Token physicalism and functional individuation

James DiFrisco¹

Received: 12 May 2017 / Accepted: 3 October 2017
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Abstract Token physicalism is often viewed as a modest and unproblematic physicalist commitment, as contrasted with type physicalism. This paper argues that the prevalence of functional individuation in biology creates serious problems for token physicalism, because the latter requires that biological entities can be individuated physically and without reference to biological functioning. After characterizing the main philosophical roles for token physicalism, I describe the distinctive uses of functional individuation in models of biological processes. I then introduce some requirements on token identity claims that arise from a position on individuation and identity known as *sortalism*. An examination of biological examples shows that these sortalist requirements cannot be plausibly met due to differences between individuation by functional biological criteria and by physical criteria. Even without assuming sortalism, token physicalism faces the more basic problem of excluding functionally irrelevant detail from the individuation of biological tokens. I close by suggesting that the philosophical roles for token identity are better fulfilled by a notion of token composition, which promotes a hierarchical picture of individuality.

Keywords Physicalism · Token physicalism · Token identity · Individuation · Functional individuation · Sortalism

1 Introduction

The problem of how mind fits into the physical world has occupied center stage in philosophy for some time. Although much attention has been devoted to the mind-body problem, considerably less attention has been paid to what might be called the “organism-body” problem (Sober 1999). On reflection, this situation is rather strange.

✉ James DiFrisco
james.difrisco@gmail.com

¹ Konrad Lorenz Institute for Evolution and Cognition Research, Martinstraße 12,
3400 Klosterneuburg, Austria

Even if one considers the mind-body problem to be more important due to connections with freedom and moral responsibility, the failure of physicalism in biology would, *a fortiori*, entail the failure of physicalism in psychology,¹ and should interest philosophers even if only for this implication.

Much of the discussion of physicalism from a biological perspective has generally focused on arguments against type physicalism from the multiple realizability of functional kinds (Kincaid 1990; Sober 1984; Kitcher 1984). This paper focuses on arguments against token physicalism from the functional individuation of biological objects, events, and processes.

Token physicalism, or token identity, is roughly the idea that all individuals the sciences talk about are identical to certain physical individuals. Though it is commonly viewed as a relatively weak and defensible ontological commitment, it becomes suspect once we take a close look at what is required for securing claims of identity between individuals. Two types of argument tell against token physicalism as a universal thesis for biological entities. According to the argument from sortalism, sortals for biological individuals and sortals for physical individuals will often provide different criteria of identity for their instances. According to the argument from functionally irrelevant detail, physical methods will often lack a principled basis for excluding functionally irrelevant physical detail from the individuation of biological entities.

The following section defines token physicalism and describes the philosophical work it is typically enlisted for. Section 3 introduces the idea of functional individuation and related notions of function and functional properties. In Section 4, the sortalist constraints on identity claims are discussed and defended. On this basis, Section 5 then assesses a series of cases of putative identity between biological and physical tokens, finding each proposal unsatisfactory. Section 6 examines how a notion of *token composition* can do the same philosophical work as token identity, including supporting certain formulations of supervenience physicalism and realization physicalism, without encountering the same problems. Finally, I conclude in Section 7 by addressing an objection to the idea that differences between physical and biological individuation have genuine ontological significance.

2 Token physicalism

The distinction between type and token physicalism originates in Fodor's (1974) classic article, "Special Sciences (Or: The Disunity of Science as a Working Hypothesis)" (see also Fodor 1979). Type physicalism is the view that all properties appearing in the special sciences (biology, psychology, sociology, economics, etc.) are identical to physical properties:

Type physicalism: For every genuine nonfundamental or special science property B , there is some physical property P such that $B = P$.

This thesis is attributed to the mind-brain identity theory that originated in the 1950s with Place (1956) and Feigl (1958) (see also Smart 1959). Type physicalism is a very

¹ That is, assuming that all minds inhere in organisms.

strong physicalist thesis: it implies that the types or kinds that appear in non-physical theories are identical to certain physical kinds, since the properties definitive of the non-physical kinds are identical to physical properties. Famously, Fodor argued that the multiple realizability of special science kinds makes it impossible to identify them with physical kinds in the way required by the identity theory. As an alternative, Fodor advanced token physicalism as a more modest version of physicalism. Token physicalism is the view that all special science *individuals* are identical with certain physical individuals.

Token physicalism: For every genuine nonfundamental or special science individual x , there is some physical individual y such that $x = y$.

Fodor's (1974, 100) token physicalism is formulated in terms of events but it can be generalized to substances, states, and processes as well. Davidson's "Mental Events" (1970) also advanced token physicalism about events as a weaker and more defensible alternative to mind-brain identity theories. Together, these seminal papers set up token physicalism as a sound baseline commitment that was rarely questioned in the following decades. Instead, it was treated as an obvious and even trivially true thesis (Bennett 1989, 146)—one expressing the mere spatiotemporal coincidence of individuals at different levels of organization (e.g., Wimsatt 2007, 384)—whereas the more important and problematic issues concerned properties, and thus type physicalism (Kim 2012).

One of the principal motivations for affirming token physicalism has been that it seems to make the commitment to multiple realizability and anti-reductionism compatible with commitment to the generality and priority of physics. Even if psychology and biology don't reduce to physics, one can still say that everything that happens is physical and that every *thing* is physical. Rejecting token physicalism, by contrast, would seem to go hand in hand with allowing items like souls, ghosts, vital substances, telepathy, and so on, into one's ontology.

A second appeal of token identity is that it puts items at different levels of organization into an ontological relation that can resolve puzzles like the one posed by Eddington's two tables. Eddington (1929, ix) famously observed that as he sat down to write he was surrounded by "two tables, two chairs, two pens"—the one being the more familiar macroscopic object subject to macro-laws of chemistry and classical mechanics, the other being the set of strange microscopic objects consisting of mostly empty space and subject to quantum mechanical laws. What is to prevent a situation in which, for example, the macro-table moves to the left while the micro-table moves to the right (Cartwright 1979)? Type identity provides one explanation: such an occurrence is nomologically impossible because the macro-laws reduce to the micro-laws (see *ibid.*). Token identity can provide a different explanation: even if macro-laws don't reduce to micro-laws, the initial conditions for those laws cannot conflict due to the token identity of macrostates with microstates. Hence, the two tables do not exhibit incongruent behavior because they are the same table in the same total physical state. Essentially the same considerations also apply to biological macroscopic objects: for example, organisms cannot weigh more than the total set of their physical parts because these are not two distinct entities.

A third reason for affirming token identity is that even if it is too weak as a form of physicalism, it might be a necessary component of stronger physicalist theses. Local

supervenience, for example, has traditionally been formulated as a relation between the physical and non-physical properties inhering in the same individual (Haugeland 1982). Without token identity, as we will see, it seems difficult to define a coherent doctrine of supervenience physicalism that does the work it is intended to do. Similarly, realization physicalism, when explicated in terms of the popular “subset view” of realization, requires that realized and realizer properties be instantiated in the same physical individual (Shoemaker 2007; Kim 1998; see Gillett 2003).

In spite of these considerations in its favor, I argue that token physicalism is untenable for the reason that biology often individuates by function exactly where physics does not. Fortunately, each of the above three desiderata can be met using a weaker relation than identity to characterize the relation between physical and non-physical tokens: namely, composition.

We might highlight before proceeding a substantive issue that has received little attention, which is how to understand what a “physical individual” or “physical token” is. Though Fodor’s (1974) and Davidson’s (1970) remarks on the matter are not entirely transparent, three possibilities can be initially distinguished. A physical individual could be: (1) any individual belonging to a kind of physics (protons, quarks, fields, collisions, planets, etc.); (2) any set of individuals in (1); or (3) any individual subject to physical laws.² Given that these possibilities differ in strength, the choice between them directly influences the plausibility of token physicalism. I return to the issue below.

3 Functional individuation

Individuation comprises semantic, epistemic, and ontic aspects. The individuation of an item can refer to how it is defined or discerned, how it is singled-out from its environment, how it is located in space, or located relative to other items, or some combination of these. Many categories of items are said to be individuated without being individuals—e.g., properties, powers, attributes, kinds, modes, activities, etc. An individual, however, is traditionally conceived as something concrete, countable, persistent, non-instantiable, and categorially non-dependent (unlike properties or universals). Individuation conditions for individuals determine the unity of their parts in space as well as their persistence in time. My remarks in what follows will largely be confined to individuals, in which I include substances, processes, and events.

The central source of problems for the token identity thesis, I argue, arises when biological individuals are functionally individuated and the corresponding physical individuals are not. For an item to be functionally individuated means that it is individuated by its *functioning*—that is, by its activities, capacities, effects, or causal roles. These aspects of functioning are, in biological contexts, typically determined in relation to fundamental biological processes such as self-maintenance, survival, development, reproduction, and evolution.

² I thank Tom Bontly for suggesting these distinctions. Note that some have argued that in fundamental physics there are no “individuals” (i.e., substances) as traditionally conceived (Ladyman and Ross 2007). Structuralists can understand the term “physical individual” in the present context as a placeholder for whatever item plays the categorial role conventionally assigned to traditional individuals—i.e., bearer of properties, logical subject of persistence—which can also be fulfilled by items like fields, structures, or regions of spacetime.

These features can be clarified with examples. Genes are commonly said to be functionally individuated. Researchers in quantitative genetics, for example, rely on top-down methods for understanding the genetic basis of morphological characters. In this approach, genes are individuated by their functional roles in causing phenotypic variations during development, such that a gene is identified as a gene “for” some character or effect. By contrast, in working from the bottom up, it can be extremely difficult to single-out the same segments of nucleic acid with the relevant functional properties (Stern 2000). More generally, the decomposition of a biological system into parts is not a matter of simply inspecting the material parts one finds within a given spatial region, but must be guided by criteria of functional relevance (Kauffman 1971; Wimsatt 1972; Levins and Lewontin 1985, 273). In this vein, Gould and Lewontin (1979) famously highlighted the non-character of the human chin in evolutionary biology: the chin doesn’t have the right modular and variational properties to function as a genuine biological character in the processes of selection and adaptation (see Laubichler and Wagner 2000; Wagner 2014, 7). In such cases, theorists rely on functional individuation to determine the appropriate domain of objects for the application of models of natural processes. This idea is expressed pointedly by the biologists Laubichler and Wagner (2000, 293): “Functionally relevant biological objects can be defined only within the context of a specific biological process.”³

It is important to note that this sense of “function” is more inclusive than the one associated with teleology and normativity, which is typically the sense of function at work in debates in philosophy of biology about biological functions. The latter, narrower sense usually only applies to organismic traits rather than to whole organisms, much less to biological events and processes, and is often not what individuates those traits (Griffiths 2006). Here, instead, functions are understood as activities, capacities, effects, or causal roles, determined relative to certain causal biological processes. In this broader sense of function, which is closer to the idea of functionalism in philosophy of mind, biological entities at many different levels of organization turn out to have functions and to be functionally individuated.

Although philosophers have not been entirely unaware of the distinctive importance of this broad sense of functioning in the biological sciences, it has not led to any serious questioning of token physicalism. This is partly due the fact that certain assumptions about functional properties, causal role playing, and realization in the standard understanding of functionalism are uncritically retained even when functionalism is applied to things other than mental states (see Gillett, 2013b). Perhaps the most damaging of these assumptions is the idea that functional properties are *second-order* properties. A second-order property is a property defined by quantification over properties, or a property of having a property. We can identify three critical difficulties that arise when this assumption is applied to functional biological properties.

- (a) Functional individuation might actually presuppose token identity. When functional properties are said to individuate states or individuals, this implies that the corresponding non-functional first-order properties individuate those same items. For example, functionalism about mental states can be formulated as the view that

³ The role of biological processes in individuating the objects/units that serve them is also discussed in Griesemer (2000).

mental states are neurophysiological states having certain functional relations to mental inputs, outputs, and other mental states (cf. Lewis 1966). Here, token identity between mental states and neurophysiological states seems to be built into the very formulation of functionalism. The same applies if biological functionalism means that biological individuals are physical individuals having certain functional properties.

- (b) Functional individuation becomes operationally parasitic on non-functional forms of individuation. Because second-order properties are abstract and essentially dependent on their first-order realizers, the specification of a second-order property doesn't allow one to uniquely single out an entity to which it applies without first establishing that the entity satisfies a realizer property (cf. Wiggins 2001, 87; DiFrisco 2017). Although second-order properties might be useful for some forms of classification, this might lead one to doubt that they can be used for individuation without relying on the corresponding first-order properties.
- (c) Functional properties, as second-order properties, cannot be causally efficacious—only their non-functional first-order realizers can be. This naturally motivates implausibly strong forms of reductionism about any domain characterized by a prevalence of functional properties (e.g., Kim 1998).

The equation of functional properties with second-order properties has been criticized in greater detail elsewhere (van Riel 2012; Gillett 2013b), so we need not labor it here. There certainly seem to be some functional properties that are higher-order, particularly those formed by functional abstraction over material objects, which isolates certain effects or relations. The functional kinds *unit of selection* in evolutionary biology or *decomposer* in ecology are arguably of this type. Other functional biological properties, however, are simply first-order causal properties of higher-level individuals—i.e., properties conferring certain causal powers on individuals that allow them to enter into certain causal processes. This is the sort of functional property that causes problems for token physicalism.

Given that functional properties are distinguished from the narrower teleological and normative sense of function, arguments against physicalism citing functional properties are distinct from the common anti-reductionist arguments citing the ineliminability of biological functions. As a result, one might justifiably wonder whether functional properties are taken in such an inclusive sense that functional individuation is no longer distinctive of biology, but is also characteristic of physics. Here it should be stressed that what is at stake in evaluating token physicalism is not that functional individuation is present in biology and absent from physics, but that those tokens that are functionally individuated in biology are not always equivalently individuated using the resources of physics. Hence, it doesn't matter whether items like electrical charge or dark energy are functionally individuated in physics, but whether organisms, ontogenies, reproduction, and so on, can be physically individuated at all (functionally or otherwise).

Even so, it does seem that those systems at the primary interface between physics and biology—chemical systems—tend to be individuated by compositional rather than functional criteria. For example, one could single-out a sample of water by means of the following functional description: “the substance in region *R* that is reacting with cesium to form cesium hydroxide and hydrogen gas.” In modern chemistry, however, portions of water are customarily individuated by chemical composition. The compositional

individuation of water is understood to be more fundamental and explanatory than the functional individuation of water because the former expresses its nature rather than one of its activities or effects—what it *is* rather than one thing it *does*. The knowledge that water is H_2O (plus some other components) can be used, along with ancillary information from chemical theory, to predict and explain a number of its causal properties, including its reaction with cesium, whereas these other properties could only be predicted from the functional description indirectly, after first arriving at the conception of water as H_2O .

Assuming that functional individuation is more fundamental to biology than it is to the physics of biological entities, how does this threaten the token identity thesis? It is a familiar fact that different descriptions or names, such as the Morning Star and the Evening Star, can refer to the same thing. Similarly, the example of water seems to show that functional and compositional criteria can individuate the same items even if these criteria comprise distinct types. But the above discussion also suggests that biological entities are very different from samples of water. Even if we could individuate biological entities by purely compositional or structural criteria, e.g., an exhaustive list of the molecular component types occupying a given region, this would probably include a large number of functionally irrelevant parts. Then the individual we single out compositionally wouldn't be the same as the one that functions in processes like development or evolution. I will return to this difficulty later in Section 5. More general difficulties arise once we carefully examine what is really required to establish an identity claim of the kind made by token physicalism.

4 Sortalism and token-token identification

In recent decades, an influential view of individuation and identity commonly referred to as “sortalism” has been developed largely by David Wiggins (2001) and E. J. Lowe (2009). There are many aspects and different versions of sortalism,⁴ but the primary claim of importance for assessing token identity is the following:

Sortalism: for objects x and y to be identical, there must be a sortal S such that x is the same S as y (see Wiggins 2001, 22; 2012, 1; Lowe 2009, 71; Marcus 2006, 102).

Sortals are general terms for kinds of individuals, such as *animal*, *chair*, or *leaf*. They are distinguished from property classes defined by qualities such as *green thing* or *round object* in the following way: whereas property classes determine criteria of instantiation or application, sortals determine criteria of instantiation *and* criteria of identity (Marcus 2006; Lowe 2009). What it takes for something to instantiate *green* is clear enough, but there are no identity conditions for green things as such. No

⁴ See Grandy (2016) and Ferner (2016, 14 ff.) for some informative historical background on sortals and sortalism. The thesis I am calling “sortalism” is often more specifically referred to as “the sortal dependency of individuation” (Wiggins 2001, 22). It is important to note that, as the term is used here, sortalism does not require commitment to other more controversial theses with which it is sometimes associated, such as Geach's (1962) claim that identity itself is sortal-relative. Sortalism, in the sense of the sortal dependency of individuation, can also be disavowed from Wiggins (2001) and Lowe's (2009) versions of essentialism, and even, I suggest, from their substance ontology.

determinate answer can be given to the question under which conditions a green thing begins or ceases to exist, or how many green things there are in a given region. Sortals, by contrast, do provide determinate answers to such identity questions. For example, let x be a green leaf on a tree branch at one time and y a brown desiccated leaf on the ground nearby at a later time. In asking whether x is the same leaf (S) as y , in principle one can receive a determinate answer. No such answer can be provided to the question whether x is the same *thing* as y , because identity conditions for “things” as such are indeterminate. Similarly, if there are piles of leaves on the ground there is a determinate answer to the question of how many leaves there are on the ground. By contrast, there is no determinate number of “objects,” “things” or “brown things” on the ground, for in assessing this case, does one count leaves, parts of leaves, piles, parts of piles, or some other unit? (see Lowe 2009, 13).

As a view of object identity, sortalism is motivated by two core principles: (i) determinate identity conditions are needed for evaluating putative identities between objects, otherwise we risk pervasive indeterminacy in identity claims; and (ii) property classes, generic terms, and even ontological categories such as *green thing*, *thing*, *object*, *individual*, and *substance* do not on their own provide determinate identity conditions (Lowe 1989; 1997). Even though Wiggins and Lowe’s versions of sortalism were developed as a view of identity for substances, Marcus (2006) shows how the same arguments that support sortalism about substances also support sortalism about events. To this we can add that sortalism also plausibly extends to processes. The major difference from Wiggins and Lowe’s sortalism is that events and processes are thought to persist in a different mode than substances, but the consequences for identity claims are no different. For example, if events and processes persist by having temporal parts rather than being wholly present whenever they exist, then what were diachronic criteria of *identity* for substances become diachronic criteria of *composition* for processes and events (see Hawley 2006; DiFrisco forthcoming). This means that sortalism can be true even if we give an ontological interpretation of a domain, such as physics or biology, in which individuals are viewed as processes or events rather than as substances (Guay and Pradeu 2016; DiFrisco forthcoming; Nicholson and Dupré forthcoming). For sortalism to hold for events and processes, all that is required is that they are countable and sortable into kinds,⁵ and that (ii) is extended so that the following is true: unsorted events and processes do not possess criteria of identity that are determinate enough to settle identity claims about their tokens.⁶

⁵ For views of processes as non-countable items akin to masses or stuffs, see Seibt (2009) and Steward (2013). For simplicity, I will refer to criteria of identity and composition together under the heading of criteria of identity.

⁶ A view of events that seems to bypass this requirement is one advanced by Quine (1985), who held that events are identical iff they occupy the same spatiotemporal region. This view arguably fails two of the standard adequacy conditions for criteria of identity, however (see Horsten 2010). For one thing, it meets intuitively compelling counterexamples. Davidson (1985) pointed out that it would sometimes identify causally distinct events such as a ball’s rotating and simultaneously heating up. The Quinean view is also uninformative, for the property of being uniquely located in spacetime does not itself determine spatiotemporal boundaries around an event. The problem of informativeness also afflicts attempts to adjudicate identity claims about unsorted individuals solely by means of Leibniz’s Law. For example, faced with the claim that the ball’s rotating and its heating up have different properties and are thus numerically distinct events, the Quinean could agree that these properties differ while simply construing them as different properties of the same inclusive event. This is just to say that we will be unable to establish that the events are identical or distinct just by inspecting “their” properties. Background determinations about the sort of event in question are needed.

The motivations that support sortalism now provide us with a basis for deciding between the different readings of “physical individual” distinguished earlier. Physical individuals include individuals belonging to the explanatory kinds of physics (1), as these kinds will provide physical sortals if anything does. Likewise for sets of such individuals (2), as the axiom of extensionality in set theory provides a clear criterion of identity for sets (two sets are identical iff they have the same members). Being subject to a physical law (3), however, is less plausibly viewed as sufficient for being a physical individual. An object could be subject to physical law solely by having a physical property and without belonging to any physical sortal. For example, any object having mass is subject to the universal law of gravitation. But *massive object* is a property class and not a sortal: it has a criterion of instantiation but not a criterion of identity. On the sortalist view, it lacks the determinacy required for evaluating identity claims about its instances.⁷

The immediate implication of accepting sortalism is that token physicalism is not so independent of type physicalism after all. The reason is that the sortals needed for evaluating putative identities between biological and physical tokens will be those provided by biological and physical *types* or *kinds*. Recall what sortalism entails: for biological token x of type X and physical token y of type Y , if $x = y$ then there must be a sortal S such that x is the same S as y . This seems to imply a reductive identification of types such that $X = Y = S$. But this is exactly the kind of reductive type identification that conflicts with multiple realizability. Token identity was only proposed in the first place to get away from this problem. Now, if token identity requires type identity, multiple realizability arguments would *also* undermine token identity.

It has been argued before on other grounds that token physicalism requires type physicalism (see Kim 2012; Latham 2003; Leder 1985).⁸ Strictly speaking, this much is not entailed by sortalism. Different sortals X and Y can individuate the same tokens if X and Y possess the same criterion of identity (Lowe 2009, 20). S can therefore be viewed as a stand-in for that generalized criterion, which may be found in potentially many different sortals. Nonetheless, this condition is still quite demanding. It seems that distinct sortals can only share criteria of identity when they are members of the same classification hierarchy—for example, *organism*, *eukaryote*, *animal*, *vertebrate*, *bird*, *raven*. Criteria of identity are invariant to shifts up and down the same classification hierarchy in the sense that if x is the same *raven* as y , x is also the same *animal* as y . As Marcus (2006) points out, the relation between adjacent hierarchical sortals is a species of determinable-determinate relation. In the context of token physicalism, the most plausible hierarchical arrangement would be that sortals for physical tokens are determinates of the most specific determinable sortals for biological tokens—roughly, *vertebrate*, *bird*, *raven*, <physical sortal>.

⁷ A further reason why possession of a physical property should not be viewed as sufficient for being a physical individual is that it allows token physicalism to be satisfied too easily. As Latham (2003, 283) points out, Descartes (1996, AT III, 690, AT VII, 442) himself wrote that immaterial minds can be viewed as having a spatial extension that parallels the extension of the bodies to which they are united. If spatial extension is a physical property, and having a physical property is sufficient for being a physical individual, then token physicalism would paradoxically be compatible with the existence of Cartesian immaterial minds.

⁸ The argument in Kim (2012) and Latham (2003) specifically applies to the view of events as property exemplifications (Fodor 1979), but not to events as concrete particulars in their own right. On Fodor's conception of events, for x and y to be the same event they must exemplify the same property, but (so the argument goes) this just means they belong to the same event type.

If we accept sortalism, then, there are only two ways for the token identity thesis to be true. One is that biological and physical tokens fall under the same sort. This is the case for the token identity of Morning Star and Evening Star, which belong to the same sort—*star* (or rather, *planet*). Since this requires type identity, it is less likely to work than the alternative, which is that biological and physical tokens fall under hierarchically related sortals sharing the same criterion of identity. However, if it is true that biological individuals tend to be functionally individuated rather than being physically individuated, then the prospects for this alternative as a universal thesis about biological and physical tokens are only marginally better. For if distinct sortals shared the same criterion of identity, it would have to be the case that they *always* have the same individuating outcomes. If one sortal is guided by criteria of functional relevance to high-level processes, and the other is guided more by intrinsic structural or compositional criteria, it seems inevitable that the individuals they single-out will sometimes pull apart. To show that this actually does occur, I now turn to the examination of more specific cases.

5 Evaluating token physicalism in biology

Virtually all direct treatments of token physicalism have focused on the relation between mental and physical events. When physicalism as a thesis about biology does come up in the context of philosophy of mind, typically it is either just assumed to be true, or this assumption is supported by a story about the failure of vitalistic theories in the history of science. More substantively, there are differences between the biological and psychological cases that might explain the different treatment they have received. However else we might think of biological individuals, it is difficult to deny that they possess intrinsic physical properties (e.g., mass, acceleration, energy), whereas the same is not obviously the case for mental events and processes. This is likely the main reason why it has seemed so evidently true that biological individuals are just physical individuals. But having physical properties is not sufficient for being a physical individual in the robust sense captured by the sortalist view of individuality. In fact, if we adopt the sortalist view, the case against token physicalism is arguably *stronger* for biology than psychology. For it is not immediately clear that psychological explanations or descriptions require localizing token mental events and processes in space with greater precision than, say, determining in which organism they occur, as judged by observed behavior. The fact that mental and neuro-physical sortals aren't linked in the right way could therefore be construed as evidence that mental sortals are not suitably *extension-involving* (Wiggins 2001, 89)—i.e., not yet genuine sortals—because psychology doesn't actually need them to be. Whatever the merits of this response, a similar move would be much less plausible in the biological case, where more demanding individuation problems demonstrably affect the explanatory practices of the science.

As mentioned earlier, token physicalism is traditionally expressed as a thesis about events only. The individuation of biological events, however, is often parasitic on that of non-events such as organisms, genes, populations, and ecosystems. For example, reproduction is an important event type in developmental and evolutionary processes, but it is difficult to adequately define reproduction without reference to the idea of a

new *organism* being produced by another (see Godfrey-Smith 2009, 69 ff.). Similar dependencies hold for complex process patterns like adaptation, or ecological succession, and events like birth, death, speciation, and extinction. Individuating these activities depends on a prior grasp of what the functionally relevant individuals are that participate in them. Accordingly, to evaluate token physicalism we can focus on these latter individuals only—and particularly on organisms—for if they are not identifiable with physical individuals, then the events and processes that depend on them will also not be identifiable with physical events and processes.

Ordinary intuition and everyday experience might suggest that organism-environment boundaries are fairly obvious, and further, that they are marked by physically discernible parts and processes. However, one of the important results of recent work on biological individuality has been to show that such boundaries are not at all obvious (Clarke 2011, 2013; Godfrey-Smith 2009; Herron et al. 2013; Pradeu 2016; DiFrisco 2017). Moreover, applying the familiar and “intuitive” vertebrate-biased conception of organisms is frequently misleading because individuality in the vast majority of multicellular taxa can take on strikingly alien forms (see Herron et al. 2013). Recognition of this fact has motivated theoretical investigation of general principles of biological individuality, much of which can be characterized as attempts to precisely define the functionally relevant objects for models of certain natural biological processes. Evolutionary conceptions of individuality, for example, seek to define the domain of biological objects that undergo natural selection (Clarke 2013; Godfrey-Smith 2009). The individuation of these “evolutionary individuals” then guides the application of models of selection processes so that the models make accurate predictions about evolutionary dynamics.

In many cases the spatial boundaries of objects that are salient from the examination of physical parts and processes coincide with the boundaries around biological individuals, but in many cases they do not. For example, attention to the physical processes underlying physiology would likely indicate that, in groups of eusocial insects such as honey bees and ants, the individuals would be single spatially unified insects. From an evolutionary perspective, however, it is whole colonies and not single insects that are the evolutionary individuals. It is difficult to see what kind of physical criteria could correctly individuate colonies of honey bees, especially when we consider that their parts can be widely spatially scattered, can move and operate independently of one another, and can intermingle with parts of other colonies. The opposite situation, in which multiple biological individuals are contained within the same physical boundaries, routinely occurs in the phenomenon of symbiosis. Microbial symbionts can be just as tightly integrated with physicochemical metabolic processes as host cells, even when they are distinct evolutionary individuals. In these two cases, applying physical sortals is likely to result in a miscount of the biological individuals occupying a given spatial region. Another kind of mismatch occurs when the boundaries of biological individuals are “blurred” by the extension of their phenotypes, as Dawkins (1982) famously argued (see Martens 2010, 391). Organismic phenotypes, like the bird in its nest or the spider in its web, may extend into the abiotic environment in a way that is analogous to the wide content of mental states (and perhaps more than analogous). Most parts of the physical environment are not parts of extended phenotypes, but how would we discover which parts are which from physical considerations alone?

We can make the examination of token identity more tractable by turning from these complex cases to the simplest living entities, minimal metabolic systems or protocells.⁹ Let us assume there is a type of metabolic system *B* that has three types of components *X*, *Y*, and *Z*. Let us further assume that the interactions between *X*, *Y*, and *Z* are organized in such a way that their collective operation, together with a stable energy influx, regenerates *X*, *Y*, and *Z* as well as their organization, allowing *B*s to maintain themselves within thermodynamic constraints on viability. Recalling the sortalist constraints from the previous section, we can now pose the question: for a token *b* of type *B*, is there a physical token *p* of type *P* that is identical to *b*?

There are several possibilities to consider for what sort of thing *p* could be, based on the available readings of “physical individual” from (1) and (2) above.

- (P1) *p* could be an instance of a physical kind *P*, which is identical to *B*. Presumably due to multiple realizability there is no such physical kind.
- (P2) *p* could be a specific set of physical parts. Given that self-maintaining metabolic systems depend on a constant turnover of matter and energy to survive, however, the set of physical parts that composes *b* at one time is almost certain to differ from the set that composes *b* at another time. These sets therefore cannot be identical to *b*.
- (P3) *B* is reductively identified with *P*, which is a set of physicochemical types reached by a reductive identification of the component types *X*, *Y*, and *Z* with physicochemical types such as chemical species of metabolites and enzymes. This possibility is more promising than (P2), because it would not matter that tokens of *X*, *Y*, and *Z* are continuously flowing through *b*. The trouble, however, is that *X*, *Y*, and *Z* need not uniquely map to physicochemical types or even large disjunctions of types. Not only is it possible for the physical realizers of *Z* to differ in different *B*s, but they can also differ in the same *B* at different times. This is because something is likely to count as a *Z* in virtue of its role relative to *X* and *Y*, which in metabolic systems can be multiply realizable. While *X*, *Y*, and *Z* are individuated by functional role, the realizing physicochemical types would be individuated by compositional or intrinsic properties.
- (P4) *p* is neither a set of microphysical parts nor an instance of *P*, defined as a set of microphysical part types. Instead, it is a unified *macrophysical* object—one that has a certain mass and extension and that interacts with other physical objects according to physical laws of motion. The most obvious issue with this option is that an organism and its corpse will sometimes be macrophysically indiscernible even though they do not belong to the same biological sort.
- (P5) A more sophisticated possibility is that *p* is identified using the resources of nonequilibrium chemical thermodynamics as a particular spatiotemporal locus of macroscopic order. Though it improves on (P4), the limitations of this idea can be appreciated by highlighting the distinction between *order* and *organization*. Order is a physically measureable variable—classically, the inverse of thermodynamic entropy, and approximated by Gibbs free energy. Organization, however, is a qualitative property that can only be denoted through functional

⁹ For detailed theoretical models of such systems, see Rosen (1991), Gánti (2003), Rasmussen et al. (2009). My simplified model in what follows is loosely based on Rosen (1991).

descriptions, like the functional description of B above. While a certain degree of physical order is typically a necessary condition for functional organization, beyond that there is little correlation between the two properties. As a result, it is possible that b dies due to a physically minor disruption of a functionally important interaction, even though the total quantity of Gibbs free energy in p continues to have the same value as b did when it was living.

(P6) Each of these possibilities for token identification is blocked either by the difference in persistence conditions of b and putative ps , or by multiple realizability in B . At this point, the token physicalist might challenge the response to (P3) that cites multiple realizability in the following way. Even if the physical realizers of b —i.e., $p_1, p_2, \dots, p_n$ —can change over the course of its lifetime, what is to prevent one from identifying b with the total set of its realizers? A final and most compelling option for token identity would thus be the following:

$$b = (p_1, p_2, \dots, p_n).$$

To evaluate this proposal, suppose for the sake of argument that n is finite. If the differences between the p_n are sufficient to make them *multiple* realizations, then by hypothesis they will each be traced under different physical sortals P_n . But this is incompatible with both the stronger and weaker sortalist requirements on token identification. In the stronger version, if $b = p$ then there is a *single* sortal S such that b is the same S as p . In the weaker version, it could be that B and P_n are members of the same hierarchy, where the P_n are determinates of B . The situation would be analogous to a raven (p_1) transforming into a dove (p_2), all the while remaining a bird (b). To admit this move, however, would be to confuse criteria of instantiation with criteria of identity. An individual raven and an individual dove both instantiate the property of being birds, but they are not the *same* bird. In order for criteria of identity to be preserved in the same hierarchy, if a raven x is not the same *raven* as y , then x cannot be the same *bird* as y . Likewise for physical tokens: if p_1 is not the same P as p_2 , then they cannot be the same B (cf. Marcus 2006, 118; Lowe 2009, 20).

Another alternative for (P6) is to interpret the succession of sortals $P_1, P_2, \dots, P_n$ as *phase sortals*, or sortals that pick out an entity at temporary stages or phases in its lifetime (e.g., *sapling, embryo, boy, adult*) (see Wiggins 2001, 30). This would seem to make sense of the situation in which a biological entity falls under different physical sortals P_n at different times, all the while remaining the same biological entity. But phase sortals depend on non-phased or unrestricted sortals for their individuating capacities. For example, *boy* is another term for *young male human being*, where the unrestricted sortal *human being* provides the criterion of identity for *boy* (Lowe 2009, 68). In order for the P_n to be interpreted as a succession of phase sortals, there would need to be an unrestricted physical sortal underlying the P_n such that the phases are phases in the lifetime of the same sort of entity. But this just re-introduces the original difficulty of finding a single physical sortal for biological entities.

Still another possibility for (P6) is to claim that any diverse collection of physical sortals like P_n can compose a further physical sortal, and that composite sortals can meet either the strong or weak sortalist requirement. This would seem to involve an abuse of the term “physical sortal.” A “physical sortal” or “physical kind” should be

something that actually appears in physical models and laws, and forms part of the scientific operations of physics. We have to countenance the possibility that biological individuals do not fall under kinds that are, from a physical perspective, explanatory or interesting or even well-defined. If the above examples of biological individuality are any indication, this is in fact the situation.

As the preceding discussion shows, accepting sortalism puts token physicalism under serious strain. One obvious response remains for the token physicalist, which is to simply reject the sortalist view of individuation and identity (see, for example, Ayers 1974; Hirsch 1982). Then, the burden lies with them to offer an alternative account of how individuation and token-identification operate. Instead of defending sortalism against potential rival views, however, I'd like to now consider a different kind of problem for token physicalism which holds independently of objections from sortalism and multiple realizability.

Let us grant that sortalism is false and that there is no problem of vagueness of boundaries around biological tokens. Suppose there is a cell, a cellular event, or cellular process that exists over the time interval t_1 - t_2 . What is to prevent identifying any such token with a physical token in the same spatiotemporal region? Even more narrowly: what is to prevent identifying the cell at instant t_1 with the set of physical individuals in the same spatial region at t_1 ? Token physicalism captures a strong intuition here: assuming that the cell at t_1 is composed of only physical parts, it must be the case that there is some set of physical parts at t_1 that is extensionally equivalent to the cell. Having abandoned the constraints of sortalism, perhaps there is some way of individuating this set even if it doesn't fall under any distinct physical sortal. From here, there may be a path towards reducing the total succession of states in the life of a cell to a succession of sets of physical states.

The obstacle facing this last attempt at token-token identification is that physical individuation will not be guided by the appropriate criterion of *functional relevance*. Typically, when there is a biological description and physical description of the "same" object, event, or process, the physical description will contain more information and more parts than the biological description, much of which is irrelevant to the aspect of functioning targeted by the biological description. For example, a description of the physical objects and events occupying the same spacetime region as a cell would include items like tiny field values and neutrinos, nearly massless and electrically neutral subatomic particles too minute to appreciably affect cells. The physical and biological descriptions would therefore not be co-referential. This would not be a problem as long as the biological individual could be identified with only the relevant parts of the physical individual. However, the physical description alone will not provide a sufficient basis for distinguishing between *functionally* relevant and irrelevant parts. For that, physical methods would need to access the entire theoretical apparatus of functional relevance for biological processes, which presumably is proprietary to biology. It is necessary to rely on this apparatus to select the relevant features out of the richer detail of microphysical description—that which is reproducing, that which undergoes selection, but also events of birth or death, or the process of adaptation.

This line of thought allows us to see how rejecting token physicalism does not require violating the naturalistic prohibition against souls, ghosts, vital substances, or telepathy. Where old-style vitalism went wrong was in maintaining that biological systems contained some extra ingredient that is lacking in the physical world, and

which explains the distinctiveness of biological systems (Sober 1984). On the contrary, the functional individuation characteristic of biological systems does not add extra components to otherwise physical configurations. Rather, it selects or specifies which physical components are relevant for a given function. Biological systems are therefore not *more* than their physical bases, but *less*. It is just that the specification of which subset this “less” is invariably depends on background determinations about biological functioning.

6 Physicalism without token identity

If token physicalism is problematic, then any position committed to it inherits its same problems. One such committed position is supervenience physicalism, at least according to standard formulations like the following one.

Supervenience: for (non-empty) sets of properties B and P , B supervenes on P just in case for any two objects x and y , if x and y differ in B properties then necessarily they differ in P properties.

According to this formulation, if two objects x and y shared the same physical properties then “they”—the very same token systems x and y —must share the same biological properties (Haugeland 1982). Although supervenience is defined as a relation between sets of properties, token identity provides an anchoring point between the sets. Without it, one permits such absurdities as the macrophysical properties of Eddington’s table supervening on the microphysical properties of his pen. But, as a universal thesis, token identity is problematic for the reasons we have seen.

One possibility for supervenience without token identity would be to widen the scope of super- and subvenient bases by turning to *global* supervenience.

Global supervenience: for (non-empty) sets of properties B and P , B supervenes on P just in case for any two worlds w_1 and w_2 , if w_1 and w_2 differ in B properties then necessarily they differ in P properties.

As has been pointed out before (Horgan 1993; Kim 1993), however, global supervenience is consistent with certain counter-physicalist scenarios. For instance, it would be consistent with global supervenience that two individuals have the same physical properties but different biological properties—whether they are in the same or different worlds. What is disallowed is only that two *worlds* have the same physical properties but different biological properties. Since individuals are not whole worlds, the property covariations of individuals are not governed by global supervenience. Clearly supervenience is not meeting the guiding aims of physicalism if it allows two physically identical cells to have different biological properties.

Adherents of supervenience physicalism therefore seem to be faced with a dilemma: if the scope is local then it is committed to token identity, whereas if the scope is global then it is probably insufficient for physicalism. Fortunately there are still other versions of supervenience that maneuver between these

alternatives—notably, Horgan’s (1982) “regional supervenience” and Kim’s (1993) “multiple domain supervenience.” The latter takes the following form, where B and P are (non-empty) sets of properties and D denotes a domain of individuals:

Multiple domain supervenience: $\langle B, D_1 \rangle$ supervenes on $\langle P, D_2 \rangle$ iff every complete distribution of P over D_2 entails a unique complete distribution of B over D_1 (ibid., 113).

Here the individuals in domains D_1 and D_2 need not be the same, thus avoiding token identity. Multiple domain supervenience would therefore seem to avoid both horns of the dilemma. Still, the domains would need to be connected by a dependence relation, which Kim calls an explanatory “coordinating relation” (ibid., 122), so that supervenience does not relate properties of arbitrary objects like pens and tables. This “coordinating relation” is essentially the ontological relation demanded by Eddington’s two tables problem.

The critical point to note from this discussion is that the coordinating relation between domains need not be identity, but can be a weaker “identity-like” relation such as material composition or constitution. Of these relations, composition is perhaps the weakest, yet it can still provide the anchoring point between domains and thereby between the sets of properties related by supervenience. Composition also suffices as the ontological relation for Eddington’s two tables because, at least for material and spatial composition relations, composing and composed entities cannot conflict in properties like location, velocity, and mass. Finally, composition also excludes things like souls, ghosts, vital substances, and telepathy, as these are usually supposed to lack physical parts altogether. These considerations suggest that the theoretical roles for token identity in defining physicalism for biology are better fulfilled by a notion of *token composition*:

Token composition physicalism: every biological individual is composed, at some level, of physical individuals.¹⁰

Similar modifications can re-orient *realization physicalism* away from the subset view of realization, which is explicitly committed to token physicalism. The basic idea of realization physicalism is the following.

Realization physicalism: everything that exists is either physical or is realized by something that is physical (Melnik 2003, 9; Poland 1994, 16).

Clearly the nature of this claim depends on how the realization relation is spelled out. According to the subset view of realization popularized especially by Kim (1998), Wilson (1999), and Shoemaker (2007), it takes roughly the following form:

¹⁰ A notion of type composition physicalism could be formulated by analogy to type identity to express the idea that every special scientific type is composed of items belonging to a physical type. By analogy to multiple realizability, “multiple composition” or “multiple constitution” phenomena would pose a problem for type composition (see Gillett 2013a). Many traditional representations of levels of organization in terms of type composition are vulnerable to exactly this problem (e.g., Oppenheim and Putnam 1958).

Subset realization: property *B* is realized by property *P* only if (I) the causal powers conferred by *B* are a (non-empty) proper subset of the causal powers conferred by *P*, and (II) *B* and *P* are instantiated in the same individual (Shoemaker 2007, 12; Kim 1998, 54, 82; see also Wilson 1999, 35).

If having a causal power just means being able to enter into a certain causal process, including high-level biological processes, we might raise a form of functional relevance objection to (I)—but this can be left to another occasion. Even retaining a condition as strong as (I), there seems to be no reason why the token identity condition in (II) cannot be replaced with token composition. Then, the subset view would join other views of realization that do without token identity (Poland 1994; Gillett 2003; Melnyk 2003).

One interesting consequence of putting token composition to work in these contexts is that it promotes a hierarchical or leveled picture of the world, which accords with common representations of levels of organization from within the life sciences. What is seldom noticed about token physicalism is that, when combined with the standard “discreteness” assumption that one and the same entity cannot be at different levels (Bechtel 2012), it precludes biological levels from having ontological significance. When token identity is replaced by token composition, then at least for biological tokens, levels once again become “[an] important feature of the ontological architecture of our natural world” (Wimsatt 2007, 203).

7 Conclusion

I have argued that the physical individuation of biological tokens faces principled difficulties. Two arguments, the argument from sortalism and from functionally irrelevant detail, indicate that the problems for token physicalism lie deeper than has been generally appreciated. For one thing, it is not necessary to invoke modal properties and exotic thought experiments to see that constitution (or composition) is not identity, since sortals and functional properties can be understood as determining *intra-world* identity conditions. For another, it is not necessary to go as far as the mind-body problem to encounter difficulties for robustly metaphysical physicalist theses about individuals. These difficulties already appear at the level of the organism-body problem. There is a clear sense in which, if we are realists about biological sortals, token physicalism would be false even if mind had never existed.

An objection to the foregoing argument that is likely to come from the defender of token physicalism is that differences of individuation do not have the ontological significance that I’ve attributed to them. Specifically, it might be objected that token physicalism need not require that biological tokens can be physically individuated.

In his Dewey lectures, Putnam (1994) developed a line of argument against token identity in theories of mind that is somewhat similar to the one presented here, based on the premise that there are no physical means of individuating mental events. In response, Campbell (1999, 572) argues that from the existence of different ways of carving up the world we cannot infer robust ontological differences:

Individuating objects (or events) will depend upon what language-game we play. If we play the folk-psychology-game, then we will individuate our objects

according to propositional content; if we play the neurophysiology-game, then we will individuate our objects according to neural properties and configurations. Since the “object” relevant to each linguistic practice is different there is no reason to expect that we should be able to identify mental content in terms of neural configurations or vice versa.

Is there likewise no reason to expect that we should always be able to identify biological entities in terms of physical configurations? My argument has been there is reason to expect exactly this, as long as token physicalism is to have substantive evidential support, since it makes the very identity claim in question.

But there is likely a deeper disagreement about individuation at play in this sort of objection. It is sometimes thought that individuation is merely an epistemic or semantic operation by which we single something out for some purpose, but which has no genuine ontological bearing on what the world is like. Individuation on this view would be like carving shapes out of material stuff, which might be done in an indefinite number of ways, each of which doesn’t affect the stuff’s intrinsic (physical) nature. Granted, it cannot be exactly like this, since the category of stuffs or masses already has its specific principles of individuation. Instead, the world as it is before the individuating operations of the mind would have to be comprised of so-called “bare particulars,” neutral substrata, or merely determinable occupants of space. Wiggins (2001, 2012) and Lowe (2009) have offered compelling arguments against this idea and in favor of something closer to the sortalist view of individuation, which Wiggins calls “conceptualist realism” (see also Steward 2013).¹¹ The main argument against the view that individuation is merely epistemic is that, if it is not a disguised constructivism, it is incoherent: there is no thinkable “raw stuff” of reality that could be such that it lends itself equally well to the contradictory determinations that different individuating operations in fact make. As long as one wishes to maintain an overall realist stance, then, the objection that individuation is merely epistemic is not a viable one.

The key idea of conceptualist realism and its corollary, sortalism, is that kinds and individuals are interdependent categories: kinds are always kinds of individuals, and individuals are only identifiable as individuals of some kind. This does not go so far as to establish that token identity requires type identity, but it does establish that the types to which identical tokens belong must have certain linkages. They must share the same criterion of identity and must individuate the same items. Given the specific reliance on functional individuation in biology as well as the multiple realizability of functional kinds, this is an extremely difficult requirement to meet. Even without assuming sortalism, token physicalism faces the more basic problem of excluding functionally irrelevant parts from the individuation of biological tokens. If these arguments are right, philosophers would do well to turn to a weaker relation than identity to characterize the relations between biological and physical tokens, such as composition.

¹¹ Note that Wiggins and Lowe diverge on whether realism about individuation should take the form of a “conceptualism,” which prioritizes the cognitive over the metaphysical aspect of individuation. Wiggins (2001, 6) maintains that “That which individuates [. . .] is in the first instance a thinker,” whereas Lowe (2003a, 93) holds that any satisfactory ontology must contain some “self-individuating” entities, on pain of a regress of determination. See Lowe (2003b, 2005) and Wiggins (2001, 159–60) for further discussion.

Acknowledgements I thank Ken Aizawa, Tom Bontly, Daniel S. Brooks, Markus I. Eronen, Johanna Seibt, and Jonathan Sholl for helpful comments and discussion. Thanks also to the audience at the 2016 Society for Metaphysics of Science meeting in Geneva, as well as the audience at the Colloquium for Theoretical Analytical Philosophy at Aarhus University, where earlier drafts of this paper were presented.

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