Grounding, reduction, and analysis*

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ABSTRACT: This paper establishes the precise relationship between grounding, reduction, and analysis. The first part identifies the conditions under which a grounding connection implies a corresponding reductive identity and distinguishes different notions of irreducibility. The second part provides an account of analysis and shows which kinds of irreducibility imply that something cannot be analysed. The third section illustrates the account of reduction by applying it to the problem of physicalism.

1 Grounding and reduction

Reduction involves property identities. The identity F = G is a reductive property identity if (i) F is a type-1 property, (ii) G is a type-2 property, and (iii) type-1 properties are grounded in type-2 properties.[1] Put differently, a reductive property identity consists in a type-1 property being identical to a member of a family of properties, the type-2 properties, in which the type-1 properties are grounded. In that case, F is identical to a type-2 property, namely G, whilst also being grounded in and explained by other type-2 properties, namely its grounds. Whilst one reduces a property F of type-1 to a property of type-2 by finding a type-2 property G to which F is identical, one reduces the class of type-1 properties (e.g. normative properties), to the class of type-2 properties (e.g. descriptive properties) by finding for every type-1 property some type-2 property to which it is identical, i.e. an entire class of properties can be reduced by establishing a reductive property identity for each member of that class.[2]

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[1] Grounding (in the sense in which it is relevant for the purposes of this paper) is a relation amongst property instantiations. To say that a property F grounds a property G is thus shorthand for saying that instantiations of Fness ground instantiations of Gness.

[2] Reduction is, accordingly, transitive: if type-1 properties reduce to type-2 properties and type-2 properties reduce to type-3 properties, then type-1 properties reduce to type-3 properties.

It is common to consider grounding to have reductionist import. The fact that reduction consists in property-identities, however, seems to preclude grounding from having straightforward reductionist implications.

- First, grounding is irreflexive. Nothing grounds itself. Identity, however, is reflexive. The fact that x's being G grounds x's being F rules out that G is identical to F. The irreflexivity of grounding implies that a property cannot be identical to its grounds and hence cannot be reduced to its grounds (cf. Audi: 2012, pp. 110-111). For instance, if a normative property N is grounded in a descriptive property D, then N is not identical to D and hence cannot be reduced to D.

- Second, whereas grounding is asymmetric, identity is symmetric. If x's being F is grounded in x's being G, then x's being G is not grounded in x's being F. However, if F is identical to G, then G is identical to F.

- Third, partial grounding can be many-one, yet identity is one-one. Γ can be a plurality of partial grounds that collectively (fully) ground x's being F. Many things can jointly make it the case that x is F, e.g. if $F = H \wedge G$, then F is grounded collectively in H, G. For instance, a normative property N can be collectively grounded in a plurality of descriptive features $D_1 \ldots D_n$ and hence cannot be identical to any of them taken individually nor to all of them taken collectively.

- Fourth, full grounding can be many-one, in which case the property is multiply realisable. A property can have multiple full grounds, both within a given situation if its different grounds are compatible, in which case it is overgrounded, as well as across different situations. A disjunctive property can be grounded in each of the disjuncts, e.g. if $F = H \vee G$, then (i) F is grounded in H, (ii) F is grounded in G, and (iii) if these grounds are compatible then F is, in addition, grounded collectively in H and G. A normative property N, for instance, can be grounded not only in D but also in D' etc. Since identity is one-one, yet the relation between N and its grounds is a one-many relation, N cannot be reduced to its actual grounds nor to all of its possible grounds.

Irreflexivity and asymmetry, as well as many-one grounding relations (at the level of both partial and full grounds) seem to conflict with establishing property identities, which are reflexive, symmetric and one-one. Grounding of type-1 properties in type-2 properties thus appears to rule out reductive identities. This, however, is puzzling. The claim that, say, normative properties are grounded in natural properties is naturally taken to have reductionist implications. How then are we to make sense of the supposed reductionist import of grounding?

Reducing F requires one to identify some property G to which F is identical. In order to establish such identities, we need criteria for property identity. A satisfactory theory of property identity has to be a hyperintensional theory that is more fine-grained than necessary co-extension (yet not ultra fine-grained either, i.e. it has to track worldly differences). Since derivative entities have their identity conditions conferred upon them by the things from which they derive, they are identical iff they derive from the same things in the same ways. Identity of (non-fundamental) properties is thus to be understood in terms of sameness of grounds. Derivative properties are identical iff they are hyperintensionally equivalent, i.e. they are grounded in the same things in the same ways (across all of modal space).

The set of fundamental properties $\mathcal{F}$ contains all those properties that are ungrounded. The set of basic grounders $\mathcal{B}$ consists of all compatible pluralities (including degenerate pluralities) of fundamental properties. The grounding set g(F) of a property F is the set that contains all basic proper and improper grounders of F, i.e. $g(F) = \{\Gamma \in \mathcal{B} : \Gamma \text{ grounds } F\}$. Two (non-fundamental) properties F and G are identical iff they are hyperintensionally equivalent, i.e. $g(F) = g(G)$.[3]

Reduction then turns out to be connected to grounding after all, since reduction involves property identities and property identities are based on sameness of grounding sets. Since establishing property identities in the case of derivative properties amounts to establishing sameness of grounding sets, the crucial question concerns the conditions under which one can establish that a type-1 property has the same grounding set as a type-2 property. If type-1 properties are grounded in type-2 properties, what are the conditions that ensure that for every type-1 property there is a corresponding type-2 property that has the same grounding set?

1.1 Horizontal reduction

Two conditions must be satisfied for a grounding connection to imply a reductive identity. If type-1 properties are grounded in type-2 properties, where this is understood such that every possible grounding chain of type-1 properties has to contain a type-2 link, i.e. every way of grounding type-1 properties has to either terminate in or pass through a type-2 property, then type-1 properties are reducible to type-2 properties iff the following two conditions are satisfied:[4]

CONDITION 1: the grounding relations connecting type-1 to type-2 properties are metaphysical grounding relations.[5]

[3] The resulting hyperintensional logic is developed in "Hyperintensional equivalence" (Bader: manuscript).

[4] Two further sources of irreducibility, in addition to non-metaphysical grounding and the possibility of violations of the closure condition, are the non-standard relations of stochastic grounding and conditional grounding. Due to considerations of space, these non-standard relations will be set aside. For relevant discussions cf. Bader: 2017, pp. 129-131, "Conditional grounding" (Bader: manuscript), and Bader: 2021.

[5] This is connected to the requirement that the modal strength of a supervenience claim has to be that of metaphysical necessity if one is to make use of a Kim-style argument to establish

CONDITION 2: the relevant grounding connections preserve the higher-order property of being a type-2 property.

If these conditions are satisfied, then for every type-1 property there is a type-2 property to which it is identical. The satisfaction of these conditions ensures that one can construct a type-2 property that has the very same grounds as a given type-1 property. By conjoining the components of the basic grounders of all instantiations of F, and then disjoining these conjunctive properties, one ends up with a property G that is a disjunction of conjunctions of type-2 properties that has the same grounds as the type-1 property one started with. Due to having the same grounding sets, the properties are hyperintensionally equivalent and hence identical.

Every (actual as well as possible) instantiation x_i of a type-1 property F is grounded in a collection of instantiations of type-2 properties Γ_i. All the different pluralities $\Gamma_1 \ldots \Gamma_n$ that ground instantiations $x_1 \ldots x_n$ together constitute the basic grounders of F. They are the members of F's grounding set g(F).[6] Out of these pluralities one can construct a disjunctive type-2 property G that has the same grounds as F. G can be constructed by disjoining the conjunctive properties that are formed by conjoining the members of Γ_i for every possible instantiation x_i of F. More precisely, for any Γ_i one forms a conjunctive property $\wedge\Gamma_i$ (which equals $H_1 \wedge H_2 \ldots \wedge H_n$ for all H_i that are amongst Γ_i). By disjoining all such conjunctive properties one ends up with a property $G = \bigvee\{\wedge\Gamma_i$ for all $\Gamma_i \in g(F)\}$ that is not only necessarily co-extensive with F but that also has the very same grounds. Both have $\Gamma_1 \ldots \Gamma_n$ as their basic grounders, so that $g(F) = g(G)$. In this way one can show that a type-1 property is nothing but (i.e. is identical to) a disjunction of conjunctions of type-2 properties and hence itself a type-2 property (given that the relevant closure conditions are satisfied).[7]

The irreflexivity and asymmetry of grounding as well as the possibility of

that for every A-property there is a corresponding B-property that is intensionally equivalent. (If the modality of the relevant supervenience claim is weaker than metaphysical necessity, then intensional equivalence can only be established by including laws or picking out worlds directly, in which case the property will, at least ordinarily, no longer belong to the family of B-properties.)

[6] For simplicity, we are assuming that type-2 properties are amongst the basic grounders, i.e. that all members of Γ are fundamental properties.

[7] The disjunctive property formed in this way need not be identical to the disjunctive property formed by disjoining the conjunctions of type-2 properties on which the type-1 property supervenes, even when making use of a minimal supervenience base that does not include maximal base-properties that correspond to type-2 descriptions of the whole world but that only characterise the object's type-2 nature whilst leaving out irrelevant information. These properties can diverge where a property is overgrounded and where one basic ground is part of another, as happens when absorption principles fail. This divergence arises because grounding is characterised by a relevance constraint, whereas supervenience is subject to a more restrictive minimality constraint. For instance, F is distinct from $H =_{df} (F \vee (F \wedge G))$, allowing for F as well as the plurality $F \circ G$ to be in the grounding set of H, yet only F is in the supervenience base, since $F \circ G$ satisfies the relevance condition but not the minimality constraint.

many-one grounding relations ensures that one cannot reduce a property to its grounds. As a result, reduction is not a 'vertical' relation connecting F to its grounds. Grounding can nevertheless have reductionist implications. This is because a grounding connection between type-1 and type-2 properties allows one to establish the 'horizontal' property identities required for a reduction of the former to the latter, as long as conditions 1 and 2 are satisfied.

Reduction does not proceed vertically. One does not move to a lower level in the fundamentality ordering by reducing a type-1 property to its type-2 grounds (neither to its actual grounds nor to its possible grounds). Instead, it is a horizontal matter. One remains at the same level and reduces a type-1 property by finding a type-2 property that has the very same grounds and to which it is hence identical.

The fact that reduction is horizontal rather than vertical gets around the irreflexivity and asymmetry problem. The relation between type-1 property F and each of its type-2 grounds Γ_i is irreflexive and asymmetric. However, the relation between this type-1 property and the type-2 property G that is also grounded in all the Γ_i is a reflexive and symmetric relation, namely the identity relation. The problems deriving from the fact that grounding can be many-one (at the level of both partial and full grounds) are addressed by suitably conjoining and disjoining the properties involved in grounding F. The different partial grounds that collectively ground instantiations of F are conjoined to form conjunctive properties: $\wedge\Gamma_i$. The different full grounds of F are disjoined to form one disjunctive property: $G = \bigvee\{\wedge\Gamma_i \text{ for all } \Gamma_i \in g(F)\}$. The resulting disjunction of these conjunctions is a single property that can stand in a one-one relation to F, namely the identity relation.[8]

1.2 Metaphysical grounding

If different types of grounding relations are countenanced, the theory that was sketched above needs to be supplemented. When introducing a range of different grounding relations, such as metaphysical grounding (g_M), normative grounding (g_N), and nomological grounding (g_C), the i-grounding set $g_i(F)$ does not have

[8]One cannot say that the two properties are distinct because the one is disjunctive whereas the other is not. Although one is specified disjunctively, whereas the other is specified non-disjunctively, this is not a difference between the properties, but a difference in the way in which they are specified and picked out. When concerned with property identities, one is not interested in how the properties are specified but in what kinds of properties they are. Now, to be a disjunctive property is nothing other than to be a property that has a plurality of grounds. Since both properties have this feature (after all, they have the same grounding set), they are both disjunctive and hence do not differ in this respect. One also cannot deny that the disjunctive type-2 counterpart exists, by arguing that there are no disjunctive properties. Since the disjunctive type-2 property has the very same grounds as the type-1 property, the one is disjunctive iff the other is disjunctive, which means that by rejecting the disjunctive type-2 property one would also be rejecting the type-1 property in question.

to contain basic grounders. It is not required that $\Gamma \in \mathcal{B}$ in order for $\Gamma \in g_i(F)$. Instead, it contains the (proper and improper) i-basic grounds of F that are the ultimate grounds in i-grounding chains giving rise to F, i.e. $g_i(F) = \{\Gamma : \Gamma \text{ grounds}_i \text{ F} \ \wedge \ \neg\exists\Delta(\Delta \neq \Gamma \wedge \Delta \text{ grounds}_i \ \Gamma)\}$, where every property is an improper ground of itself with respect to every grounding relation.[9]

Hyperintensional equivalence is then a matter of (i) having the same grounds and (ii) being grounded in those grounds in the same ways, i.e. via the same type of grounding relation. Non-fundamental properties F and G are identical iff $g_i(F) = g_i(G)$ for some basic grounding relation g_i.[10] This allows some non-fundamental properties to be individuated in terms of (pluralities of) other (more fundamental) non-fundamental properties, generating a recursive structure that ultimately terminates in basic grounders, i.e. in compatible pluralities of fundamental properties, where fundamental properties are i-basic with respect to every i-grounding chain.

Condition 1 is required to ensure that the type-1 property F is grounded in the same way as the type-2 property to which it is to be reduced. The disjunctive type-2 counterpart is metaphysically grounded. G is constructed by means of conjunction and disjunction, both of which are property-forming operations that involve metaphysical grounding. This implies that the type-1 property also has to be metaphysically grounded in order for these properties to be hyperintensionally equivalent. Only then will they have the same metaphysical grounds: $g_M(F) = g_M(G)$. Otherwise, even though F and G will be grounded in the same things, they will be grounded in them in different ways, namely via different grounding relations.

For instance, if F is not metaphysically but normatively grounded in descriptive properties, then there will be a disjunctive descriptive counterpart that is necessarily co-extensive with F and that will have the same grounds.[11] This property, however, is nevertheless hyperintensionally inequivalent to the descriptive property, because the normative property is normatively grounded whereas the descriptive property is metaphysically grounded. Even though these properties are grounded in the same things, they are grounded in different ways namely via

[9] In case the relevant laws are metaphysically contingent and admit of variation across modal space, one has to specify not only the type of grounding relation but also relativise grounds to worlds (or better, to laws), so that grounding sets have the following form: $g_i(F) = \{\Gamma_{|w_1...w_i}, \Delta_{|w_j...w_k}, \Lambda_{|w_l...w_n}\}$.

[10] This condition is restricted to basic grounding relations since constructed grounding relations, in particular the transitive closure of the various basic grounding relations, would ensure that $g_i(F)$ would be identical to $g_i(G)$ in terms of $g_\vee$ even when these properties are grounded in different ways. (Thanks to Louis deRosset for pointing out the need to address constructed grounding relations.)

[11] This will be the case as long as normative and metaphysical modality coincide, such that there is a unique set of norms that holds in all metaphysically possible worlds. There is then no need to relativise grounds to worlds or laws and the properties will be co-extensive across all metaphysically possible worlds.

different relations. As a result, they are hyperintensionally inequivalent and thus distinct. Normative properties are then not reducible to descriptive properties.[12]

1.3 Preserving type-2

The hyperintensionally equivalent property G is a (possibly infinitary) disjunction of (possibly infinitary) conjunctions of type-2 properties. This property itself needs to be a type-2 property in order for the property identity to be a reductive identity. It is for this reason that condition 2, which is a closure condition, has to be satisfied.

To establish a reductive identity one needs to construct a type-2 property. This is only possible when the relevant construction operations preserve the higher-order property of being a type-2 property. Being constructed out of type-2 properties is not enough for being a type-2 property. Only if the family of type-2 properties is closed under the operations involved in the construction of the property will the constructed property itself be a type-2 property. This is guaranteed to be the case if type-2 properties are closed under both (infinitary) conjunction and (infinitary) disjunction.[13,14]

There are various cases where closure clearly fails. These cases show that grounding connections do not always have reductionist implications. For instance, disjunctive properties are grounded in non-disjunctive properties, yet the family of non-disjunctive properties is not closed under disjunction. One does not remain within the class of non-disjunctive properties by disjoining some members of that class. Disjunctive properties, accordingly, cannot be reduced to non-disjunctive properties. Likewise, infinitary properties are grounded in infinite collections of finitary properties. Yet, finitary properties are not closed under infinitary conjunction and disjunction. Similarly, though being grounded in superdeterminates (in fact, being nothing but disjunctions of superdeterminates), determinables are nevertheless not reducible to superdeterminates, since superdeterminates are not closed under disjunction, i.e. a disjunction of superdeterminates is not itself a superdeterminate. Yet again, derivative properties are grounded in fundamental properties, but the family of fundamental properties is neither closed under disjunction nor conjunction, thereby ensuring that derivative properties are not reducible to fundamental properties.

[12] It is for this reason that non-reductive realists have to countenance a relation of normative grounding that is distinct from metaphysical grounding, cf. Bader: 2017.

[13] Infinitary closure with respect to conjunction and disjunction guarantees that the constructed property is a type-2 property. Closure, however, is not required in full generality but only with respect to the specific applications of the property-forming operations involved in the construction of the property in question, namely the conjoining of the different components in the case of each Γ_i and the disjoining of the resulting conjunctive properties.

[14] There is no need for closure under negation. Cf. van Cleve: 1990 for an argument that closure under negation is not required for a closely related construction in the context of supervenience.

1.4 Irreducibility

There are different ways in which a property can fail to be reducible. Depending on the reasons for which it fails to be reducible, it will either be irreducible tout court or not reducible to type-2 properties.

A property F is irreducible tout court iff:

1. F is not grounded in anything, i.e. F is a fundamental property, or

2. F is not metaphysically grounded (though it can be grounded in different ways).[15]

A type-1 property F fails to be reducible to a type-2 property iff:

3. F is not (always) metaphysically grounded in type-2 properties (though it can be metaphysically grounded in properties that do not belong to type-2, such as other type-1 properties), or

4. F is not (always) metaphysically grounded in type-2 properties in such a way that the grounding connections preserve the higher-order property of being a type-2 property (though it can be metaphysically grounded in type-2 properties).

These types of irreducibility are ordered in decreasing strength. A property that is 1- or 2-irreducible is irreducible tout court. These types of irreducibility are both absolute notions. They represent deep forms of irreducibility. 3- and 4-irreducibility, by contrast, are relative notions and represent somewhat shallow forms of irreducibility. A property satisfying these conditions is irreducible to a particular type of property, namely type-2 properties, where this is compatible with there being some other type of property to which it is reducible.

Relative irreducibility is only of interest if type-1 properties are grounded (in some way or other) in type-2 properties, i.e. the property F stands in the transitive closure of the various grounding relations to type-2 properties. Mere 3-irreducibility then applies only if there are grounding chains starting with F that only reach type-2 properties via grounding relations that do not involve metaphysical grounding and hence involve 2-irreducibility. This means that a type-1 property F that is 3-irreducible without being 2-irreducible fundamentally differs in kind from type-2 properties, yet that this difference is inherited from the type-1 properties in which F is grounded and that are 2-irreducible. This means that the irreducibility of cases involving 3-irreducibility is inherited from 2-irreducibility.

[15] The fact that F is not metaphysically grounded in type-2 properties ensures that no reductive property identity can be established. This is compatible with F itself being a type-2 property, as long as the non-metaphysical grounding relation giving rise to F preserves being a type-2 property. Conditions 1 and 2 are in this way independent of each other, i.e. the closure condition can be satisfied even when F is not metaphysically grounded.

4-irreducibility is the weakest form of irreducibility. If type-1 properties are merely 4-irreducible to type-2 properties, then they are metaphysically grounded in and constructed out of type-2 properties. Accordingly, they are homogenous with each other, i.e. there is no fundamental difference in kind. Nevertheless, reducibility fails because the closure condition is not satisfied, since type-2 properties are not closed under (possibly infinitary) conjunction and/or disjunction. As we will see in section 2.4, cases of 4-irreducibility involve type-1 properties that are not reducible to type-2 properties, yet that are nevertheless fully analysable in terms of type-2 properties.

2-, 3- and 4-irreducibility are at issue when dealing with non-reductive forms of moral realism.[16]

- 2-irreducibility applies to basic normative properties. Such properties are not metaphysically grounded but are instead normatively grounded.[17]

- 3-irreducibility applies to non-basic normative properties vis-à-vis descriptive properties. Such non-basic properties are not reducible to descriptive properties. Even though they are metaphysically grounded, they are not metaphysically grounded in descriptive properties but in other normative properties. For instance, disjunctive normative properties are metaphysically grounded in (basic) normative properties.

  (Mixed normative properties such as $F =_{df} N \vee D$ are such that some, but not all, of their metaphysical grounds are descriptive properties. The fact that some of their grounds are normative is sufficient to preclude a reduction to descriptive properties. It is for this reason that 3- and 4-irreducibility are characterised in terms of not *always* being metaphysically grounded in type-2 properties, which is the case if not all possible metaphysical grounding chains starting with type-1 properties contain a type-2 link, i.e. a full ground involving only type-2 properties.)

  The relative shallowness of mere 3-irreducibility derives from the fact that the non-basic normative properties that are metaphysically grounded in the basic normative properties inherit their irreducibility from the latter.

[16]Radical versions of non-reductive realism even countenance 1-irreducibility in the form of normative properties that are entirely ungrounded. Such theories end up with violations of the supervenience of normative properties on non-normative properties, at least if fundamentalia are independently recombinable, i.e. they either have to accept brute differences or posit brute necessary connections.

[17]Pattern goods involve basic normative properties that are normatively grounded in other normative properties. As such, they are irreducible and classify as emergent normative properties. Even though they are normative properties that are grounded in normative properties, they are nevertheless not reducible to them. (Likewise, as we will see in section 3, mental properties are irreducible, despite being physical properties, when they are non-metaphysically grounded in a physicality-preserving way.)

It is the basic normative properties that give rise to a commitment to 2-irreducibility and that make non-reductive moral realism into a controversial thesis.

- Type 4-irreducibility applies when it comes to non-basic normative properties. These properties are 4-irreducible with respect to basic normative properties, given that being a basic property is not preserved by the relevant grounding connection and hence implies a violation of the closure condition.

1.5 The asymmetry of reduction

Reduction is an asymmetrical notion: if x is reduced to y, then y cannot be reduced to x. Property identities, however, are symmetrical: if x is identical to y, then y is identical to x. Although reduction and identity differ in this way, this does not cause difficulties for construing reduction in terms of property identities.

When one reduces type-1 properties to type-2 properties, one establishes that for every type-1 property there is a type-2 property to which it is identical. If one can establish the requisite reductive property identities for all type-1 properties, where type-1 properties are grounded in type-2 properties, then the converse cannot be the case: it cannot be the case that every type-2 property has a corresponding type-1 property to which it is identical. This holds if grounding chains are well-founded and not dense, i.e. they are constructed out of immediate and not only mediate grounding relations.[18] In that case, there is a point in every grounding chain that starts with a type-1 property below which the chain is type-1 free. The type-2 properties below this point (of which there will be some given that type-1 properties are grounded in type-2 properties) will not have corresponding type-1 properties to which they are identical. (If the grounding chain should be non-well-founded or dense (where neither type-1 nor type-2 properties are amongst the fundamental properties), then there could be infinite alternating sequences of type-1 and type-2 properties.)[19] This implies that if type-1 properties are reduced to type-2 properties, then type-2 properties cannot be reduced to

[18] Well-foundedness should be uncontentious at least in the case of intra-object grounding whereby properties of x are grounded in other properties of x rather than in properties of x's parts (inter-object grounding relations will be considered in section 1.8). Well-foundedness of intra-object grounding is compatible with non-well-foundedness of inter-object grounding, which derives from a non-well-founded, i.e. gunky, mereological hierarchy. Here it is important to note that one cannot generate non-well-founded intra-object chains on the basis of non-well-founded inter-object chains. If x is F (i.e. has the property of having a part that is G) because its part y is G and y, in turn, has property G because its part z is H, then x has a property F* (namely the property of having a part that is H), yet it will not be the case that x is F because x is F*. The inter-object grounding relations do not transfer to intra-object grounding relations.

[19] In that case one might well consider reduction to not be asymmetric and instead consider type-1 and type-2 properties to be inter-reducible.

type-1 properties. Reduction, accordingly, turns out to be asymmetrical.

Asymmetry is thus to be found at the level of classes of properties, not at the level of the particular properties between which property identities are established. Although the relation between a particular type-1 property F and its type-2 disjunctive counterpart G is a symmetrical identity relation, the relation between the class of type-1 properties and the class of type-2 properties is asymmetric. The former is a proper subset of the latter. Every type-1 property is a type-2 property, but not vice versa. There are some type-2 properties that are not type-1 properties.

The significance of reduction is not merely a matter of there being more type-2 properties than type-1 properties, i.e. that the former are more numerous than the latter. Importantly, since a reductive identity is an identity between a type-1 property F and a type-2 property G that is constructed out of the type-2 grounds of F, it follows that amongst the additional type-2 properties that are not identical to any type-1 properties are type-2 properties that are not disconnected and that have nothing to do with type-1 properties but that instead function as their grounds. These additional type-2 properties are to be found in each grounding chain containing type-1 properties, thereby ensuring that the subset relation amongst the classes of properties derives from the fact that there are type-2 properties that are more fundamental than type-1 properties and that account for the latter. Put differently, the properties that classify as both type-1 and type-2 properties are less fundamental than the properties that only classify as type-2 properties and that ground them.

1.6 Anti-realist import

When establishing horizontal reductions, we are merely working with conjunction and disjunction.[20] It is for this reason that reductionist arguments are so significant. They show that type-1 properties are nothing other than disjunctions of conjunctions of type-2 properties. Being able to reduce type-1 properties to type-2 properties in this way is significant because the application of these property-forming operations would seem to be trivial and uncontroversial. If one can get from type-2 properties to type-1 properties merely by means of conjunction and disjunction, then this implies that there is no fundamental heterogeneity between these classes of properties. The autonomy and distinctiveness of type-1 properties (e.g. of normative properties) is thus threatened.

Reductions do not flatten the fundamentality hierarchy. They are not vertical and do not collapse different levels. Instead, one remains at the same level and establishes a horizontal property identity. Nevertheless, they do flatten something.

[20]At the level of the grounding set conjunction amounts to forming collective grounds, i.e. combining the partial grounds that are members of Γ_i, namely $H_1 \circ H_2 \ldots \circ H_n$ for all H_i that are amongst Γ_i. Disjunction, by contrast, amounts to taking the union of all the Γ_i as well as of their compatible combinations.

They replace seemingly deep differences and distinctions in kind by mere subset relations. For instance, the reducibility of normative properties implies that we do not have separate domains of descriptive and normative properties. Instead, the latter are simply a subset of the former. Rather than there being some form of deep heterogeneity, we are merely left with subset relations. This means that, rather than collapsing levels, reductions collapse different domains.

As a result, the anti-realist import of a reduction is to be understood neither in terms of denying 1. the existence of type-1 properties, nor 2. their reality, nor 3. their fundamentality. After all, the starting-point of the argument is that they are derivative properties that are grounded in type-2 properties and hence really exist. Instead, reductionism is antirealist insofar as one denies, for instance, the reality of the normative construed as a separate domain. On the face of it, the normative would seem to constitute a domain of its own. The reality of such a separate domain is precisely what is denied by a reductionist argument. If type-1 properties are reducible to type-2 properties, then the class of type-1 properties is not a sui generis class. These properties do not differ in kind and do not constitute a separate domain of their own. Rather than avoiding ontological commitments, reductions allow one to streamline one's ontology. By reducing various types of properties, one ends up with a unified ontology that is parsimonious as regards quality rather than quantity.[21]

1.7 Informative property-identities

The conditions for a successful reduction allow us to explain why reduction is a metaphysically substantive matter, despite the fact that property identities are metaphysically uninteresting. Schroeder has criticised the idea that reduction can be understood in terms of property identity, claiming that "it makes reductive views out not to really be theses of metaphysics at all, but only in the philosophy of language or epistemology" (cf. Schroeder: 2007, p. 64). The thought seems to be that identities are trivial from a metaphysical point of view. Everything is identical to itself and to nothing else. Accordingly, it might seem that a property identity does not tell us anything about the property itself but only something about language, namely that we pick out the same property by means of different expressions, i.e. we learn that certain expressions are co-referring.

This critique is misguided. It is a substantive metaphysical matter whether the property identities required for the reducibility of type-1 to type-2 properties can be established.[22] To begin with, there has to be a metaphysical grounding relation between the properties in question if a reductive property identity is to

[21] We can think of reduction as underwriting a form of second-order parsimony, by reducing the number of separate domains of properties to which one is committed.

[22] In addition, the general idea that identities are uninteresting and not informative may well be mistaken, as witnessed by water = H_2O, Hesperus = Phosphorus etc. For an inflationary view of the significance of identity statements cf. Gallois: 2005.

be established by constructing a hyperintensionally equivalent type-2 disjunctive counterpart, since the type-1 property has to be grounded in the very same way as the disjunctive property. Though the reductive property identity itself is not explanatory, it is based on an explanatory relation. That every type-1 property is metaphysically grounded in type-2 properties is a substantive matter that reveals something important about the nature of type-1 properties, namely how such properties are grounded, and not merely something about how we pick out properties. Moreover, reductive property identities can only be established if the grounding connection preserves the higher-order property of being a type-2 property. Since it is a non-trivial matter which property-forming operations preserve the properties required for classifying as a type-2 property, the reductive identity will not be trivial but metaphysically substantive. Finally, the reducibility of type-1 properties is not a claim about a particular property identity but a claim about an entire class of properties. It is a metaphysically substantive matter that all type-1 properties are identical to type-2 properties but not vice versa, i.e. that the former constitute a proper subset of the latter.[23]

1.8 Inter-object reductions

There are two dimensions of fundamentality in the case of property instantiations, namely: an object-dimension and a property-dimension.[24] Grounding occurs along both dimensions. If a property of an object is grounded in other properties of that very same object, then we are dealing with intra-object grounding. By contrast, if a property of an object is grounded in properties of and relations amongst that object's parts, then it is a case of inter-object grounding.[25] This distinction at the level of grounding corresponds to that between multiple-domain supervenience (where the domains are coordinated by a suitable mereological relation)

[23] Moreover, we acquire plenty of information about the particular properties when we perform the relevant construction, rather than merely establish that such a construction is possible in principle. By analysing and revealing the structure of the grounding set of a given type-1 property, we come to identify the type-2 grounds that enter into the construction.

[24] We need a vectorial representation of relative fundamentality with both an object- and a property-component. Relative fundamentality can then be understood in terms of a dominance principle that induces an incomplete ordering, whereby ϕ is more fundamental than ψ iff both the object- and a property-components of ϕ are at least as fundamental as the components of ψ and at least one of them is strictly more fundamental. Alternatively, it can be understood in terms of a lexical ordering that gives priority to the object-component, such that ϕ is more fundamental than ψ iff the object-component of ϕ is more fundamental than that of ψ or if the property-component of ϕ is more fundamental than that of ψ in case their object-components are equally fundamental.

[25] Since there is no such thing as grounding at a distance, there is no inter-object grounding without a mereological connection. That is, x's being F cannot fully ground y's being G, where x and y are mereologically disjoint (and where being G is not simply a relational property to the effect of being R-related to something that is F, in which case the full ground of y's being G would not only be x's being F but also x's and y's being R-related).

and single-domain supervenience relations. In the latter but not the former case the A-properties are instantiated by the same things as the B-properties such that they involve a single domain of objects, whereas the other requires two distinct (though not necessarily disjoint) domains.[26]

The fact that an object x is F is intra-object fundamental, i.e. fundamental as far as x is concerned, as long as x's being F is not grounded in any features of x. Yet, this very fact can be inter-object derivative insofar as it can be grounded in properties of x's parts. A fact is inter-object fundamental if it is not grounded in any properties of x's parts (which can happen either if x does not have any parts, i.e. x is a mereological simple, or if F is an emergent feature of x that does not have any grounds).[27] Something that is fundamental in both ways is fundamental as far as the entire grounding hierarchy is concerned, i.e. it is not grounded in any features of anything.

Difficulties arise when reducing properties that are intra-object fundamental yet inter-object derivative. The property that is to be reduced is then instantiated by objects that are distinct from the objects that instantiate the properties that function as its ground. In such cases, type-1 properties are had by wholes, whereas type-2 properties are had by their parts. Since these properties are instantiated by different objects they fail to be necessarily co-extensive, let alone hyperintensionally equivalent. Although we can specify a disjunctive condition in terms of type-2 properties, this condition will not be satisfied by the object that has the type-1 property F but by that object's parts. Even though any world in which the one condition is satisfied is also one in which the other condition is satisfied, the objects satisfying these conditions are distinct. Whereas the grounds Γ are to be found at the level of the parts (= the xx's), the grounded property F is to be found at the level of the whole (= x). As a result, it looks like one cannot construct a disjunctive type-2 counterpart that is identical to F and to which this type-1 property can be reduced.

Analogous considerations apply in the context of supervenience. Kim-style reasoning enables us to establish a necessarily co-extensive B-property for every A-property, given that A-properties strongly supervene on B-properties:

$$\Box\forall x\forall F_{\in A}(Fx \rightarrow \exists G_{\in B}(Gx \wedge \Box\forall y(Gy \rightarrow Fy)))$$

The B-property G necessitates the A-property F. This way of stating supervenience already builds in the assumption that B-properties are closed under conjunction.

[26] The significance of inter-object grounding and of the two dimensions of fundamentality is obscured by propositional approaches that make use of schematic letters (e.g. A grounds B) rather than operating with a metaphysically perspicuous representation that identifies the relevant entities and makes it clear whether the entity/entities instantiating the grounded property is identical or distinct from the entity/entities instantiating the grounding properties (e.g. Γ(xx) grounds Fx).

[27] Depending on whether one takes composition or decomposition to be generative and correspondingly takes parts or wholes to be prior, one can understand this condition in terms of 'parts' referring either to proper parts or super parts. (We will proceed on the assumption of atomism.)

Rather than stating that there is a single B-property G that necessitates F, as is usually done, one should specify supervenience in terms of there being some B-properties $G_1 \ldots G_n$ such that necessarily anything that instantiates all of them is F. These B-properties can then be conjoined to form a conjunctive property: $\wedge G_i$. Such a conjunctive property is a sufficient condition for being F. By disjoining all such necessitating bases, one ends up with a necessary condition for being F, since the disjunction of all sufficient conditions is a necessary condition. The property $G^* = \bigvee\{\wedge G_i\}$ for all necessitating bases G_i is, accordingly, a property that is necessarily co-extensive with F, i.e. $\Box\forall x(Fx \leftrightarrow G^*x)$.

This reasoning applies only in the context of single-domain supervenience but not in the context of multiple-domain supervenience. In that case, A-properties are instantiated by members of the supervening domain and supervene on the B-properties instantiated by members of the subvening domain (which is a distinct though not necessarily disjoint domain), whereby the members of the subvening and supervening domains are connected by a co-ordination relation R.

$$\Box\forall x\forall F_{\in A}(Fx \rightarrow \exists yy\exists G_{\in B}(yyRx \wedge Gyy \wedge \Box\forall zz(Gzz \wedge \exists w(zzRw) \rightarrow Fw)))$$

Three things undermine Kim-style reasoning. First, the constructed property $G^* = \bigvee\{\wedge G_i\}$ will be a plural property. Second, the object that is F will be distinct from the plurality instantiating G^*. Third, G^* does not necessitate there being an F. Instead, it only necessitates that any x that is R-related to some yy's instantiating G^* will instantiate F. This leaves it open that there could be some G^*yy without there being any F.[28] This means that, even though $\Box\forall x\forall yy(Fx \leftrightarrow G^*yy)$ given that yyRx, these properties are not necessarily co-extensive and hence cannot be used for reductionist arguments.

To address these problems, we need to find a type-2 property G at the level of the whole that has the same inter-object grounds as the type-1 property F that is to be reduced. These properties will be hyperintensionally equivalent and hence identical. We can do this by appealing to mereological properties. Whenever a part has some property H, then the whole has the property of having a part that has property H. If $\exists y(Hy \wedge y \ll a)$, then $\lambda x[\exists y(Hy \wedge y \ll x)]a$. Whenever some yy's that satisfy condition ϕ compose the whole in question, then the whole has the property of being composed of some yy's that satisfy condition ϕ. If $\exists yy(\phi(yy) \wedge fu(yy) = a)$, then $\lambda x[\exists yy(\phi(yy) \wedge fu(yy) = x)]a$.[29] By suitably

[28] If we wanted to make the necessitation unconditional we would have to work with:

$$\Box\forall x\forall F_{\in A}(Fx \rightarrow \exists yy\exists G_{\in B}(yyRx \wedge Gyy \wedge \Box\forall zz(Gzz \rightarrow \exists w(zzRw \wedge Fw))))$$

In that case it would not only be the properties of the members of the supervening domain that supervene on the subvening domain, but also the very existence of these objects.

[29] The precise form of the relevant mereological properties depends on how exactly one conceives of inter-object grounding, in particular on the precise way in which mereological facts about parthood or composition enter into inter-object grounding. Here the question is whether

conjoining and disjoining such properties, we can construct a hyperintensionally equivalent disjunctive counterpart G at the level of the whole that is identical to the type-1 property F.

This means that we do not reduce properties of wholes to properties of parts. We instead reduce type-1 properties of wholes to type-2 properties of the very same wholes, whereby these type-2 properties are mereological properties of the form 'having a part that has type-2 property H' that are likewise grounded in the properties of the parts.[30] The property identity is then established on the basis that the type-1 property and the type-2 property (both of which are intra-object fundamental) have the same inter-object grounds.[31]

In order for this property identity to be a reductive identity, the constructed property G has to be a type-2 property. The crucial condition here is what we can call mereological closure. This is the requirement that the property had by the whole, namely the property of having a part that is H (or being composed of some yy's that satisfy condition ϕ) is a type-2 property given that H is a type-2 property (or ϕ a type-2 condition). The mereological connection between the parts that instantiate the type-2 properties that function as inter-object grounds of the type-1 property F and the whole that instantiates F has to preserve the higher-order properties that make something a type-2 property such that the mereological property

the mereological connections are amongst the grounds or whether they play a different role by operating in the background. Is it the fact that the xx's satisfy condition Γ together with the fact that the xx's compose x that grounds x's being F or is it the fact that the xx's satisfy condition Γ that grounds x's being F, given that x is the fusion of the xx's? If the mereological relationships are amongst the grounds, then inter-object grounding is simply another situation in which the relational properties of an object are grounded in its standing in the relevant relations. In that case all inter-object grounded properties are relational properties in disguise. By contrast, if the mereological facts operate in the background and are not to be included amongst the grounds (as happens when considering composition to be a generative operation), then inter-object grounding is a distinctive way in which the parts of an object can ground non-relational properties of the whole.

[30] Mereology is understood in a broad sense, such that, for instance, the members of a set are parts thereof (cf. Fine: 2010). Inter-object grounding involving sets and their members can thus be treated in the same way: whenever a member of a set has some property H, then the set has the property of having a member that has property H.

[31] This type of property identity established on the basis of sameness of inter-object grounds is also at issue when it comes to the question whether triangularity and trilaterality are identical (where this would not be a reductive property identity). The properties of being triangular and being trilateral are both intra-object fundamental yet inter-object derivative. E.g. the property of being trilateral, which is had by the whole, is grounded in the properties of the three sides that compose this whole. Whether the property of being triangular is identical to the property of being trilateral accordingly depends on whether they have the same inter-object grounds. Being trilateral is (immediately) explained in terms of the three sides, whereas being triangular is (immediately) explained in terms of the three interior angles. Whilst these explanations differ, these two properties may nevertheless ultimately be explained in terms of the same underlying facts (triangular and trilateral would then correspond to two different ways of 'carving' up non-basic grounds).

had by the whole likewise classifies as a type-2 property. The closure condition in the case of inter-object grounding goes beyond closure under conjunction and disjunction by also including mereological closure.

Mereological closure and the issue of inter-object grounding more generally is important for reductionism in the philosophy of mind, since the grounds of mental properties are instantiated by parts of the objects that instantiate the mental properties. The ground of pain, for instance, consists in C-fibres firing. The C-fibres, however, are not in pain. Only conscious subjects can be in pain, yet C-fibres are not conscious subjects. Being in pain is a property that is had by the subject. It is the person, i.e. the subject of consciousness, that is in pain. This subject has the property of having C-fibres that are firing. This mereological property, however, does not classify as a neurological property. This is because neurological properties are instantiated by neurons, not by persons. If such mereological properties were to be classified as neurological properties, then every object, no matter how gerrymandered, that has neurons as parts would have neurological properties. This means that the class of neurological properties does not satisfy the mereological closure condition that is required for the reduction of mental properties to neurological properties. Accordingly, mental properties cannot be reduced to neurological properties but only to their mereological counterparts. Since these mereological properties are physical properties, this failure of mereological closure with respect to the family of neurological properties does not undermine physicalism but only speaks against the stronger thesis that mental properties are reducible to the subset of physical properties consisting of neurological properties.[32]

2 Reduction and analysis

Reduction operates at the level of (classes of) properties. Analysis, by contrast, operates at the level of predicates (or concepts or other forms of representational items). One and the same property can be picked out and characterised in different ways. When establishing a non-trivial property identity, one establishes that two predicates pick out the same property. In the case of reductive property identities, the predicates that pick out the same property belong to different types. A reductive property identity $F = G$ involves two ways of picking out the same property: by means of the type-1 predicate 'F' and by means of the type-2 predicate 'G'. The property is the same, yet the predicates differ.

Predicates can be complex and can have internal structure. They can have components that are structured in various ways. Moreover, they can have very fine-grained individuation conditions. The predicate 'F & G' may very well be distinct from the predicate '$F \wedge G$', since they involve distinct components, and

[32]Analogous reasoning also shows that mental properties are not reducible to micro-physical properties.

likewise for ‘G ∧ F’, which structures these components in a different way. Yet, these predicates pick out the same property, namely the conjunctive property that is collectively grounded in F and G. Properties, by contrast, need not be conceived of as having any structure. Instead, they can simply be treated as points. This means that we do not need to think of the property as itself being structured. Their individuation conditions are more coarse-grained than those of predicates. They are not to be individuated in terms of their components and how these are structured, but in terms of their grounds. It is only their grounding sets that have components and structure, but not the properties themselves.

For instance, we do not need to think (and, in fact, should not think) of a disjunctive property as a property that has disjunction as a part or component, e.g. as being made up out of ‘F’, ‘G’ and ‘∨’. Instead, a disjunctive property is to be understood as one that has a plurality of grounds: its grounding set has a plurality of members. It does not just have one ground but a number of different full grounds and hence can be had in different ways, namely either in virtue of the one ground or in virtue of the other. The complexity is not to be located in the property but in its grounds. Boolean operations are not constituents of properties but only come in at the level of predicates. For instance, we use ‘F ∧ G’ to pick out the property that is collectively grounded in F and G, i.e. that has the plural ground F ∘ G. Likewise, we use ‘F ∨ G’ to pick out the property that is distributively grounded in F and G, i.e. that can be grounded in each of them separately as well as in both of them collectively if they are compatible.

Although properties are not structured, their grounding sets do have structure. Grounding sets and predicates both have internal structure and can come in varying degrees of complexity. This makes it possible for the internal structure of predicates to correspond in varying degrees to that of the grounding set of the property picked out by the predicates. Predicates, accordingly, can differ in terms of the extent to which they reveal the structure of the property’s grounding set.

What it is to be a certain derivative property is to be the property the instantiation of which is grounded in certain ways in certain things. This is what makes a derivative property the particular property that it is. Since the task of analysis is to reveal what it is to be a given property and since the identity of a derivative property is fixed by its grounding set, analysing a property amounts to identifying predicates that reveal the structure of its grounding set. By identifying the different ways in which a property is grounded, one is identifying that which makes it the case that the property in question is the very property that it is. This means that one is not revealing the structure of the property when one is engaged in analysis, but one is instead identifying the structure of its grounding set.

One attempts to successively unpack the structure of the grounding set by means of more and more complex predicates, the internal structure of which corresponds more and more closely to that of the grounding set. In this way, one proceeds from a relatively uninformative predicate to a more informative one that reveals more of the structure of the property's grounding set. In the limit one ends up with an ultimate analysis that identifies all the basic grounders of the property and thereby fully reveals its grounding set.[33]

The ultimate analysis of a property F is a complex predicate P that has as its components simple predicates that correspond to fundamental properties, where these are combined by means of conjunction and disjunction in a way that corresponds to the structure of the grounding set of F, i.e. the fundamental properties have a corresponding structure to the basic grounders. When stated in disjunctive normal form predicates '$G_1 \ldots G_n$' are conjoined in 'P' iff $G_1 \circ \ldots \circ G_n \in g(F)$, and 'G' is a disjunct in 'P' iff $G \in g(F)$.

For example, what it is to be a bachelor is to be an unmarried male. The property of being a bachelor is the very same property as the conjunctive property of being unmarried and male. This means that the simple predicate 'bachelor' and the complex predicate 'unmarried and male' pick out the same property. Whilst the one does so in a way that does not reveal anything about what this property consists in, the other reveals its grounding set. What grounds being a bachelor is being unmarried and being male. The plurality $U \circ M$ collectively grounds the conjunctive property $U \wedge M$, which is identical to the property B, i.e. $g(B) = g(U \wedge M) = \{U \circ M\}$ (if U and M were basic grounders).[34]

2.1 Successive refinements

Analysis starts with a simple predicate. It then proceeds to more and more complex predicates that reveal more and more of the structure of the grounding set of the property that is to be analysed. By successively refining the initial analysis one moves from non-basic to basic grounds. In the end, one arrives at an ultimate analysis in terms of predicates that pick out fundamental properties. Such an analysis fully reveals the way in which the property in question can be grounded.

Non-ultimate analyses do not identify all the basic grounds but at least some non-basic grounds. They involve components that do not correspond to fundamental properties but to non-fundamental properties that are themselves all grounded in members of g(F), without remainder. When stated in disjunctive normal form predicates '$G_1 \ldots G_n$' are conjoined in 'P' iff $g(\bigwedge\{G_1 \ldots G_n\})$ is a subset of g(F), whereas 'H' is a disjunct in 'P' iff g(H) is a subset of g(F).

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[33] The analysis has to reveal all of the grounders of F and not simply a set of grounders that is such that any thing that is F will always be F in virtue of them. This can be brought out by considering Rosen's proposal to understand a real definition of F in terms of a condition ϕ that is such that $\Box\forall x(Fx \rightarrow (Fx \text{ in virtue of } \phi x)$. This account runs into difficulties since $F =_{df} H \vee (G \vee \neg G)$ will be such that $(G \vee \neg G)x$ will of necessity always ground Fx, yet it will not be the case that "there is nothing more to being F than being ϕ" (Rosen: 2015, p. 198).

[34] The property of being a bachelor is analysed in terms of 'unmarried and male' since it is grounded in 'unmarried' and 'male'. Importantly, it is not grounded in but identical to 'unmarried and male'.

One analysis can classify as a refinement of another analysis. An analysis of F refines another analysis thereof and gets closer to an ultimate analysis by identifying disjunctions or conjunctions of predicates that replace simple predicates that are components of the analysis that is to be refined.

DISJUNCTIVE REFINEMENT

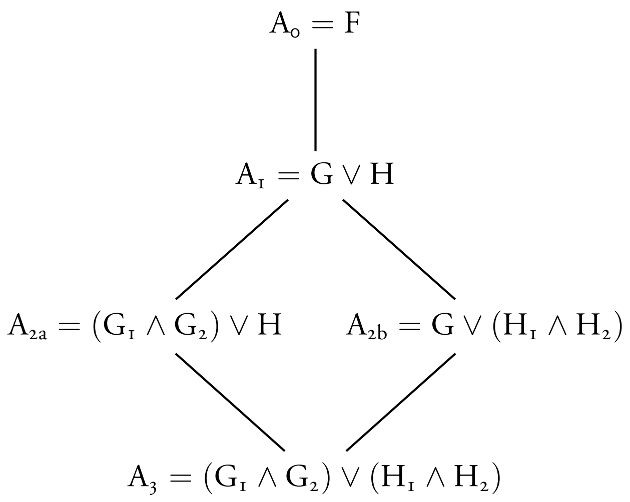
An analysis A_j of F is a disjunctive refinement of another analysis A_i of F if the grounding sets of all the disjuncts occurring in A_j are proper or improper subsets of those occurring in A_i and at least some are proper subsets, whereby these analyses involve the same grounds, i.e. the union of the grounding sets of the disjuncts in A_j is identical to that of the disjuncts in A_i.[35]

CONJUNCTIVE REFINEMENT

An analysis A_j of F is a conjunctive refinement of another analysis A_i of F if a predicate H occurring in A_i is decomposed into a conjunction $\bigwedge\{G_1 \ldots G_n\}$ in A_j that is such that the grounding sets of the conjuncts are subpluralities of the plural ground of H such that concatenating them yields the ground of H, i.e. $\{g(G_1) \circ \ldots \circ g(G_n)\} = g(H)$.

These types of refinement (or more precisely their transitive closure) induce an incomplete ordering since some analyses will not be refinements of each other, which happens when A_i and A_j are such that the former is a refinement of the latter in some respects, yet the latter is a refinement of the former in other respects. For instance, consider the property $F = (G_1 \wedge G_2) \vee (H_1 \wedge H_2)$, where G_1, G_2, H_1, H_2 are fundamental properties such that $g(F) = \{G_1 \circ G_2, H_1 \circ H_2\}$.

[35]When different disjuncts are compatible with each other, amalgamation ensures that the combination of their compatible grounds is also a ground of the disjunctive property, i.e. if $F = (G \vee H)$ where G and H are compatible, then the grounding set g(F) will contain $G \circ H$. In this case the analysis needs to contain the conjunction 'G and H' as a disjunct, thereby making it explicit that G and H are compatible and that F can be collectively grounded in G and H taken together, since otherwise the union of the grounding sets of the disjuncts in the disjunctive refinement would not be identical to but instead be a proper subset of the union of the grounding sets of the disjuncts in the analysis that is to be refined (which in the case at hand would be the degenerate analysis consisting of the degenerate disjunction 'F').



A_0 is a degenerate analysis. It involves a simple predicate 'F' that does not have any internal structure. It is an uninformative label that picks out the property. We then have various (non-degenerate) analyses, some of which are refinements of each other, that all terminate in an ultimate analysis. A_1 is a disjunctive refinement of A_0. The grounding sets of the disjuncts, namely $g(G) = \{G_1 \circ G_2\}$ and $g(H) = \{H_1 \circ H_2\}$, are both proper subsets of $g(F) = \{G_1 \circ G_2, H_1 \circ H_2\}$ that together make up g(F). A_{2a} is a conjunctive refinement of A_1 (and likewise, mutatis mutandis, for A_{2b} and, in turn, for A_3 vis-à-vis both A_{2a} and A_{2b}). The disjunct 'G' is decomposed into the conjunction $G_1 \wedge G_2$, whereby the concatenation of the members of the grounding sets of these conjuncts is identical to the plural ground that is the sole member of the grounding set of G.

A_{2a} and A_{2b} are both refinements of A_1 and are such that the ultimate analysis A_3 is a refinement of each of them. Yet neither is a refinement of the other, nor are they identical. In this way, we start with a simple characterisation 'F' and successively add further complexity until ultimately ending up with an analysis that fully reveals what the property consists in. These different analyses are all correct, yet they differ in terms of how informative they are, depending on the extent to which they reveal the structure of the grounding set. Analyses can thus be genuinely informative. The paradox of analysis can in this way be resolved.

2.2 Analysis and inter-object reductions

When engaging in analysis and revealing a property's grounding set we can either operate at the level of intra-object grounds or the level of inter-object grounds. A property that is derivative as far as x is concerned will admit of a non-trivial analysis in terms of its intra-object grounds that can be revealed by analysing the property. Properties that are intra-object fundamental will only admit of analyses in terms of inter-object grounds that reveal the conditions that x's parts need to satisfy in order for x to have the property in question. One can analyse what it is to be a given property in terms of the mereological properties to which the property in question can be reduced.[36]

Whilst it is possible to proceed to inter-object grounds once one reaches properties that are intra-object fundamental, this is not necessary. An analysis in terms of the property's intra-object grounds is perfectly adequate and often more useful than one that brings in inter-object grounds. Intra-object fundamental properties constitute a natural stopping point when analysing a property that is intra-object derivative and that can be analysed in terms of its intra-object grounds.

Moreover, when moving to the level of inter-object grounds, one can operate at various levels of decomposition, since there are different inter-object grounding sets that can be revealed by means of analysis depending on which parts one picks out, without necessarily having to go to the decomposition into mereological atoms. Going further down the mereological hierarchy by itself does not mean that one gets more information about the property's grounding set. Instead, one acquires information about different inter-object grounding sets of the property that correspond to different decompositions. This means that there is no need for analysis to terminate at the level of atomic parts. Instead, it is possible to remain at the level of intra-object grounds as well as to appeal to relatively proximate inter-object grounds. Indeed, doing so may for many purposes be more appropriate and informative.

2.3 Analysis and higher-order conditions

Analysis reveals the structure of a property's grounding set. One analyses what it is to be F by identifying what instantiations of Fness are grounded in. The identity of a derivative property is given by its grounds, such that identifying those grounds allows us to specify what it is to be that property.

The most straightforward way of doing this consists in providing a list that contains all the (ultimate) grounds of a given property. Although an analysis that lists all the grounds is not wrong, it is not especially informative and perspicuous. Such list-style analyses and definitions can be distinguished from more informative analyses that identify unifying features that are shared by the grounds. In the case of interesting properties, one can identify the grounds in question not only by providing a complete list of them but also by identifying higher-order conditions that characterise these grounds. One can give a perspicuous characterisation of the grounding set by stating what the various grounds share in common. Rather than listing all the members of g(F) separately, one specifies a condition that characterises them. In that case there is something that unifies F's grounds and this is something that a good and perspicuous analysis will identify.

[36]In this case one needs mereological refinements that reveal that F has certain inter-object grounds, in addition to conjunctive and disjunctive refinements. Whilst collective grounding is represented by conjunction and distributive grounding is represented by disjunction, inter-object grounding is represented by mereological lambda abstraction.

Derivative properties are abundant. Amongst this plenitude of properties are some that are interesting. In particular, some of them are such that their grounds are unified in important respects. These properties have various interesting features that unify their instances. When the grounds are suitably unified, one can not only provide an analysis of the property in terms of all its possible grounds but also give an analysis of the property in terms of what these different grounds have in common. That is, one can pick out the property's grounds without listing them, but instead by specifying what unifies them, i.e. by identifying the higher-order features that these grounds share in common.

By contrast, in the case of uninteresting properties one can only give a list-style analysis. The grounds of such a property can only be characterised in an impredicative way as all those properties that ground Fness, which makes reference to the very feature that is to be analysed and is thus not informative and illuminating. For instance, the grounds of a merely disjunctive property can only be specified by means of a list. All properties that have a plurality of grounds are disjunctive properties. Those where the grounding set admits only of a list-style definition, due to the lack of higher-order features that unify the various grounds, are mere disjunctions, whereas those disjunctive properties that admit of a more informative analysis, such as determinable properties which are disjunctions of their determinates, are not mere disjunctions. The difference between interesting and uninteresting properties is thus not a formal or structural difference but a difference at the level of content.[37]

2.4 Unanalysability

There are important connections between unanalysability/indefinability and irreducibility. In particular, the distinction between robust and shallow forms of irreducibility maps onto the distinction between unanalysable and analysable properties.

4-IRREDUCIBILITY
: Type-1 properties that are 4-irreducible cannot be reduced to type-2 properties. However, one can analyse the former in terms of the latter. One can fully specify the conditions of property instantiation of type-1 prop-

[37]There is a spectrum ranging from interesting properties, the grounds of which are unified, to uninteresting properties that have disparate grounds that cannot be characterised by means of suitable higher-order conditions (since higher-order properties are abundant, it is only possible to characterise uninteresting properties as those where there are no higher-order features that unify their grounds, when higher-order properties are suitably restricted, for instance by restricting them to basic higher-order properties). In between the extremes, there are for instance various gerrymandered properties, like the property of being grue, that admit of an analysis in terms of a list of interesting properties, i.e. there is a plurality of disparate derivative properties, each of which is such that one can specify higher-order conditions in terms of which their grounds can be characterised.

erties in terms of type-2 properties. One can fully characterise its grounds and specify what this property consists in. By analysing the type-1 property, one can reveal all of its grounds as belonging to type-2. (If type-2 properties are not amongst the fundamental properties, then one ends up with a complete analysis in terms of type-2 properties even though these type-2 grounds will not be basic grounds.) Although we have irreducibility with respect to type-2 properties, since the way in which the components are combined to construct the disjunctive counterpart fails to preserve being a type-2 property, we nevertheless have analysability in terms of type-2 properties. This indicates that this form of irreducibility is rather shallow.

3-IRREDUCIBILITY
Type-1 properties that are 3-irreducible can be reduced and analysed, yet only in terms of other type-1 properties (or in terms of some other type of property) but not in terms of type-2 properties. As a result, they are neither reducible to nor analysable in terms of type-2 properties. For instance, non-basic normative properties can be analysed in terms of basic normative properties, not however in terms of descriptive properties.

2-IRREDUCIBILITY
Properties that are 2-irreducible are neither reducible nor analysable. For instance, given that basic normative properties are not metaphysically but normatively grounded, one cannot give a metaphysical analysis of goodness that allows one to identify the descriptive properties that ground this normative property. Normative properties that are 2-irreducible thus do not admit of an analysis. Such properties are unanalysable and indefinable.

It is for this reason that there is a gap between descriptive and normative properties that can be brought out by open question arguments. When we can give an analysis and specify what a property consists in, then it is a closed question (for anyone having a sufficient grasp of the concepts involved) whether something that satisfies the relevant conditions has the property in question. Yet, when concerned with normative properties it is an open question whether something having the relevant descriptive properties has the normative property in question. This question is not settled by the nature of the normative property. What it is to be this normative property, accordingly, cannot be specified in descriptive terms but requires ineliminable and irreducible normative notions. Instead of being settled by the nature of the normative property, the question whether something satisfying certain descriptive conditions has this property is settled by the normative grounding principles that govern normative grounding relations. One needs to bring in normative grounding principles that function as bridge principles. These principles allow us to bridge the gap and allow us to specify what descriptive conditions something needs to satisfy in order to have a given normative property.[38]

1-IRREDUCIBILITY

Properties that are 1-irreducible are neither reducible nor analysable. Since they have a singleton grounding set, there is no structure that can be revealed by analysis. Though fundamental properties are unanalysable, it is nevertheless possible to characterise them. For instance, one can characterise such properties in terms of what they do, what role they play, what higher-order features they have and how they relate to various other things.

There are thus two types of gaps between the grounds and what is grounded. On the one hand, there are those gaps that are bridged by metaphysical grounding. These are rather shallow gaps that allow the grounded to be analysed in terms of its grounds. Any difference in kind between the grounded and its grounds results from a failure of the relevant closure condition and gives rise to the weakest form of irreducibility, namely 4-irreducibility. Metaphysical grounding, accordingly, does not allow for the emergence of genuinely new features at the derivative level. New kinds of properties can only be introduced by mediated but not by unmediated grounding relations. Mediated non-metaphysical grounding relations that are governed by laws can bridge more robust gaps, such as the gap between the normative and the descriptive. Properties grounded in this way cannot be analysed and are 2-irreducible.

2.5 Normative analysis

Normatively grounded properties do not admit of a metaphysical analysis and are hence indefinable. Nevertheless, one can engage in normative analysis. Unlike a metaphysical analysis which specifies the identity of a property, a normative analysis specifies the conditions that something has to satisfy in order for the normative grounding principles to apply and for a basic normative property to be grounded. This allows one to identify normatively necessary and sufficient conditions and hence identify the properties that make for goodness (or rightness etc.).[39]

If normative and metaphysical modality coincide and are co-extensive, then these conditions will also be metaphysically necessary and sufficient. Identifying a

[38] The role of these principles is not restricted to bridging the gap between descriptive and normative properties. They are also required for grounding basic value in other basic values, as happens in the case of pattern goods, where, say, the goodness of an organic whole is grounded in the goodness of its parts rather than in their descriptive properties. The central role of normative grounding principles is thus to generate basic normative/evaluative facts, where such facts can result both from descriptive inputs as well as from normative inputs.

[39] These conditions are not only modally necessary and sufficient but also satisfy a relevance constraint and hence classify as good-makers (or right-makers etc.).

metaphysically necessary biconditional between normative and descriptive properties, however, does not amount to giving an analysis of a normative property. Such a biconditional merely specifies under which conditions something has that property. However, it does not constitute a metaphysical analysis. It does not specify what it is to be that property.

In short, a normative analysis does not specify what it is to be good (= what goodness consists in), but what it takes to be good (= what makes for goodness). Specifying the conditions that something has to satisfy in order to be good, accordingly, turns out to be a normative rather than a metaphysical matter. Rather than analysing goodness, one analyses the norms of good-making. In the same way that analysing a property amounts to revealing the structure of its grounding set, so analysing a grounding principle amounts to revealing the structure of the grounding operation that it governs. One gives an account of what it takes to be good, i.e. an account of what makes for goodness. One does this by specifying the input-output relationships that are governed by the normative law. Such an account identifies the inputs (whether descriptive or normative) that give rise to basic normative outputs and thereby introduce normativity into the world, imbuing things with normative significance.[40]

What is distinctive about metaphysical grounding and explains why it makes analysis possible is that it is a form of unmediated grounding. The fact that metaphysical grounding is unmediated and does not involve any laws of metaphysics is the reason why that which is metaphysically grounded is analysable. Mediated forms of grounding, by contrast, do not allow one to analyse the grounded property but only to analyse the laws that mediate the grounding relations. When grounding is unmediated, there is no gap to be bridged, there are no principles that need to be brought in, and there is no open question that needs to be closed. In this case, the grounds take one directly to the property and there is no need to go via something else. This immediacy ensures that the identity of the property is given by its grounds. The grounds then fully account for the identity of that which they ground.

The various forms of non-metaphysical grounding, by contrast, are mediated forms of grounding that involve laws that govern the grounding connection. In the case of mediated grounding, the grounds do not account for the identity of the grounded property. In that case, one can only give an account of what it takes to be F, by identifying what F's grounds are, which is fixed by the relevant laws. However, one cannot give an account of what it is to be F. Since the nature

[40]The normativity of the outputs has to be basic rather than derivative. Normative grounding is not a matter of the nature of the relata. E.g. the non-basic normative property $(N_1 \vee N_2)$ is a normative property, yet is metaphysically grounded in its disjuncts. The fact that a grounded property is normative does not imply that it is normatively grounded, even if it is grounded in descriptive properties. Instead, it only implies that at least one element of the grounding chain (understood in terms of the transitive closure of the different grounding relations) connecting these properties is a normative grounding relation.

of these properties will not be given by their grounds, properties that are non-metaphysically grounded cannot be analysed. Non-metaphysical grounding gives rise to properties that are in the relevant sense basic properties (e.g. normatively grounded properties are basic normative properties) and that cannot be analysed but only characterised.[41]

The unanalysability that arises in the case of non-metaphysical grounding is due the fact that grounding is mediated. If laws were amongst the grounds, then normative properties would be analysable. Normative properties would then be distinctive not because of the way in which they are grounded, namely in terms of normative grounding, but because of what they are metaphysically grounded in, since they would be partly grounded in normative laws. To be N would then be to satisfy Γ and for law L to obtain. Normative properties would then effectively be nothing but conjunctive properties (or disjunctions of conjunctive properties) that are collectively grounded in Γ and L.

More precisely, if laws were to play a grounding role, one would have to bring in nomic properties. The suggestion that the normative law L is a partial ground of the normative property N runs into difficulties since N is a property of x, yet the conjunctive fact that x is Γ and that L obtains is not a property of x. This means that one cannot ground x's being N in L. Instead, one has to appeal to features of x, in particular the nomic property had by x of being such that L obtains.[42] Γ together with this nomic property can then ground N, such that to be N is to be Γ and such that L obtains.[43] All normative properties would then admit of an analysis and the normative laws would be the only normative items that would be unanalysable.[44]

The fact that normative properties would turn out to be conjunctions of descriptive properties and nomic properties in terms of which they could be analysed brings out particularly clearly the level confusion involved in considering laws to be partial grounds. When this confusion is avoided and normative laws are not

[41] If one were to countenance mediated alongside unmediated metaphysical grounding, by accepting robust metaphysical laws that can govern metaphysical grounding relations (rather than Humean laws that merely summarise grounding relations), then even some metaphysically grounded properties would not admit of a reduction/an analysis. (Condition 1 would then have to be modified so as to require the metaphysical grounding connection between type-1 and type-2 properties to be unmediated.) If one were to insist that all metaphysical grounding is mediated, then all properties would be irreducible/unanalysable. This means that those who insist on there being grounding gaps that need to be bridged by grounding laws in the case of all derivative properties (cf. Schaffer: 2017), will render all properties irreducible/unanalysable.

[42] Nomic properties are relational properties that derive from relations that involve L. E.g. the relation that x and L stand in due to being worldmates that both exist/obtain in w allows one to derive the lambda-abstract had by x of being such that L obtains.

[43] If normative laws are metaphysically contingent, then N can be analysed in terms of a disjunction of grounds together with their corresponding laws, e.g. being Γ_1 and such that law L_1 obtains or being Γ_2 and such that law L_2 obtains etc.

[44] Since the relevant nomic properties involve normative laws, normative properties would not be fully analysable in descriptive terms.

included amongst the grounds but are instead construed as playing a different role and operating at a different level, namely as governing the grounding connection and bridging the gap between the grounds and the grounded, thereby ensuring that the properties are normatively rather than metaphysically grounded, then Γ will be the sole ground.[45] As a result, one ends up with basic normative properties that cannot be analysed. In the case of such properties, one can only specify the conditions of their instantiation but not what they consist in, i.e. one can only specify what it takes to be N but not what it is to be N. All those who consider basic normative properties to be indefinable, accordingly, have to deny that laws are amongst the grounds and instead have to work with a normative grounding relation that is governed by normative laws.

3 Consciousness

Many consider the mental to be grounded in the physical. Does this grounding claim imply a commitment to physicalism, in particular to a reductive form of physicalism? Correspondingly, do those opposed to physicalism have to reject this grounding claim and instead consider mental properties to be ungrounded?

Physicalism is usually deemed to be a contingent thesis, since it seems to be metaphysically possible for there to be fundamental non-physical properties that are not instantiated in the actual world. If these fundamental alien properties include mental properties, then reductionism is not to be understood as a reduction of the mental in general, but of a restricted class of mental properties. In particular, reductionism is restricted to all those mental properties instantiated in the actual world (as well as in close-by physicalistically acceptable worlds). More precisely, the mental properties that are to be reduced are those that are such that every way in which they can be instantiated is instantiated in some physicalistically acceptable world, i.e. a property M is physicalistically acceptable only if every member of g(M) is physicalistically acceptable. Otherwise, there will be disjunctive properties that are instantiated in the actual world but nevertheless involve physicalistically unacceptable disjuncts (e.g. the disjunctive property '$F =$ human-pain $\vee$ ectoplasm-pain'). Even though such properties are not reducible to physical properties, this does not conflict with physicalism, since they are not instantiated in the actual world (as well as in close-by worlds) in virtue of the physicalistically unacceptable properties that render them irreducible.

[45] On this approach, one can even go so far as to deny the existence of nomic properties on the basis that laws are not worldly items. Laws are not part of the fundamentality hierarchy but stand outside it and induce its structure, which means that they are neither grounded nor that they ground anything. The fact that a certain law obtains is then not a fact in the world, but a fact about the world (in the same way that the fact that certain facts are the totality of facts is, on pain of contradiction, not itself a fact in the world but rather a fact about the world, cf. Bader: 2020, pp. 43-44).

Reductive physicalism is implied by the claim that the mental is metaphysically grounded in the physical, given that the physical is closed under disjunction and conjunction and satisfies mereological closure.[46] The grounding argument allows one to construct a hyperintensionally equivalent disjunctive physical counterpart for each mental property and thereby establish the requisite reductive property identities. By suitably conjoining and disjoining the physical properties that are involved in grounding mental properties, one can construct properties that are metaphysically grounded in the very same grounds as the mental properties. Given that the closure conditions are satisfied, these properties will themselves be physical properties. As a result, it is necessary to deny that the mental is metaphysically grounded in the physical in order to defend a non-physicalist view.

3.1 Zombies and reductive physicalism

Various conceivability arguments attempt to establish that the physical does not metaphysically necessitate the mental. The conceivability of zombie worlds suggests that it is metaphysically possible to have a world that is a duplicate of the actual world with respect to all fundamental physical facts, yet fails to be a duplicate with respect to mental facts, since it is entirely devoid of consciousness. The metaphysical possibility of zombies is sufficient to rule out reductive physicalism. It implies that there cannot be reductive property identities. Metaphysical grounding implies metaphysical necessitation.[47] Hence, denying necessitation due to the possibility of zombie worlds implies a denial of metaphysical grounding. This means that, if the mental is grounded in the physical, then it will not be metaphysically grounded in this way but instead grounded via a non-metaphysical grounding relation. This, in turn, means that one cannot establish a reductive identity by constructing a physical property out of the very same metaphysical grounds that is hyperintensionally equivalent to the mental property in question.

3.2 Zombies and non-reductive physicalism

The metaphysical possibility of zombies is incompatible with the mental being metaphysically grounded in the physical and thereby rules out reductive physicalism. However, it is not sufficient for ruling out physicalism, due to the possibility of non-reductive physicalism that invokes metaphysically contingent physical

[46] Opponents of physicalism generally consider the physical and the mental to be radically heterogeneous. Accordingly, trying to resist physicalism by rejecting the closure conditions is not a promising strategy, given that a difference in kind, such as that between mental and physical properties, cannot be bridged by innocuous operations like conjunction and disjunction.

[47] Even when denying necessitation due to conditional grounding, we nevertheless end up with a commitment to conditional necessitation, which is violated by zombie worlds since they are duplicates of the actual world with respect to all fundamental physical facts and hence do not differ in terms of which enablers and disablers are present or absent.

bridge laws. The metaphysical possibility of zombie worlds can be accommodated by accepting metaphysically contingent bridge principles. This is compatible with physicalism as long as the bridge principles preserve physicality, such that something that is grounded in the physical in accordance with these bridge principles is likewise physical. This is a non-reductive form of physicalism. Everything (including the mental) is considered to be physical, yet the mental is not reducible to the type of property (namely neurological properties) in which it is grounded.[48] Accordingly, though being a physicalist view, it is incompatible with micro-physicalism. The bridge laws that it invokes are not laws of micro-physics. Yet, they nevertheless preserve physicality and hence are physicalistically acceptable.[49] The physicality of the mental is then not established by means of a reductionist argument, but by a direct argument.

The non-reductive physicalist will consider the relation between mental properties and the neurological properties in which they are grounded to be analogous to the relation between dispositional properties and the categorical properties in which they are grounded. Dispositional properties are not reducible to categorical properties. These properties differ in kind. Yet both kinds of properties are nevertheless physical properties, i.e. they constitute two heterogeneous sub-classes of the physical. Despite not being metaphysically grounded in categorical properties and despite not being metaphysically necessitated by categorical properties (given that causal laws are metaphysically contingent), dispositional properties are nevertheless physical properties. This is because the bridge principles that are required to connect these kinds of properties are physicality-preserving grounding principles.

A non-reductive physicalist of this kind will argue that the fact that mental states are distinct from (and not reducible to) brain states does not imply that they are not physical states. This approach can account for the possibility of zombies. In the same way in which a categorical duplicate of a brain can have different dispositional properties in a world with different causal laws, a fundamental physical duplicate of a brain can have different mental properties in a world with different psycho-physical laws. A world with zombies, i.e. without mental properties, is just as (un)problematic as an acausal world in which there are only categorical but no dispositional properties. Similarly, a world with swapped dispositions is just as (un)problematic as one involving inverted spectra.

[48] We can thus make sense of non-reductive physicalism by accepting that the mental is grounded in a physicality-preserving way in the neurological, contra Kim who claims that "a physicalist has only two genuine options, eliminativism and reductionism" (Kim: 1993, p. 267).

[49] An important challenge for this type of approach is Smart's objection that such laws are unlike ordinary physical laws, due to the fact that they apply only to highly complex physical states (cf. Smart: 1959 and Schaffer: forthcoming, especially section 3.3).

3.3 Non-physicalist grounding

Whereas metaphysical grounding implies reductive physicalism, physicalism is compatible with non-metaphysical grounding as long as it preserves physicality, making room for non-reductive physicalism. While non-physicalists need to reject metaphysical grounding, they can accept non-metaphysical grounding as long as the relevant psycho-physical bridge laws do not preserve physicality. A grounding non-physicalist will consider the grounding principles to be analogous to those accepted by non-reductive moral realists, namely as giving rise to heterogeneity. In the normative case, we are dealing with descriptive and evaluative properties that are different in kind. They are connected by normative grounding principles (which do not preserve being a descriptive/physical property) and hence are distinct properties that belong to distinct classes (cf. Bader: 2017).

Such a view differs in important respects from views that reject grounding altogether and instead consider mental properties to be emergent features that are synchronically caused. Though both types of views invoke bridge laws to allow for variation across worlds and to explain nomologically-based co-variation between mental and physical properties, they differ in terms of these laws being laws of grounding in the one case and causal laws in the other.

Though grounding laws and causal laws might initially seem to be not all that different (some even think of grounding as a form of metaphysical causation), there are crucial differences between them. In particular, these approaches differ in terms of whether they consider mental properties to be fundamental. Only if they are grounded will they be non-fundamental. Emergent properties, even if they are synchronically caused, by contrast, are ungrounded. Though they are not to be found at the fundamental level, i.e. they are only instantiated by mereologically complex objects, they are fundamental properties that are not grounded.

That these are two distinct approaches can be brought out by considering substance-dualism. Since there is no such thing as 'grounding at a distance', the substance dualist has to reject grounding and instead operate with causation.[50] The property dualist appealing to synchronic causation thus operates with the same mechanism as the substance dualist. They will invoke the same explanatory relation and simply differ in terms of whether the relation holds in an intra-object way (= immanent causation) or an inter-object way (= transeunt causation). By contrast, the property dualist appealing to grounding operates with the same explanatory relation as the non-reductive physicalist and will simply differ in terms

[50] It might be objected that causation is subject to a corresponding 'no action at a distance' constraint. The notion of distance, however, is different in the case of causation. In particular, there is no problem with transeunt causation between different objects, i.e. mereological 'distance' is not a problem. Instead, only spatial and temporal distance are problematic. Yet, there is no temporal distance in the case of synchronic causation and spatial distance is not defined, given the non-spatiality of mental substances, which means that, even if there is no spatial proximity, there is no spatial distance either.

of whether the grounding connection is considered to be physicality-preserving.

3.4 Complexity constraints and mixed worlds

Grounding laws can vary across modal space. Invoking psycho-physical grounding laws allows one to restrict strong supervenience, such that it only holds across worlds with the same laws but not across all possible worlds, thereby making room for cross-world variation when the worlds differ in terms of their psycho-physical grounding laws. This makes it possible to account for zombie worlds and other conceivable scenarios. There can be both variation in terms of whether grounding laws obtain (zombie worlds are ones in which the relevant grounding laws are absent) and in terms of the nature of the laws (e.g. inverted spectra can arise due to inverted grounding laws). The extent to which these psycho-physical laws and the mental properties to which they give rise can vary, however, would seem to be limited.

First, grounding has to satisfy a complexity constraint. Laws and grounds play different roles, such that treating laws as being partial grounds involves a level-confusion. Laws transform given content rather than introduce content of their own. They take us from inputs to outputs. In order to preserve a principled distinction between laws and grounds, the 'division of labour' between them needs to be preserved. This requires the inputs that are transformed by the laws to have sufficient complexity in order to be able to generate the relevant output. The complexity of the output has to be embeddable in the complexity of the input. Otherwise, laws would be providing input and thereby function as grounds instead of playing a different role from grounds. It would then not merely be the grounds that would be doing the work in generating and determining the mental properties but also the laws.

This imposes constraints on the degree of possible variation that can arise across worlds that are fundamental physical duplicates yet differ in terms of their psycho-physical grounding laws. It rules out worlds where the mental properties have more structure than their grounds, as would happen, for instance, in case a single neuron were to ground a highly complex mental state. This means that mental and physical properties are not independently recombinable but only allow for limited variation, when the former are considered to be grounded in the latter via psycho-physical grounding principles.

Second, whilst there can be variation across worlds that differ in terms of the contingent grounding principles that obtain, there cannot be intra-world variation. Accordingly, one cannot reject weak supervenience. This means that intra-world zombies, where an intra-world duplicate of a conscious being is a zombie that lacks consciousness, are ruled out. In short, there is a ban on mixed worlds. Similarly, spectrum inversion can only happen across worlds but not within words. This means that recombination is limited – one cannot form a possible world by recombining objects from worlds involving different grounding principles.[51]

This might be thought to spell trouble for accounts in terms of psycho-physical grounding (independently of whether such grounding is taken to preserve physicality or not), if the seeming conceivability of intra-world zombies is taken to imply their possibility. The possibility of mixed worlds, however, is unproblematic, as long as the mental properties in mixed worlds are not grounded.[52] In that case they can be considered to be alien fundamental properties. Mixed worlds are then worlds in which (fundamental) mental properties are sprinkled sparsely. From the perspective of grounding such worlds are equivalent to pure zombie worlds, insofar as no mental properties will be grounded in either world. These worlds will differ in terms of additional (fundamental) mental properties existing in mixed worlds. The conceivability of mixed worlds, in which there are zombies joined with non-zombie twins, is hence unproblematic for psycho-physical grounding. Since there can be mental properties that are not grounded in terms of which physical duplicates can differ, the ban on mixed worlds is restricted to properties that are grounded.

Intra-world duplicates also cannot differ in mental properties if mental properties are emergent properties that are synchronically caused. As a result, one has to think of the mental properties in mixed worlds not only as not being grounded but also as not being caused. Here, again, a difference between synchronic causation and psycho-physical grounding arises that is due to the fact that mental properties will be fundamental according to the former but derivative according to the latter. There is no difficulty in allowing for the very same properties that are synchronically caused in w to exist in w*, where the relevant causal laws are absent and where they are not caused in this way. There is no difficulty for a property that has instantiations that are caused to also be instantiated in a mixed world without being caused. By contrast, it is not possible for properties that are grounded in w to exist in w* where they are not grounded. A property that has grounds cannot be instantiated other than by being grounded. It cannot be fundamental at one world, yet not fundamental at another. Psycho-physical grounding thus implies that the mental properties in mixed worlds cannot be the

[51] These limits on recombination are compatible with consciousness being intrinsic. Though intrinsic properties are freely recombinable, the scope of recombination is restricted to those worlds where the relevant grounding principles obtain. In the same way that a property that is grounded in intrinsic properties is itself intrinsic, a property that is ϕ-grounded is ϕ-intrinsic and will only be recombinable across ϕ-worlds.

[52] In order to render grounding compatible with mixed worlds, the laws would have to be partial. This can either take the form of a partial applicability, whereby the laws apply in some cases but not in others. Since mixed worlds involve qualitative physical duplicates that differ in mental properties, the laws would need to make reference to non-qualitative features, such that it would not be possible to state the laws in qualitative terms. Or it can take the form of partial outputs, i.e. chancy laws that generate outputs in some cases though not in other cases that involve qualitative physical duplicates.

very same mental properties that are to be found in our world, given that fundamentality is not a contingent property of properties, but can instead only be alien fundamental properties that are functional analogues thereof.

3.5 Neutral monism?

The metaphysical possibility of zombies is sufficient for rejecting reductionist versions of physicalism. However, it is not sufficient for establishing non-physicalism since non-reductive physicalists can consider the non-metaphysical grounding principles to preserve physicality.[53] To refute physicalism, one needs to refute both reductive and non-reductive versions thereof. The former can be achieved by establishing the metaphysical possibility of zombies. The latter, however, requires additional arguments. One needs to establish that the psycho-physical bridge principles do not preserve physicality. The problem now is that it is difficult to see how one could determine whether a bridge principle preserves physicality other than by assessing for the physicality of what is grounded via this principle. This, however, means that the non-physicalist will have to show that the mental is not physical, that these properties are heterogeneous and differ in kind.[54]

The non-physicalist might argue that considering the mental and the physical to be heterogeneous and to differ in kind is the default and that the burden of proof is, accordingly, on the physicalist to establish that they are homogeneous. The non-reductive physicalist, by contrast, will claim that there are various indirect arguments that favour physicalism, such as the simplicity of a physicalist ontology and exclusion arguments about mental causation. The seeming heterogeneity of the mental and the physical, on the one hand, speaks against physicalism, which treats them as being homogeneous and is thus not faithful to the appearances, yet, on the other hand, is also what gives rise to difficulties for the non-physicalist, due to interaction/exclusion worries. Neither kind of consider-

[53] In fact, it is not necessary either since one can accept non-physicalism whilst rejecting the metaphysical possibility of zombies, by considering the psycho-physical bridge principles that connect the physical and the non-physical to hold with metaphysical necessity. By accepting metaphysically necessary bridge principles, one can accept metaphysical necessitation, despite rejecting metaphysical grounding. (This situation is analogous to that in which certain dispositional essentialists find themselves, in particular those essentialists who deny that dispositional properties are reducible to categorical properties, despite the fact that the latter metaphysically necessitate the former.)

[54] Yet if one can establish the distinctness of the mental and the physical, then one can directly establish non-physicalism, without having to make any detour involving zombies. (More precisely, the only way to be a physicalist would then be to be an eliminativist.) Any argument that would succeed in refuting non-reductive physicalism would render the zombie argument otiose. Zombies would then be redundant insofar as any argument that refutes non-reductive physicalism simultaneously refutes reductive physicalism, whereas the zombie argument only refutes reductive physicalism but does not succeed in refuting non-reductive physicalism.

ation would appear to be decisive so that one is left with a stalemate and has to weigh up the costs and benefits of the alternative views.

At this point, the physicalist can try to argue that the dialectical default is misguided and that the apparent heterogeneity of the mental and the physical is merely superficial. For instance, he could invoke the Kantian idea that the appearance of heterogeneity is due to the fact that we have two distinct modes of access to one and the same thing, namely via inner sense and via outer sense (cf. Kant: 1787, B427-428; also cf. Bader: 2010, pp. 82-85). The one mode of access only provides us with structural information (outer sense only reveals relational structures), whereas the other provides us with non-structural information (inner sense reveals the inner nature of mental states). Such a contrast between structural and non-structural information ensures that there is no inherent conflict between a physical and a non-physical characterisation. The heterogeneity is thus not inherent in the things themselves, but only in the way in which we access them. Yet, once this apparent heterogeneity is undermined, one is left with the question whether this actually leads one to end up with physicalism, or whether one rather ends up with some form of neutral monism.

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