# DISPOSITIONS AND GROUNDING IN A CAUSAL DISPOSITIONAL FRAMEWORK

## Disposiciones y grounding en el marco del disposicionalismo causal

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**Abstract**

This paper explores the presence of grounding relations within a causal dispositional framework. In particular, we examine the relationship between a cause and the dispositions whose manifestations give rise to a causal process (Mumford & Anjum, 2011). To determine whether this relation qualifies as a grounding relation, we evaluate two key criteria: (i) the satisfaction of the standard features typically attributed to grounding— irreflexivity, asymmetry, and transitivity—and (ii) the fulfillment of the negative criterion that grounding relations are neither identity nor causal relations.

**Key words:** Grounding; Dispositions; Dispositional Causation; Causal Power.

**Resumen**

Este artículo explora la presencia de relaciones de fundamentación *(grounding)* dentro del marco disposicional de la causación. En particular, se examina la relación que se establece entre una causa y las disposiciones cuyas manifestaciones dan lugar a un proceso causal (Mumford & Anjum, 2011). Para determinar si esta es una relación de fundamentación, se evalúan dos criterios clave: (i) la satisfacción de las características estándar que suelen atribuirse a la fundamentación —irreflexividad, asimetría y transitividad—, y (ii) el cumplimiento del criterio negativo según el cual las relaciones de fundamentación no son ni relaciones de identidad ni relaciones causales.

**Palabras clave:** Fundamentación; Disposiciones; Causalidad disposicional; Poder causal.

## Introduction

The relation of Grounding (G) between A and B is generally described as a metaphysical relation of non-causal dependence, typically expressed through locutions such as "in virtue of", "depends on", or "is determined by" (see Clark & Liggins, 2012). To assert that B *is grounded in* A is to claim that A *is* ontologically *prior to* B; that B (exists, obtains) in *virtue of* A (existing, obtaining); that B *depends on* A or *is determined by* A. Moreover, this relation plays an explanatory role, insofar as positing a grounding relation (G) between A and B—i.e., that A grounds B—contributes to explaining B.

The grounding relation has been a central topic of research in metaphysics over the past two decades (see, for instance, Correia & Schnider, 2012; McKenzie, 2022; Kortabarria, 2023). Likewise, in the metaphysics of science, there has been increasing work on the characterization of dispositions and the development of theories of powers (Molnar, 2003; McKitrick, 2004, 2005; Mumford & Anjum, 2011; Kistler & Gnassounou, 2016; Kimpton-Nye, 2022). In this paper, we engage with the intersection of both debates, examining the presence of grounding (G) relations within a causal dispositional framework, where causation is framed in dispositional terms.

Causal dispositionalism (henceforth CD) has its roots in those accounts of properties referred to as dispositional essentialism (Tugby, 2021, 2022), where the connection between properties and their causal powers is necessary insofar as natural properties have dispositional essences. A particular form of dispositional essentialism is pan-dispositionalism, according to which all properties are dispositions, i.e., all properties are inherently causal powers. It is within this framework that a specific proposal of dispositional causation has been developed: Mumford and Anjum's dispositional theory of causation (2011. See also Molnar, 2003). We are going to explore whether G relations can be found in this CD framework.

The consideration of G relations in the broader debate concerning the relationship between properties and their causal powers is quite common. Thus, some authors have explored the possibility of causal powers being *grounded* on categorical bases (we refer to this G relation as GD-A) (Lowe, 2010);[1] while others have focused on the possibility of natural properties to

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[1] This is opposed to classical approaches that conceive of the relation between a disposition and its basis as type-identity, token-identity or functionalism (the disposition is a higher-order property). We do not dwell on this matter here, but we concur with Lowe's arguments: grounding is a relation that might solve the problems of the other theories in the framework of a strong causal dispositionalism.

ground their causal power (i.e., the disposition) (we refer to this G relation as GD-B) (Tugby, 2021, 2022).[2]

We contend that additional grounding relations can be identified within a dispositional framework, particularly in the context of the dispositional theory of causation. Mumford and Anjum do already acknowledge the possibility of grounding relations among dispositions, even considering the existence of *ungrounded* fundamental dispositions (Mumford & Anjum, 2011, p. 100). They also propose that the relationship between natural possibility and dispositions might be one of grounding so that what is naturally possible is grounded on what is disposed to happen (2011, p. 182). However, the presence of grounding relations within causal dispositionalism remains largely unexplored. In this sense, we propose the recognition of another significant relation: the one between a *cause* and the *disposition(s)* whose manifestation(s) initiate a causal process (hereafter GD-C).

Our aim is thus to assess whether GD-C constitutes a G relation. In doing so, we adopt a twofold strategy: a positive and a negative one. On the positive side, we examine whether GD-C satisfies the standard features typically attributed to grounding relations (which we refer to as *the standard view of grounding*): irreflexivity, asymmetry, and transitivity. On the negative side, we investigate whether GD-C can be identified as either an identity relation or a causal relation, thereby assessing whether it meets the negative criterion that G relations are neither identity nor causal relations.

The structure of the paper is as follows: First, we characterize the standard view of grounding (§1). Next, we outline the main features of dispositions, with a particular focus on dispositional theories of causation (§2). In the central section (§3), we investigate whether GD-C qualifies as a G relation. In doing so, we argue that GD-C constitutes a Strict Partial Order (SPO) relation—i.e., a relation that is irreflexive, asymmetric, and transitive (§3.1)—and that it is neither an identity nor a causal relation (§3.2). In section (§4), we present how GD-C allows us to solve the interaction and production gaps (Baltimore, 2022; Raimondi, 2022). Finally (§5), we argue that GD-C cannot be reduced to other dependence relations (Wilson, 2014, 2016), which allows us to claim that GD-C is, in fact, a genuine grounding relation. We conclude with some final remarks (§6).

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[2]  Tugby's proposal appeals to grounding to explain the necessary connection between properties and their causal powers (i.e., dispositions). In his own words: "[a]ccording to the grounding theory, qualitative properties are not identical with powers but rather *ground* powers. On this view, qualitative properties and powers are intimately connected but nonetheless numerically distinct: qualitative properties are fundamental while powers are not" (2021, p. 11198).

## 1. Characterizing Grounding

The grounding relation concerns what it is for something to exist *in virtue of* something else, providing a framework for understanding how more fundamental facts give rise to less fundamental ones, thereby offering a hierarchical picture of reality. For instance, the fact that a particular object is a table may be said to be grounded in its having a certain arrangement of material parts; or the moral wrongness of an action may be grounded in the suffering it causes, its consequences, or its alignment with a common natural norm, reflecting various moral theories.

Despite its intuitive appeal, the notion of grounding has generated considerable debate, raising concerns about its vagueness, the potential for infinite regress, and the difficulty of establishing clear criteria for what constitutes a grounding relation (Hofweber, 2009; Daly, 2012; Koslicki, 2015; Wilson, 2014, 2016). Furthermore, several key questions remain unresolved, such as those concerning its primitive (Fine, 2001) or definable character (Bricker, 2006), or the consideration of whether there are distinct types of grounding corresponding to different kinds of dependence (Fine, 2001; Hofweber, 2009), among others.

Engaging in a comprehensive analysis of these debates, along with the various controversial positions they entail, is an extensive task that goes beyond the scope of this paper. Instead, we proceed by adopting what we call the *Standard View* (henceforth SV) of grounding, which aims to remain neutral regarding certain contentious issues while adhering to an orthodox characterization of grounding that is widely accepted. Accordingly, SV holds that grounding is a *primitive term* denoting a binary relation, expressed in predicate terms, between two *relata*—one being *the ground* and the other *the grounded*. Concerning its ontological status, SV maintains that grounding is a real (ontological) relation and that its *relata* are facts, understood either as states of affairs or Russellian propositions (Fine, 2012). This commitment to the reality of grounding and its *relata* is justified by the nature of our inquiry: since our paper investigates whether grounding relations exist in dispositions understood as real, ontological properties, realism about grounding must be assumed.

SV also adheres to an orthodox characterization of the grounding (G) relation, accepting that G is defined by both positive and negative features. Concerning the positive features, the orthodox view maintains that grounding contributes to determining what is grounded and, therefore, plays a role in explanation: the grounding relation explains why something is so. Precisely due to its explanatory nature, the orthodox view holds that G imposes a strict partial ordering on reality (SPO)— what makes it

irreflexive: *X* is not grounded in itself; asymmetric: If *X* grounds *Y*, then *Y* does not ground *X;* and transitive: If *X* grounds *Y* and *Y* grounds *Z*, then *X* grounds *Z*.[3]

Regarding its negative features, it is generally agreed that G is neither an identity relation nor a causal one. That G is not an identity relation is quite straightforward: claims about grounding are used to express the structure of reality, which is typically conceived as hierarchical and ordered by priority relations in nature. The *relata* of grounding, therefore, differ insofar as one of them (the ground) must be prior to the other (the grounded) (Schaffer, 2009; Raven, 2013). We refer to this requirement of priority between the relata of the grounding relation as the *Intuitive Condition* (IC):

*Intuitive Condition* (IC): X grounds Y only if X is prior to Y

Notice that IC expresses our basic intuitions about grounding, that is, that what is grounded is explained by, determined by, and metaphysically depends on its grounding. Even if IC is not a definition of grounding, it expresses a crucial and basic necessary condition.

While the distinction between identity and grounding is relatively clear, differentiating grounding from causation is more complex due to the number of features they seem to share: "Both are generative relations; both are partial orders, admitting a type/token distinction, a component/net distinction, an incomplete/complete/total distinction, and screening-off relations; both are backed by non-accidental generalizations, delimit a specific form of necessity, are supportive of and diagnosable by counterfactuals, and can back explanation" (Schaffer, 2016, p. 59). Furthermore, both grounding and causation satisfy IC since generally causes are prior to their effects, and both are best formalized using structural equation models (Schaffer, 2016).

Despite these similarities, several key differences justify treating grounding as a non-causal relation (Bernstein, 2016; Schaffer, 2016). Bernstein, for instance, categorizes these differences into three kinds:

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[3]   It is important to emphasize that here we are considering what we have called the Standard View of Grounding, while acknowledging that different arguments can be developed against some or all of the features typically attributed to grounding. In this regard, Wilson (2014) has questioned whether grounding is truly transitive, asymmetric, and even irreflexive. Similarly, Rodríguez-Pereyra (2015) has argued that grounding does not satisfy these three criteria, based on the claim that the truthmaking relation lacks them. We will not engage in these specific debates, as they fall beyond the scope of this paper.

structural, logical, and dialectical, although in this paper we will not pay attention to the last one.[4] *Structural differences* concern the way causation and grounding are organized and operate within the metaphysical structure of the world. These relations differ in the nature of the connections they establish, thus: i) causation is an external relation, whereas grounding is an internal one. In Schaffer's words: "causation is an external relation linking distinct portions of reality, while grounding is an internal relation operating within a given portion of reality" (Schaffer, 2016, p. 76). To further clarify the distinction between internal and external relations, we refer to Moore's classical account, according to which $R$ is internal if and only if, whenever $Rxy$ holds, it necessarily holds that $Rxy$—such that $x$ and $y$ cannot be conceived of without being in that relation (Moore, 1920; *Tractatus Logico-Philosophicus* 4.123). Conversely, $R$ is external if it is not internal. While what is grounded cannot be thought of without being related to what grounds it, an effect can be conceived with independence of what causes it.[5] ii) Grounding structures reality into levels, operating synchronically; whereas causation occurs within a particular level and operates diachronically.[6] Finally, iii) The *grounded* inherits its reality from its ground, whereas *the effect* does not inherit its reality from its cause.

*Logical differences* involve variations in the logical behavior of each notion. While both causation and grounding are generally considered to be asymmetric, irreflexive, and transitive, the motivations and arguments

[4]  *Dialectical differences* refer to the divergences that arise in debates about grounding and causation. These differences are significant because they "reveal the implausibility of moves in one debate that might be made in another, or vulnerability in one kind of view not present in another" (Bernstein, 2016, p. 32). These differences are irrelevant for our purposes.

[5]  The internal/external character of the grounding/causation relations is related to the one about its modal nature. Debates concerning the necessary or contingent character of the grounding relation are common in the literature. In this sense, there are authors who defend grounding necessitarianism (Audi, 2012; Fine, 2012; Dasgupta, 2014a, 2014b; Lenart, 2021); whereas others advocate grounding contingentism (Dancy, 2004; Leuenberger, 2014; Schneider, 2016). Recently, it has been proposed that grounding may be both necessary and contingent, depending on whether we are referring to *what-grounding* or *why-grounding*, respectively (see Richardson, 2021). Given our commitment to the Standard View of Grounding, this paper adopts a necessitarian stance.

[6]  It has recently been argued that there are cases of "cross-temporal grounding" (Correia & Merlo, 2022). In this kind of cases, present facts are explained in terms of past facts. Unlike the more standard view of G, cross-temporal grounding is characterized for connecting *present facts* for instance, "the fact that Caesar was alive"; with the so-called "past-directed-facts", namely "the fact that Caesar is alive [roughly 2000 years ago]". In this sense, it is possible to think of grounding as being a diachronic relation instead of a synchronic one.

for accepting or rejecting these features differ in each case, especially concerning the features of asymmetry and irreflexivity.[7] Thus, *asymmetry* in causation aligns with temporal asymmetry, since causes temporally precede their effects, whereas asymmetry in G is based on IC, that is, that the ground is ontologically prior to the grounded. Similarly, concerning the rejection of *reflexivity:* in the case of causation, reflexivity is denied to maintain temporal order; whereas in the case of grounding, cases of reflexivity will put into question the work of grounding in hierarchically structuring reality.

## 2. General Features of Causal Dispositionalism

In metaphysics, properties are typically categorized into two distinct ontological kinds: dispositional and categorical. Dispositional properties are understood as those responsible for the *potential behaviors* objects can exhibit under certain conditions. Classical examples include solubility, elasticity, and fragility. Categorical properties are better conceived of in negative terms: they are non-dispositional and, thus, do not necessarily require to manifest any behavior in response to a given stimulus.

The debate concerning the characterization of categorical and dispositional properties, their ontological status, and the nature of their interrelation is extensive (see, for instance, Armstrong, 1969; Mellor, 1974; Mumford, 1998). Yet, for this discussion it is sufficient to adopt the core features of dispositional essentialism (Molnar, 2003): i) *directedness (or tendency)*: dispositions are oriented toward their manifestations. This tendency constitutes the *essence* of the dispositional property, as the manifestation toward which a disposition tends determines its identity (see Marmodoro, 2013);[8] (ii) *dispositional modality:* dispositions tend

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[7] In the case of transitivity, as Bernstein argues, more similarities can be found between causation and grounding. The counterexamples that can be developed against transitivity affect both causation and grounding similarly, and the solutions proposed in each debate tend to be alike. Yet, as Bernstein claims, "The similarity of the problems about transitivity and grounding is not itself sufficient to support the grounding/causation analogy [...]. And it is particularly not so given the myriad other structural differences between them" (2016, 31).

[8] The characterization of the essence or identity of dispositional properties is not without difficulties. On the one hand, dispositions rarely operate in isolation; rather, they often combine to produce effects or manifestations that could not arise if each disposition acted independently. This interdependence makes it challenging to determine the manifestation associated with a particular disposition and, consequently, to establish its identity. On the other hand, there are multi-track dispositions—dispositions capable of producing different kinds of manifestations under varying circumstances. Despite

towards their manifestation without necessitating them; thus, even when a disposition is triggered, its manifestation might fail to occur due to certain factors—such as masks (Johnston, 1992), antidotes (Bird, 1998), or interfering conditions (Mumford & Anjum, 2011)—that can block or inhibit the disposition; iii) *independence*: dispositions do not require their manifestations to exist; iv) *actuality*: dispositional properties are as actual as the categorical ones;  what remains in potency is the *manifestation* of that disposition (Mumford, 1998; Molnar, 2003; Heil, 2005); and v) *objectivity*: dispositions are not anthropocentric properties; their existence does not depend on human construction, thought, or perception (Molnar, 2003).[9]

It is within this framework of dispositional essentialism that dispositional theories of causation have been developed (Molnar, 2003; Mumford & Anjum, 2011). These accounts are based on the central tenet that dispositional properties are causal powers, enabling the object that bears them to exhibit specific kinds of behavior under appropriate circumstances. According to the causal dispositional account, causation is a process initiated when a disposition is triggered and begins to manifest. In other words, "causation occurs when powers manifest themselves" (Mumford & Anjum, 2011, p. 209).

Following Shoemaker (1980) and Molnar (2003), Mumford and Anjum argue that it is rare for a causal process to involve the manifestation of a *single disposition*.[10] Instead, dispositions typically combine to produce effects that could not arise from them acting in isolation. The activation of different dispositions gives rise to a *causal process* in which the cause (i.e., the activated dispositions) and the effect (i.e., the manifestation of the dispositions) are simultaneous, i.e., they occur concurrently. The effect starts to exist at the time at which the dispositions are triggered, but its production unfolds over time, so that causation is understood as *one* process. Once the effect has been realized, the causal process concludes. This effect will be, in fact, a new disposition

these challenges regarding identity, pandispositionalists maintain that the advantages of adopting a dispositional ontology outweigh its deficiencies. Mumford, for instance, considers that a pandispositionalist ontology allows the clarification of metaphysical questions such as those concerning modality, laws of nature (see Mumford, 2004) or causation.

[9]   Molnar also acknowledges another feature of dispositions, namely intrinsicality, according to which a dispositional property of an object does not depend on the existence of other distinct objects. However, the intrinsicality of dispositional properties has been questioned by authors such as McKitrick (2003), who argues that dispositions can be both extrinsic and intrinsic.

[10] Some exceptions can be considered, such as the atom decay (Mumford & Anjum, 2011).

that may function as a cause in subsequent causal processes, provided that it interacts with the relevant dispositions (see also Molnar, 2003, p. 166).

Within causal dispositionalism, the connection between the cause and the effect is not necessary. Since effects do not occur instantaneously but their production unfolds over time, interfering factors might appear such that they interfere with the causal process affecting the way the effect is manifested or even stopping its manifestation. According to CD, once dispositions are triggered and begin to manifest, some effect is already present, even if the causal process has not reached the end-state. The disposition of salt to dissolve in water serves as an illustrative example of this idea. When the disposition of a salt cube to dissolve is triggered—namely, when the salt is introduced into water—a causal process begins: the dissolution of the salt. In this process, the cause (that is, the joint manifestation of the disposition of the salt to dissolve and the disposition of water to dissolve salt) and the effect (the dissolution itself) occur simultaneously. This causal process may be interrupted before complete dissolution is achieved. Even in such cases, some effect is still produced: the salt cube partially dissolves, and the effect of the causal process is the partial dissolution of the salt.

## 3. Causes Are Grounded in Dispositions

After examining the main features of both grounding and causal dispositionalism, we now turn to the question of whether the relation between a cause and the dispositions whose manifestations initiate a causal process (GD-C) can be characterized as a grounding relation. We will evaluate whether the positive and negative features typically attributed to grounding relations in the standard view (§1) apply to the case of GD-C. To this end, we will first characterize the GD-C relation and its *relata*. Given that grounding has been defined as a relation between *facts*, and that the manifestation of dispositions does not occur in isolation (§2), GD-C can be expressed as follows:

GD-C: The fact that $x_1$ has disposition $D_1$ and … and $x_n$ has disposition $D_n$ grounds the fact that $D_1… D_n$ cause $x_1… x_n$ to behave in a certain way when they meet together.

In this characterization, the two facts that serve as the *relata* of the grounding relation are: (i) the fact that $x_1$ has disposition $D_1$ and … and $x_n$

has disposition $D_n$ (*the ground*)[11], and (ii) the fact that $D_1… D_n$ cause $x_1… x_n$ to behave in a certain way when they meet together (*the grounded*).

In what follows, we will demonstrate that GD-C satisfies both the positive and negative conditions for a grounding relation.

### 3.1. GD-C satisfies the positive conditions: GD-C is a Strict Partial Order Relation

The standard view holds that $G$ is a strict partial order relation (SPO), as it satisfies the conditions of irreflexivity, asymmetry, and transitivity. In this section, to argue that the GD-C relation constitutes a SPO, we must first demonstrate that GD-C satisfies what we have termed the *Intuitive Condition* (IC) (§1). Recall that this condition states that:

(IC) $X$ grounds $Y$ only if $X$ is prior to $Y$ (because $X$ plays a role in the explanation of $Y$, $X$ determines $Y$ in some sense, and $Y$ metaphysically depends on $X$).

Now, consider the relation between the fact that some objects $x_1,…,x_n$ have dispositions $D_1,…D_n$ and the fact that these dispositions cause those objects to behave in a particular way when their dispositions meet together. Within the framework of causal dispositionalism causation is elucidated precisely in terms of the dispositions that generate a causal process when properly activated. The fact that an object possesses a particular disposition determines the causal process in which it may participate in various ways, depending on the specific nature and circumstances of the disposition in question. Therefore, GD-C satisfies the intuitive condition.

Taking these ideas into account, we are now in a position to argue that the GD-C relation is irreflexive and asymmetric. Concerning *irreflexivity*, since GD-C satisfies IC, it necessarily follows that a fact cannot be in the relation GD-C to itself since no fact is prior to itself. Thus, GD-C is irreflexive. This point can be further clarified taking into account the features of causal dispositionalism. The fact that an object possesses a disposition is ontologically prior to the fact that such a disposition manifests causally. If the same fact were both the ground and the grounded, the distinction between potentiality and manifestation would collapse, undermining the very notion of a disposition as a power. Reflexivity in GD-C would entail that the possession of a disposition and its causal manifestation are

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[11]  This is a conjunctive fact, that is, a fact constituted of other facts.

identical, thereby erasing the explanatory hierarchy that dispositionalism is meant to preserve.

Regarding *asymmetry*, we can similarly assert that IC is sufficient to guarantee *asymmetry,* given the explanatory direction inherent in the dispositional framework. In every case, the metaphysical dependence runs from the dispositional fact to the causal one: it is because an object possesses a certain disposition that it can bring about a specific causal process, not vice versa. The manifestation of a disposition cannot account for its possession, since the very possibility of manifestation presupposes the existence of the disposition itself.

Finally, concerning *transitivity,* recall that within CD the effect of a causal process is, in fact, another disposition (see §2), say $D_z$ of a further object $x_z$, and $D_z$ causes $x_z$ to behave in a certain way when meeting with the relevant dispositions. We can consider three different *relata:* (1) the fact that $x_1$ has dispositions $D_1$… and that $x_n$ has disposition $D_n$; (2) the fact that $D_1$… and $D_n$ cause $x_1$… and $x_n$ to behave in a certain way when $D_1$… and $D_n$ meet; and (3) the fact that $D_z$ cause $x_z$ to behave in a certain way when meeting the appropriate dispositions. Thus, transitivity can be recognized, since the fact that $D_z$ can cause $x_z$ to behave in a certain way when meeting the proper dispositions is grounded on the fact that $x_1$ has the disposition $D_1$ and $x_2$ has the disposition $D_2$. To illustrate this idea, let us consider saline water. In this case, it is possible to say that the disposition $(D_1)$ of salt $(x_1)$ to dissolve into water and the disposition $(D_2)$ of water $(x_2)$ to dissolve salt cause saline water $(x_3)$, which has the disposition of curability $(D_3)$, when meeting the proper dispositions (e.g., the disposition of an open wound to heal). By transitivity, the disposition of curability is grounded on the disposition of solubility of salt and on the disposition of water to dissolve salt.

## 3.2. GD-C satisfies the negative features: it is neither an identity nor a causal relation

Given that according to the SV grounding is not identity nor causation, in order to establish that GD-C is a case of grounding, we must show that it can be conceived neither as identity nor as a causal relation.

### GD-C is not an identity relation

Regarding identity, two main arguments can be developed to demonstrate that GD-C is not an identity relation: the *different facts argument* and the *dispositional character of D argument*. The *different facts argument* maintains that the fact that an object possesses a particular

property is distinct from the fact that a disposition causes an object $x$ to behave in a certain way when properly activated. The first fact concerns *the instantiation of a property* by an object, or the combination of a property with an object in a specific manner, thereby giving rise to a fact. In contrast, the second fact is a *causal fact*, where the behavior the object manifests under certain circumstances is not attributed directly to the object itself but rather to the disposition it possesses. These two facts are distinct because they involve different constituents. In the first fact, the constituents are an *object* and a *dispositional property*, whereas in the second, the constituents are the *dispositional property* and its *causal manifestation*.

The *dispositional character of the D argument* follows from the previously discussed feature of independence (see §2), namely, that dispositions do not require their manifestation to exist. Thus, the first fact (i.e., the fact that an object possesses a disposition) can hold without the second fact being realized (i.e., the fact that the disposition causes the object to behave in a certain way). This is so since the mere possession of a disposition does not necessitate its activation or causal manifestation. A cube of salt, for instance, is said *to be soluble* (i.e., to possess the dispositional property of solubility) even if it is never put into water and dissolved. This further reinforces the distinction between the two facts under consideration and supports the claim that the relation between them is not one of identity.

*GD-C is not a causal relation*

From an intuitive standpoint, it seems reasonable to think that the relation between certain objects possessing certain dispositions and those dispositions being a cause is not itself a causal relation. When those dispositions are properly activated, an effect is produced. However, this effect is not the fact that *those dispositions are acting as a cause*, but rather a distinct fact—namely, whatever fact results from the manifestation of the dispositions. Furthermore, and before turning to the detailed arguments, within the dispositionalist framework, interpreting the dependence between dispositions and causes as itself causal would collapse two distinct explanatory levels: *the metaphysical level*, which concerns what grounds causal processes, and *the nomological or empirical level*, which concerns how those processes unfold.[12]

Nevertheless, in case these reasonings prove insufficient, we offer four arguments to support that GD-C is not a causal relation. Three of them are inspired by the so-called structural differences given between

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[12] We thank an anonymous reviewer for pressing us to clarify why a causal interpretation of GD-C would be problematic.

grounding and causation (see §1) and the arguments Bernstein (2016) and Schaffer (2016) offer to support these differences, namely: (i) the *reality argument*, (ii) the *nature of relations argument*, and (iii) the *temporal argument*. The last one is a novel argument we will refer to here as (iv) the *infinite regress argument*.[13]

Regarding the *reality argument*, as we have previously seen, one of the differences between G and causation lies in the consideration that the grounded inherits its reality from the ground, whereas the effect does not inherit its reality from the cause. Within a causal dispositional framework, the effect does not inherit its reality from its cause, as the manifestation of a disposition also depends on the presence of other appropriate dispositions. Now, consider the case under examination: Does the fact that $D_1…D_n$ cause $x_1…x_n$ to behave in a certain way when they meet together, inherit its reality from the fact that $x_1$ has disposition $D_1$ and … and $x_n$ has disposition $D_n$? Within a causal dispositional framework, the answer is affirmative, as all causal power derives from dispositions themselves. In other words, if the dispositions (the ground) are not real, the cause (the grounded) cannot be real either.

The *nature of relations argument* addresses the internal and external nature of grounding and causation. In the case of the GD-C relation, the causal connection expressed in the second *relatum* (i.e., the fact that $D_1…D_n$ cause $x_1…x_n$ to behave in a certain way when they meet together) is external because it is conceivable that *those dispositions do not meet* and, consequently, they do not manifest. Furthermore, this relation links distinct portions of reality, as the manifestations of $D_1…D_n$ produce an effect that is distinct from the objects $x_1 … x_n$ possessing dispositions $D_1 … D_n$.

Now, consider the GD-C relation itself. Is it internal or external? Can $x$ possess a disposition $D$ without $D$ causing $x$ to behave in a certain way when meeting the appropriate dispositions? The answer is negative. It is necessarily the case that if some objects $x_1 … x_n$ possess dispositions $D_1 … D_n$, these dispositions will exercise their causal power when they meet together, making GD-C an internal relation. Moreover, GD-C does not link two distinct portions of reality; rather, it connects the object possessing the disposition and the disposition's causal role, with both *relata* belonging to the same portion of reality. Therefore, if Schaffer's account is correct, GD-C should be considered a grounding relation rather than a causal relation.

[13] We are not going to consider neither the logical nor the dialectical differences between grounding and causation, since we are interested in addressing the differences that more directly refer to how grounding and causation operate within the metaphysical structure of the world.

Finally, another argument against GD-C being a causal relation, also based on Schaffer's account of grounding and causation, is the *temporal argument*. Schaffer posits that explanatory relations can be categorized as either causal or grounding relations depending on temporal and metaphysical levels. If *A* explains *B* and they exist *at different levels*, the relation is one of grounding. Conversely, if *C* explains *D* and they exist *at different times*, the relation is one of causation (Schaffer, 2016, p. 89. See also Bernstein, 2016).[14] In the case of GD-C, the relation between a cause and the disposition that grounds it is synchronic, and one could argue that the metaphysical level of an entity and its dispositional properties are distinct from the level of causation. This aspect of GD-C suggests that it should be understood as a grounding relation rather than a causal one.

In addition to the previously discussed arguments, we propose what we term the *infinite regress argument* to support the claim that the relation posited in GD-C is not a causal one. Let us suppose that the relation described in GD-C were genuinely causal. Then *C* would be true:

C: The fact that $x_1$ has disposition $D_1$ and … and $x_n$ has disposition $D_n$ *cause* the fact that $D_1…D_n$ cause $x_1…x_n$ to behave in a certain way when they meet together.

In this scenario, two causal relations are present. The first, CR1, is the relation between the fact that $x_1$ has disposition $D_1$ and … and $x_n$ has disposition $D_n$ (the cause) and a causal fact (specifically, the fact that $D_1…D_n$ cause $x_1…x_n$ to behave in a certain way when they meet together). The second causal fact, CR2, represents the causal relation between dispositions and their manifestations when they meet together. To evaluate whether C holds in a causal dispositional framework, we must first consider CR2. In a dispositionalist framework, CR2 is indeed a causal relation, as causation is understood to be the process by which a disposition (in our case, dispositions $D_1 … D_n$) manifests when activated. The challenge arises, however, with CR1: What disposition is being manifested in CR1? For CR1 to be a causal relation, there must be at least a disposition D* that manifests when properly activated. Notice that D* can be none of $D_1 … D_n$, as they are already manifested in CR2. This introduces a new causal

process that consists in the manifestation of D*, leading to the formulation of a new relation C*:

C*: The fact that an object $x$ has disposition D* *causes* the fact that D* causes $x$ to behave in a certain way when properly activated.

A similar argument can now be made to propose yet another disposition, D**, which would lead to the formulation of a new relation, expressed as C**. This process could continue indefinitely, generating an infinite regress. Consequently, C cannot be true. And, therefore, GD-C is not a case of causation.

## 4. Grounding and the Interaction and Production Gaps

Recent work has raised a twofold related difficulty for CD: the interaction gap (Baltimore, 2022) and the production gap (Raimondi, 2022). Both difficulties revolve around the problem of how dispositions combine to cause effects. The *interaction gap* refers to the problem of explaining "how powers causally *interact* with one another so as to bring about *collective* results" (Baltimore, 2022, pp. 677-678). Baltimore distinguishes between two accounts of dispositions: the contributions combination view (CCV) and the mutual manifestation view (MMV). According to the CCV, the identity of a disposition is determined by the manifestation towards which it tends. But then, since each disposition tends towards its own manifestation, the interaction gap arises, that is, something extra is necessary to account for how different manifestations combine to give rise to collective results.

Baltimore considers the MMV to be better prepared to account for the interaction gap, since in this case each disposition is not directed towards its own manifestation, but its nature contains its cooperative potential, that is, its ability to combine with other dispositions to bring about collective results, and this is what it tends towards. We might reinforce this line of reasoning if we blend the CCV and the MMV: the nature of a disposition accounts for both the particular contribution of such manifestation to the whole process and for how the contributions combine to give rise to collective results. Note that not every disposition can combine with any other to give rise to causal processes. The solubility of salt cannot combine with the elasticity of a rubber band to generate interesting causal processes, while it can combine with the disposition of water to dissolve salt. The mutual-manifestation potential of each disposition is built into the directedness of its own manifestation. When each manifests according to its directedness, their manifestations meet as partners and jointly bring

about the single effect of dissolution. Raimondi (2022) follows Baltimore in considering that the MMV can account for the interaction gap.

Let us now turn to the production gap. According to Raimondi, we must account not only for how dispositions interact, but also for what makes them *productive*. According to him, neither the CCV nor the MMV can account for this gap. Concerning CCV, Raimondi argues that it explains the connection between a disposition and its manifestation due to the internal relation given between them. Yet, this view is unable to account for how several manifestations combine to *produce* an effect. Regarding MMV, Raimondi argues that it cannot account for the production gap either.

In what follows, we intend to show that GD-C offers a possible solution to the production gap. Before getting into the details of Ramondi's difficulty, let us introduce a distinction between two forms of production: *c-production* and *m-production*. C-production is the production involved in causation and it is the relation in which a prior state contributes its powers or processes to the coming-to-be of a later state. In CD terms, we could say that c-production is the manifestation of a causal power that brings another event into existence through its directed activity. It is this c-production that Raimondi demands to be explained.

M-production is a sort of metaphysical production, that is, a non-causal form of generation in which something determines, generates or gives rise to something else. M-production is the kind of generation that Schaffer (2016) attributes to grounding. Aristotelian formal and final "causes" are examples of M-production: the form of an entity m-produces the entity and the end of an action m-produces the action. While c-production is a temporal process in which one event brings about another, m-production is a non-causal form of generation in which more fundamental facts make derivative facts obtain simply in virtue of how reality is structured. Consider now our new grounding relation:

GD-C: The fact that $x_1$ has disposition $D_1$ and … and $x_n$ has disposition $D_n$ grounds the fact that $D_1…D_n$ cause $x_1…x_n$ to behave in a certain way when they meet together.

As we have seen, grounding is a relation of metaphysical explanation. So that what GD-C amounts to is the claim that causes metaphysically depend on dispositions. Let us now consider the production gaps. Dispositions are productive because they ground causal processes in which they operate. In terms of the two kinds of production, we can say that dispositions are c-productive precisely because they m-produce those causal processes. The core idea is to take GD-C seriously, so that to say that dispositions ground

causal processes is to say that they account for them all the way down: c-production ultimately derives from m-production (grounding).

Raimondi's difficulty is, however, more sophisticated. We turn now to its details to show that GD-C is able to reach them. According to Raimondi, MMV is not able to account for the production gaps because it cannot explain what sustains such a causal process in time, and this is crucial for CD, because on that view causation is processual. We will call this problem *the causal-process persistence problem* (our expression). In CD, in principle, the *causal-process persistence problem* can be explained by elucidating both the simultaneity of cause and effect and the continuity of the process —that is, the internal connection between its stages. According to Raimondi, the particular version of CD we are committed to in this paper, the one represented by Mumfond and Anjum (2011), has some resources to account for both features of the causal process. The causal process can hold both simultaneity and continuity because it is *one* process, i.e., one in which the manifestations of the triggered dispositions form a continuous flow of change. Taking now GD-C into account, we can also have recourse to the synchronicity that is proper of the grounding relation to make the point clearer: as long as the causal fact is grounded in the conjunctive dispositional fact, they are synchronic, and therefore, the process can be conceived as one in which simultaneity and continuity hold.

Yet, Raimondi thinks that the causal process does also require homogeneity, so that if some dispositions are manifesting at a particular interval of time ($t_1$—$t_n$), then they are also manifesting at any subinterval of ($t_1$—$t_n$). Here is where the difficulty arises: most causal processes have subintervals in which what happens depends on particular and distinct contributions of the powers involved at each progressive stage. The problem arises because dispositions at different levels are being conflated. Consider Raimondi's example, the solubility of sugar in water. If dispositions $D_1$ (solubility of sugar) and $D_2$ (capacity of water to dissolve sugar) are manifesting at a particular interval of time ($t_1$—$t_n$), then they are also manifesting at any subinterval of ($t_1$—$t_n$). However, the heat of the solution depends on the energy used to break, move, and disperse molecules during the process, and this in turn depends on dispositions ("micro") other than $D_1$ and $D_2$. This requires us to abandon homogeneity. Raimondi sees here the problem that the MMV cannot account for properties such as heat, which changes along the dissolution process, unless it appeals to those dispositions ("micro"). But the problem is not a real one. In this case, we have to consider two processes. One is the process of dissolution, in which the dispositions involved are $D_1$ and $D_2$. The metaphysical *explanandum* is the dissolution process, and that is a causal process *grounded* in

(metaphysically explained by or m-produced by) the conjunctive fact that sugar is soluble and water can dissolve sugar. The process of dissolution is homogeneous even if it proceeds through different microstructural stages with further dispositions involved. The reason is that the energetic profile varies across sub-stages, but the *same* dispositional basis—molecular polarity of sucrose and hydrogen-bonding capacities of water—continuously  grounds[15] the dispositions involved and their c-production of the same type of local interaction throughout the process. The unity of the effect does not depend on chemical homogeneity at every sub-interval, but on the persistence of a single underlying c-production mechanism. Thus, the process is metaphysically homogeneous even if it is chemically variable.

We can consider further *explananda,* such as, for example, the increase or decrease of the heat of the solution. These changes constitute further causal processes grounded in (i.e., metaphysically explained by or m-produced by) other conjunctive facts constituted by molecules and their dispositional properties. By focusing on the metaphysical *explanandum,* the causal process to be accounted for, we can appeal to the corresponding dispositions as its grounding. Thus, in Raimondi's example, there are two different causal processes, and therefore two different causal facts grounded in different conjunctive dispositional facts.[16] In a nutshell, the metaphysical work that is necessary to avoid the claim that production is just a brute fact is provided precisely by the metaphysics of grounding.[17]

## 5. Is GD-C a Grounding Relation, really?

In arguing that the relation GD-C satisfies both the positive and negative features of G, we have some indications that GD-C can qualify as a grounding relation. However, this conclusion might still be premature. In the literature, it is common to encounter critics of the very idea of grounding. Some authors have argued that attempts to develop a theory of grounding

[15] Notice that this is a case of GD-A (see the introduction above).

[16] The question arises about the relation between both classes of dispositions (solubility of sugar and water's capacity to dissolve, on the one hand, and the dispositions of the molecules that are responsible for the energy conditions of the process, on the other). This is a very interesting issue, and we think that in order to satisfy Raimondi's demands, some kind of dependency is required: the former class depends on the latter. We find, thus, a further grounding relation, one that is envisioned by Mumford and Anjum themselves (2011, p.  100).

[17] We are grateful to an anonymous referee for insightful comments and suggestions, which helped us to substantially improve this section.

are fundamentally flawed (see, for instance, Hofweber, 2009; Koslicki, 2015; Wilson, 2014, 2016). Among these criticisms, Wilson's objections are particularly significant.

According to Wilson, there is no need to postulate grounding as a distinct relation of metaphysical dependence insofar as it is too general a notion to fulfill the explanatory role it is intended to play. She argues that there are already alternative relations of dependence in our metaphysical toolbox that fulfill the role that is attributed to grounding. Wilson refers to these other relations of metaphysical dependence as "small-g relations", which include type or token identity, functional realization, classical mereological parthood, set-membership, the proper subset relation, and the determinable/determinate relation. She claims that these relations provide a more effective account of metaphysical dependence than grounding. In particular, they offer a stronger basis for metaphysical explanation, as she argues:

> *From the fact that some goings-on are grounded in some others, it hardly follows that the latter metaphysically explain the former in any interesting sense*; nor does a bare grounding claim itself constitute an explanation in either a metaphysical or epistemic sense. Gaining even basic explanatory illumination about metaphysical dependence requires an appeal to the specific relations (type and token identity, functional realization, the classical mereological parthood relation, the causal composition relation, the set-membership relation, the proper subset relation, the determinable-determinate relation, and so on) that are the typical focus of investigations into such dependence (Wilson, 2014, p. 553. Emphasis added).

In this section, we explore whether the G relation given in the case of GD-C might refer to another form of metaphysical dependence already captured by some of the "small-g" relations such as those considered by Wilson (see text above).[18]

*Type and token identity*

One way of articulating a form of dependence is by appealing to the notions of type and token identity. *Type identity* refers to the metaphysical relation whereby entities are identified as belonging to the same kind or category in virtue of sharing a general, repeatable property or structure.

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[18]  We are not going to consider the causal composition relation in this section since we have already argued why GD-C is not a causal relation (see §3.2).

*Token identity*, by contrast, concerns numerical identity: it holds when two descriptions or conceptualizations refer to the same particular instance or occurrence. In the case of the GD-C relation, it can be argued that it is neither a case of type nor of token identity, insofar as there is no identity between (1) the fact that $x_1$ has disposition $D_1$ and … and $x_n$ has disposition $D_n$ and (2) the fact that $D_1…D_n$ cause $x_1…x_n$ to behave in a certain way when they meet together. As previously argued (§3.2), these two facts belong to distinct categories: (1) concerns the instantiation of a property, whereas (2) involves a causal fact. In this sense, given the absence of an identity relation between them, the GD-C relation cannot be accounted for in terms of either type or token identity.

*Functional realization*

Functional realization is a form of dependence that can hold between higher and lower-level properties of a system. The core idea of realization is that the function of the higher-level property is performed by the lower-level token properties of the system in which it is instantiated. In essence, functional realization describes how higher-level properties depend on lower-level ones by considering the latter as performing the functions associated with the higher-level properties. A classic example to illustrate this idea refers to the relationship between a mental state (like pain) and a physical state (like certain neurons firing in the brain) where the mental state of pain is said to be realized by the physical state when that physical state performs the function of pain (e.g., causing withdrawal behavior, prompting verbal reports of pain). In the case of GD-C, there is no higher-level *function* that is performed by a lower-level property.

*Classical mereological parthood relation*

Mereology is the discipline concerned with the relations between parts and wholes. Concerning the GD-C relation, to explore whether there is a mereological parthood relation, we need to see whether (2) the fact that $D_1…D_n$ cause $x_1…x_n$ to behave in a certain way when they meet together is a part of (1) the fact that $x_1$ has disposition $D_1$ and … and $x_n$ has disposition $D_{n,}$. One reason to consider that GD-C is not a mereological parthood relation lies in the nature of its relata. (1) and (2) refer to facts, and facts do not participate in mereological parthood relations in the strict sense defined by classical mereology, where parts and wholes, typically applied to concrete or spatially located entities. Facts, by contrast, are abstract, intensional, and often structured in ways that resist the axioms of mereology, such as extensionality and the existence of fusions. Moreover,

facts do not support operations like fusion or overlap in the way material objects do (Turner, 2016).[19]

*Set-membership relation and the proper subset relation*

*The set-membership relation* holds between an object and a set when the object is one of the members (or elements) of that set. *The proper subset relation*, on the other hand, holds between two sets A and B when every element of A is also an element of B, and A is not identical to B. Neither of these metaphysical relations seems to be the ones given in the case of GD-C, since this one concerns a relation between facts and not between sets or membership of elements within sets. Thus, (2) the fact that $D_1...D_n$ cause $x_1...x_n$ to behave in a certain way when they meet together does not refer to an object that is a member of a set, say (1), since (1) does not refer to a set, which shows that there is not a case of set-membership relation. Analogous reasoning allows us to show that G is not a proper subset relation.

*Determinate/determinable relation*

The determinate/determinable relation describes how properties can be related such that one property is a specific version of a more general property. For instance, *scarlet* is a determinate of the determinable *red*, and *red* is a determinate of the determinable *coloured*. The determinable, therefore, refers to a general property that can be manifested in various specific forms, whereas the determinate is a specific manifestation of a determinable property. Concerning the metaphysical debate on properties, in some frameworks it is possible to claim that *dispositional* and *categorical* are two determinates of the determinable *property*. *Dispositional* and *categorical* share the possibility to be possessed by an object, but they differ in that dispositional properties manifest when the appropriate conditions are met, while categorical properties are non-dispositional. Consider now our two *relata:* (1) *that objects have dispositions* and (2) *that dispositions cause something*. If they were conceived as in the determinable/determinate relation, this would amount to conceiving *cause* as a specific version of the more general *disposition*. Yet, this is not possible since *cause* is not a specific version of *disposition: all dispositions are causal*. The disposition acting as a cause when properly activated is not a way in which the disposition can be determined, as in the case of *scarlet* being a determinate of *red*, for instance.

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[19] Conjunctive facts are an exception, since they are sums of their conjuncts, so that a fact can be conceived as a mereological part of the conjunction of that fact with other fact(s). In any case, (2) is not a conjunct of (1).

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The kind of relation given in the case of GD-C, therefore, cannot be reduced to other metaphysical dependence relations we already have in the literature, as Wilson claims. As it has been shown, the relations of type/token identity, functional realization, classical mereological parthood relation, set/membership relation, proper subset relation and the determinable/determinate relation are unable to explain the kind of relation that is given between (1) the fact that $x_1$ has disposition $D_1$ and … and $x_n$ has disposition $D_n$ and (2) the fact that $D_1…D_n$ cause $x_1…x_n$ to behave in a certain way when they meet together. We think that this serves to reinforce the consideration that GD-C is a case of grounding.

This conclusion, however, invites a further question about the broader implications of this result. What follows if GD-C indeed constitutes a genuine case of grounding rather than merely a *sui generis* dependence relation? In other words, what is metaphysically at stake in classifying the relation as big-G rather than small-g? If GD-C cannot be reduced to any of the small-g relations, then it provides a concrete case in which postulating a genuine grounding relation is explanatorily indispensable. The fact that GD-C connects dispositional and causal facts in a way that cannot be captured by other dependence relations shows that the metaphysics of powers requires big-G grounding to account for its own internal structure. In this sense, the causal dispositional framework not only benefits from the notion of grounding but also lends support to it: GD-C stands as an instance that motivates realism about grounding against the eliminativist stance advocated by grounding nihilists such as Wilson.

## 6. Concluding Remarks

Grounding is a highly controversial relation that has been extensively discussed and challenged by various authors. In this paper, we have examined an intriguing case of grounding that arises within the framework of causal dispositionalism—specifically, the relation between the fact that $x_1$ has disposition $D_1$ and …. and $x_n$ has disposition $D_n$ (*the ground*) and the fact that $D_1….D_n$ cause $x_1….x_n$ to behave in a certain way when they meet together (*the grounded*). This relation, which we have termed here as GD-C, is crucial, as it underpins the central tenet of the dispositionalist account of causation: that causes are grounded in dispositions.

We have argued that GD-C constitutes a relation of metaphysical dependence that satisfies the criteria of being a strict partial order (SPO) relation, and that cannot be regarded as either an identity or a causal

relation. Consequently, we have concluded that GD-C is best understood as a grounding relation. In addition, we have shown that considering GD-C as a grounding relation also allows shedding light on some problems in recent literature on grounding, such as the interaction and the production gaps. Finally, we have also demonstrated that this relation cannot be reduced to other allegedly similar relations (e.g., type/token identity, functional realization, classical mereological parthood relation, set-membership relation and the proper subset relation, and the determinable/determinate relation), as suggested by some grounding nihilists.

This work contributes to two key areas of research in analytic metaphysics. First, it advances the metaphysics of grounding by providing a concrete case of grounding, thereby highlighting the indispensability of this relation within metaphysical discourse. Second, by establishing that causes are grounded in dispositions, we have offered causal dispositionalism a metaphysical framework that elucidates its central tenet: causation must be explained in terms of dispositions, as dispositions are the grounds of causes.

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