identity (see Dorr, 2016; for links to essence and ground see Correia & Skiles, 2019). Coherentists may try to capture a reciprocal dependence between structures and their places by assuming that, to oversimplify, the relata *just are* the relations. The proposal would be that, for example, the existence of all the natural numbers 0, 1, 2 etc. *just is* the obtaining of the successor relation in accordance with the Peano axioms. However, this interpretation still only claims in abstract terms that the existence of certain mathematical objects comes down to the same thing as the obtaining of a network of mathematical relations. It does nothing to make it comprehensible in detail how that can be the case. Also, the foundationalist's two operations of relational abstraction and reification of contact points are plausibly explanatory: the triadic relation exists because there is the complex manner of being related; the three contact points exist because there is that triadic relation. By contrast, generalised identity and its symmetry are typically defended by "tight analogies" to ordinary objectual identity (Correia & Skiles, 2019: 665). It will then be difficult for coherentists to also maintain that this relation is explanatory in both directions. Hesperus does not explain Phosphorus, nor vice versa. We have the very same object on the left and on the right of identity, and that object does not explain itself.[22] Similarly, if we have the very same "worldly" fact on the left and on the right in "the existence of 0, 1, 2, … just is the infinite iteration of the successor function", one wonders what fact is supposed to explain what *other* fact (and vice versa). An alternative view would be that the two sides express different "representational" facts that reflect the same underlying "real" fact. But then both the nature of this underlying fact and its relatedness to the two representational facts is left in the dark. What is more, the structure would then appear to be one of common ground and hence accord with foundationalism rather than coherentism.

Coherentists are invited to develop their own concrete account of objects in structures and their essences. For the time being, I conclude that while a detailed foundationalist account of the relationship between structures and objects is available in principle, no comprehensible coherentist account is within sight. The claim that coherentism affords either the only possible or the superior account of mathematical structuralism cannot be maintained.

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[22] The point here is that identity itself is not an explanatory relation holding between the relata. Whatever the explanatory relation expressed by "Water is $H_2O$" may consist in, it evidently exceeds the mere numerical identity of a stuff to itself and is asymmetric. The point does not preclude identities from being "excellent stopping places for explanation" (Dorr, 2016: 41), i.e., ultimate explanantia, though I am sceptical about this contention, too. To all appearances, many identities do have a deeper explanation. For example, the fact that $E=mc^2$ is explained by more basic laws of special relativity.

### 3.4 Insubstantiality: states of affairs and moderate structural realism

Finally, there are metaphysical views that have received interpretations in terms of metaphysical interdependence, which, however, remain *insubstantial* in that they fail to reveal a concrete metaphysical structure of the phenomenon in question.

Regarding D. M. Armstrong's metaphysics of states of affairs and their constituents, Barnes (2018: 57) argues that the "most stable position" for Armstrong is "that states of affairs are cases of symmetric dependence". The background problem is that Armstrong presents his metaphysics of universals in two rather different ways. One version, dominant in Armstrong (1989: ch. 5), starts with a defence of sparse universals and primitive particulars and then argues that both compose to form a third kind of entities called states of affairs. The other, prevailing in Armstrong (1997), focusses on a defence of states of affairs (1997: 113–119) and goes on to elucidate universals as truncated states of affairs that result from complete ones by abstracting away (1997: 28–29) the primitive particulars.

According to Barnes's interpretation, "*both* states of affairs and their constituents are fundamental, […] but they each depend on the other" (2018: 57–58). The problem with this is that Armstrong offers specific accounts for both directions of dependence, which, however, strongly suggest incompatible orders of metaphysical priority. Maybe, when a particular *a* and a universal F are given, those two entities can link together in such a way that they (in a "non-mereological" manner) compose a third entity, the state of affairs of *a*'s being F. But then the particular and the universal appear to come first in metaphysical order and the state of affairs appears to be a derivative entity metaphysically dependent on them. (Plausibly, the state of affairs would result as a reification of the truth that *a* instantiates F for an assumed primitive nexus of instantiation.) Maybe, when several states of affairs are given, they can be similar to each other in such a way that by disregarding what is still different about them, we refer to a common characteristic abstracted from them that can be called a universal. But then the states of affairs come first in the metaphysical order and the universal is a derivative entity metaphysically dependent on them. (Plausibly, the universal would be a reification of one respect in which the states of affairs resemble.) Taken together, Armstrong's composition and his abstraction account of states of affairs and their constituents must be suspected to be incoherent. To merely point out, in abstract terms, that the intended total view is one of mutual dependence cannot resolve the tension between the quasi-compositional and the abstraction account.

Coherentists could maintain that the abstraction of constituents is best viewed as a decomposition of states of affairs, which, conversely, are composites of the constituents. The idea could be that we can move back and forth between a state of affairs as a whole and its constituents without assuming a privileged direction of metaphysical priority. Such symmetry makes pretty good sense for Lewis's account of composition as identity. If the fusion just *is* the plurality of parts and, symmetrically, the parts just *are* the fusion (1991: 81), then the fusion results from composing the parts and the parts result from decomposing the fusion without any direction of priority. But Armstrong (1989: 92) is explicit that the formation of states of affairs by "a nonmereological mode of composition" (1989: 93) cannot be innocent fusion. While for Lewis the parts and the fusion are "the same portion of Reality" (1991: 81), the state of affairs

is not just the same thing as its constituents. If it were the same thing, coherentists could not claim reciprocal metaphysical explanation anyway, assuming that no portion of reality explains itself. Altogether, it remains the case that the formation of states of affairs from constituents establishes one order of priority and the abstraction of constituents from states of affairs establishes the opposite, incompatible order.[23]

Could a coherentist simply deny the tension between the composition- and the abstraction-account, because she does not think that grounding is asymmetric in the first place? I doubt it. The tension is there. Armstrong for his part practically acknowledged it by advancing over the decades ever new approaches to resolve or soften it. When $a$ and F non-mereologically compose $a$'s being F, it is highly plausible that the components are taken as independently given and that the compositum results from them. That priority of the components over the compositum seems crucial for the latter being metaphysically explained on the basis of the former. Conversely, when $a$ and F are abstracted from $a$'s being F, it is highly plausible that the state of affairs is taken as independently given and the constituents result from it. That priority of the item from which the constituents are abstracted over the abstracted constituents seems crucial for the latter being metaphysically explained on the basis of the former. Trying to dissolve the apparent incoherence by simply denying it is no better than trying to solve it by simply claiming that grounding is symmetric in that case. Both moves fail to provide a detailed account of *how* exactly $a$ and F ground $a$'s being F and vice versa.

Alternatively, one could assume a single fundamental subject matter that can be described equally well as constituents composing a state of affairs and as constituents being abstracted or abstractable from a state of affairs. However, such an approach would belong in a foundationalist framework. The underlying subject matter would ground both the composition of a state of affairs from given constituents and the abstraction of constituents from a given state of affairs. The apparent incoherence of Armstrong's views would be resolved by *fiat*: a fundamental underlying I-know-not-what would be expected to do the trick. This foundationalist view seems no worse than the coherentist interpretation. However, both interpretations assume two incomprehensible relationships of dependence and end up with a picture puzzle of the assumed real situation. They are equally insubstantial, by abstractly postulating the apparent incoherence away instead of resolving it. As I see it, this failure of both the coherentist and the foundationalist approach suggests that Armstrong's composition-and-abstraction theory of states of affaires is in fact incoherent. It would hardly be a merit of any view of metaphysical dependence and explanation to declare a metaphysical thesis acceptable that is really incoherent – no more than it would be a merit

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[23] Similarly for the claimed example of interdependence concerning "integrated wholes", such as that between two semi-circles and the circle they form (Thompson, 2018: 111). My view is that unless we are just talking in Lewis's way about the same portion of reality in the singular and in the plural, we ought to distinguish between two different constitutive, asymmetric relations here, composition and decomposition. Two semi-circles constitute a circle by composition, they are its constitutive parts. The circle may in turn be decomposed into two half-circles, these are abstracted parts of it. For categorial reasons, the constituent parts are not strictly identical to the abstracted parts, though, plausibly, the existence of both kinds of parts is necessarily related. No mutual dependence ensues.

of a model of scientific explanation to also cover failed attempted explanations from the sciences.[24]

Thompson ([2018](2018): 118–119) also interprets M. Esfeld and V. Lam's ([2008](2008)) "moderate structural realism" about spacetime by metaphysical coherentism. Esfeld and Lam defend an objects-in-relations view of spacetime facts. In opposition to structuralist "relations first" accounts, they refer to the (assumed) principle that there can be no concrete, occurrent relations without relata. Still, while for them relata occur at the basic level of physical reality, "all there is to the basic physical objects are the relations in which they stand" (2008: 31). This is a coherentist view: at the basic level, a mutual dependence is assumed between occurrent spatiotemporal relations and spacetime positions as their relata (2008: 32, 34).[25] The view crucially differs from ("radical", Esfeld & Lam, [2008](2008): 30) metaphysical structuralism (cf. Morganti, [2018](2018): 262–269), according to which the basic level consists in nothing more than a relational network (cf. the anti-individualism of Dasgupta, [2009](2009)) and particulars either disappear from the picture completely or emerge from the network as derivative entities.

A concrete relation may be identified with a relational fact that $a$ is R to $b$. It is plausible that the fact depends on the relata as its constituents. Can Esfeld and Lam also specify the reversed dependence of relata on relations? One elucidation they offer is that spacetime points have no intrinsic properties in addition to the relations they bear to one another (2008: 31). But this fails to pin down dependence. Positions could be self-standing entities without having intrinsic, non-relational properties. For example, they could be occupied by concrete bits of matter or fields having intrinsic

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[24] Rodriguez-Pereyra ([2015](2015): Sects. [5–6](5); cf. Thompson, [2018](2018): 110–111) assumes a pair of true propositions A=⟨B is true⟩ and B=⟨A is true⟩ and argues that each grounds the other. There are reasons to doubt that there can be such a pair on a tenable theory of propositions. A plausible view is that a proposition's subject term is metaphysically prior to the proposition: ⟨$a$ is F⟩ is in some way built up from object $a$ and being F. Thus, A is prior to ⟨A is true⟩, and B is prior to ⟨B is true⟩. This precludes the assumed identifications, not to mention mutual grounding. If talk of A and B makes sense at all, it seems to be talk about a kind of fictional entities that are co-constituted by a stipulative practice, much like Holmes and Watson. That practise could create a relational essence of A and B to the effect that each is fictionally true/false/indeterminate just in case the other is, which would explain the two proposition-fictions' interdependence with respect to fictionally assumed truth value.

[25] A few remarks from a purely metaphysical perspective on the motivation of their structuralism-inspired view by the hole-argument about relativistic spacetime. This argument concerns a form of determinism: the facts outside the hole are to lawfully determine the facts inside the hole, which, it is argued, is not so if spacetime substantivalism is true (Esfeld & Lam, [2008](2008): 36). The laws of nature are predeterministic iff any two nomologically possible worlds that are duplicates up to a certain time are duplicates throughout (Lewis, [1983](1983): 31–32). Duplication is a purely qualitative notion concerning agreement in qualitative pattern or structure. The corresponding hole-related demand of determinism would be that given the laws of general relativity, the qualitative structure outside the hole – the pattern of spatiotemporal relations, metric tensors, masses, etc. – fixes the qualitative structure inside the hole. This may be so independently of whether qualitative structure is all there is or is instead instantiated by substantive spatiotemporal positions, and independently of whether a structure can be instantiated by an amount of positions only in one or in several ways. Laws of nature relate qualitative structures: whenever this qualitative pattern, that qualitative pattern. Laws were never meant to relate facts concerning this particular object rather than that instantiating a specific property! If the underlying metaphysical principle is that whatever fails, in its particularity, to feature in the laws does not exist, particulars can already be eschewed by the purely qualitative character of laws (cf. Dasgupta, [2009](2009): 37–47). That principle, however, "is too parsimonious" (cf. Esfeld & Lam, [2008](2008): 31).

properties instead of instantiating intrinsic properties themselves (Lewis, 1986: 14). In reverse, positions could have intrinsic properties after all without those properties being essential to them or individuating them. A second elucidation is modal: "objects can[not] exist […] without relations in which they stand, and relations can[not] exist […] without objects that stand in the relations." (2008: 32) However, Fine's example of Socrates and his singleton showed that necessary co-existence does not entail mutual ontological dependence. The reciprocal necessitation between relations and relata may result not from an interdependence but from a one-sided dependence, for example, by derivative positions together with their relational essences emerging from a purely relational spacetime. Regarding a third elucidation in terms of identity conditions, it is not explained in what way criteria of identity state more than a (true) theory about objects of a certain kind (Horsten, 2010) that is neutral on dependence. Barring multiple or splitting spacetimes, all sides can agree that positions $x$ and $y$ are identical just in case they have no non-zero distance from each other. Maybe we can make sense of the idea that identity of spatiotemporal positions generically grounds in zero distance (cf. Fine, 2016). But only if "radical" structuralism is right that positions derive from a purely relational network of distances. Not if we also insist that identical relata are already required for the constitution of the underlying zero distance facts. (Compare: agreement of beliefs in psychological role can hardly ground identity of belief contents if identity of content is already constitutive of agreement in role.)

The claimed metaphysical interdependence remains unsubstantiated by all three elucidations. While concrete spatiotemporal relations, construed as spatiotemporal relational facts, are plausibly constituted by spacetime positions as relata, it remains unspecified how those concrete relations in turn metaphysically explain the positions.

An alternative view could be that spacetime is a fundamental subject matter that can equally well be broken up into relational states of affairs, from which spacetime positions are abstractable as constituents, and into a manifold of positions, which are found to be essentially related. We would then have a structure of common ground, in accord with foundationalism. The view leaves the real structure of spacetime in the dark, however, postulating an underlying I-know-not-what that derivatively features positions in relations. The account seems to be no worse than the coherentist one. However, both postulate two relations of metaphysical dependence without specifying them and thereby making them comprehensible.

As I see it, the failure of both the coherentist and the foundationalist approach suggests that moderate structural realism cannot be made sense of. Still, much of what Esfeld and Lam say is plausible enough. Very plausibly, spatiotemporal relational facts consist in relations holding between relata. Quite plausibly, spacetime positions are not traditional substances that have a life on their own regardless of their relations. As I see it, we can simply hold that spacetime is a manifold of fundamental spatiotemporal particulars standing in fundamental spatiotemporal relations and explicitly reject any upgrading of those particulars into traditional substances, such as attributing to them an intrinsic essence. A well-motivated view is that, being fundamental and therefore not having a real definition, those positions have no non-trivial neo-Aristotelian essences at all, neither intrinsic nor relational (cf. Wang, 2019). They simply are the things they are.

In sum, coherentism cannot make any better sense than foundationalism of contentious metaphysical theses such as Armstrongianism about states of affairs and moderate structural realism. This failure of both coherentist and foundationalist interpretations speaks against the tenability of those metaphysical theses. But there are good alternatives to Armstrongianism[26], even among universals theories. And the spirit of the Esfeld-Lam view of spacetime can be saved without ambitious claims of dependence.

## 4 Coherentism about quantum entanglement: superficiality, ambiguity, insubstantiality

### 4.1 Coherentism vs. structuralism and holism about quantum entanglement

Thompson (2018: 117; cf. 119) asserts: "[…] our best current physics […] points to the presence of holism and/or non-separability at the quantum level […] Metaphysical interdependence is the only theory of grounding (perhaps other than monist foundationalism) suited to characterise this sort of metaphysical dependence." C. Calosi and M. Morganti (2021) motivate and expose a more detailed coherentist account of genuine quantum entanglement. Genuine entanglement typically (Calosi & Morganti, 2021: 878) concerns systems of several particles, which due to entanglement exhibit certain non-local correlations among their states.[27] Calosi and Morganti argue that entanglement can be interpreted as mutual metaphysical dependence between the particles of the system and that such a coherentist interpretation is preferable to extant structuralist and holist accounts.

Structuralism and holism agree that there is something metaphysically prior to individual particles, something on which those particles metaphysically depend and to which they reduce (see Calosi & Morganti, 2021: 871 on reduction). For structuralists, unless individual particles are eliminated from the picture completely, they are derivative from physical structures, which are pure networks of physical relations. For holists, individual particles are derivative from an encompassing ontic whole, either from the complete entangled physical systems in question or, on monist versions, from the complete universe. Coherentism rejects such metaphysical derivativeness of individual particles. According to Calosi and Morganti's objects-in-relations view, entangled particles are related in such a way that they reciprocally depend on one another without reducing either to relations or to a larger whole.

As Calosi and Morganti (2021: 887) remark, their view is *prima facie* preferable for reasons of conservativeness. It treats quantum particles as (more or less) traditional objects with a familiar bottom-up mereological dependence structure, according to which the whole depends on its parts. In addition, they argue in detail that the availability of unreduced quantum objects affords them more informative and more adequate interpretations of entanglement in general and of subtleties in specific

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[26] For my own nominalist position see Busse (2018).

[27] In contradistinction to mere entanglement due to symmetricalisation, which does not give rise to violations of Bell inequalities (Calosi & Morganti, 2021: 866–867).

instances of entanglement. (One example is the three particles system mentioned in 2021: 879–880 n. 41.) Personally, I am on their side regarding an objects-in-relations view of quantum phenomena and am happy to appreciate their detailed arguments in its favour. The crucial question with respect to metaphysical coherentism, however, is whether entangled objects-in-relations are in fact convincingly construed as objects that metaphysically depend on each other in a symmetric way. In the following, I will raise some doubts about this interdependency thesis by reference to the three issues of superficiality, ambiguity, and insubstantiality.

## 4.2 Superficiality

The first problem is the superficiality of the thesis of metaphysical interdependence. Consider two entangled particles, such as, paradigmatically, the two particles of a pair of electrons in the so-called singlet state. This state is standardly written as $\sqrt{\frac{1}{2}}|\uparrow\rangle_1|\downarrow\rangle_2 - \sqrt{\frac{1}{2}}|\downarrow\rangle_1|\uparrow\rangle_2$ (cf. (1) in Calosi & Morganti, 2021: 866).[28] It is to the effect that in case of a measurement of their spin in a selected spatial direction, the two particles labelled "1" and "2" can be found, with an equal probability of 50%, either in the combination that the first of them is spin up and the second is spin down, $|\uparrow\rangle_1|\downarrow\rangle_2$, or, conversely, that the first is down and the second is up, $|\downarrow\rangle_1|\uparrow\rangle_2$. What is impossible, given the singlet state, is that one finds both electrons with spin up or both with spin down. In a case of genuine entanglement, where the two electrons are located at definitely different positions in space and are possibly far away from each other, this constitutes the non-local correlation between measurement results concerning quantum objects that is paradigmatically discussed with regard to the Einstein-Podolsky-Rosen-(EPR-)experiment.

Calosi and Morganti (2021: 882) adopt Fine's indexed box to express an essential interrelatedness and hence mutual dependence between the particles: "$\Box_{x1}(Ex_1 \rightarrow Ex_2) \wedge \Box_{x2}(Ex_2 \rightarrow Ex_1)$" (their statement (26)). In words, object $x_1$ is essentially such that its existence requires that of $x_2$, and, conversely, object $x_2$ is essentially such that its existence requires that of $x_1$. By the two objects $x_1$ and $x_2$ they do not mean the two electrons per se, "as they may well exist unentangled" (p. 882; cf. p. 869). This denial of an essential relatedness of the particles as such reflects their anti-reductionism concerning quantum objects. Instead, the two variables "refer to two things that exist with certain properties" (p. 883), or "qualitative profiles" (p. 869, p. 882). Calosi and Morganti do not specify the ontological category of the intended referents of the variables. A plausible proposal could be *qua*-objects in the sense of Fine (1999: 67–68). It may be held that when Joe Biden became US-president in January 2021, a new entity came into existence in addition to the person Joe Biden, viz., the social object Joe Biden-*qua*-US-president. While Joe Biden is only accidentally US-president, this political role is essential to the social object Biden-*qua*-president. The idea can be generalised to relational *qua*-objects. We can say that when Ann and Bob marry, two social objects emerge, Ann-*qua*-married-to-Bob and Bob-*qua*-married-to-Ann.

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[28] For the sake of argument, we take Calosi and Morganti's objects-in-relations view of entanglement as a basis and will not problematise the labelling of the two particles as "1" and "2".

While Ann and Bob are only accidentally married, Ann-*qua*-married-to-Bob is essentially married to Bob and Bob-*qua*-married-to-Ann is essentially married to Ann.

Similarly, the proposal is that it is electron-1-*qua*-in-the-singlet-state-together-with-2, or 1-*qua* for short, and electron-2-*qua*-in-the-singlet-state-together-with-1, or 2-*qua* for short, that are essentially related regarding their existence. When we define relation R as $Ruv =_{def} Eu \rightarrow Ev$ (*u*'s existence requires that of *v*), we can state a pair of facts of reciprocal essence in Fine's sense: $\Box_{1\text{-}qua}R(1\text{-}qua, 2\text{-}qua)$ and $\Box_{2\text{-}qua}R(2\text{-}qua, 1\text{-}qua)$ or, in predicational notation, $E_{1\text{-}qua}\lambda uR(u, 2\text{-}qua)$ and $E_{2\text{-}qua}\lambda uR(u, 1\text{-}qua)$. The two electrons-*qua*-entangled appear to metaphysically depend on one another in a reciprocal way. However, in Sect. 3.3, we argued following Fine that while reciprocal ontic dependence can be admitted for a liberal, consequential notion of essence, it always derives from a more basic relational essence. In the present case, the underlying fact of relational essence is that 1-*qua* and 2-*qua* are essentially such that the first exists only if the second does, and vice versa: $\Box_{1\text{-}qua,2\text{-}qua}R(1\text{-}qua, 2\text{-}qua) \wedge R(2\text{-}qua, 1\text{-}qua)$ or, in predicational notation, $E_{1\text{-}qua,2\text{-}qua}\lambda uv(Ruv \wedge Rvu)$, which in effect is $E_{1\text{-}qua,2\text{-}qua}\lambda uv(Eu \leftrightarrow Ev)$. In this more basic analysis, the objects 1-*qua* and 2-*qua* do not feature in each other's essence and are therefore not ontologically dependent on one another after all. They only have a common, relational essence. The appearance of symmetric dependence is merely superficial.

It could be urged that relational essence is symmetry enough to threaten foundationalism. However, there is nothing here to worry about. What underlies the relational essence of Ann-*qua*-married and Bob-*qua*-married is the ordinary fact that Ann and Bob are married. Similarly, what underlies the relational essence of 1-*qua* and 2-*qua* is the fact that the two electrons 1 and 2 stand, as a matter of fact, in a specific physical relation of entanglement that requires the existence of both relata. In both cases, the contingent fact that two objects stand in a certain relation constitutes two *qua*-objects that have a common relational essence and thereby, derivatively, constitutes the harmless reciprocal dependence of those *qua*-objects.

## 4.3 Ambiguity

Calosi and Morganti are likely to reply that by the qualitative profiles with respect to which entangled particles depend on one another (p. 869) they do not mean properties to the effect that the particles are entangled. Instead, they speak of "a specific set of objective properties" (p. 869), of "physical observables" and "actual properties" (p. 875). For the singlet state, the relevant observable is spin in a selected direction. The corresponding objective or actual properties would be the determinate properties spin up and spin down in that direction. The view might be that what reciprocally depends on each other is not particles-*qua*-entangled, but specific facts or states of affairs to the effect that one particle is in a particular determinate spin state, either up or down. As an instance of their formula stating mutual dependence, we would have

$\Box_{1\text{'s being up}}(E(1\text{'s being up}) \rightarrow E(2\text{'s being down})) \wedge \Box_{2\text{'s being down}}(E(2\text{'s being down}) \rightarrow E(1\text{'s being up})),$

plausibly extended by two further conjuncts for $\square_{1\text{'s being down}}$ and $\square_{2\text{'s being up}}$, with "E" expressing the existence of a (potential) fact or the obtaining of a state of affairs.

Focus only on the first conjunct. The problem with this proposition of essence is that it is simply not true, according to the authors' own view. It is not true that it is essential to the fact (or state of affairs) of electron 1's being spin up that this fact exists (or the state of affairs obtains) only if the fact of electron 2's being spin down exists (or the state of affairs obtains). For as part of their anti-reductionism about quantum objects, the authors maintain that each one of the two particles might well exist without being entangled with the other particle. Electron 1 could simply be spin up all on its own, for example after having been found to be spin up by a spin measurement in the selected direction. No correlations with states of affairs concerning determinate spin states of any other particle, such as electron 2, are essential to the potential fact of 1's being spin up; electron 2 need not even exist.

This brings us to the problem of ambiguity. For it is intuitively correct that potential facts concerning determinate spin states of the two electrons in the singlet state stand in a relationship of mutual dependence. The question only is whether this relationship is metaphysical dependence or of some other kind. To see the dependencies in question, consider the system in the singlet state in a context in which possible determinate spin states become manifest. Suppose a pair of electrons exists in the singlet state before a time $t$ and that spin measurement in the relevant direction is performed on the system (actually, on one of the two electrons) at $t$. For the sake of argument, let us adopt some collapse interpretation, so that after measurement at $t$, the two electrons exist in determinate spin states, either up-down or down-up. Let us assume that 1 is up and 2 is down after $t$.

We may ask, first: before $t$, does the fact that 1 is up depend on the fact that 2 is down, and vice versa? The intuitive answer is no, simply because before $t$ those two determinate spin states do not exist. Secondly, then, after $t$, does the fact that 1 is up depend on the fact that 2 is down, and vice versa? Plausibly yes, but only in a broadly causal sense, which can be made explicit by a pair of counterfactuals: if 1 had not been up after $t$, 2 would not have been down after $t$; and if 2 had not been down after $t$, 1 would not have been up after $t$. To evaluate those counterfactuals, we may adopt a standard closest-world analysis. The closest worlds in which 1 is not spin up after $t$ are worlds in which the electrons are still in the singlet state before $t$ and in which still spin measurement is applied to them at $t$. Given the laws of nature, the only alternative under those conditions to the result up-down is down-up. So under the counterfactual assumption that 1 is not spin up after $t$, 2 would not be spin down; similarly for the second counterfactual.[29] Thirdly, with regard to the time before $t$, in which the electrons are not in determinate spin states yet, can we not make sense of the claim that *potential* facts concerning their being in such determinate states mutually depend on each other? Plausibly yes, but once again only in a broadly causal sense made

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[29] It is not our topic whether such reciprocal counterfactual dependencies constitute "spooky action-at-a-distance". Bell's argument (see Maudlin, 1994) precludes the existence of local hidden variables that deterministically cause the correlated measurement results. Still, the counterfactuals need not reflect a reciprocal event causation between the two particles' determinate spin states. Instead, spin measurement could be a common indeterministic cause of both results: the act of measurement enhances the probability of the two events of 1 being up and 2 being down from some low value to 50%.

explicit by a bunch of counterfactuals: if electron 1 had been up at a certain time *t'* before *t*, electron 2 would have been down at *t'*, etc. Those counterfactuals are true only because we can assume that the two electrons have been in the singlet state for a while. In the closest worlds in which 1 is up at *t'*, this is so because a (nonactual) spin measurement has been applied to the pair in the singlet state some time before *t'*, with the result that 1 is up and 2 is down, so that 2 would have been down under the counterfactual assumption that 1 is up; similarly for the reversed counterfactual that if 2 had been down, 1 would have been up.

The upshot is that (potential) facts about particles being in determinate spin states plausibly stand in reciprocal relationships of dependence, but that the dependence is of a broadly causal kind rather than genuinely metaphysical. The impression of a metaphysical interdependence seems to result from an ambiguity in the term "dependence": a broadly causal interdependence is misinterpreted as metaphysical.

## 4.4 Insubstantiality

A conceivable response would be to concede that the suggested counterfactuals express a broadly causal interdependence, but to insist that this independence is a mere surface phenomenon of entanglement, which is to be analysed as reciprocal metaphysical dependence after all to properly account for that causal surface profile. Calosi and Morganti (2021: 885, 886) present their view as a "philosophical analysis of entanglement" and question the view that "entanglement is a genuine physical relation". This could mean that the relation requires a genuinely metaphysical analysis – in terms of metaphysical interdependence. According to this response, the proper target of essentialist claims is not particular quantum (*qua-*)objects nor particular facts about such objects. Instead, the claims would concern specific type-relations of entanglement, such as that of two electrons being in the singlet state. The contention would be that it is essential to the singlet state-relation as a type that any two objects standing in this relation are such that they are causally-counterfactually interdependent: if spin-measurement were performed on one of them, then after measurement, if one were spin up, the other would be spin down, etc. Formally, the claim would read:

$$\Box_{\text{SingletState}} \forall xy [\text{SingletState}^2 xy \rightarrow (\text{Measured}^2 xy \,\Box\!\!\rightarrow ((\text{Up}^1 x \,\Box\!\!\rightarrow \text{Down}^1 y) \wedge (\text{Down}^1 x \,\Box\!\!\rightarrow \text{Up}^1 y) \wedge \ldots)].$$

If we ignore the index and the nesting of "□→", this formulation is remarkably close to A. Birds (2007: 46) schematic representation of essentially dispositional properties, $\Box(Px \rightarrow (Sx \,\Box\!\!\rightarrow Mx))$, in words: potency P is such that, necessarily, whenever it is instantiated by an object, if the object received stimulus S, it would react with manifestation M. The singlet state is presented as a kind of joint disposition of particle pairs to reveal, upon measurement, certain counterfactual correlations between their spin states.

However, the only explicit interdependence we are dealing with is still causal-counterfactual. The fact that a disposition is characterised by a profile of counterfactual interdependencies does not mean that the disposition itself involves a genuinely

metaphysical kind of interdependence. Due to its mechanical construction, a seesaw has a disposition to the effect that, if its left part were up, its right part would be down, and if its right part were down, its left part would be up, etc. But the construction itself hardly involves a specifically metaphysical kind of interdependence.

The crucial question therefore is what the exact nature of the disposition in question is, due to which it necessarily exhibits a counterfactual interdependence regarding its possible manifestations. One position would be analogous to Bird's: the singlet state is a metaphysically fundamental relation that simply is necessarily connected to the counterfactual profile in question. In my view, such a fundamentality claim would be deeply problematic.[30] The main point, however, is that fundamentalism about dispositional quantum states would be a version of metaphysical foundationalism and not of coherentism. The claim would be that the states are fundamental and that a counterfactual profile somehow flows from their nature. A second position could be that the modality at work is not metaphysical, but only natural necessity. Contingent laws of nature would underlie the connection between the state and its counterfactual profile. This too accords with foundationalism. A third view would be that being a joint disposition, the singlet state is not fundamental but can be metaphysically analysed in a more or less Humean manner by reference to determinate properties, such as spin up and spin down. A metaphysical analysis of quantum states in terms of more basic determinate states would be openly foundationalist.

I lean towards the third view, with elements from the second. The idea is that quantum states are potencies in the sense of potencies accounts of objective chance. The potencies reduce to Humean laws of nature basically in the way of Lewis (1994), though with a more explicitly frequencies-related construal of "fit". In outline, the singlet state would be metaphysically analysed as follows:[31]

> For two particles to be in the singlet state is for them to originate from circumstances (a source, say) of a kind C such that the laws of nature assign to C the spin function $\sqrt{1/2}|\uparrow\rangle_1|\downarrow\rangle_2 - \sqrt{1/2}|\downarrow\rangle_1|\uparrow\rangle_2$, where it is part of the laws assigning that spin function to C being the actual laws that the squares of the two coefficients, $1/2$ and $1/2$, closely fit the actual frequencies of the two combinations up/down and down/up of determinate spin values (represented by $|\uparrow\rangle_1|\downarrow\rangle_2$ and $|\downarrow\rangle_1|\uparrow\rangle_2$) for particles originating from circumstances of kind C in the case of spin measurement. At a minimum, this sketch illustrates the form an explicit metaphysical analysis of quantum states would need to take.

In sum, an anti-reductionist objects-in-relations view of entanglement seems well-motivated.[32] What does not become apparent is a metaphysical analysis even of the

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[30] The necessary connection to a counterfactual profile is acceptable only if the profile is essential to the state. But since essence is a notion of metaphysical priority, the profile would have to be prior to the state, which therefore could not be fundamental. Cf. Wang (2019), Busse (2021).

[31] For Humean approaches see Miller (2014), Bhogal and Perry (2017), Dorst (2023). Crucially, the fact that an entangled system's quantum state does not supervene on the individual states of its elements is compatible with the state supervening on the complete Humean mosaic.

[32] An obvious hurdle such an interpretation needs to clear is the complementarity of spin in different directions. Note that Calosi and Morganti do not tell us what quantum objects are. Here is a Humean approach.

paradigmatic singlet state in terms of genuine metaphysical interdependence. The idea that quantum entanglement is reciprocal metaphysical interdependence remains a mere slogan. It is not substantiated by an explicit and concrete metaphysical analysis of entanglement relations in terms of specifically metaphysical interdependence concerning determinate physical properties. One might think that the underlying physics is concrete enough. But this stunt of jumping from the details of quantum physics directly to diagnoses in highly abstract terms of metaphysical dependence is precisely the problem of the approach. What is missing is the required intermediate step of a substantive metaphysical interpretation. Far from substantiating coherentism about entanglement, Calosi and Morganti's idea of a metaphysical analysis of quantum states rather points towards foundationalism.

## 5 Conclusion

The claimed advantages of metaphysical coherentism over foundationalism do not hold up to scrutiny. No explanatory surplus value of having metaphysical dependence run in circles instead of assuming terminating chains could be confirmed, nor could it be established that a reasonable model of holistic explanation must assume irresolvable reciprocal metaphysical dependence. Alleged examples of reciprocal metaphysical dependence are either shown to really involve other, typically causal relationships, or they can at least as well and sometimes much better be dealt with in a foundationalist framework. Some apparently symmetry-friendly metaphysical theses cannot be satisfactorily made sense of on either approach. This, I assume, just speaks against those theses. Similar problems recur for a view of quantum entanglement as metaphysical interdependence. At the current state of the debate at least, no good reasons for preferring coherentism to an orthodox foundationalist view emerge.

On the contrary, coherentism seems to be at a systematic disadvantage. At no point could mutual metaphysical dependence be substantiated by a specific account of *how in detail* one item metaphysically explains another, and vice versa. Foundationalism, by contrast, could offer comprehensible more specific explanatory relations. Is there a more general reason for this difference? The diagnosis I wish to suggest is that

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Applied to the circumstances given by the source of an electron pair in the singlet state, the quantum laws determine a position wavefunction describing one particle moving, say, to the left, if only as one factor of a common wavefunction for both electrons, and another such function describing a particle moving to the right. Call a region of space at a time *occupied* iff there is a position function determined by actually obtaining circumstances that assigns a non-negligible probability of a particle's presence to positions within the region but not to positions outside of it. The particle moving to the left (likewise the one moving to the right) is a spacetime-worm consisting of occupied spatial regions as its time-slices. The worm is counterfactually integrated: if this region now were not occupied, that region a moment later would be occupied with a much lower probability. The integration is specific to that worm in that it obtains independently of whether the entanglement regarding spin is maintained or broken. Humeans, and Lewisians in particular, may identify such a counterfactually integrated spacetime-worm with an electron moving to the left. The proposal does not quite work for entanglement due to anti-symmetricalisation. Regarding the electrons in a helium shell, for example, one would need to refer in an irreducible plural to "two" particles. This plural reference cannot be dissolved into two separate singular references, because there is only a single counterfactually integrated spacetime-worm, the spatial area of the atomic shell across time. Unless a Bohmian interpretation is assumed, there simply are no two individual persisting electrons in the shell.

grounding and essence can be distinguished both from less tight, typically causal forms of dependence and from mere modal connections only if those relations are construed as relationships of constitution (Fine, 2012: 37; Fine, 2015; Bliss & Trogdon, 2021: introduction; for doubts see Correia & Skiles, 2019: 664). Essence and ground are two different modes of constitutive explanations of given items in terms of others.[33] They are different ways of reflecting what a target phenomenon consists in (for grounding see Fine, 2012: 39); in the introduction, I suggested that they are two different aspects of complete accounts of how a phenomenon is and can be constituted. But it seems that we lose track of the idea of a constitutive explanation if we admit that both A (partially) consists in B and B in A. For example, a conjunctive truth $p \wedge q$ consists in its two conjuncts in that $p$, $q$ together constitutively explain the conjunction. They do so in a specific, comprehensible manner: $p \wedge q$ results from the fact that the two given truths $p$, $q$ *conjoin*, as contrasted, for example, with the fact that a given truth $p$ is *disjoined* with arbitrary $q$ to yield $p \vee q$.[34] If we insisted in a coherentist fashion that the conjunction in turn constitutively explains its conjuncts, we would lose track of the notion of metaphysical explanation, because the notion would appear to collapse into one of mutual entailment.

## Declarations

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[33] The diagnosis remains essentially the same if determination rather than explanation is assumed to be at the centre of grounding; see Bliss and Trogdon (2021: introduction and Sect. 1.1). Following Fine (2012: 37), I believe that grounding is both explanatory and determinative.

[34] I am strongly inclined towards the view that, regarding grounding, the real explanatory work in first-order metaphysics is done by specific "building relations" (Bennett, 2017) or "small-g grounding relations" (Bliss & Priest 2018: 16 n.; Wilson, 2014). As I see it, this does not in the least undermine the philosophical value of understanding those relations as species of generic "big-G" metaphysical grounding. Similarly, essentiality in general is a generic "big-E" relation that has many specific "small-e" essence-generating relations as its species, such as that $p$ is a required conjunct for $p \wedge q$.

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