**An Egalitarian Account of Composition and Realization[[1]](#footnote-1)**

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**Abstract**: I argue that wholes are neither identical to nor (completely) distinct from their parts. Instead, wholes are invariants under some transformations in their parts. Similarly, higher-level properties are neither identical to nor (completely) distinct from their lower-level realizers. Instead, higher-level properties are aspects of their realizers that are invariant under some transformations in their realizers. Nowhere in this picture is there any ontological hierarchy between levels of composition or realization. Neither wholes nor their parts are more fundamental. Neither is prior. Neither reduces to the other. Neither is eliminated. Ditto for higher-level properties and their lower-level realizers. Instead, wholes and their properties as well as parts and their properties are different yet invariant aspects of reality. The result is an egalitarian account of composition and realization.

**Keywords**: composition, realization, levels, whole, part, property, invariant

1. **Composition and Realization**

We often talk about levels of physical objects (particulars). Looking downward, we say that objects are composed of (proper) parts. Parts are themselves objects, which have their own parts. Looking upward, we say that parts compose wholes. Wholes may combine with other objects to form larger wholes. In other words, typically, objects are composed by lower-level objects (their components or parts, their parts’ parts, and so forth) and compose higher-level objects (the larger wholes they partially compose). Following tradition, I will refer to the putative relation between parts and wholes as *composition*.

We also talk about levels of physical properties (and relations; I will usually omit this qualification from now on). Looking downward, we say that objects have certain properties because their components have certain properties. Looking upward, we say that the properties of an object contribute to the properties of the larger wholes that contain that object. Again, we can keep going downward or upward about properties as long as there are levels of composition. I will refer to the putative relation between properties of parts and properties of wholes as *realization*. That is, when parts *p*1, … *p*n compose a whole *w*, I will say that the properties of *p*1, … *p*n realize the properties of *w*.[[2]](#footnote-2)

Unless otherwise noted, when I write “levels” I mean levels of composition and realization, and when I write “properties” I mean *natural* properties, including relational natural properties (cf. Dorr 2019). Natural properties are qualities, powers, or structures that objects have (or relations that they stand in) objectively and that carve nature at its joints (Lewis 1983). Natural properties include properties that objects have in virtue of physical relations that alter them intrinsically. For instance, atoms chemically bond with one another in virtue of their natural properties. When atoms chemically bond, their natural properties are altered by such bonds—chemically bonded atoms may share electrons that they didn’t share prior to bonding, and chemically bonded atoms move with the atoms they are bonded to in a way that they didn’t move prior to bonding. Thus, chemical bonding alters the properties of atoms. In contrast, when I go from your right side to your left side, that change, by itself, doesn’t change any of your intrinsic properties. Being to someone’s right (or left) is not a natural property or relation and does not affect someone’s natural properties.

Talk of composition and realization is deeply embedded in all kinds of human practices, including modeling, theorizing, explaining phenomena, designing and building artifacts, diagnosing malfunctions, and fixing things. To give just one obvious example, when an object—say, a stove—is not working right, we identify the part that’s broken—say, its control panel—, replace it with a well-functioning token of the same type, and thereby repair the stove.

Talk of composition and realization gets tricky when it comes to quantum systems, because in some cases—such as systems of entangled particles—it’s not clear that parts and their properties can be identified independently of the systems they compose (French 2015). Addressing this complication goes beyond the scope of this essay. I will limit my discussion to systems such that parts and their properties can be identified independently of the systems they compose and realize.

Talk of composition and realization raises the question of whether objects and properties that stand in compositional and realization relations are identical. Are wholes identical to their parts, distinct from them, or what? Are properties of wholes identical to their realizers, distinct from them, or what? In addition, levels raise ontological puzzles such as the ship of Theseus, the causal exclusion problem, and so forth.

Given space constraints, I cannot review the literature on composition and realization, let alone the puzzles involving them. What I will do, instead, is examine a widespread assumption among philosophers who discuss such matters—the assumption that levels form an *ontological hierarchy*. Ontological hierarchy can be understood in different ways. The most basic is *asymmetric ontological dependence*—the notion that some levels ontologically depend on others but not vice versa (cf. Tahko and Lowe 2016). A related notion is that at least one level is ontologically *prior* to or more *fundamental* than the others (cf. Tahko 2018). If there is an ontological hierarchy, perhaps nonfundamental levels *reduce* to the fundamental level (cf. van Riel and Van Gulick 2019); perhaps they are *grounded* in the fundamental level (cf. Bliss and Trogdon 2016); or perhaps they aren’t even real and the fundamental level is the only real one. Be that as it may, ontological hierarchy is assumed to be there on the mistaken supposition that it’s needed to make sense of composition or realization or solve ontological puzzles such as causal exclusion.[[3]](#footnote-3) Once we see that we can solve such puzzles without ontological hierarchy, there is no need to retain it and pay the price that comes with it. To show that ontological hierarchy is dispensable, I will sketch an *egalitarian* account of composition and realization—an account that avoids the assumption of ontological hierarchy.

To avoid begging certain questions, it is convenient to have a term that is neutral between a whole and its parts. For this purpose, I adopt the term “portion of reality” (Lewis 1991). When I speak of a portion of reality, I am referring to everything that exists within a spacetime region while being neutral between referring to the whole object (and its properties), that object’s parts (and their properties), its parts’ parts (and their properties), and so forth.

1. **The Myth of Ontological Hierarchy between Levels**

Some things’ existence asymmetrically depends on others’ existence. A straightforward example is *diachronic* ontological dependence. For something to exist at a certain time, certain ingredients must exist at a prior time. For example, before hummus can be made, chickpeas (and tahini, etc.) must be available, but not vice versa. In this sense, the existence of hummus asymmetrically depends on the prior existence of the chickpeas. Someone might even want to say that the chickpeas are more fundamental than the hummus, or that the chickpeas ground the hummus. Again, this relation of asymmetric ontological dependence involves the passage of time: the chickpeas are said to be ontologically prior to the hummus because they must literally exist *before* the hummus can exist. Without chickpeas, the hummus cannot be made.

This example illustrates two points. First, the notion of asymmetric ontological dependence is not problematic per se. In cases such as diachronic ontological dependence, it makes sense and it’s warranted to conclude that some things are asymmetrically dependent on others. Second, the notion of ontological dependence between levels—the notion of ontological hierarchy that is under scrutiny here—is *not* the notion of diachronic ontological dependence.

Composition and realization are *synchronic* relations. They are relations that occur between a whole and its parts (or its parts and their parts, and so on) as well as between the properties of the whole and the properties of its parts (or the properties of its parts and the properties of their parts, and so on), respectively, either *at one time* or *during a time interval*. If there is asymmetric dependence between parts and wholes, or properties of parts and properties of wholes, it must be *synchronic* ontological dependence.

Someone might be tempted to infer that, since parts often come before wholes (the Big Bang led to the formation of stable matter, which self-organized into atoms, which formed molecules, etc.), wholes synchronically depend on their parts. This is tantamount to saying that diachronic ontological dependence entails synchronic ontological dependence. It’s a non sequitur.

Besides the fact that synchronic dependence simply doesn’t logically follow from diachronic dependence, diachronic dependence can go either from parts to wholes or from wholes to parts. In either case, what is prior may cease to exist by the time what is posterior comes into existence. For instance, marble statues asymmetrically depend on the prior existence of marble blocks. If synchronic dependence followed from diachronic dependence, we should conclude that marble statues synchronically depend on marble blocks. That is absurd. At the time that a statue exists, the marble block from which the statue was carved no longer exists! *X* cannot be synchronically dependent on *Y* if *Y* does not exist. Thus, we cannot infer synchronic ontological dependence from diachronic ontological dependence.

One putative reason to posit synchronic dependence between levels is parsimony. A whole and its parts spatially coincide—they cover the same portion of reality. Thus, one of the two seems redundant. Because of this, it seems that a complete ontology should posit just one of the two—either the parts or the whole—as being fundamental. Either the whole asymmetrically depends on the parts or the parts asymmetrically depend on the whole, not both. Either the whole reduces to the parts or the parts reduce to the whole, not both. Either the whole is fundamental (ontologically prior), or the parts are fundamental (ontologically prior), not both. Either the whole grounds the parts or the parts ground the whole, not both. Some would even go all the way to the extreme conclusion that either the whole is real or the parts are real, not both (cf. Schaffer 2018). It can’t be both, it seems, on pain of ontological profligacy. (Mutatis mutandis, the same line of thinking can be applied to properties of wholes versus properties of parts.)

As compelling as this argument from parsimony may seem, it’s fallacious. To see why, we should distinguish two kinds of whole, which I call *fiat* wholes and *substantive* wholes. I will argue that synchronic ontological dependence is true of fiat wholes but that is irrelevant to the ontology of levels that matter to science and most ordinary discourse; it is relevant but false of substantive wholes.

Fiat wholes are arbitrary collections of objects, without anything physically connecting their parts or holding them together. Fiat wholes are just mereological sums of arbitrary parts.[[4]](#footnote-4) To distinguish the objects that define a fiat whole from any other parts they have, let’s call them *defining parts*. For example, the Great Sphynx of Giza and the Colosseum, together, make up a fiat whole *F*. *F* has many parts, including the many stones that make us the Great Sphinx, the many stones that make up the Colosseum, the molecules that make up the stones, and so forth. But *F* has two and only two defining parts: the Great Sphynx and the Colosseum. No physical relation ties a fiat whole’s defining parts. Their composing a fiat whole does not alter any of their intrinsic properties. The properties of the whole are just the sum of the properties of the defining parts. Destroying a defining part destroys the whole.

In the case of fiat wholes, there is a straightforward sense in which the whole asymmetrically depends on its defining parts. That is, the existence of the whole with its properties depends on the existence on its defining parts with their properties in a way that the existence of the defining parts with their properties does not depend on the existence of the whole. The existence of a fiat whole depends on the existence of its defining parts because, by definition, it could not exist if those very parts did not exist. The defining parts of a fiat whole do not depend on the existence of a fiat whole because, by definition, the existence of a fiat whole neither adds to nor subtracts anything from its defining parts, nor does it change the parts in any way. Thus, a fiat whole asymmetrically depends on its defining parts.

Consider *F* again. If you destroy either the Great Sphynx or the Colosseum, you thereby destroy *F*. The mereological sum of the Great Sphynx and the Colosseum no longer exists if either the Great Sphynx or the Colosseum no longer exists. But if you destroy the whole (by, say, destroying one of its defining parts), you don’t thereby destroy the other parts or alter any of their intrinsic properties in any way.[[5]](#footnote-5) In this sense, the existence of the whole depends on the existence of the parts but not vice versa. There is asymmetric dependence of the whole on the parts.

Nevertheless, the asymmetric dependence of fiat wholes on their defining parts does not establish an ontological hierarchy. For fiat wholes are not relevant to the ontology of science and most ordinary discourse. By definition, becoming part of a fiat whole does not alter an object in any intrinsic way—composing a fiat whole makes no difference to its parts. Thus, fiat wholes are to particulars what nonnatural properties are to properties. Because of this, many people deny that fiat wholes are genuine entities that really exist. But even if we admit fiat wholes within our ontology, fiat wholes are an exotic case. The ontological dependence of fiat wholes on their defining parts does not generalize to ordinary cases of composition.

The kind of ontology I’m interested is not about fiat wholes but about substantive wholes such as atoms, molecules, organs, and organisms. These are the objects we directly interact with, study, physically create, physically damage, and attempt to fix. What is peculiar to substantive wholes is that their parts’ (natural) properties are intrinsically *altered* by their becoming part of the whole.[[6]](#footnote-6)

Consider molecules. There is a big difference between the intrinsic properties of a plurality of unconnected atoms and the intrinsic properties of those same atoms after they bond together to compose a molecule. For instance, the isolated atoms do not share any electrons, whereas the atoms within a molecule do. The isolated atoms can move independently of one another. The atoms within a molecule are bonded together in such a way that most forces can only move them together with the other atoms that form the molecule. A similar point applies to any other type of substantive whole. The intrinsic properties of the parts within the whole are different from the intrinsic properties of the parts when they are isolated from one another (and thus do not form that type of whole).

One important logical consequence of the fact that objects change their properties when they become part of substantive wholes is that substantive wholes are *organized*. What I mean is that objects come to form substantive wholes by altering one another via physical relations that constitute the organization of the whole. Such organizational relations, in turn, are the source of the intrinsic properties that are specific to substantive wholes, as opposed to their unorganized parts.

Consider a common object, such as a smartphone. None of its components, when isolated from one another, possess the functionalities of a smartphone. Even all of its components taken together, but disassembled or only partially assembled, lack the functionalities of a smartphone. To create a smartphone, with its specific functionalities, the parts must be physically connected together in specific ways. When they are so connected, they acquire the specific functionalities of a smartphone and thereby become a smartphone. Being connected with other parts, of course, is what alters the parts’ properties.

When it comes to substantive wholes, the kind of asymmetric ontological dependence that we noted in fiat wholes vanishes. The existence and identity of a substantive whole does not reduce to the existence and identity of the mereological sum of its parts considered in isolation from one another, as in the case of a fiat whole. For a substantive whole has specific qualitative, structural, and dispositional properties that define it and depend on the specific physical relations that must hold between its parts, relations which alter the intrinsic properties of the parts. E.g., a smartphone has certain component types organized in certain ways that endow it with certain powers. The specific properties of a substantive whole retain some degree of invariance even under transformations in the whole’s parts. E.g., a smartphone retains considerable structural, qualitative, and dispositional invariance even if it gets scratched, dented, its battery or screen or SIM card are replaced, etc.

Substantive wholes are not identified entirely by any of their *token* parts, as fiat wholes are with regards of their definitive parts. Instead, substantive wholes are partially identified by their stable global properties, including the *types* of parts they have. These properties can remain (fairly) stable through some changes in their token parts. Thus, some of a substantial whole’s parts can be lost, added, or replaced, or change some their properties, while the whole retains (close to) the same structural, qualitative, and dispositional properties. As long as a substantial whole retains enough of its properties, it may persist even though one or more of its parts are destroyed. This marks a big difference from fiat wholes. In short, the existence of a substantial whole does not depend on the existence of each of its token parts in the way that the existence of a fiat whole does. Therefore, there is no ontological hierarchy within substantive wholes.

Interestingly, there is a kind of ontological dependence within substantive wholes, but it’s a symmetric (i.e., mutual) dependence between wholes and parts. In one direction, substantive wholes require parts of certain types organized in specific ways for their existence. Substantive wholes cannot exist without having parts of the right types organized in the right way. In the other direction, parts of substantive wholes require wholes of a certain type to acquire some of their properties, and thus to exist *as* that type of part. For the parts of a substantive whole cannot be separated from the whole while retaining all of the properties they have when they are part of that type of whole. For instance, an atom that is separated from a molecule it previously composed will no longer share electrons with the other atoms that compose that molecule.

Someone might reply that, if a part is separated from a substantive whole it previously composed, the whole ceases to exist while the part still exists. Therefore, the dependence between wholes and parts is asymmetric after all. This reply misses the point. On one hand, a substantive whole can continue to exists even without some of its parts, or at least so long as the parts it loses are replaced by parts of the same type. Thus, a substantive whole need not cease to exist simply because it loses a proper part. On the other hand, a part of a substantive whole loses some of its crucial properties qua that type of part, which properties contribute to the properties of that type of whole, as soon as the part is separated from the whole. This is precisely because, by definition, being part of a substantive whole alters the properties of a part in a way that contributes to the properties of the whole. Thus, being a certain type of part (of a substantive whole) requires being part of that type of whole. Therefore, the ontological dependence between substantive wholes and their parts is mutual. Mutual dependence establishes no ontological hierarchy between levels of being.

My tentative conclusion is that there are no positive reasons in favor of, and there are good reasons against, an ontological hierarchy between levels of being within substantive wholes, which are the wholes that matter for our ontology of science and most everyday discourse. If so, how shall we make sense of composition and realization? Isn’t it redundant to posit both parts and their properties as well as wholes and their properties? (This question iterates through all levels of composition and realization, whose existence may seem to lead to massive redundancy.)

1. **Against Identity between Levels**

If two things seem redundant, the simplest way to eliminate the redundancy—short of eliminating one of the two things—is to identify them. If what appeared to be many things are really just one, our ontology only needs to posit that one thing. Accordingly, the simplest way to avoid ontological redundancy between levels of being is to identify levels of being with one another. If the properties of a whole are identical to the properties of its parts, then there is no redundancy of properties. This is the type identity theory (cf. Smart 2009). If a whole and its parts are one and the same object, there is no redundancy of objects. This view is known as composition as identity (Schumm, Rohloff, and Piccinini 2020).

The type identity theory is usually seen as a form of reductionism, which is more than a mere identity claim. Reductionism is identity plus a direction of ontological priority, whereby one level is said to be more fundamental than the other(s). Composition as identity may be seen as involving a similar reductionism. But identity does not entail reductionism and, if anything, is antithetical to it. For it doesn’t make sense to say that one thing is more fundamental than another and yet those two things are one and the same. It’s like saying that one thing is more fundamental than itself.[[7]](#footnote-7) Be that as it may, I’ve already rejected the kind of ontological hierarchy that posits that one level of being is (synchronically) more fundamental than others. I’ll set aside any putative reductionist aspect of either the type identity theory or composition as identity; I’ll focus exclusively on the identity claim.

To assess the claim that levels are identical to one another, we need to consider the differences between different kinds of identity statements, whether or not they pertain to levels of composition and realization. Here are some examples that come up in the relevant literatures, including the literature on the type identity theory and composition as identity:

1. Hesperus = Phosphorus
2. Water = H2O
3. Lightning = electrical discharge (between two regions of a planet’s atmosphere)
4. Temperature (of an ideal gas) = mean kinetic molecular energy
5. Sensations = brain processes
6. Pain = c-fiber firing
7. Statue = Lump of bronze
8. Ship of Theseus at time t1 = Ship of Theseus at time t2

Some of these statements pertain to objects, others to properties (or processes and phenomena, which are properties’ manifestations; cf. Piccinini 2017). Some pertain to types, others to tokens of either objects or properties. Some pertain to observables, others to unobservables, or at least things that were unobservable at the time the identification was initially proposed. Some are synchronic, others diachronic. To get clear on what is being identified with what, we need to be careful about all of these distinctions.

The most central and relevant (putative) identifications are identifications of token wholes with their token parts as well as identifications of higher-level property instances with lower-level property instances that realize them. One example is the claim that a token mental state is identical to a token brain state. (Terminological note: I use “state” as synonymous with “property”.) If token identity does not hold, a fortiori type identity fails. If token identity goes through, type identity may or may not hold.

Some identifications do go through. “Hesperus” and “Phosphorus” turn out to be names of the same object, so Hesperus = Phosphorus. Any given body of water is primarily made of H2O molecules (in certain complex physical configurations that vary with whether the water is solid, liquid, or gas, modulo considerations about impurities, which I disregard here). Because of this, water as a type of substance is H2O. Similarly, any lightning strike is a discharge of electricity between two regions of a planet’s atmosphere. Because of this, lightning as a type of event is identical with electrical discharge between two regions of a planet’s atmosphere. With both water and lightning, we begin with an observable substance or phenomenon (water, lightning), then we develop a scientific theory and experimental practices involving components of the substance or phenomenon (chemistry, electrical theory and practice), and eventually we identify parts and their properties that are involved in the original substance or phenomenon (H2O, electrical discharge).[[8]](#footnote-8) None of these cases involve the composition of individual whole objects by their parts, so none of these cases show that the type identity theory or composition as identity are true.

Let’s begin with composition as identity. Composition as identity is plausible with respect to fiat wholes, because they are defined by their defining parts. That is, there is a reasonable case to be made that fiat wholes are identical to their defining parts. Composition as identity is also plausible with respect to substantive wholes during time intervals such that their parts remain the same. As long as a substantive whole retains the same parts, there is a case to be made that the whole is identical to the parts.[[9]](#footnote-9) As soon as we allow parts to change, however, an object can persist even though its parts change. This is one lesson of examples such as the Ship of Theseus.

Suppose that Theseus has a ship. One plank gets replaced by a new plank, and then another plank gets replaced, and so forth, until all the planks are replaced and there is a ship made of all new planks. Suppose that the original planks, which were replaced by new planks one by one, are reassembled into the structure of a ship. Now there are two ships. Which is the original Ship of Theseus? Is it the ship made by replacing one plank at a time or the ship made of the original planks? This is the puzzle of the Ship of Theseus. There is a large literature discussing solutions. Regardless of our preferred solution, we should all agree that a ship can persist through the replacement of one of its planks. For a ship is a substantive whole and, by and large, substantive wholes persist through the replacement of one of their parts.[[10]](#footnote-10)

In addition, when we consider objects together with their properties, composition as identity requires the token identity theory. For a whole cannot be identical to its parts, taken collectively, if the whole and its parts, taken collectively, have different properties. Thus, composition as identity requires that an object and its parts, taken collectively, have the same properties. This is the token identity theory. I will now argue that there is an important way in which the *token* identity theory fails, which entails both that composition as identity fails and that the *type* identity theory fails.

When a token property of an object is realized by token properties of that object’s parts, generally, the realized property is not identical to the realizing properties but it’s just a partial *aspect* of them. An aspect is not identical to what it’s an aspect of. Therefore, realized properties are not identical to their realizers.[[11]](#footnote-11)

For example, suppose we look for realizers of classic thermodynamic macrostates such as gas volume, temperature, or pressure. And suppose we find that such properties are realized by the positions, kinetic energies, and collisions of the molecules that compose gases, respectively. In general, any token macrostate—e.g., the temperature of a gas—is not identical to any token microstate. Instead, the macrostate is an *aspect* of many microstates—in our example, temperature is not identical to any configuration of token kinetic molecular energies (a token microstate) but to their *average*. So, the higher-level property (temperature) is not actually identical to its lower-level realizer (plurality of individual molecular energies). That’s why temperature can remain constant while the plurality of individual molecular energies can vary, as long as their average remains constant.

Of course, we can always say that the whole object (e.g., a gas) has a specific structure made out of its individual molecules, and that such molecules have a specific configuration of kinetic molecular energies at any given time, and that all of these are properties of the whole, so the specific configurations of kinetic molecular energies are also properties of the whole object. That’s true but unhelpfully trivial. The point of trafficking in macroscopic objects, such as gases, and their macroscopic properties, such as temperature, is precisely to ignore the vagaries of their myriad parts and their unbearably complex configurations of lower-level properties in favor of stable macroscopic properties that helps us understand, model, theorize about, explain, and manipulate the world. To make this work, it is critical that (typical) higher-level properties not be identical to their lower-level realizers. Thus, for present purposes, the token identity theory fails and both the type identity theory and composition as identity fail with it.

1. **Against Distinctness between Levels**

The obvious alternative to identity is (complete) distinctness. By “complete” distinctness, I mean distinctness such that two putatively distinct entities must be counted separately in an inventory of what there is, even if they overlap spatiotemporally. For instance, if two entities (e.g., a whole and the plurality of its parts) are completely distinct, we should count two entities within the same portion of reality. From now on, by “distinctness” I will mean complete distinctness unless otherwise noted. Many philosophers maintain that wholes are distinct from their parts, or that higher-level properties are distinct from their realizers, or both, in this sense. The view that higher-level properties are (completely) distinct from their realizers is an important version of *nonreductive physicalism*.[[12]](#footnote-12)

Typically, defenders of distinctness between levels still maintain that there is an ontological hierarchy between levels. Even though they hold that higher-level objects and their properties are distinct from their parts and the parts’ properties, respectively, they also hold that lower levels are more fundamental. I’ve already dispensed with ontological hierarchy. Clearly, someone could get rid of ontological hierarchy and retain the view that levels are distinct from one another. I’ll now argue against this view.

Distinctness of properties entails distinctness of objects. More precisely, if a whole and its parts (or its parts and their parts, or any two levels of composition) have distinct properties, then they are distinct objects. Let’s see why. When two objects that partially overlap possess distinct properties, this is because they possess distinct properties where they don’t overlap. For example, a soccer player can kick the ball but her hands can’t (legally) touch the ball. This discrepancy is explained by the fact that the soccer player has feet, which do not overlap her hands, and feet can kick the ball. In contrast, a whole and (all of) its parts, taken collectively, overlap completely, without remainder. If wholes and their parts have distinct properties, then, it cannot be that they have distinct properties where they don’t overlap. Therefore, they must be distinct objects. Because of this, any argument against distinctness of objects that coincide, such as a whole and its parts, is also an argument against distinctness of properties.[[13]](#footnote-13)

Distinctness of wholes and their parts is where the argument from parsimony takes its bite. For distinctness of wholes and their parts is the ultimate redundancy. Wholes and their parts coincide. If a portion of reality is already covered by the parts, there is no need for a whole object, distinct from its parts, to also cover it. To maintain otherwise is tantamount to double counting; counting the same portion of reality twice (cf. Baxter 1988). Since wholes are not distinct from their parts and distinctness of properties requires distinctness of objects, properties are not (completely) distinct from their realizers either. Distinctness between levels of composition and realization fails.

To recap, in the last two sections I have rejected both identity and (complete) distinctness between levels. The best way to avoid unappealing options is to find a more attractive one. That’s what we now turn to.

1. **Substantive Wholes as Invariant Abstractions from their Parts**

Obviously, a substantive whole can be considered together with all of its parts at any given time. Having those parts at that time is a structural property of the whole. Nevertheless, one important reason to consider a substantive whole as such is to consider aspects of that portion of reality that remain stable under certain changes in the parts.

For instance, when we talk about our cat Grey, we consider an aspect of a portion of reality that remains largely invariant through myriad changes in its parts. Over time, Grey sheds hair and nail layers, eats food and drinks water that are largely absorbed in its body, exchanges oxygen and carbon dioxide with the surrounding air, its cells multiply, some cells die, and so forth. In other words, over time, Grey’s parts change yet there is a lot of stability throughout those changes. Four aspects of that portion of reality considered as a substantive whole remain stable during most short enough time intervals: Grey retains the vast majority of its parts as well as most of its structure, global qualities, and global powers.

First, during any short enough time interval, the vast majority of Grey’s parts remain the same; only relatively few parts are lost or added. Thus, most of Grey’s individual parts are preserved. Second, most of Grey’s changes in parts preserve Grey’s structure. For instance, cells that die are typically replaced by cells of the same type. Hair and nail layers that are shed are replaced by hair and nail layers of the same type. In short, during any short-enough time interval, Grey’s structure is largely preserved. Third, most of Grey’s global qualities are preserved. His color, shape, size, mass, etc. remain mostly the same through ordinary changes in Grey’s parts. Finally, most of Grey’s global powers are preserved. For example, he remains skittish and cuddly through ordinary changes in his parts. I will abbreviate Grey’s stability through changes in its parts by saying that Grey as a whole is an invariant under some part transformations. The transformations that Grey is an invariant under are precisely those that preserve Grey as an individual cat.

What goes for Grey goes for other substantive wholes. They retain most of their individual parts, structure, global qualities, and global powers through changes in their parts. That’s why they are neither identical to their parts (some parts are either lost or acquired, substantive wholes persist) nor completely distinct from their parts (substantive wholes overlap each of their parts during the time interval they have it as a part). In general, substantive wholes are invariants under some part transformations. The part transformations they are invariant under are precisely those that preserve them as individual substantive wholes of that type.

Notice that the usual notion of *invariant* applies to properties alone. In physics, especially, certain properties are said to be invariant under certain transformations. The properties are assumed to be borne by objects that remain the same objects under that transformation. What I am now pointing out is that objects (property bearers) can also persist as individuals under various property transformations including structural transformations—specifically, substantive wholes can persist through the loss of old parts and acquisition of new parts. Thus, substantive wholes are themselves invariant under certain transformations.

What makes this a case of *object* invariance rather than *property* invariance is that most of the individual parts that make up the object, which are themselves objects, are preserved under the relevant transformations. To see this, consider what happens when we replace most of the parts of an object at once. If we were to replace most of Theseus’s ship’s original planks at once with equivalent planks, leaving only a few scattered original planks within the ship, we would not conclude that the original ship persists through such a change. At best, we might conclude that some of the original planks have been salvaged from the ship’s destruction and recycled into a new ship. If you are not persuaded yet, imagine that the process begins by blowing up Theseus’s ship with explosives.

Reasonable people may disagree about when, exactly, a whole comes into existence or goes out of existence, but this doesn’t affect my point. My point is that objects are invariant under some part transformations, and those part transformations are precisely those that retain enough of the properties that identify the whole as such, including enough of its token parts. What counts as enough property preservation varies with how we identify and reidentify objects, which may vary from context to context.

For example, in some contexts we may be interested in whether a portion of reality is the same lump of bronze through time. If so, we count any change in its shape as irrelevant, for a lump of bronze is the same lump no matter its shape. But we count any loss or addition of bronze as a replacement of the original lump of bronze with another lump, for a particular lump of bronze is identified by the bronze that constitutes it. Thus, lumps of bronze are invariant under shape change but not under changes in their parts.

In other contexts, we are interested in whether a portion of reality is the same statue through time. If so, we count the addition or subtraction of a small part as irrelevant, for a statue is the same statue even though it loses or acquires a small part. But we count any drastic change in shape as the creation or destruction of the statue, for a statue is identified at least in part by its approximate shape. Thus, statues are invariant under small changes in their parts but not under drastic shape changes.

This solves the puzzle of the statue and the lump. Is the statue identical to the lump, and how can that be since the lump can exist before and after the statue? The answer is that lumps and statues are different aspects—different invariants—of portions of reality, and the different invariants may coincide during some time intervals. A statue is constituted by a lump during some time interval, but it can be constituted by slightly different lumps during other intervals. The lumps can exist before the statue comes into existence and after the statue goes out of existence simply because the identity criteria for lumps and statues are different. They are two different kinds of invariant.

In summary, substantive wholes are invariant aspects of a portion of reality that persist through some changes in their parts. That’s why they can be considered in abstraction from their parts. Their (organized) parts, collectively, are embodiments of the substantive whole. Through time, different pluralities of parts may embody the same substantive whole.

1. **Higher-level Properties as Invariant Aspects of Realizers**

In discussing substantive wholes as invariants, I took it for granted that substantive wholes as such have properties and their properties are neither identical to nor (completely) distinct from the properties of their parts. I need to say more about how the properties of a whole relate to the properties of its parts. As before, I will say that the properties of the parts *realize* the properties of the whole. I will now argue that realized properties are invariant aspects of their realizers.

To begin with, consider a whole that retains the same parts over a time interval. Now consider a whole that retains one of its properties—say, its temperature—over that time interval. As I’ve already mentioned, the properties of the parts—the microstate—can undergo an enormous number of changes—e.g., trillions of molecules can change speed—while the temperature remains the same. This is true so long as the average of the kinetic molecular energies of the parts remains the same.

Now consider what happens if a whole object loses or acquires some parts. Suppose that a gas loses some molecules but those molecules are replaced by other molecules of the same type. And suppose that the average molecular energy of the molecules that make up that gas remains the same through that change. The temperature of the gas—the macrostate—remains the same even though some of the parts have been replaced. In conclusion, whether a gas retains the same individual parts or changes some of them, its higher-level properties—its macrostate—can remain the same through myriad changes in the properties of the parts. In our example, temperature is an invariant aspect of the microstate.

What goes for temperature goes for all higher-level properties. Whether a substantive whole retains the same parts or changes some of them, as long as the parts are of the right kind and their properties provide the same contributions to the properties of the whole, the properties of the whole can persist through all kinds of changes in the properties of the parts. In short, higher-level properties are invariant aspects of their realizers.

The one-many relation between higher-level properties and their realizers should not be confused with multiple realizability as is usually understood. Multiple realizability requires that a property be realized in different ways, and I haven’t said anything about that. In the case of gas temperature and many other higher-level properties, there is no difference in kind between its realizers. They are all different configurations of molecular kinetic energies. To distinguish this ordinary one-many relation between higher-level properties and their realizers from multiple realizability as usually understood, I call it *variable realizability*.[[14]](#footnote-14)

1. **Conclusion**

Objects and their parts are different ways of carving the same portion of reality, either at a time or during a time interval. I have argued that substantive wholes are neither identical to nor (completely) distinct from their parts. Instead, substantive wholes are abstractions from their parts that are invariant under some part transformations.

At any given time, the properties of an object’s parts realize the properties of the whole. And, when it comes to substantive wholes, becoming a part of that whole changes the parts’ properties. Nevertheless, the parts’ properties can undergo many changes while the properties of the whole as such stay the same. That’s why the properties of the parts are not identical to the properties of the whole. Nor are they (completely) distinct. Instead, higher-level properties are invariant aspects of their realizers.

One important reason to study higher-level properties is precisely that they can remain stable through enormous variation in their realizers. Consider the huge number of microstates that correspond to the same temperature in a gas. Temperature may remain the same over myriad changes in microstate. This makes temperature a useful property to measure and study.

Organization is also the source of object stability and persistence. That is, an organized collection of parts forms a substantive whole, and a substantive whole can remain stable in the properties that define it through many changes in parts. That is, a substantive whole—such as an organism or an artifact—may persist through the subtraction, addition, or substitution of some of its parts. In other words, a substantive whole is an invariant under some changes in its parts.

Nowhere in this picture is there any ontological hierarchy between levels. Neither substantive wholes nor their parts are more fundamental. Neither is prior. Neither reduces to the other. Neither is eliminated. Ditto for higher-level and lower-level properties. Instead, substantive wholes and their properties as well as substantive parts and their properties are different yet invariant aspects of reality. The result is an egalitarian account of composition and realization.

**References**

Baxter, D. (1988). “Many-One Identity,” *Philosophical Papers*, 17: 193–216.

Bliss, R. and Trogdon, K. (2016). "Metaphysical Grounding", *The Stanford Encyclopedia of Philosophy*(Winter 2016 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2016/entries/grounding/>.

Chang, H. (2012). *Is Water H2O?: Evidence, Realism and Pluralism*. Dordrecht: Springer.

Dorr, C. (2019). "Natural Properties", *The Stanford Encyclopedia of Philosophy*(Fall 2019 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/fall2019/entries/natural-properties/>.

French, S. (2015). “Identity and Individuality in Quantum Theory.” In E. N. Zalta (ed.), The Stanford Encyclopedia of Philosophy (Fall 2015 Edition), URL = <https://plato.stanford.edu/archives/fall2015/entries/qt-idind/>.

Heil, J. (2003). From an Ontological Point of View. Oxford: Clarendon Press.

Heil, J. (2012). The Universe as We Find It. Oxford: Clarendon Press.

Hemmo, M. and Shenker, O. (2021). “Flat Physicalismm,” *Theoria*, forthcoming.

Lewis, D. K. (1983). “New Work for a Theory of Universals.” *Australasian Journal of Philosophy* 61: 343–77.

Lewis, D. K. (1991). *Parts of Classes*. Wiley-Blackwell.

Martin, C. B. (2009). *The* *Mind in Nature*. Oxford: Clarendon Press.

McLaughlin, B. and K. Bennett, "Supervenience" (2021). *The Stanford Encyclopedia of Philosophy* (Summer 2021 Edition), Edward N. Zalta (ed.), forthcoming URL = <https://plato.stanford.edu/archives/sum2021/entries/supervenience/>.

Noonan, H. and Curtis, B. (2018). "Identity", *The Stanford Encyclopedia of Philosophy*(Summer 2018 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/sum2018/entries/identity/>.

Piccinini, G. (2017). “Activities are Manifestations of Causal Powers,” in Marcus Adams, Zvi Biener, Uljana Feest, and Jacqueline Sullivan (eds.), *Eppur Si Muove: Doing History and Philosophy of Science with Peter Machamer*, Berlin: Springer, pp. 171-182.

Piccinini, G. (2020). *Neurocognitive Mechanisms: Explaining Biological Cognition*. Oxford: Oxford University Press.

Piccinini, G. (forthcoming). “Physicalism: Flat and Egalitarian.” In M. Hemmo, S. Ioannidis, O. Shenker, and G. Vishne, eds., *Levels of Reality*, Berlin: Springer

Schaffer, J. (2018). "Monism", *The Stanford Encyclopedia of Philosophy*(Winter 2018 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2018/entries/monism/>.

Schumm, A., Rohloff, W., and G. Piccinini (2020). “Composition and Trans-scalar Identity.” [Preprint] http://philsci-archive.pitt.edu/id/eprint/18253

Shoemaker, S. (2007). *Physical Realization*. Oxford: Oxford University Press.

Smart, J. J. C. (2007). “The Mind/Brain Identity Theory.” In E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy (Summer 2007 Edition)*, URL = <<http://plato.stanford.edu/archives/sum2007/entries/mind-identity/>>.

Smith, B. (2001). “Fiat Objects.” *Topoi* 20: 131–148.

Tahko, T. E. (2018). "Fundamentality", The Stanford Encyclopedia of Philosophy (Fall 2018 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/fall2018/entries/fundamentality/>.

Tahko, T. E. and Lowe, E. J. (2016). "Ontological Dependence", *The Stanford Encyclopedia of Philosophy*(Winter 2016 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2016/entries/dependence-ontological/>.

van Riel, R. and Van Gulick, R. (2019). "Scientific Reduction", *The Stanford Encyclopedia of Philosophy* (Spring 2019 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/spr2019/entries/scientific-reduction/>.

Varzi, A. (2016). “Mereology.” In E. N Zalta (ed.), *The Stanford Encyclopedia of Philosophy* (Winter 2016 Edition), URL = <<https://plato.stanford.edu/archives/win2016/entries/mereology/>>.

Wilson, J. (1999). “How Superduper Does a Physicalist Supervenience Need to Be?” *The*

*Philosophical Quarterly* 49(194): 33–52.

Wilson, J. (2010). “Non-Reductive Physicalism and Degrees of Freedom.” *British Journal*

*for Philosophy of Science* 61: 279–311.

Wilson, J. (2011). “Non-Reductive Realization and the Power-Based Subset Strategy.” *The*

*Monist* 94: 121–54.

Zangwill, N. (1992). “Variable Realization: Not Proved.” *The Philosophical Quarterly* 42

(167): 214–19.

1. Thanks to my colleagues at the University of Missouri – St. Louis, Frank Faries, John Heil, Meir Hemmo, Orly Shenker, and two anonymous referees for helpful feedback on previous versions of this paper. [↑](#footnote-ref-1)
2. Many authors use “realization” for a putative relation between distinct properties of one and the same object, as when they say that an agent’s mental property is realized by one or more of the agent’s neural properties. This view is sometimes called *flat* view of realization and stands in opposition to the *dimensioned* view of realization, according to which realization holds between properties at different levels of composition (Bickle 2020). It seems to me that, in the intended sense, realization according to the flat view relies on composition implicitly (e.g., neural properties are properties of neural structures, which are parts of agents), so that realization according to the flat view reduces to realization according to the dimensioned view. I cannot do justice to this topic here; from now on I will restrict my attention to the relation between properties of entities at different levels of composition. I discuss the flat versus dimensioned views of realization in greater depth in Piccinini 2020, Chap. 2. [↑](#footnote-ref-2)
3. The assumption of ontological hierarchy is almost universal in the enormous literatures on composition, realization, and related puzzles such as causal exclusion. The encyclopedia articles listed in the main text are useful entries into these literatures. In some strands of these literature, especially from ca. 1970-2000, the notion of supervenience plays a prominent role. A plurality of properties *A* *supervenes* on plurality of properties *B* if and only if things cannot differ with respect to their *A*-properties without also differing in their *B*-properties. Although supervenience was adopted as a relatively ontologically neutral way of discussing the relation between levels of properties, supervenience is consistent with ontological hierarchy (McLaughlin and Bennett 2021). Most authors who discuss levels of properties in terms of supervenience, at least in the philosophy of mind and the philosophy of the special sciences, are also committed to some form of ontological hierarchy. [↑](#footnote-ref-3)
4. Barry Smith (2001) uses the term “fiat object” for objects with artificially created boundaries—e.g., non-naturally demarcated nations. Smith’s term “fiat objects” and my “fiat wholes” originate independently and mean different things. [↑](#footnote-ref-4)
5. You do destroy the structural “relation” of being part of that fiat whole. But that is not a natural property, which is what we are interested in. [↑](#footnote-ref-5)
6. This point and the following discussion are indebted to Martin 2009 and Heil 2003, 2012. [↑](#footnote-ref-6)
7. Proof:

   A is more fundamental than B [premise]

   A = B [premise]

   Therefore, A is more fundamental than A [from (1) and (2) by substitution]

   Many reductionists attempt to avoid this conundrum by claiming an asymmetric relation between representations (models, theories, explanations, sciences) rather than between entities and properties. But relations between representations are epistemic. Here I am focusing on ontological reduction rather than epistemic reduction. [↑](#footnote-ref-7)
8. For some complications in the case of water, see Chang 2012. [↑](#footnote-ref-8)
9. Composition as identity is contentious and there is a large literature on it. I defend it with respect to fiat wholes and substantive wholes while they retain the same parts in Schumm, Rohloff, and Piccinini 2020. [↑](#footnote-ref-9)
10. Mereological essentialists disagree, of course (cf. Varzi 2016). Mereological essentialists hold that objects have their parts essentially, so any change in parts is a change in the identity of an object. Mereological essentialism holds about fiat wholes with regards to their defining parts. When it comes to substantive wholes, however, mereological essentialism conflicts with both scientific and ordinary discourse. I’m looking for an ontology that makes the most sense of ordinary talk, including scientific talk. So, I set mereological essentialism aside. [↑](#footnote-ref-10)
11. If higher-level properties are aspects of their realizers, then they are *identical* to aspects of their realizers. This identity holds for both type and token properties. If we focus on this identity, we might conclude that the token identity and type identity theory hold. This is the route taken by flat physicalism (Hemmo and Shenker 2021). I think classical identity theories were claiming that higher-level properties (either type or tokens) are identical to their realizers simpliciter, not to mere aspects of their realizers, so I prefer to say that the identity theory doesn’t hold. Elsewhere, I compare and contrast the egalitarian physicalism I defend with flat physicalism and I argue that, terminological differences aside, physicalism ought to be both flat and egalitarian (Piccinini forthcoming). [↑](#footnote-ref-11)
12. Note that strong synchronic emergentism—the view that an object’s higher-level properties include causal powers that outstrip those of its lower-level properties—is a version of nonreductive physicalism, but there are articulations of nonreductive physicalism that attempt to avoid strong synchronic emergentism while still maintaining that higher-level properties are completely distinct from their realizers. There are also versions of nonreductive physicalism that reject distinctness of higher-level properties and their realizers. Specifically, some authors hold that higher-level properties are just subsets of the causal powers that constitute their realizers (e.g., Wilson 1999, 2010, 2011; Shoemaker 2007), and this subset view of realization may be construed as rejecting distinctness. The subset view, construed so as to reject distinctness, is a precursor of the view I defend below in Section 6, so it is not a target of the present critique. [↑](#footnote-ref-12)
13. Some authors, such as many nonreductive physicalists, talk about one and the same object having distinct properties at different levels, some of which realize the others. This presupposes that a property can be realized by another, distinct property without the realizer property belonging to the parts of the object that possesses the realized property. As I pointed out in fn. 2, I doubt that this presupposition holds. At any rate, I am discussing the notion of realization that makes the most sense of multilevel explanation in the special sciences. [↑](#footnote-ref-13)
14. I borrow this term from Zangwill 1992, who—unlike me—uses it as a synonym for multiple realizability. As I’ve argued elsewhere (Piccinini 2020, Chap. 2), multiple realizability is a special kind of variable realizability that occurs when the same higher-level property can be realized via different mechanisms. Some systems have *complex* organization, that is, they have different *kinds* of parts which are organized in specific relations that give rise to wholes with entirely new capacities (relative to what the unorganized parts can do). Such complex systems have properties that are not mere aggregates of the properties of their parts. [↑](#footnote-ref-14)